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Performance of SCC with Triple Blending in Hardened Properties

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Abstract : Concrete is the most any nation. Civil engineering practice and construction works around the versatile heterogeneous construction material and the impetus of infrastructural development of world depend to a very large extent on concrete. Self-compacting concrete or self-consolidating concrete (SCC) is a highly flowable, non-segregating concrete that can spread into place, fill the formwork, and encapsulate the reinforcement without any mechanical consolidation. When large quantity of heavy reinforcement is to be cast in a reinforced concrete member, it is difficult to ensure that the formwork gets completely filled with concrete. In this paper an experimental study was made on fresh and hardened properties of self compacting concrete(SCC) with mineral admixtures like fly ash, metakaolin, silica fume and chemical admixture Conplast SP 337 as super plasticizer. Based on the guidelines given by European Federation of National Associations for Representing Concrete(EFNARC) the mix design for SCC is obtained. In this study the self compacting oncrete is obtained from cement, coarse aggregates, fine aggregates (Robo sand),water, mineral admixtures (fly ash , metakaolin & silica fume),and super plasticiser. The robo sand is used for various Fineness Modulus like 2.5,2.7,2.9. The proportions of the admixtures are flyash (25%), Metakaolin(5%), Silica Fume(5%).The fresh properties of self compacting concrete like Slump flow, T_{50} spread time, V-funnel, L-box tests and hardened properties like compressive strength, split tensile strength and flexural strength are tested. The strength tests of SCC are conducted after 7, 28 and 90 days of curing at room temperature.

Key Words : Self Compacting Concrete, Fineness Modulus, Fly ash, Silica Fume (SF), Metakaolin (MK), Viscosity Modifying Agent (VMA).

1.Introduction

In the early 1980s, Japan faced a lack of skilled workers who could construct durable concrete structures. Professor Hajime Okamura (University of Tokyo, now Kochi Institute of Technology) advocated the use of SCC as a solution to this problem. SCC technology in Japan was based on using conventional super plasticizers to create highly fluid concrete, while also using viscosity-modifying agents (VMA) which increase plastic viscosity thus preventing segregation up to a level of fluidity that would normally cause segregation. Many research works carried out in this area have proved that the role of chemical admixtures is inevitable in achieving good rheological properties of SCC.SCC thus obtained is dense, homogeneous and has a superior surface finish. The utilization of organic By-products as replacements for Portland cement in SCC, such as fly ash and the usage of chemical admixtures have been reported to significantly enhance the rheology and strength properties of SCC. One of the biggest differences between SCC and usual concrete is their incorporation of materials. SCC is considered to be a concrete that can be placed and compacted with no vibration and segregation. Cement which is the most important part of the concrete is very expensive and hence the use of SCC makes it more economical.

2. Literature Review

Concrete is the backbone of all the construction and development activities around the world. Ordinary Portland Cement (OPC) is the key ingredient of concrete [1]. Self-compacting concrete (SCC) was first developed in Japan in the late 1980‘s as a concrete that can flow through congested reinforcing bars with elimination of compaction, and without undergoing any significant segregation and bleeding (Melo K.A et al., 2010; Siddique R 2011; Liu M 2010) [2]. Studies to develop self compacting concrete, including a fundamental study on the workability of concrete, have been carried out by Ozawa and Maekawa at the University of Tokyo.(Ozawa 1989, Okamura 1993 and Maekawa 1999) [3]. Selfcompacting concrete (SCC) was thus developed to increase concrete usage by engineers in Japan in the early1980s with the introduction of conventional super-plasticizers to create highly fluid concrete, while also using viscosity-modifying admixtures (VMA), which increased plastic viscosity thus preventing segregation up to a level of fluidity that would normally cause segregation[4]-[9]. The dosage of the superplasticizer and viscosity modifying admixtures (VMA) is an important parameter, which influences the rheological properties of SCC. Many research works carried out in this area have provedthat the role of chemical admixtures is inevitable in achieving good rheological properties of SCC [10]-[12]. The usage of mineral admixtures in the production of SCC not only provides economical benefits but also reduces heat of hydration (EFNARC guidelines 2002) [13]. Silica fume (SF) is one of several types of industrial byproducts generated. With increased environmental awareness which is a by product of the smelting process in the silicon and ferrosilicon industry. Silica fume is very effective in the design and development of high strength high performance concrete [14].

3.Experimental Investigation:

3.1 Materials used:

Cement : Ordinary Portland Cement,53grade conforming to IS12269-1987.

