Indexed in
Scopus Compendex and Geobase Elsevier,
Geo-Ref Information Services-USA, List B of Scientific
Journals, Poland, Directory of Research Journals

International Journal of Earth Sciences and Engineering

www.cafetinnova.org

ISSN 0974-5904, Volume 09, No. 03

June 2016, P.P.544-548

Flexural Behaviour of Reinforced Beam using Self-compacting Concrete

V SRE ADETHYA[1], A VENNILA[1], R VENKATASUBRAMANI[2] AND V SREE VIDYA[1]
[1]*Department of Civil Engineering, Sri Krishna College of Technology, India*
[2]*Department of Civil Engineering, Dr.Mahalingam College of Engineering and technology, India*
Email: *sreadethya@gmail.com, vnilaa.21@gmail.com, rvs_vld@yahoo.in, sreevidya.sankr@gmail.com*

Abstract: In recent years, Self-compacting concrete (SCC) gained wide use for the placement in the congested reinforced structure with difficulty in casting condition. For, such applications fresh concrete must possess high fluidity and good cohesiveness. One of the disadvantages of Self-compacting concrete is its cost by usage of high volume of Portland cement and chemical admixture. One alternative to reduce the cost of Self-compacting concrete is by adding mineral admixture such as Silica Fume as replacement cement by 5%, 10%, 15% and 20%. Moreover, by the addition of mineral admixture in the manufacturing of Self-compacting concrete not only it reduces the cost but also reduces the heat of hydration, also parameters like environmental consciousness, sustainable development plays important role in future. So keeping that in mind the research is made with partial replacement of foundry sand with fine aggregate by 50%. Knowing that concrete is weak in tension, Glass fibre are added by 1% to improve the tensile property. The initial results of experimental programs aimed at producing and evaluating SCC made with fly ash, silica fume, foundry sand and Glass fibres are presented and discussed. The mix design of SCC was arrived as per guidelines of European Federations of National Associations Representing for Concrete (EFRNAC). Based on the results obtained from the comparison study of SCC with fly ash and silica fume the results have concluded that the use of fly ash increases the early age strength and the addition of silica fume increases the latter age strength of the concrete. To study the flexural behaviour of Self-compacting concrete and taking consideration of latter age strength of concrete a beam of size 100 x 200mm and span of 1m is cast and tested for its flexural properties.

Keywords: *Self-compacting concrete, Fly ash, Silica fume, Foundry sand, Glass fibre and Hardened properties*

1. Introduction

Self-Compacting Concrete (SCC) is a concrete which can be placed and compacted under its own weight with little vibration. Self-compacting concrete is cohesive enough to be handled without bleeding and segregation. SCC was first developed in Japan in late 1980’s to be used mainly in congested reinforced areas.

The increase of paste volume with emphasis to low water powder ratio (w/p) in the presence of compatible chemical admixtures further strengthens the fluidity and helps in attaining homogeneity. Adequate homogeneity improves viscosity of the mix, which in turn enhances the segregation resistance. An optimum balance between fluidity and viscosity is the key to achieve efficient self-compacting characteristics of the concrete mix in fresh state.

1.1. Properties of Self-compacting Concrete

Fresh SCC should possess the following key properties related to workability:

1.1.1. Filling ability: This is the ability of SCC to flow, spread and fill into spaces under its own weight. Slump flow test, V-funnel test and orimet test are conducted to measure the filling ability of SCC.

1.1.2. Passing ability: This is the ability of SCC to flow through close spacing such as reinforcing bars under its own weight without blocking. L-box, U-box and fill box test are conducted to measure the passing ability.

1.1.3. Resistance to segregation: The SCC must meet the required levels of properties and its composition must remain uniform throughout the process of transport and placing. GTM test and V-funnel at T_{5min} are conducted to measure the property.

2. Material Properties

2.1 Cement

Ordinary Portland cement of grade 43 is used with confirmation to IS 8112-19890. Its physical properties are given in the table 1.

