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An Experimental Investigation on Fresh and Hardened Properties of Self Compacting Concrete with Various Fineness Modulus of Robo Sand

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Abstract : Concrete is a composite material that is produced from the combination of cement, aggregate and water. In those materials cement plays an important role in the concrete. In the present experimental study investigates about self compacting concrete, cement is replaced partially by Fly ash by 25% and metakaoline by 10%. Whereas the river sand is replaced with 100% of Robo sand. Glenium 6100 is used as a superplasticiszer and as well as viscosity modifying agent (VMA), the design and mix procedures followed according to European Federation of National Associations for Representing Concrete (EFNARC) guidelines. In this investigation the properties of SCC Is studied for the different Fineness Modulus of robo 2.5, 2.7 and 2.9 the fresh properties I.e. Filling ability and passing ability were studied by conducting the tests Slump flow, V- funnel test and L- box test. And the hardened properties Compressive strength, Split tensile strength and Flexure strength were calculated for 7, 28 and 90 days of curing.
Key words: : Self Compacting Concrete, Fineness Modulus, robo sand and Flyash, Metakaoline, Glenium 6100.

1. Introduction

Self Compacting concrete is an advanced technique in concrete and it was developed and improved in Japan in 1988 by Okamura and Quchi. It has the property of consolidating itself without need of any vibrators and any other instruments, and this type of concrete has high strength properties and having more durable properties than conventional concrete. The mix composition was chosen to satisfy all the fresh and hardened properties of concrete. As there is no readymade mix design procedure all institutes and investigators were developed their own procedures. According to the EFNARC guide lines the main difference between the conventional and the self compacting concrete is incorporating of viscosity modifying agent. Many experiments are going on the replacement of aggregates content to enhance the fresh and mechanical properties of SCC, in that fly ash light weight aggregates enhances the fresh and hardened properties of SCC up to 30% of replacement [1]. Self compacting concrete has to satisfy the fresh properties primarily [2] and the fresh properties have to satisfy EFNARC guidelines to become SCC. Self compacting concrete to have more paste volume to attain its filling ability, passing ability [2], due to much usage of cement it leads to develop cracks and it emits CO_2 more, to reduce these emissions and cracks the replacement of cement is also necessary thus replacement of cement by fly ash will given best strength [4] usage of metakaoline and silica fume up to some percentages will increase fresh and hardened properties [10] particularly usage of metakaoline alone will enhance both the properties.

Usage of robo of sand as the remedial measure to the river sand, robo sand will give the good results in terms fluidity and strength is nearly same to both up to some percentages [12].

The present research is investigates about the effect fineness modulus of sand on properties of self compacting concrete, the fineness modulus used in the present study are 2.5, 2.7 and 2.9. cement is partially replaced with 25% of fly ash and 10% of metakaoline. Fresh and hardened properties of SCC is examined and compared.

2. Experimental procedure

2.1 materials

The materials used in the present study are class F fly ash (ASTM 618) [13] procured from thermal power plant, ACC 53 grade cement from local traders, coarse aggregate procured from local quarries of 12mm size and having the specific gravity 2.63 and robo sand of having 2.56 specific gravity and fineness modulus of 2.5, 2.7 and 2.9 for varying of mixtures. Metakaoline procured from ASTRRA chemicals, Chennai having specific gravity 2.62 is used as a pozzolona replacement of cement.

Glenium 6100 is used as a superplasticiszer as well as viscosity modifying agent procured from ASTRRA chemicals, Chennai.