Physical Property	Result
Specific Gravity	3.12
Fineness (m^2/kg)	311.5
Normal consistency	28%
Initial setting time (min)	80
Final setting time (min)	360

Fine Aggregate : Robosand confirming to Zone II IS383-1970. This sand is obtained from Hyderabad. The properties of fine aggregate are

S.No	Property	Result
1	Specific Gravity	2.63
2	Bulk Density	1560 kg/m^3
3	Zone	II

Coarse Aggregate : Locally available crushed aggregate of normal size less than 12mm is used. It is obtained from near byquarry in Anantapur. The properties of coarse aggregate are

S.No	Property	Result
1	Specific Gravity	2.56
2	Bulk Density	1580 kg/m^3
3	Water Absorption	0.3%

Mineral Admixture : Flyash of class F conforming to IS 3812-2000.Flyash used in this study is obtained from Rayalaseema Thermal Power Plant (RTPP). class F fly ash 25%

Physical properties

Specific Gravity	2.13
Fineness(m^2/kg)	360

Chemical Composition

Particulars	**Percentage(%)**
Silica(SiO_2)	65.6
Alumina(Al_2O_3)	28.0
Iron Oxide(Fe_2O_3)	3.0
Calcium oxide (CaO)	1.0
Magnesium oxide (MgO)	1.0
Sulphite (SO_3)	0.2
Titanium Oxide(TiO_2)	0.5
Loss on ignition	0.29

Metakaolin and Silica Fume:

Physical Properties of Metakaolin and Silica Fume:

Property	**Value MK**	**SF**
Specific Gravity	2.60	2.20
Bulk Density (g/cc)	0.3 to 0.4	0.1
Colour	Off-White	Light to Dark Grey
Physical Form	Powder	Powder

Chemical composition of Metakaolin and Silica Fume:

Particulars	**Percentage of MK**	**Percentage of SF**
SiO_2	51.52	96.0
Al_2O_3	40.18	0.1
CaO	2.0	0.1
MgO	0.12	0.2
K_2O	0.53	0.4
SO_3	0.0	-
TiO_2	2.27	-
Na_2O	0.08	0.1
Fe_2O_3	-	0.6

Chemical Admixture : Super plasticiser Conplast SP 337 and also serves as viscosity modifying agent. It is one of the main components useful to obtain the fresh properties of SCC. Properties of Conplast

Aspect	Dark brown liquid
Relative Density	1.20 at 27^oC
Chloride ion content	Nil

Water : Water used was fresh, colourless, odourless and tasteless potable water free from organic matter of any type. Generally tap water is used.

4. Mix proportions of SCC : Here we have prepared three different mixes with same binder content to check the fresh and hardened properties of SCC having fineness modulus of 2.5, 2.7 and 2.9. Mix is having 38.1% of paste content as per guidelines given in EFNARC(2002). In order to obtain fresh properties the water/cement (W/C) ratio used is 0.338 and the dosage of super plasticiser is 0.9%.

By weight:

Type of mix	Binder (Kg/m^3)	Fine Aggregate (Kg/m^3)	Coarse Aggregate (Kg/m^3)	Water (Kg/m^3)	W/P ratio	SP (Kg/m^3)	VMA	Paste (lit/m^3)
SCC	490	892.67	692.78	165.62	0.338	8.82	0	390.540
Proportions	1.000	1.820	1.413	0.338				

By volume:

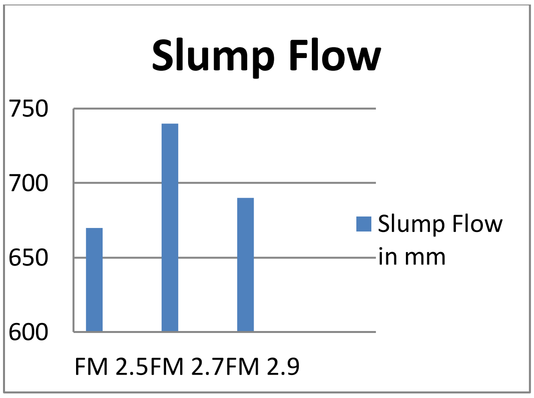
Concrete Mix proportions by volume (lit/cum)			
CA	**Mortar**	**Sand**	**Paste**
270.07	729.93	339.42	390.51
Sand (kg/cum)			892.67
Total aggregates (kg/cum)			1589.45

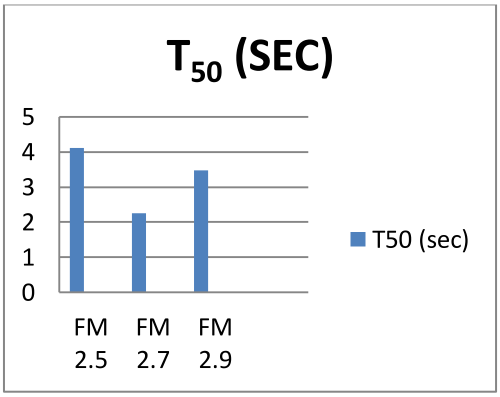
5. Results and Discussions:

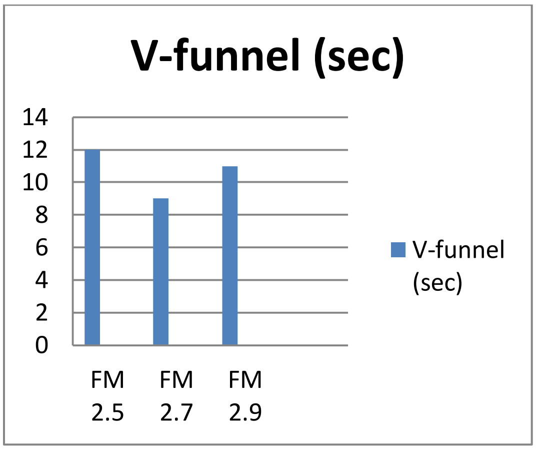
After performing the experiments the following results were obtained.

Fresh properties of SCC blended with mineral admixtures

Fineness Modulus	Slump Flow (mm)	T_{50} cm (sec)	V- funnel (sec)	L- box (h_2/h_1)
2.5	670	4.12	11.6	0.82
2.7	740	2.26	7	0.86
2.9	690	3.48	9	0.84
Standards as per EFNARC (2002)				
Range	650-800	2-5	6-12	0.8-1