Table 1: *Physical Properties of Cement*

S.No.	Physical Properties	Values
1.	Specific gravity	3.14
2.	Initial setting time	90min
3.	Final setting time	300min
4.	7 days compressive strength	34 N/mm^2
5.	28 days compressive strength	45 N/mm^2

2.2 Silica fume

Silica fume is obtained from the Ferro-silicon alloy industries. The physical properties are given in table 2.

***Table 2:** Physical Properties of Silica fume*

S.No.	Physical Properties	Values
1.	Colour	Grey (Black)
2.	Specific gravity	2.22

2.3 Chemical admixture

Sulphonated Naphthalene Formaldehyde based super plasticizer was used with the brand name Fosroc Conplast SP430 DSI. Dosage of super plasticizer is 1% of cementations material. The physical properties are given in table 3.

***Table 3:** Physical Properties of Chemical admixture*

S.No.	Physical Properties	Values
1.	Colour	Dark brown
2.	Specific gravity	1.145

2.4 Fine aggregates

Natural fine aggregate available from locally available market is used. The physical properties are tested in accordance to IS: 383 and are given in table 4.

***Table 4:** Physical Properties of Fine aggregates*

S.No.	Physical Properties	Values
1.	Fineness modulus	2.72
2.	Specific gravity	2.58

2.5 Foundry sand

Foundry sand obtained from the nearest foundry industry is used. The physical properties are tested and are given in table 5.

***Table 5:** Physical Properties of Foundry sand*

S.No.	Physical Properties	Values
1.	Colour	Red.
2.	Specific gravity	2.55

2.6 Coarse aggregate

The coarse aggregate obtained from the locally available crushing plant is used. The physical properties are tested in accordance with IS: 383 and is given in table 6.

***Table 6:** Physical Properties of Coarse aggregate*

S.No.	Physical Properties	Values
1.	Size	10-12.5 mm
2.	Fineness modulus	6.14
3.	Specific Gravity	2.62

3. Mix Proportion

Mix design is defined as the process of selecting suitable ingredients of concrete and determining the relative proportions with the objective of producing concrete of a fixed minimum strength and durability as economically as possible. The mix composition is chosen to satisfy all performance criteria for the concrete in both fresh and hardened state. However, to obtain the required properties of fresh concrete in SCC, a higher proportion of ultrafine materials and the incorporation of chemical admixture are necessary. The components shall be coordinated one by one so that segregation, bleeding and sedimentation are prevented. A rational mix design process should be used, to reduce the number or trial tests in laboratory.

Based on the EFNARC guidelines mix proportion for M_{30} grade is achieved. The following table 7 gives information about EFNARC guidelines.

***Table 7:** Physical Properties of Coarse aggregate*

Constituent	Typical ranges by mass (kg/m^3)	Typical ranges by litre (lit/m^3)
Powder	380-600	
Paste		300-380
Water	150-210	150-210
Coarse aggregate	750-1000	270-360
Fine aggregate	Constituents balance the volume of other constituents, typically 48%-55% of total aggregate weight.	
Water/Powder ratio by volume		0.85-1.10

4. Experimental Investigation

In this investigation the hardened properties of self-compacting concrete for various replacement percentages of fly ash, silica fume and partial replacement of foundry sand are determined. The research work is done to find out the hardened properties between silica fume.

4.1 Compression strength

Compressive strength of concrete is the capacity of concrete to with stand axially directed pushing force. When the limit is reached, the brittle material (concrete) will be crushed. Compressive strength of cubes was determined using a compression testing machine. Cubes are tested for their 28 days strength.

***Figure 1.**Compression strength*

Compression strength was found on cubes with a size 150 x 150 x 150 mm using a 2000kN compression testing machine. The rate of loading was maintained at a level of 14 N/mm^2/min.