Table 1: properties of robo sand

S.No	Property	Test result
1	Specific gravity	2.63
2	Bulk density	1560 kg/m3
3	Fineness modulus	2.5, 2.7, 2.9

Table 2: properties of class F fly ash

S.No	Characteristics	percentages
1	Silica(SiO_2)	65.6
2	Alumina($Al2O_3$)	28.0
3	Iron oxide($Fe2O_3$)	3.0
4	Lime(CaO)	1.0
5	Magnesia(MgO)	1.0
6	Sulphur tri oxide(SO_3)	.5
Physical properties	Property	values
1	Specific gravity	2.06
2	Fineness (m^2/kg)	360

Table 3: properties of metakaoline

S.No.	Characteristics	Percentage
1	$SiO_2 + Al_2O_3 + Fe_2O_3$	96.88
4	CaO	0.39
5	MgO	0.08
6	TiO_2	1.35
7	Na_2O	0.56
8	K_2O	0.06
9	LI.O	0.68

2.2 Mix proportions

In this present study three different mixes were prepared with same binder content to check the influence of fineness modulus of sand on fresh and hardened properties of self compacting concrete having 2.5, 2.7 and 2.9 are having the fineness modulus. Mix having 38.1% of paste content as per SCC guide lines [2]. In order to obtain fresh properties the ratio of water to cement ratio (W/C) as .338 and the super plasticizer dosage of 0.9%.

Table 4: mix designations 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 lt/m^3
SCC	496	892.67	692.78	165.62	0.338	4.464	0	390.5406
proportions	1	1.82	1.413	0.338				

Table 5: mix proportions 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

2.3 mixing and testing

Mixing was done in two stages. First cement, fly ash and metakaoline blended then water mixed with super plasticizer is added to the blended material and lastly the aggregate is added to the paste this all process was taken 2-3 minutes of time. To get the good homogeneity it again mixed for another 2 minutes, freshly prepared mix is used to assess the fresh properties i.e. slump flow, V- funnel time and blocking ratio (L-box) test [2]. The mix done in batches cubes of size 150mm×150mm, cylinders having diameter 150mm,hight of 300mm and beams having standard size 700mm×150mm×150mm were casted, after demoulding these samples kept in curing tank in ambient nature. The specimens were tested for compressive strength, split tensile strength and flexure strength for 7, 28 and 90 days of age of curing.

3. Results and discussions

This section discussed about the effect of fineness modulus of sand on the fresh and hardened properties of concrete.

3.1 Effect of fineness modulus on fresh properties

The fresh properties were tested according to EFNARC guide lines [2] and the results were tabulated as follows.

Table 6: fresh properties of SCC

Fineness modulus	Slump flow in mm	T_{50cm} time in seconds	V- funnel flow in seconds	L-box ratio (H_2/H_1)
2.5	660	5	12	.81
2.7	720	3	9	.88
2.9	680	4	10	.84

SCC acceptance criteria according to EFNARC

Slump flow	**T_{50cm} seconds**	**V-funnel**	**L-box ratio ($H2/H_1$)**
650-800 mm	2-5	6-12	.8-1

Various fresh properties conducted are as shown in fig 1,2,3

Fig 1 slump flow

Fig 2 V- funnel test

Fig 3 L-box test

Fig 1 shows that slump test for SCC is most commonly used test for the filling ability having a limit 650-800mm as per EFNARC [2] guidelines, here the slump flow is first increases to 2.7 from 2.5 and then decreased for 2.9 due to increase in coarse fraction of fine aggregate.

