EFFECT OF PARTIAL REPLACEMENT OF GGBFS FOR CEMENT AND M-SAND FOR FINE AGGREGATE ON COMPRESSIVE STRENGTH DEVELOPMENT OF SELF COMPACTING CONCRETE

[Bhargavi J][1], [Adana Gouda][2]

[1]Master of Technology (Structural Engineering) PG student, Department of Civil Engineering, Rao Bahadur Y Mahabaleshwarappa Engineering College Ballari, Karnataka, India
[2]Assistant Professor, Department of Civil Engineering, Rao Bahadur Y Mahabaleshwarappa Engineering College Ballari, Karnataka, India

---***---

Abstract - *As it's familiar, Concrete, a construction material of the civil engineering field, is made up of binding material, water and coarse aggregate. Considering throughout its full development from its preparation, to the recycling it makes an outstanding offering for the sustainable development. However there are certain limitations such as proper surface finishes, flow of concrete at heavily reinforced components of building. Because of this restriction we are going for SCC (self compacting concrete) in addition to usage chemical admixture and mineral admixture. In concrete, SCC are one most progressive concrete type because of its many supremacy in economic, environmental and technical aspects. Particularly in view of environmental terms the research proceeds with the use of artificial sand. Because of exhaustion of natural resources and limitation of environmental consideration, shortage of best quality Natural River sand makes manufacturers of concrete seek the desirable substitute to Fine aggregate and artificial sand can be one of best alternative to it.*

The concrete type which by its self weight could be positioned will get compacted devoid vibration that would fill up the formwork although the reinforcing bars are placed very densely is the one that is called Self Compacting Concrete. In order to enhance the workability of fresh concrete, to improve resistance of concrete to alkali-aggregate expansion, thermal cracking and sulphate attack & to permit depletion of cement content generally mineral admixtures are used in the concrete in large quantities.

The experimental investigation deals with the development of compressive strength of self compacting concrete by utilizing partial replacement of GGBFS and also by replacement of fine aggregate by M-sand. The GGBFS used here in the proportion of 0 to 50% range in replacement with cement. Chemical admixture called VMA (Viscosity modifying admixture) is utilized for strength development process for 7 & 28 days. M-sand, due to its special properties enhances strength to the concrete in a required proportion. The experiment is carried out to determine compressive strength at 7 & 28 days , split tensile and flexural strength at 28 days by using necessary equipment and using required mix proportion. Before conducting test on hardened concrete, fresh concrete tests such as [slump flow, V-funnel & L-box test] were carried out to determine their physical features too. Optimum values were obtained and hence the experiment proceeded with casting and curing process which led to determination of strength properties of SCC.

***Key Words*: Concrete, SCC, GGBFS, Compressive strength, Viscosity modifying agent, Artificial sand etc..**

1. INTRODUCTION

At Japan (1983), matter of durability for the structure made up of concrete was a most important subject in the field of building construction. Skilled labors are necessary required compaction to create the durable concrete. But, in Japan's construction industry the acute of availability of skilled labors has reduced the effort of quality construction. Implementation of SCC could be compressed all over the place in a shuttering, usually through self weight and devoid necessity for vibrating compression may be one better solutions for the attainment of durable concrete buildings without any skilled man power requirement at work site. Okamura of Japan has developed such type of concrete in 1986. The team led by the University of Tokyo which is headed by Ozawa formed a committee to review the effects of SCC, making the basic inspection on the workability of concrete. In 1988, the very first use able variety of SCC was ended also name was given like "High Performance Concrete", which relabeled to "Self Compacting Concrete". The main criteria to get self-compactibility in Self Compacting Concrete are minimize coarse aggregate content & to use least water–powder ratios at the side of new generation Super plasticizers (SP). The exaggerated flow ability may cause bleeding and segregation throughout the placement and transportation of SCC that might be controlled by providing the mandatory viscosity, that is sometimes equipped by restricting the most size of aggregate by increment in powder content; the fine aggregate content increment; or using by viscosity modifying admixtures (VMA). The minimization of damages due to sound on the worksite that are evoked through concretes trembling may be facilitated by using SCC.