4.2 Split tensile strength

This test is carried out by placing the cylinder specimen horizontally between the loading surface of compression testing machine and by applying the load until failure of the cylinder, along the vertical diameter. It is sometimes called as ‘Brazilian Test’. This test was developed at Brazil in 1943.

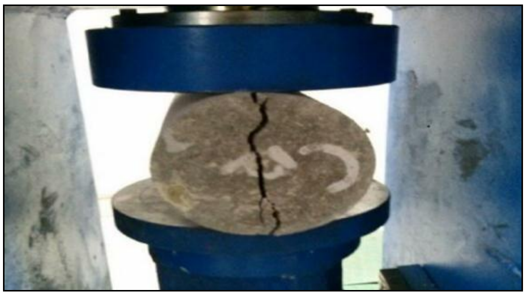

Figure 2.*Split tensile strength*

The test results are discussed in the following tables. Graphs are plotted to compare the 7 and 28 days compression and split tensile strength of SCC silica fume.

4.3 Flexural strength

In flexural strength prism were cast and tested for its 7 days and 28 days of strength. The following tables of the paper.

Table 8: *7 days compressive strength*

S.No.	Silica fume replacement percentage	Compressive strength (N/mm^2)
1.	0	24.00
2.	5	24.02
3.	10	25.30
4.	15	26.25
5.	20	27.95

Table 9: *28 Days compressive strength*

S.No.	Silica fume replacement percentage	Compressive strength (N/mm^2)
1.	0	33.76
2.	5	34.89
3.	10	35.68
4.	15	37.88
5.	20	41.22

Table 10: *7 days split tensile strength*

S.No.	Silica fume replacement percentage	Split tensile strength (N/mm^2)
1.	0	1.85
2.	5	1.92
3.	10	2.05
4.	15	2.10
5.	20	2.12

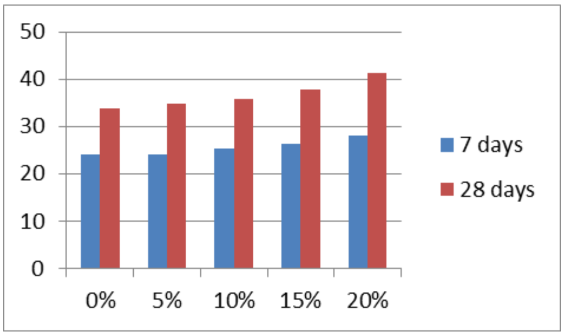

Figure 3.*7 and 28 days compression strength*

Table 11: *28 days split tensile strength*

S.No.	Silica fume replacement percentage	Split tensile strength (N/mm^2)
1.	0	3.22
2.	5	3.52
3.	10	3.62
4.	15	3.75
5.	20	3.82

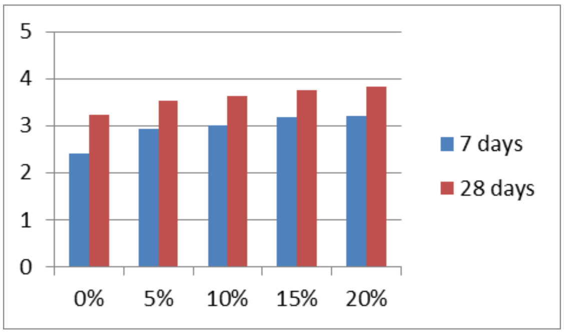

Figure 4.*7 and 28 days split tensile strength*

Table 12: *7 days Flexural strength*

S.No.	Silica fume replacement percentage	Flexural Strength (N/mm^2)
1.	0	2.67
2.	5	2.84
3.	10	3.02
4.	15	3.33
5.	20	3.44

Table 13: *28 days Flexural strength*

S.No.	Silica fume replacement percentage	Flexural Strength (N/mm^2)
1.	0	3.58
2.	5	3.77
3.	10	3.99
4.	15	4.07
5.	20	4.15

