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Effect of Carbon and Silica Fiber on Properties of M-30 Concrete Mix: An Experimental Investigation

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ABSTRACT: In the present study the effect of fiberon self-compacting concrete is investigate. The investigation is done with the effect of silica and carbon fiber. The weight of fibers is taken as 0, 0.4%, 0.6%, 0.8%, 1.0%, and 1.2% by weight of cement. Various experiments like Compression strength, split tensile strength, flexural strength, slump flow and L-box are performed for various mixes of carbon and glass fibre mixed SCC. The study reveals that an appreciable amount of improvement observed in compressive strength split tensile strength and flexural strength with the addition of optimum percentage of carbon and glass fibre whereas remarkable changes is also noticed on slump flow of concrete mix.

KEYWORDS: Carbon, Fibre, Silica, Slump, Strength

I. INTRODUCTION

Self-compacting concrete (SCC) is a flow-able concrete mixture that is provided with viscosity by adding various types of admixtures with impart the fluidity to the composite. The highly fluid nature of this concrete makes it adaptable for putting it in difficult conditions and in sections with complicated reinforcement. SCC is a highly flow-able type of concrete that need not required mechanical vibration to be placed as such normal concrete. SCC is non-segregating concrete that is moved with fluidity under gravitation and also, the addition of super-plasticizers and viscosity modifier are added to concrete to make it that way.

SCC inhibits segregation by the use of mineral fibres which help in holding the components together and so that all has equivalent viscosity and does not separate under the gravitation and hence, it helps in the thorough movement of the concrete. Self-consolidating concrete is needs to be placed in its own weight, Flow-ability should be high enough to makes it flow under its own weight. It is necessary to meet this kind of requirement.

Self-compacting concrete has higher strength when compared to the vibrated concrete of the same proportion and hence it is more convenient in providing a better interface between aggregates and the cement. Also, Self-Compacting concrete can be placed taller than the 5 meters height and at very rapid pace than the conventional concrete.



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Vol. 8, Issue 6, June 2019

II. MATERIAL

Following material are used for the study:

Cement

Cement is an important gradient for the concrete mix which have binding properties and gives strength to the mix.

Grades of Cement

The OPC is classified into three grades, namely 33 grade, 43 grade and 53 grade depending upon the strength of cement at 28 days when tested as per IS 4031-1988. If the 28 days strength is not less than 33N/mm2, it is called 33 grade cement, if the strength is not less than 43N/mm2, it is called 43 grade cement and if the strength is not less than 53 N/mm2, it is called 53 grade cement. Cement used in the work is of 43 grade OPC.

- I. 33 Grade OPC (IS: 269-1998): Minimum Compressive strength after 28 days is 33 N/mm2
- II. 43 Grade OPC (IS: 8112-2000): Minimum Compressive strength after 28 days is 43 N/mm2
- III. 53 Grade OPC (IS: 12269-1999): Minimum Compressive strength after 28 days is 53 N/mm2

Aggregates

These are the inert or chemically inactive materials which form the bulk of cement concrete. These aggregates are bound together by means of cement. The aggregates are classified into two categories: fine and course.

The material which is passed through BIS test sieve no. 480 is termed as a fine aggregate. Usually the natural river sand is not available economically so the finely crushed stone may be used as fine aggregate. The material which is retained on BIS test sieve no. 480 is termed as coarse aggregate. The broken stone is generally used as coarse aggregate. The nature of work decides the maximum size of coarse aggregate. For thin slabs and walls, the maximum size of coarse aggregate should be limited to one-third the thickness of the concrete section.

Sand

The final residue of resistant mineral grains resulting from the weathering action upon rocks is known as sand and the final form has often been reached after many cycles of deposition and weathering. The most important mineral in sand is quartz and it is hardly affected by the ordinary weathering agents.

Design Specification

The principal objective of this work is to analyse the behaviour of the specimen based on the concept of Strength Properties based Performance analysis of carbon fibre and glass fibre for strength and durability. The design method used is the Mix-Design Proportion- Guidelines IS 10262: 2009. In the thesis the mix proportioning for a concrete of M 30 grade adding glass fibre and carbon fibre on SCC as per the recommendation mentioned in the IS 10262: 2009. Even the entire Mix-Design was done under the control environment favourable for accomplishment of anticipated data and result. Some of the general data/details are mentioned below that are essential for the initial stage of Mix-Design.