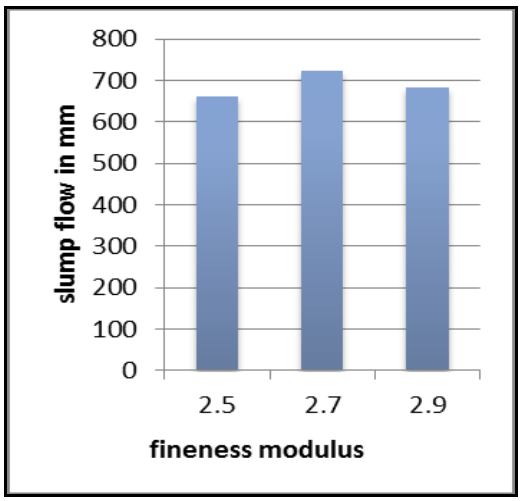

Fig 4: Fineness modulus Vs slump flow

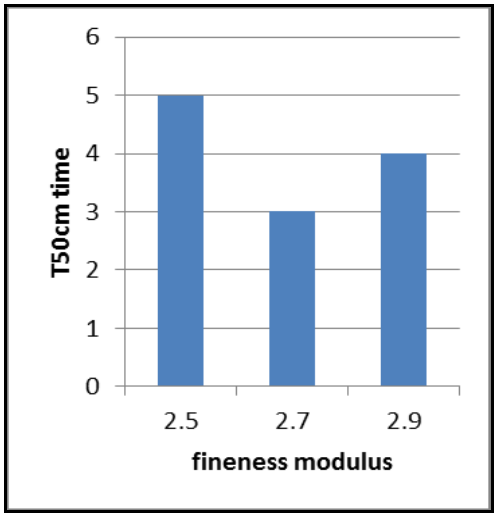

Fig 5: fineness modulus Vs T_{50cm} time

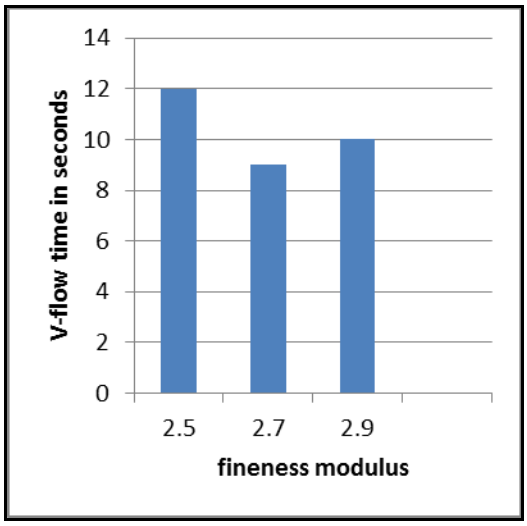

Fig 6: Fineness modulus Vs V- flow in sec

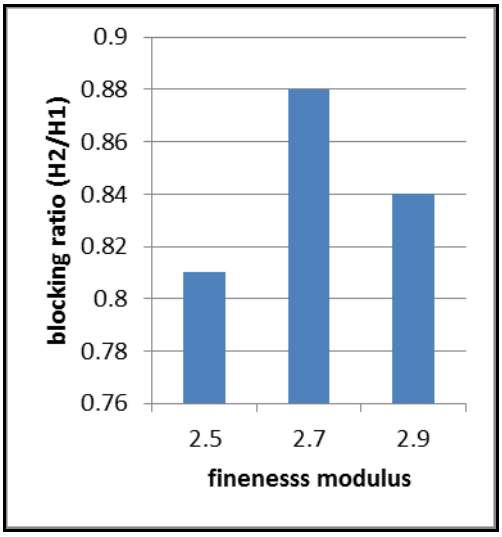

Fig 7: fineness modulus Vs blocking ratio

Analyzing the results and above figures 4,5,6 and 7 all the fresh properties are rising from fineness modulus 2.5 to 2.7 and from there decreasing for fineness modulus 2.9, this is due to the fineness modulus 2.5 having more finer fraction in sand and 2.9 having coarser fraction, in the investigation I observed that fineness modulus 2.7 giving optimum results.

3.3 Effect of fineness modulus on hardened properties

From the test results of fresh properties self compacting concrete is successful so the cubes, cylinders and beams were casted, the specimens were tested for compressive strength, spilt tensile strength and flexure strength for 7,28 and 90 days curing.