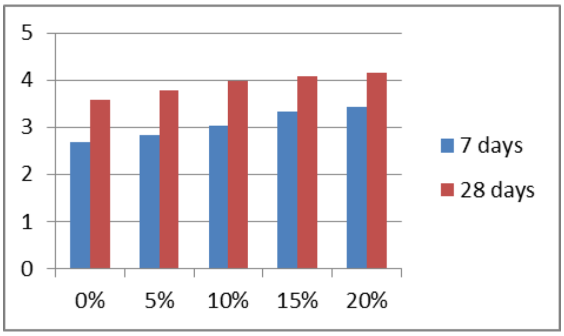

Figure 5.*7 and 28 days Flexural strength*

5. Crack patterns and Failure mode

As expected, the flexural cracks are initiated in the pure bending zone. As the load increased, existing cracks propagated and new cracks developed along the span. In the case of beams with larger tensile reinforcement ratio some of the flexural cracks in the shear span turned into inclined cracks due to shear effect of shear force. Near peak load the beam deflected significantly, thus loading that the tensile steel must have yielded at failure. The final failure of the beams occurred when the concrete in the compression zone crushed, accompanied by buckling of the compressive steel bars. The failure mode was typical of that an under reinforced concrete beam. The crack pattern and failure mode of several test beams are shown in figures below:

Figure 6.*Initial Crack pattern*

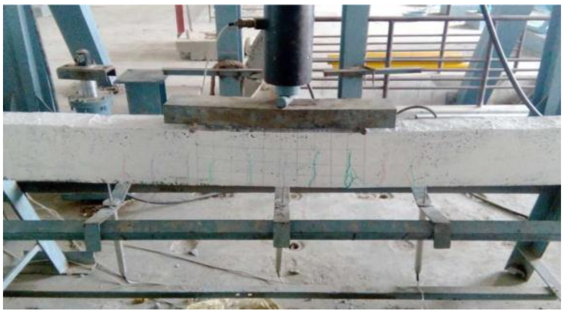

Figure 7.*Flexural cracks at Ultimate Load*

Table 14: *Load vs. Deflection test results for Flexural beam*

NM		M1	
Load (kN)	**Deflection (mm)**	**Load (kN)**	**Deflection (mm)**
0	0	0	0
10	0.18	10	0.20
20	1.33	20	1.48
30	2.52	30	2.68
40	3.25	40	3.45
50	4.02	50	4.25
55	4.55	60	4.65
52	10.2	55	12.20

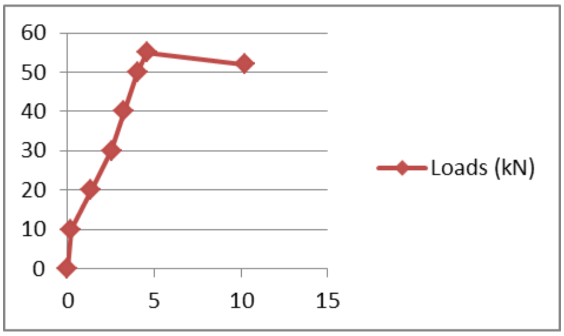

Figure 6.*Load deflection curve plot for NM.*

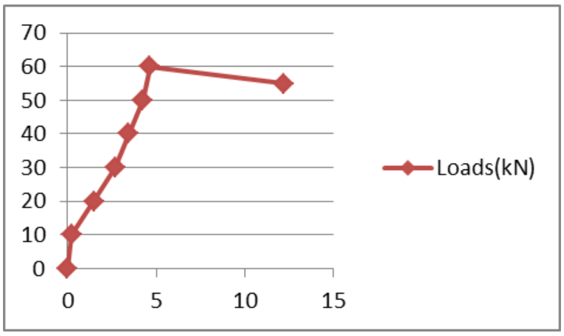

Figure 7.*Load deflection curve plot for M1.*

6. Conclusion

- The compressive strength of the cubes are increased by 15-20%.
- Addition of Glass fiber increases the Split tensile strength and flexural strength by 10% compare with normal concrete.
- From load deflection curve we have predicted that after yielding point load fails but curvature starts increasing and that will lead to failure.