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Vol. 8, Issue 6, June 2019

III. MIX DESIGN

Calculation for quantities of materials used in experiment

Following quantity is obtained for the M-30 grade SCC mix as per IS10262:2009

Water cement ratio = 0.35

Water content = 190 litres

Cementitious material = 190/0.35 = 542.85 kg/m3

Fly ash (taken as 40% of cementitious material) = 217.14 kg/m3

Carbon Fibre / Glass Fibre = 6.51 kg/m3

Cement = $542.85 - (217.14 + 6.51) = 319.20 \text{ kg/m}^3$

Volume of Coarse aggregate & Fine aggregate (C.A. = 0.49 & F.A. = 0.51)

Mix calculation

Volume of concrete = 1m3

Volume of cement = $(319.20/3.15) \times (1/1000) = 0.101 \text{ m}3$

Volume of Fly ash = $(217.14/2.2) \times (1/1000) = 0.0987 \text{ m}3$

Volume of Water = $(190/1) \times (1/1000) = 0.19 \text{ m}3$

Volume of Fibre = $(6.51/2.38) \times (1/1000) = 0.00273m3$

Volume of Super Plasticizer $(0.8\%) = (4.34/1.145) \times (1/1000) = 0.00379 \text{ m}3$

Aggregate volume = 0.60189 m3

Mass of fine aggregate = $0.51 \times 0.60189 \times 2.61 \times 1000 = 801.17 \text{kg/m3}$

Mass of coarse aggregate = $0.49 \times 0.60189 \times 2.72 \times 1000 = 802.198 \text{ kg/m}^3$

IV. EXPERIMENTAL RESULTS

• Compressive Strength

It is observed from Fig. 1 & Fig. 2 that the addition of fiber increases the compressive strength of concrete up to certain limit. Further addition of fiber decreases the compressive strength.



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Vol. 8, Issue 6, June 2019



Fig. 1. Compressive strength of SCC mixed with carbon fiber





• Split Tensile strength

It is observed from Fig. 3& Fig. 4 that the addition of fiber increases the split tensile strength of concrete up to certain limit. Further addition of fiber decreases the split tensile strength.



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Vol. 8, Issue 6, June 2019



Fig. 3. Split tensile strength of SCC mixed with carbon fiber



Fig. 4.Split tensile strength of SCC mixed with glass fiber

Flexural Strength

It is observed from Fig. 5& Fig. 6 that the addition of fiber increases the flexural strengthof concrete up to certain limit. Further addition of fiber decreases the flexural strength.



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Vol. 8, Issue 6, June 2019



Fig. 5. Flexural strength of SCC mixed with carbon fiber



Fig. 6. Flexural strength of SCC mixed with glass fiber



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Vol. 8, Issue 6, June 2019

• Slump Flow

It is observed from Fig. 7& Fig. 8 that the addition of fiber decreases the slump flowand L-box respectively.



Fig. 7. Slump flow of SCC with additives



Fig. 6. L-box of SCC mixed with additives



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Vol. 8, Issue 6, June 2019

V. CONCLUSION

At the water/cement ratio of 0.35 to 0.45, slump flow test and L-box test results were found to be satisfactory, i.e.

passing ability, filling ability and segregation resistance are well within the limits.