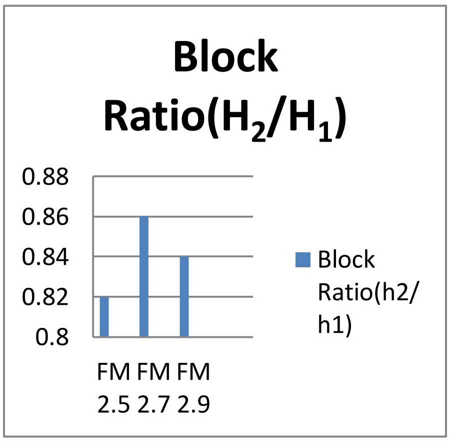


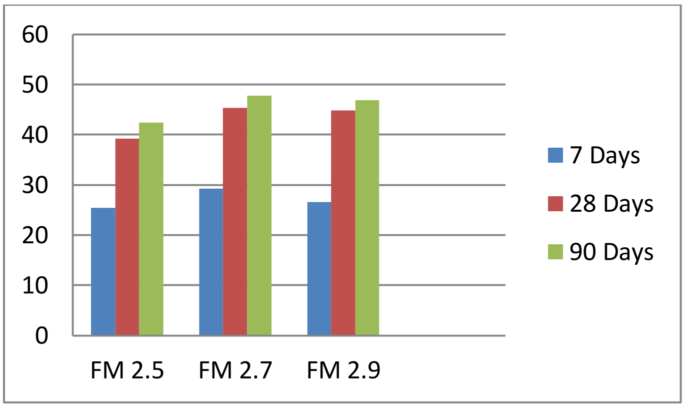
Fig 1 Slump Flow Test

Fig 2V-funnel test

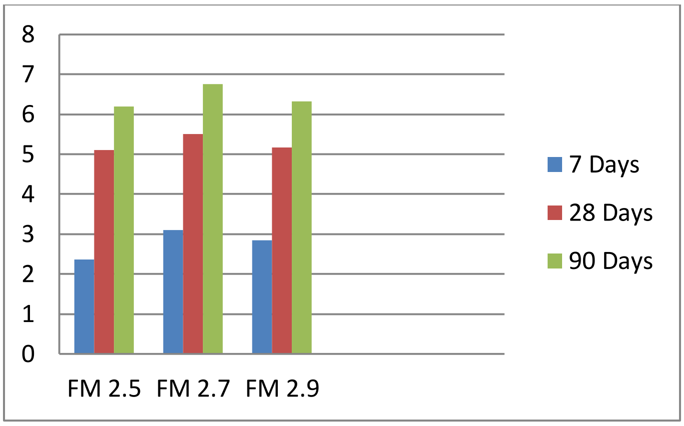
Fig 3 L-box test

6. Hardened Properties:

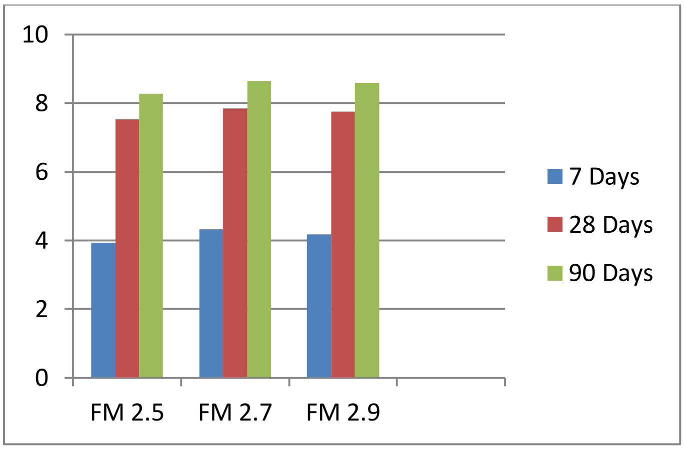
Fineness Modulus	Compressive Strength (N/mm^2)			Split Tensile Strength (N/mm^2)			Flexural Strength (N/mm^2)		
	7 Days	28 Days	90 Days	7 Days	28 Days	90 Days	7 Days	28 Days	90 Days
2.5	25.40	39.20	42.40	2.36	5.11	6.20	3.94	7.53	8.27
2.7	29.30	45.30	47.80	3.10	5.51	6.76	4.32	7.85	8.65
2.9	26.60	44.80	46.90	2.84	5.17	6.32	4.17	7.76	8.59



Graph showing Compressive Strength (N/mm^2)



Graph showing Split Tensile Strength (N/mm^2)



Graph showing Flexural Strength (N/mm^2)

7. Conclusions:

- In our present experiment all the mixes tested satisfies the fresh properties as specified by EFNARC guidelines.
- Regarding the fresh properties the mix with respect to FM 2.5 is well within the limits specified by EFNARC.
- In the present study it is found that the mechanical properties corresponding to fineness modulus 2.7 and 2.9, there is a decrease in mechanical properties than mix with fineness modulus 2.5.
- Finally from the results it is concluded that the mix corresponding to 2.7 satisfies all the rheological and mechanical properties and proves to be optimum of all the mixes.

8. References:

1. Olafusi, O.S. and Olutoge, F.A. (2012) Strength Properties of Corn Cob Ash Concrete. Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS), 3, 297-301.
2. European Scientific Journal April 2014 edition vol.10, No.12 ISSN: 1857 – 7881 (Print) e - ISSN 1857-7431.
3. Ozawa 1989, Okamura 1993 and Maekawa 1999, Journal of Advanced concrete Technology volume 1, No 1, 5-15, April 2003.
4. Liu, M. (2010) Self-Compacting Concrete with Different Levels of Pulverized Fuel Ash. Construction and Building Materials, 24, 1245-1252. http://dx.doi.org/10.1016/j.conbuildmat.2009.12.012
5. Leemann, A., Loser, R. and Munch, B. (2010) Influence of Cement Type on Its Porosity and Chloride Resistance of Self-Compacting Concrete.Cement and Concrete Composites, 32, 116-120. http://dx.doi.org/10.1016/j.cemconcomp.2009.11.007
6. Kou, S.C. and Poon, C.S. (2009) Properties of Self-Compacting Concrete Prepared with Coarse and Fine Recycled Concrete Aggregates. Cement and Concrete Composites, 31, 622-627. http://dx.doi.org/10.1016/j.cemconcomp.2009.06.005
7. Filho, F.M.A., Barrag´an, B.E., Casas, J.R. and ElDebs, A.L.H.C. (2010) Hardened Properties of Self-Compacting Concrete—A Statistical Approach. Construction and Building Materials, 24, 1608-1615. http://dx.doi.org/10.1016/j.conbuildmat.2010.02.032
8. Boukendakdji, O., Kenai, S., Kadri, E.H. and Rouis, F. (2009) Effect of Slag on the Rheology of Fresh Self-Compacted Concrete. Construction and Building Materials, 23, 2593-2598. http://dx.doi.org/10.1016/j.conbuildmat.2009.02.029
9. Craeye, B., Schutter, D.G., Desmet, B., et al. (2010) Effect of Mineral Filler Type on Autogenous Shrinkage of Self-Compacting Concrete. Cement and Concrete Research, 40, 908-913. http://dx.doi.org/10.1016/j.cemconres.2010.01.014
10. Li, B., Wang, J. and Zhou, M. (2009) Effect of Limestone Fines Content in Manufactured Sand on Durability of Lowand High-Strength Concretes. Construction and Building Materials, 23, 2846-2850. http://dx.doi.org/10.1016/j.conbuildmat.2009.02.033
11. Corinaldesi, V. and Moriconi, G. (2009) Influence of Mineral Additions on the Performance of 100% Recycled Aggregate Concrete. Construction and Building Materials, 23, 2869-2876. http://dx.doi.org/10.1016/j.conbuildmat.2009.02.004
12. Grdić, Z., Despotović, I. and Ćurčić, G.T. (2008) Properties of Self-Compacting Concrete with Different Type of Additives.FactaUniversitatis, 6, 173-177.
13. EFNARC (2002) Specification and Guidelines for Self-Compacting Concrete.
14. Journal of Engineering and Technology Research, Academic Journals, Kennouchi.S, Zerizer.A

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