7. Acknowledgement

I thank the almighty **God** for giving me the strength and determination to motive myself to complete the project.

I thank **my beloved Parents** for their encouragement, comfort, prayers and all the who have extended their help for successful completion of my project.

I thank **Sri Krishna College of Technology** for providing a very good support in terms of materials and equipments to complete my project in great success.

I thank **Dr.A. RAMESH, Ph.D., Principal, Sri Krishna College of Technology** for having providing necessary facilities to carry out this project.

I manifest deep sense of my gratitude to **Dr.I.PADMANABAN, Ph.D., Professor and Head of Department of Civil Engineering** for his continuous encouragement and helped me a lot to complete the thesis on time.

I express my whole-hearted indebtedness to my project guide **Ms.A.VENNILA, M.E., Assistant Professor, Department of Civil Engineering** for her warm blessings, moral support, constant encouragement at various stages of course study and for providing all necessary facilities for completing this project work.

References

[1] N.Bouzoubaa and M.Lachemi, Self-compacting Concrete Incorporating High Volume Fly Ash, Cement and Concrete Research, Vol. 31, 2001, pp. 413-420.

[2] Prajapati Krishnapal, R.K.Yadav and Chandak Rajeev, Strength Characteristics of Self-compacting Concrete Containing Fly Ash, Research Journal of Engineering Sciences, Vol.2, No. 6, 2013, pp.1-5.

[3] I.Papayianni and E.Anastasiou, Development of Self-compacting Concrete by using high Volume Calcareous Flash, Conference in World of Coal Ash (WOCA), Denver, CO, USA, 2011.

[4] S.Kennoche, A.Zerizer, A.Benmounah, B.Hami, M.Mahdad and H.Benouli and S.Bedjou, Formulation and Characterization of Self-compacting Concrete with Silica Fume, Journal of Engineering and Technology Research, Vol.5, No. 5, 2013, pp.160-169.

[5] K.S.Shobana, R.Gobinath, V.Ramachandran, B.Sundarapandi, P.Karuthapandi, S.Jeeva, A.Dhinesh, R.Manoj kumar, M.Subramaniam, Preliminary Study of Self-compacting Concrete by adding Silica Fume – A Review Paper, International Journal of Engineering Research & Technology, Vol.2, No. 1, 2013, pp.1293-1304.

[6] Rafat Siddique and Ravindrer Kaur Sandhu, Properties of Self-compacting Concrete Incorporating Waste Foundry Sand, Leonardo Journal of Science, No. 23, 2013, pp.105-124.

[7] Kiran K.Shetty, Gopinath Nayak and Rahuk Shetty, Self-compacting Concrete using Red Mud and used Foundry Sand, International Journal of Research in Engineering and technology, Vol.3, No. 3, 2014, pp. 703-711.

[8] S.Anbarsan and S.Mohammed Yusuf, Self-compacting Concrete using Industrial Waste, International Conference on Engineering Trends and Science & Humanities, Imayam College of Engineering, kannaur, Thuraiyur, 2015, pp.55-59.

[9] A.Deepak Raj, M.Mergin Benzine, J.Esther Daisy and M.Sri Nikhil, Experimental Methods on Glass Fibre Reinforced Self-compacting Concrete, Journal of Mechanical and Civil Engineering, Vol.11, No. 2, pp.19-23.

[10] P.T.Shahana Sheril, Self-compacting Concrete using Fly Ash and Glass Fibre, International Journal of Engineering Research and Technology, Vol.2, No. 9, 2013, pp.3074-3076.

[11] IS 383: 1970 Specification for coarse and fine aggregates from natural sources for concrete, Bureau of Indian Standards, New Delhi, 1993.

[12] EFNARC, Specification and Guidelines for Self-compacting Concrete, Association House, Surrey GU9 7EN, UK, 2002, pp. 4-31, pp. 1-19.