1.1 PROPERTIES OF SCC

SCC should have the subsequent characteristics in fresh state:
1. Filling ability (excellent deformability) – flows simply at appropriate speed into formwork
2. passing ability (ability to move through reinforcement without blocking) -passes through reinforcements while not blocking
3. High resistance to segregation- the distribution of aggregate particles remains unvaried in both vertical and horizontal directions

1.2. ADVANTAGES OF SCC

1. An excellent building of good durability is achieved.
2. Expenditure on maintenance is decreased.
3. Well Improved constructability.
4. Apparatus scratches are reduced generally.
5. On highly reinforced areas decrease of formation of voids can be observed.
6. Allows for easier pumping procedure.
7. Permits for creative engineered properties.
8. It is usually required for huge sections or lengthy wise applications.
9. It obtains a huge variation of placing methods.
10. Secure and beneficial operating atmosphere is achieved.
11. Faster and a lot of systematic positioning of fresh concrete is made successfully. Total time of concreting is changed.

2. AIM AND OBJECTIVES

1. The chief objective of research is, studying the out-turn of Mineral admixture (mainly GGBFS which is used in this research) and also chemical admixture while making self compacting concrete.
2. Here, experimental studies will be conducted in order to know the hardened and fresh features of SCC where in the substitution for cement is GGBFS that is used in different proportions for M25 grade.
3. The replacement of cement by GGBFS is in the scale of 0% to 50% through self weight of Cement for M25 mix.
4. The flexural behavior, Compressive strength, and Split tensile strength behavior of SCC should be studied by using available equipments in the laboratory.
5. Second objective is to assess the influence of hardened & fresh SCC by replacing fine aggregates with M-sand.

3. MATERIAL PROPERTIES

3.1. Cement

Here, OPC (53 grade) Ultratech cement satisfying to IS 269-2015 were utilized. On cement various experimental tests were carried out to determine final & initial setting time, standard consistency, and compressive strength according to IS 4031 and IS 269-2015. Outcomes recorded in Table 1. The outcome satisfies to the IS guidelines.

Table -1: Physical Properties of Cement

Sl no.	Test conducted on cement	Observation
1	Specific gravity	3.14
2	Normal consistency	29%
3	Initial setting time	140 min
4	Final setting time	280 min
5	Compressive strength 7 days 28days	 41 Mpa 55 Mpa

3.2. Fine aggregate (m-sand)

Fine aggregate is a significant ingredient in concrete which comprises of river sand or crushed stone. In this experiment replacement of river sand for Fine aggregate is done by M-sand. M-sand is material used instead natural sand for production of concrete. M-sand obtained by crushing from hard Granite Stone. M sand is mostly cubical shaped with grounded forms, cleansed clearly & graded as a building material. The particle size of M-Sand is lesser than 4.75mm.The code book used in this study is IS:383-2016.

Table-2: Properties of Fine Aggregate

Properties	Observations
Fineness modulus	3.02
Specific gravity	2.56
Bulk density(kg/m3)	1822 kg/m3

3.3. Coarse aggregate

Coarse aggregates are the most important portion of the construction application. In this research both 12.5mm and 20mm size aggregates are utilized for the mix to prepare self compacting concrete. Sieve analysis is carried out separately for both sized aggregates using appropriate apparatus necessary for the test.

Table-3: Properties of coarse aggregate

Properties	12.5mm	20mm
Water absorption	0.6%	0.4%
Specific gravity	2.66	2.68
Bulk density (kg/m3)	1555kg/m3	1504kg/m3

4. Viscosity modifying admixture

In this experiment, the VMA used is Sika viscoFlow 50H. Sika ViscoFlow 50 H is more acceptable for mixes of concrete with requirements of workability and also well improved flow characteristics. Sika ViscoFlow 50 H doesn't consist of chlorides or any different ingredients that enables the steel corrosion. Hence its use in reinforced and prestressed concrete structures is of vital in nature.

- Appearance / Colour: Light brown to light yellowish hazy liquid
- Chemical Base: Polycarboxylate Ether
- Specific gravity: 1.09
- Consumption / Dosage: 0.5% to 2.0% by self weight of cement .Higher dosage may be used if agreed by engineer and consultant.