Table 6.1 Increment in Compressive Strength in % at 14 Days

Increment in Compressive Strength in % at 14 Days				
Additive, %	Carbon Fibre	Glass Fibre		
0.4	3.113685735	5.173635719		
0.6	9.884141926	11.44578313		
0.8	13.03403331	12.33947555		
1	5.756698045	4.21686747		
1.2	-0.543084721	0.885896527		

Table 6.2 Increment in Compressive Strength in % at 28 Days

Increment in Compressive Strength in % at 28 Days				
Additive, %	Carbon Fibre	Glass Fibre		
0.4	10.83032491	11.25150421		
0.6	13.44765343	15.94464501		
0.8	18.68231047	19.49458484		
1	15.94464501	15.01203369		
1.2	10.19855596	13.20697954		



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Vol. 8, Issue 6, June 2019

Table 6.3 Increment in Split Tensile Strength in % at 14 Days

Increment in Split Tensile Strength in % at 14 Days				
Additive, %	Carbon Fibre	Glass Fibre		
0.4	18.57142857	14.64285714		
0.6	27.85714286	23.21428571		
0.8	46.42857143	40		
1	61.42857143	50.71428571		
1.2	30	19.28571429		

Table 6.4 Increment in Split Tensile Strength in % at 28 Days, Flexural Strength in % at 14 Days &28 Days

Increment in Split Tens	sile Strength in % at 28 Days	
Additive, %	Carbon Fibre	Glass Fibre
0.4	16.56626506	9.638554217
0.6	33.13253012	26.80722892
0.8	47.59036145	42.1686747
1	64.15662651	57.22891566
1.2	40.06024096	32.8313253
Increment in Flexural	Strength in % at 14 Days	
Additive, %	Carbon Fibre	Glass Fibre
0.4	28.32550861	19.09233177
0.6	34.89827856	26.60406886
0.8	44.60093897	38.34115806
1	53.36463224	44.60093897
1.2	47.88732394	33.17683881
Increment in Flexural	Strength in % at 28 Days	
Additive, %	Carbon Fibre	Glass Fibre
0.4	29.57746479	21.12676056
0.6	38.02816901	29.57746479
0.8	46.47887324	38.02816901
1	54.92957746	46.47887324

49.29577465

1.2

35.21126761



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Vol. 8, Issue 6, June 2019

- Result shows that the addition of carbon fibre and glass fibre in SCC increases the compressive strength up to certain limit. Further addition of fibres decreases the compressive strength. So as per the obtained result optimum percentage of fibre in SCC for the compressive strength is 0.8%. 0.8% carbon fibre increases the compressive strength about 13.03% & 18.68 whereas for Glass fibre addition it increases 12.33% & 19.49 at 14 & 28 days respectively
- Similar observation is obtained from the split tensile strength. Above table indicate that the addition of carbon fibre and glass fibre in SCC increases the split tensile strength up to certain limit. Further addition of fibres decreases the split tensile strength. So as per the obtained result optimum percentage of fibre in SCC for the split tensile strength is 0.8%. 0.8% carbon fibre increases the split tensile strength about 46.42% & 47.59 whereas for Glass fibre addition it increases 40% & 42.16 at 14 days & 28 days respectively.
- Slightly different result is obtained for the flexural strength. Above table indicate that the addition of carbon fibre and glass fibre in SCC increases the flexural strength up to certain limit. Further addition of fibres decreases the flexural strength. So as per the obtained result optimum percentage of fibre in SCC for the split tensile strength is 1 %. 1 % carbon fibre increases the split tensile strength about 53.36% & 54.92 whereas for Glass fibre addition it increases 44.60% & 46.47 at 14 days & 28 days respectively.
- Results indicated that the slump flow and L-box is decreases with the addition of fibre in SCC.
- It is concluded as per the study optimum range of glass and carbon fibre in SCC is 0.8 % to 1%. Carbon fibre improves the compressive strength, Split tensile strength and flexural strength 15%-20%, 60%-65% & 50%-55% respectively whereas glass fibre improves the compressive strength, Split tensile strength and flexural strength 15%-20%, 55%-60% & 45%-50% respectively.

