International Journal of Engineering (IJE)
Singaporean Journal of Scientific Research(SJSR)
Vol 6.No.2 2014 Pp. 76-79
available at:www.iaaet.org/sjsr
Paper Received :10-03-2014
Paper Accepted:20-03-2014
Paper Reviewed by: 1Prof.Dr. Kabilan 2. Chai Cheng Yue
Editor : Dr. Binod Kumar

EXPERIMENTAL INVESTIGATION ON FLY ASH BASED SELF COMPACTING CONCRETE

Manikandan.S and Prof.A.Sofi
Structural and Geotechnical Engineering Division
VIT university, India
manikandan_2051@yahoo.com

ABSTRACT

Self-compacting concrete is an innovative concrete which has improved workability and durability properties than normal concrete at the same water-cement ratio. It makes the construction of heavily congested structural members easier due to its ability to compact itself under its own weight. In this project an experimental investigation is carried out to find the properties of Self compacting concrete with class C Fly ash replaced with Ordinary Portland cement 53 grade. Super plasticizer named Varaplast SP 123 is used to improve the workability properties. Workability tests such as Slump flow, D_{50} and J ring are done to characterize Self compacting concrete for its passing and filling ability. Cube specimens of size 100X100X100 mm, Cylinder specimens of size 100X200 mm and Prism specimens of size 100X100X500 mm are casted for M40 concrete grade . In this study 28 days compressive strength, Flexural strength, split tensile strength and modulus of elasticity of Self compacting concrete with 30%,35%,40%,45% and 50% replacement of Fly ash with cement are compared with conventional concrete.

Key words: Fly ash (class C), Varaplast SP 123, Slump flow, $D_{50,}$ J ring.

1. INTRODUCTION

The concept of Self compacting concrete was first proposed by Okamura in the late eighties [1]. Later a fundamental study on the workability properties of concrete was conducted by Ozawa and Maekawa [2]. Self compacting concrete is defined as "high flow yet stable concrete that can ensure filling gaps of formwork and congested reinforcement without any consolidation and significant segregation"[3-5].

The main difference between traditional concrete and SSC is the increased powder content and reduced coarse aggregate proportions to improve the flow ability[6]. To reduce the cost of concrete cement is partially replaced with mineral admixture. Mineral admixture improves the rheological properties of concrete and reduces cracks which are thermally induced due to heat of hydration[7]. Reduced coarse aggregate content minimize the risk of concrete getting blocked at the congested reinforcement.

High range water reducing plasticizer along with viscosity modifying agent is used to increasefluidity and to maintain a homogeneous stable mix to prevent segregation of solids during flow[13]. Excess water present in concrete results in bleeding of water which results in decreased strength at hardened stage. Mix proportioning used in this study achieve good packing of the constituents and minimal void content.

The objective of this study is to arrive at the optimum constituents of the mix for designing Self compacting concrete and to determine the workability of fresh concrete and mechanical properties of hardened concrete.

2. EXPERIMENTAL PROCEDURE

1.Material investigation

1.1 Cement

Ordinary Portland Cement of 53 grade confirming to IS 269-1976with specific gravity 3.22 and standard consistency of 28.5% is used as binder.

1.2 Fine aggregate

Locally available sand passing through 2.36mm sieve with specific gravity of 2.63 is used in this study.

1.3 Coarse aggregate

Coarse aggregate content is divided into two proportions 60% of 20-12mm and 40% of 12-10mm are used in this project with specific gravity of 2.66

1.4 Fly ash

Class C flash from Neyveli lignite corporation with specific gravity of 2.1 is used.

1.5 Super plasticizer

Varaplast SP123,a poly-carboxylate based high range water reducing plasticizer with viscosity modifying agent is used. It is a low viscous fluid with specific gravity of 1.22

2. Compatibility test

The optimum dosage of super plasticizer is found out by Marsh cone test. This test is used to study the flow properties of cement paste. Water binder ratio of 0.35 is fixed. Mixing of paste is done by portable blender.

3. Fine aggregate proportion

With the help of mini slump test the optimum quantity of fine aggregate is estimated. Fine aggregate content should not affect the flow of the concrete but maintain the stability of the mix.

4. Mix proportion

Mix proportion is arrived by optimising the paste content by Marsh cone studies and mortar phase by the results of mini slump test. Coarse aggregate content is adjusted corresponding to the workability properties of fresh concrete.

5.Workability properties of fresh concrete

SCC in fresh state should possess filling ability, passing ability and segregation resistance.Filling ability is defined as the ability of concrete to flow easily when confined by formwork. Passing ability is the ability to flow through tight openings such as spaces between reinforcing bars without blocking. Segregation resistance is the ability to remain homogeneous in composition during transport and placing of concrete. It gives an indication of stability of concrete. Filling ability can be measured using slump flow test.

In slump flow test the horizontal free spread of SCC in the absence of obstructions is evaluated. The diameter of the spread concrete is measured in two perpendicular directions and the mean is recorded as slump spread. The time required for the concrete to reach a diameter of 500mm is also measured and recorded as t_{500}. Passing ability can be measured using J-ring test. It is an extension of the slump flow test in which a ring apparatus is used and the difference in height between the concrete inside and the periphery is measured.

Desirable range for slump test lies between 650-800mm and for t_{500} is 2-6 sec. For J-ring test the acceptable limit is 0-10mm.

6. Mechanical properties of hardened concrete

Specimens were casted for determining mechanical properties such as compressive strength, flexural strength and split tensile strength with design mixes that passes the workability criteria. The casted specimens were cured for 28 days at lab temperature and then tested.