Table7: hardened properties of Self compacting concrete

Fineness modulus	Compressive strength in N/mm2			Split tensile strength in N/mm2			Flexural strength in N/mm2		
	7 days	28 days	90 days	7 days	28 days	90 days	7 days	28 days	90 days
2.5	24.6	38.1	41.2	2.291	3.82	3.87	3.09	5.102	5.21
2.7	28.4	44.8	47.2	2.97	4.47	4.65	3.86	6.465	6.762
2.9	25.3	43.3	46.2	2.71	4.67	4.97	3.12	5.432	5.86

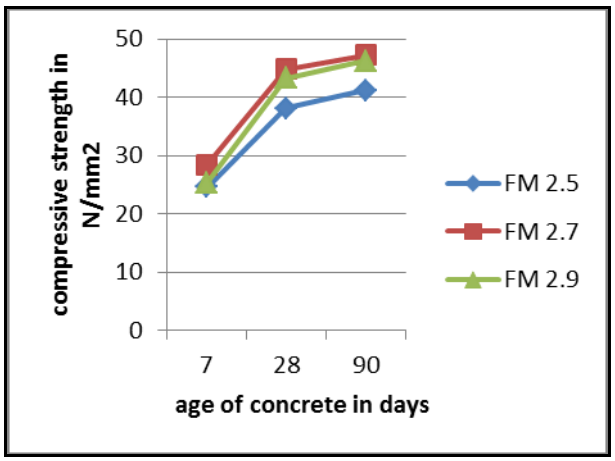

Fig 8: comparison of compressive strength

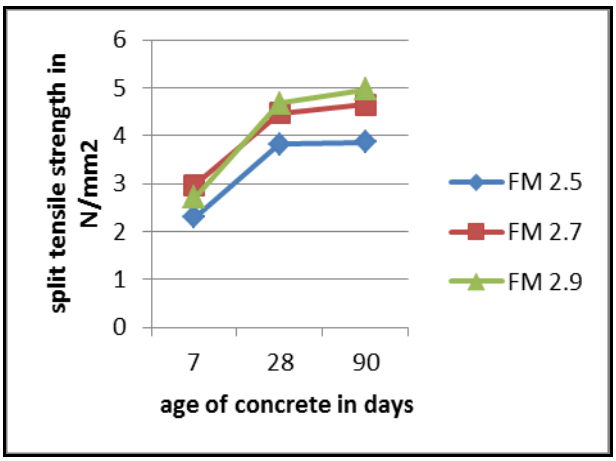

Fig 9: comparison of split tensile strength

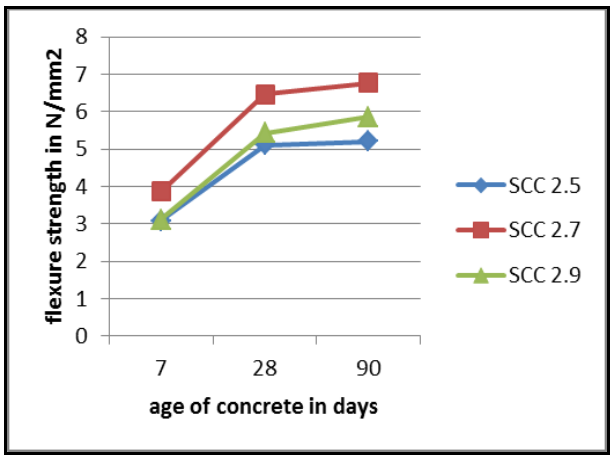

Fig 10: Comparison of flexure strength

From fig 8 it is illustrated that 28 days compressive strength of concrete is more for fineness modulus 2.7 than 2.5 and from there it is decreasing for 2.9, remaining values are relative to the compressive strength are also varying in the same manner.

4. Conclusions

1. Based upon the studies all the varieties of mixes were achieved the fresh properties according to EFNARC guidelines.
2. All the mechanical properties of the variety of 2.7 were more than that of remaining two varieties but regarding to fresh properties it is just achieved the limits as stated by EFNARC.
3. In the present investigation observed that compressive strength values for fineness modulus 2.7 are more due to increase in fluidity from 2.5 to 2.7 and then decreasing for fineness modulus 2.9

4. Finally concluded that the fineness modulus 2.7 will give better workability as well as mechanical properties.

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