REFERENCES

- A.A. Maghsoudi "Mix design and Mechanical properties of self-compacting light weight concrete" International Journal of Civil Engineering Vol. 9, No. 3, September 2011
- [2] Abbas Al-Ameeri. "The effect of steel fibre on some mechanical properties of self-compacting concrete" American Journal of Civil Engineering Vol. 1, No. 3, 2013, pp. 102-110
- [3] Antonios Kanellopoulos. "Durability Indicators of SCC" 2nd International RILEM workshop on concrete Durability and Service Life Planning 7-9 September, Haifa, Israel
- [4] A.S. Dieb "Flow characteristics and acceptance criteria of fiber-reinforced self-compacted concrete (FR-SCC)" 2011 Elsevier.
- [5] Athulya Sugathan "Self-Compacting Concrete Reinforced with Sisal Fibres" International Journal of latest Technology in Engineering, Management and Applied Science (IJLTEMAS) Volume VI, Issue VII, July 2017, ISSN 2278-2540
- Batham Geeta "A Review: Recent Innovations in Self-Compacting Concrete" International Journal of Scientific & Engineering Research, Volume 4, Issue II, November 2013 ISSN 2229-5518
- Biswajit Jena "Study on the Mechanical Properties and Microstructure of Chopped Carbon Fibre Reinforced Self-Compacting Concrete" International Journal of Civil Engineering and Technology (IJCET) Volume 7, Issue 3, may-june 2016, pp. 223-232
- [8] Biswajit Jena "Study on Mechanical Properties and Fracture Behaviour of Chopped Steel Fibre Reinforced Self-Compacting Concrete" International Journal of Research in Engineering and Technology ISSN:2319-1163
- B. Krishna Rao "Steel Fibre Reinforced Self-Compacting Concrete Incorporating Class F Fly Ash "International Journal of Engineering Science and Technology Vol. 2(9),2010,4936-4943
- [10] Chirag Rohilla "A Study on Behaviour of Chopped Fiber Reinforced Self-Compacting Concrete" Volume 1 Issue 12016 ETJ 2016, 1, 33-38
- [11] Dhiyaneshwaran, S. "Study on Durability Characteristics of Self-Compacting Concrete with Fly Ash" Jordan Journal of Civil Engineering Volume 7, No. 3, 2013
 [12] Dinach A. "Exacting Concrete" Internetional Journal of Engineering Sciences & Bessereth Technology JSSN: 2277
- [12] Dinesh. A, "Experimental Study on Self-Compacting Concrete" International Journal of Engineering Sciences & Research Technology ISSN: 2277-9655 Impact Factor: 4,116
- [13] G. Elangovan "Evaluation of Self Consolidating Steel Fibre Concrete (SCSFRC) &its Fresh Properties" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)e-ISSN:2278-1684, p-ISSN:2320-334X, Volume 10,Issue 2(Nov – Dec 2013), PP 06-10
- [14] S. A. Bhalchandra "Performance of Steel Fibre Reinforced Self Compacting Concrete" International Journal of Computational Engineering Research Vol 2. Issue 4
- [15] Eduardo N. B. Pareira "Steel Fibre Reinforced Self-Compacting Concrete Experimental Research and Numerical Simulation 2015-16"
- [16] Faiz A. Mirza "Performance of Polypropylene Fibre Reinforced Self Compacting Lightweight Concrete in Hardened State" Fourth International Conference on Sustainable Construction Materials and Technology.SCMT4,Las Vegas,USA ,August 7-11,2016
- [17] Gergely A. "The Optimization of the Self-Compacting (SCC) Production Scheduling –Specially the Effect of the Fine Aggregate" IACSIT International Journal of Engineering and Technology, Vol.4, No.4, August 2012
- [18] Haddadou N "Fresh and Hardened Properties of Self-Compacting Concrete with different Mineral additions and Fibres" Build Mater .Struct(2015)2:41-50 ISSN 2353-0057