3. RESULTS AND DISCUSSIONS

1.Dosage of Super plasticizer

Marsh cone tests were conducted for all the paste mixes containing the replacement of cement with flyash from 30% to 50%. A graph is drawn by plotting time taken for flow versus dosage of SP. Optimum dosage of SP was found to be 1.25%

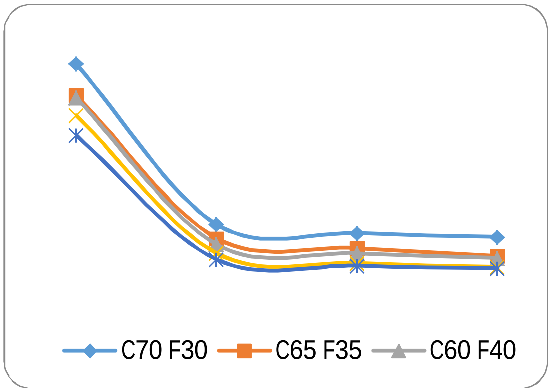

Figure 1. Dosage of SP vs Time of flow

2.Mortar phase

Mini slump tests are conducted for different powder to sand ratios such as (60:40,65:35,70:30) by volume. Diameter of spread and the time of spread are noted. It is observed that as the paste content increases, the diameter of spread increases. The minimum time taken to initiate the bleeding and the intensity of bleeding at different time intervals was also noted for all mixes. Stability of mortar increases with the increase of sand content up to some level and then the stability of mortar decreases.

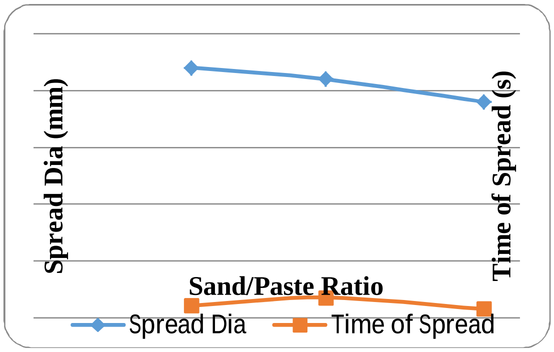

Figure 2. Spread diameter and Time of spread

3.Workability tests

The proportioning of concrete was also done in a similar method based on the different combinations of flowing and suspending medium.workability tests are performed on all fresh concrete mixes to meet the requirements of SCC.

Table 1.Mix proportions

DESIGN MIX	CEMENT	FLY ASH	FINE AGG	COARSE AGG
M1(70:30)	429	183	672	796
M2(65:35)	398	214	662	751
M3(60:40)	367	245	621	712
M4(55:45)	337	275	594	681
M5(50:50)	306	306	560	645

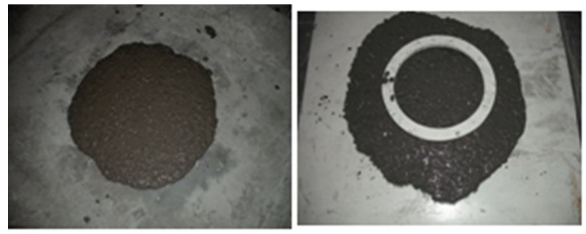

Figure 2. Slump flow and J-ring test

Table 2.Mechanical properties

Mix	slump spread (mm)	t 500 (sec)	Mechanical property (N/mm^2)	
			compressive	Split tensile
M1	672	6	38.1	4
M2	661	6	36	4
M3	688	4	35.4	4
M4	655	5	31.8	3.6
M5	670	4	31.5	3.5

4. CONCLUSIONS

(i) From the mini slump studies, mix containing 60% paste and 40% sand showed better performance regarding flow and stability.

(ii) Based on experimental results, it is observed that M1 mix is far superior in terms of compressive and split tensile strength.

(iii) M3 mix showed the maximum spread diameter of about 688mm.

REFERENCES

[1]Okamura H (1997). Self compacting high–performance concrete.Concrete Int., pp. 50-54.

[2]European guidelines for self compacting concrete (2005). Specification,Production and Use, pp. 50-52.

[3]Roussel N. Rheology of fresh concrete: from measurements to predictions of casting processes. Mater Struct 2007;40(10):1001–12.

[4] Chiara FF, Karthik HO, Russel H (2000). The influence of mineral admixtures on the rheology of cement paste and concrete. Cem. Concrete Res., 31: 245-255.

[5]ASTM (2002), Annual Book of ASTM Standards, Standard Designation, C1611, Standard test method for slump flow of self consolidating concrete, Annual book of ASTM standards, Philadelphia, pp. 1-6.

[6]ASTM (2002). Annual Book of ASTM Standards, Standard Designation C1621, standard test method for passing ability of self consolidating concrete by j-ring, Philadelphia, pp. 1-4.

[7] Pineaud A, Cabrillac R, Re´mond S, Pimienta P, Rivillon P. Mechanical properties of self-compacting concrete – Influence of composition parameters. Proceedings of SCC 2005 conference Centre for Advanced Cement Based Materials. USA: Northwestern University; 2005. p. 863–8.

[8] Bouzoubaa N, Lachemi M. Self-compacting concrete incorporatinghigh volumes of class F fly ash: Preliminary results. Cement Concr Res 2001;31(3):413–20.

[9] Benson SDP, Karihaloo BL. CARDIFRC_ – development and mechanical properties. Part I: Development and workability. Mag Concr Res 2005;57(6):347–52.