5. GGBFS

It is lighter than Portland cement and considerably off-white in color. Consequently the large structures such as Bridges and Retaining walls are softened with it. GGBF slag obtained from JSW Toranagallu Ballari was utilized in project work. The Specific Gravity of GGBF slag is 2.72

Table-4: Mix proportioning for varied percentage of GGBFS

%	GGBS 0%	GGBS 10%	GGBS 20%	GGBS 30%	GGBS 40%	GGBS 50%
Cement kg/m3	360	324	288	252	216	180
GGBS kg/m3	0	36	72	108	144	180
W/B ratio	0.5	0.5	0.5	0.5	0.5	0.5
F.A kg/m3	1000	1000	1000	1000	1000	1000
C.A kg/m3	807.8125	803.068	798.3235	793.575	788.8346	784.0901
VMA kg/m3	3.6	3.6	3.6	3.6	3.6	3.6

6. EXPERIMENTAL RESULTS

6.1. Fresh state properties

A concrete mix can only be classified as SCC, if it fulfills the following 3 workability properties,

1. Filling ability by V-funnel test

2. Passing ability by L-box test &

3. Segregation resistance by slump flow test

Workability of SCC mixes with different percentage of substitution of cement by GGBFS are found out by carrying out V-funnel test, Slump flow test & L-Box test, the outcomes are tabulated in Table 5. It is noted that workability increases up to 30% replacement with GGBS and then decreases.

Table-5: Workability test results

Sl no	GGBS IN %	Slump (mm)	T50 slump flow (sec)	V-funnel test (sec)	L-box (h2/h1)
1	0%	625	2	6	0.86
2	10%	627	3	7	0.85
3	20%	660	3	8	0.85
4	30%	665	4	8	0.87
5	40%	645	5	11	0.82
6	50%	650	5	12	0.8

Figure-1: Flow table and Slump cone test

Figure-2: V-funnel and L-box test

6.2. Casting and curing

All substances are blended completely even before addition of water to mix. Afterwards water is added to concrete and blended in such a way that uniform group of things that are all pretty much the same mix is obtained, the casting moulds are to be fitted well with Screws and Nuts, Mould size for cube was said to be 150 x 150 x 150mm, the cylinder mould size was taken as 100 x 200 mm and prism mould size was taken as 100 x 100 x 500mm.

The curing of samples were achieved by positioning in a Water pond continuously for a period 7 and 28 days for prisms, cubes and cylinders.

Figure-3: Casting of concrete

6.3. Hardened properties of concrete

1. Compressive strength
2. Split tensile strength
3. Flexural strength

Figure-4: Compressive strength test

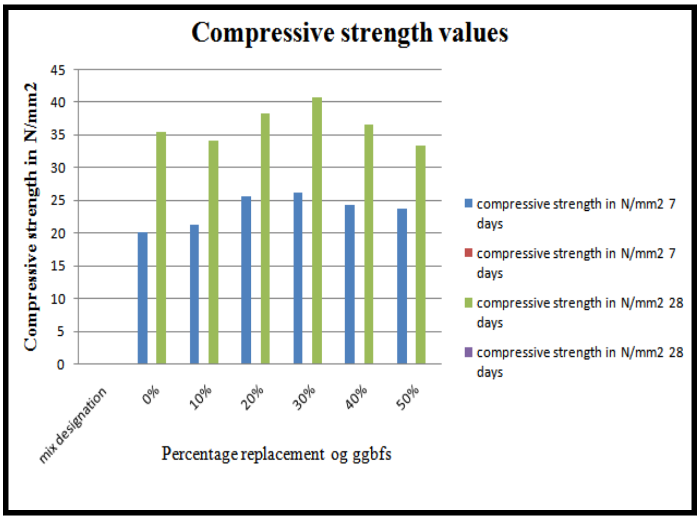
Figure-5: Split tensile strength test

Figure-6: Flexural strength test

7. TEST RESULTS

Table-6: Compressive strength on 7 & 28 days

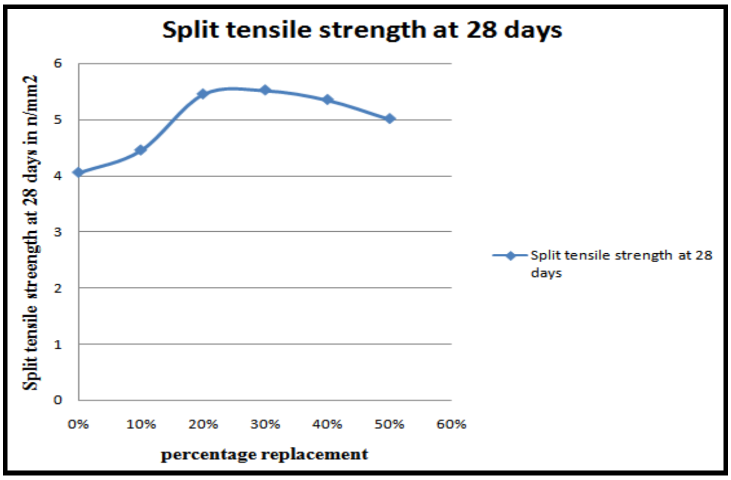
GGBS %	Compressive strength (N/mm2)	
	7 days	28 days
0%	22.13	35.37
10%	21.1	34.03
20%	25.53	38.22
30%	26.11	40.56
40%	24.2	36.55
50%	23.6	33.20