(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 8, Issue 6, June 2019

- [19] H J H Brouwers "Self-Compacting Concrete: Theoritical and Experimental Study" Department of Civil Engineering ,Faculty of Engineering Technology, University of Twente 2005 Elseveir
- [20] Jacek Katzer "Fresh Mix Characteristics of Self-Compacting Concrete Reinforced by Fibre" Periodica Polytechnica Civil Engineering 61(2), pp. 226-231,2017
- Kennouche. S "Formulation and Characterization of Self Compacting Concrete with Silica Fume "Journal of Engineering and Technology [21] Research, Vol. 5 (5), pp. 160-169, june-2013, ISSN 2006-9790@2013
- [22] K.S. Johnsirani "Experimental Investigation of Self-Compacting Concrete using Quarry Dust" International Journal of Scientific and Research Publications, Volume 3, Issue 6, June 2013
- [23] Mohamed I. Abukhashaba "Behaviour of Self-Compacting Fibre Reinforced concrete containing cement kiln dust" Alexandria Engineering Journal (2014) 53, 314-354
- Mounir M. Kamal "Mechanical properties of self-compacted fibre concrete mixes " Housing and Building National Research Center, HBRC [24] Journal (2013)
- [25] Osman Gencel "Workability and Mechanical Performance of Steel Fibre Reinforced Self-compacting Concrete with Fly Ash" Composite Interfaces 18(2011) 169-184
- [26] P. Ghoddousi "A Model for Estimating the Aggregate Content for Self Compacting Fibre Reinforced Concrete (SCFRC)"International Journal of Civil Engineering, Vol. 8, No. 4, December 2010
- P.L.Domone "A Review of the hardened mechanical properties of self-compacting concrete" Cement and Composites 29 (2006) 1-12 [27]
- P. Muthupriya " Strength study on fibre reinforced self-compacting concrete with fly ash and GGBFS" International Journal of Advanced [28] Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 03, No. 02, April 2014
- [29] Prasad M L V Prasenjit Saha " Eco-efficient Fibre Reinforced Self-compacting Concrete for Replacements of Cements and Natural Sand with Waste Materials' International Journal of Earth Sciences and Engineering ISSN 0974-5904, Volume 09, No. 03, June 2016, P.P. 71-77 R.Beissel "Self-compacting concrete: modern concrete and admixture technology" 26th Conference on Our World in Concrete & Structures : 27-28
- [30] August 2001, Singapore.
- R Bharathi Murugan "Influence of Glass Fibre on Fresh and Hardened Properties of Self Compacting Concrete" IOP Conf. series: Earth and [31] Environment Science 80 (2017) 012004
- [32] S. Brundha "Fresh and Durability Studies of Polypropylene Fibre Reinforced Self-Compacted Concrete (SCC)" International Journal of Science, Technology and Management Volume No. 04 Special Issue No. 01. March 2015 ISSN 2394-1537
- S. Grunewald "Improved Tensile Performed with Fibre Reinforced Self-Compacting Concrete" G. J. Parra-Montesinos, H. W. Reinhardt, and A.E. [33] Naaman(Eds.): HPFRCC 6, pp, 51-58
- Sholihin AS'AD "Fresh State Behaviour of Self Compacting Concrete Containing Waste Material Fibres" The Twelfth East Asia-Pacific [34] Conference on Structural Engineering and Construction. Procedia Engineering 14 (2011) 797-804
- [35] Siddharth Anand "Effect of Steel Fibre on Self-Compacting Concrete: A Review" International Research Journal of Engineering and Technology (IRJET), Volume 03Issue :03, Mar 2016 e-ISSN:2395-0056, P-ISSN:2395-0072
- [36] S. Nandhini " A Study on Hybrid Fibre Reinforced Self-Compacting Concrete" SSRG International Journal of Civil Engineering-Special Issue-April 2017, ISSN: 2348-8352
- Thomas Paul "Experimental Study on Self-Compacting Concrete with Steel Fibre Reinforcement" International Journal of Science, Engineering [37] and Technology Research (IJSETR) Volume 5, Issue 4, April 2016
- Tomasz Ponikiewski "Properties of Steel Fibre Reinforced Self-Compacting Concrete for Optimal Rheological and Mechanical Properties in [38] Precast Beams" Concrete and Concrete Structures 2013 Conference, Procedia Engineering 65(2013) 290-295
- Wenzhong Zhu "Permeation Properties of Self-Compacting Concrete" Cement and Concrete Research, 2003, 33(6), 921-926 DOI: 10.1016/S0008-[39] 8846(02)01090-6
- [40] Yeong-Nain Sheen "Engineering Properties of Self-Compacting Concrete Containing Stainless Steel Slags" Sustainable Development of Civil, Urban and Transportation Engineering Conference, Procedia Engineering 142(2016) 79-86