

Performance of SCC With Triple Blending in Hardened Properties

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Abstract:— Self-compacting 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. This study was made on fresh and hardened properties of self compacting concrete (SCC) blended with mineral admixtures like fly ash(25%), metakaolin(5%), silica fume(5%) and chemical admixture Conplast SP 337 as super plasticizer. Sand plays a very important role for imparting better properties to concrete in its fresh and hardened state. It also affects many concrete properties, including workability and finishability. sBased on the guidelines given by EFNARC the mix design for SCC is obtained by replacing natural river sand with robosand, with various FM 2.5, 2.7, 2.9. The fresh and hardened properties of SCC are tested after 7, 28 and 90 days.

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

I. 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.

II. 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]. Self compacting concrete (SCC) was thus developed to increase concrete usage by engineers in Japan in the early 1980s 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 super plasticizer 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 proved that 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 byproduct 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].

III. EXPERIMENTAL INVESTIGATION:
3.1 Materials used:

Cement: Ordinary Portland Cement, 53 grade 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: Robo sand conforming 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 by quarry 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). Proportion of class F fly ash used for this study is 25%. The physical properties are

Property	Value
Specific Gravity	2.13
Fineness(m ² /kg)	360

Chemical Composition

Particulars	Percentage(%)
Silica(SiO ₂)	65.6
Alumina(Al ₂ O ₃)	28.0
Iron Oxide(Fe ₂ O 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 ₂ O ₃	40.18	0.1
CaO	2.0	0.1
MgO	0.12	0.2
K ₂ O	0.53	0.4
SO ₃	0.0	-
TiO ₂	2.27	-
Na ₂ O	0.08	0.1
Fe ₂ O 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 SP 337 are

Aspect	Dark brown liquid
Relative Density	1.20 at 27°C
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.

IV. 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

V. RESULTS AND DISCUSSIONS:

After performing the experiments the following results were obtained. Fresh properties of SCC blended with mineral admixtures are shown below

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

Graphs for various fresh properties are drawn below.

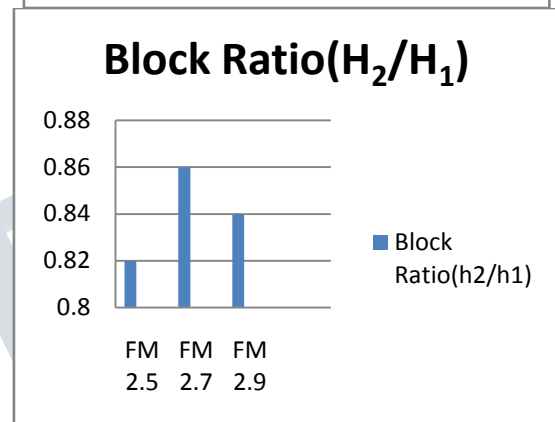
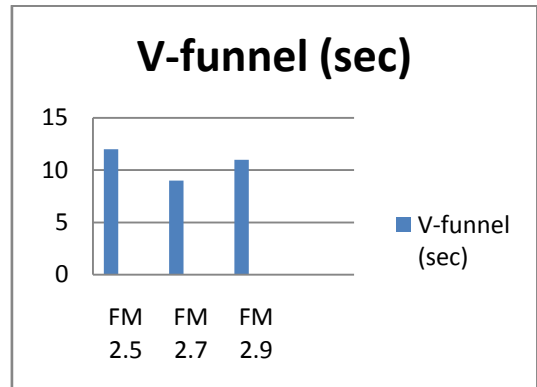
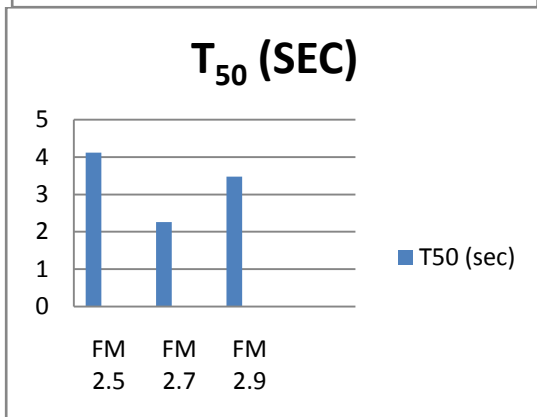
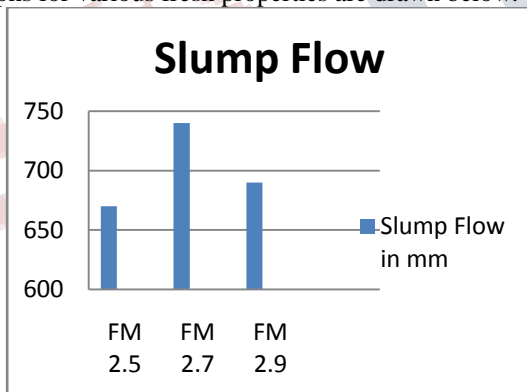


Fig 1 Slump Flow Test



Fig 2 V-funnel test

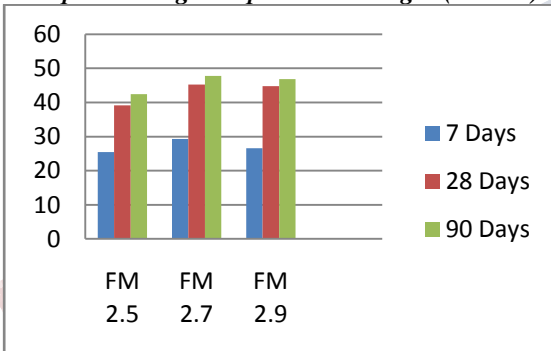


Fig 3 L-box test

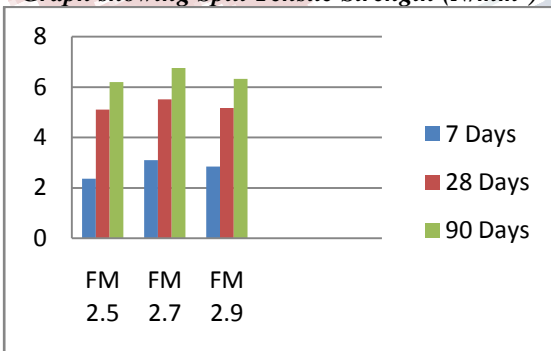
VI. HARDENED PROPERTIES

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

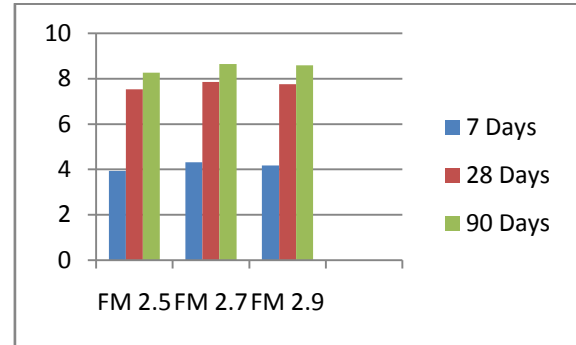
Graph showing Compressive Strength (N/mm²)



Graph showing Split Tensile Strength (N/mm²)



Graph showing Flexural Strength (N/mm²)



VII. 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.

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