Graph 1: Compressive strength at 7 & 28 days

Table-7: Split tensile strength at 28 days

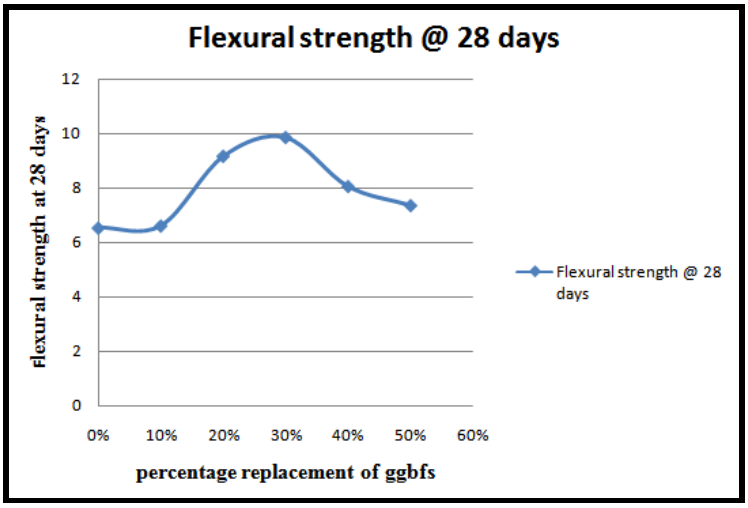
Mix	Split Tensile strength at 28 days(N/mm2)
0%	4.35
10%	4.45
20%	5.45
30%	5.52
40%	5.35
50%	5.02



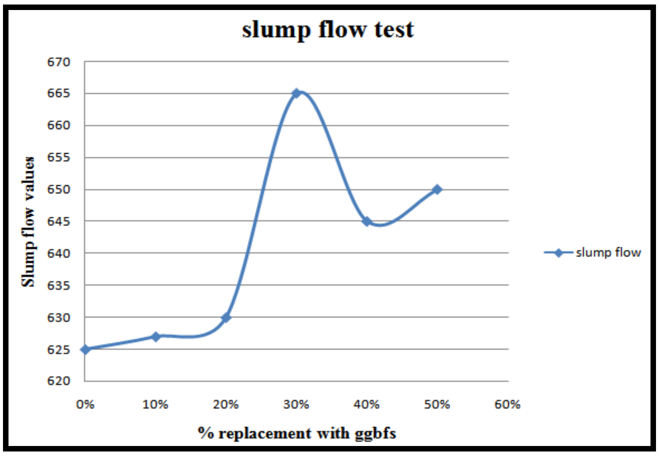
Graph 2: Split tensile strength at 28 days

Table-8: Flexural strength at 28 days

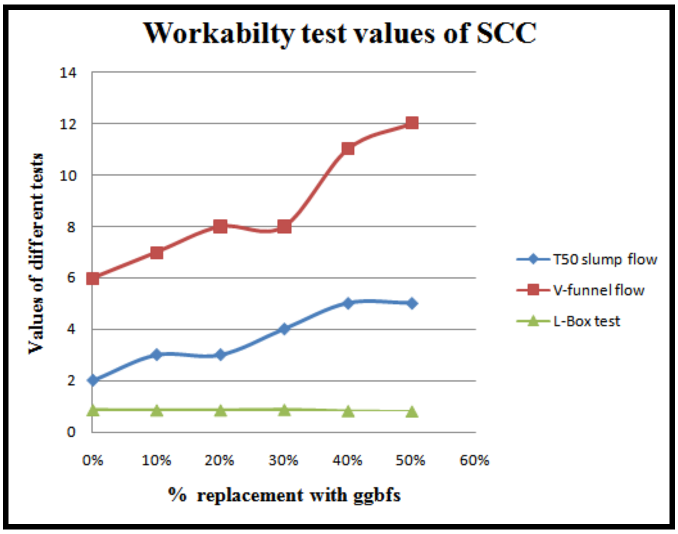
Mix	Flexural strength at 28 days(N/mm2)
0%	6.52
10%	6.6
20%	9.16
30%	9.85
40%	8.05
50%	7.35



Graph 3: Flexural strength at 28 days



Graph 4: Slump flow values



Graph 5: T50 slump flow, V-funnel & L-box test values

8. CONCLUSIONS

1. The features of SCC mix is obtained through utilizing high powder content in the form of GGBFS along with use of high volume of fine aggregate in comparison to coarse aggregate.
2. Also M-sand is used as fine aggregate, that has shown same properties as that of River sand and it will be major alternative to river sand, as latter is depleting day by day.
3. Effect of GGBFS on different features & on hardened properties of SCC was studied.
4. Usage of fine standard super plasticizer required to obtain SCC mix of sufficient workability. VMA is adequate in SCC mix to completely keep away from bleeding and segregation of the concrete mixture.
5. It is examined that workability reduces with increment in content of GGBFS in SCC this is due to higher finer content of GGBFS.
6. The results produced from compressive strength tests revealed that GGBS replacement with 30% of cement are more effective than normal concrete at 7, 28 days strength. Also outcomes are similar for split tensile strength and Flexural strength test.
7. The further study could be conducted for the 20%-40% of replacement of cement by GGBFS with 5% replacement interval.
8. About 30 % cement content is substituted by supplementary cementitious substance such as GGBFS. Result of huge cement content in the concrete like thermal effects and bleaching of calcium hydroxide could be decreased where in enhancing structure durability. Also it contributes to environment by reducing the use of cement content.

REFERENCES

[1]. **Dr. M. B. Varma, 2 S. B. Magare**, "Comparative Study Of Self Compacting Concrete Using Artificial Crushed Sand With Conventional Concrete Without Using Artificial Crushed Sand"

[2]. **Biswadeep Bharali**, " Experimental Study On Self Compacting Concrete (SSC) Using Ggbs And Fly Ash", International Journal Of Core Engineering & Management (IJCEM) Volume 2, Issue 6, September 2015.

[3] **IS 456:2000 Annex J**, self-compacting concrete.

[4] **M.S.Shetty**, "concrete technology", 6th Edition, 1982.

[5] **MuctebaUysal, Mansur Sumer** (May 2011)"Performance of self-compacting concrete containing different mineral admixtures" Science Direct, pp: 4112-4120.

[6] **Pamnani Nanak J., Verma A.K., Bhatt Darshana R**,(December2013) "Comparision between Mechanical Properties of M30Grade Self Compacting Concrete for Conventional Water Immersion and Few Non- Water based Curing Techniques "International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-3, Issue-2,pp:265-272.

[7] **P. Dinakar , Kali Prasanna Sethy, Umesh C. Sahoo,** "Design of Self-Compacting Concrete With Ground Granulated Blast Furnace Slag "

[8] **Vidivelli B, T. Kathiravan, T. Gobi** (July 2013) "Flexural Behaviour of Self Compacting and Self Curing Concrete beams" International Journal of Engineering Mathematics & Computer Science ISSN: 2321 – 5143, Vol 1, Issue 2, pp: 64-77.

[9] **Wenzhong Zhu, Peter J.M. Bartos** (December 2002), "Permeation properties of self-compacting concrete" Cement and Concrete Research pp: 921–926.

[10] **Vinayak Supekar, Dr.Popat Kumbhar**, "Properties of Concrete by Replacement of Natural Sand with Artificial Sand", International Journal of Engineering Research & Technology (IJERT), Vol. 1 Issue 7, September - 2012.

[11] **M.Adams Joe1, A.Maria Rajesh2**, "Study on the Effect of Ggbs & M Sand in Self Compacting Concrete"

[12] **Manvendra Verma1, & Mayank Nigam2**, "Mechanical Behaviour of Self Compacting and Self Curing Concrete"

[13] **Prof. Wakchure, M.R., Er Shaikh A.P.** "Effect of Types of Fine Aggregate on Mechanical Properties of Cement Concrete", International Journal of Modern Engineering Research (IJMER), ISSN: 2249-6645, Vol.2, Issue.5, Sep-Oct. 2012 pp-3723-3726.