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Strength Characteristics of Self Compacting Concrete Containing Flyash and Silicafume

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ABSTRACT

Self-Compacting Concrete (SCC) has more attention because of its ability to compact without the need of internal or external vibration. The placing of normal conventional concrete is difficult in reinforcement confinement places and also the strength of the concrete is low when it is subjected to severe exposure condition. In order to overcome these effects the admixtures were used in the concrete to increase the strength and durable properties. As the concrete is flow able, SCC has more workability and by the addition of mineral admixture like fly ash and silica fume, the concrete will attain more strength and durable, so that the concrete will behave as Self Compacting High Performance Concrete (SCHPC). In this paper the tests on fresh SCC such as slump flow test, V funnel tests and L-box tests were presented and the test results were discussed. Cubes and cylinders were made with different percentage replacement of cement with fly ash and silica fume and strength tests such as cube compressive strength at 7th and 28th days and split tensile strength test at 28th days was performed. The test results showed that the 30% replacement of cement with combination of fly ash and silica fume gave better strength when compared to that of the normal conventional concrete.

Keywords: Self Compacting Concrete, Fly ash, Silica fume, Superplasticizer, Viscosity Modifying Admixture

I. INTRODUCTION

Self-Compacting Concrete (SCC) is a flow able concrete that is able to consolidate under its own weight. In other words it is a relatively a new product that seeks the addition of super plasticizer and a stabilizer to the concrete mix to significantly increase the ease and rate of flow [1]. By its nature, SCC does not require vibration. It achieves good compaction simply by means of its own weight without any segregation of the coarse aggregate. It has been developed in Japan and Continental Europe and is now being increasingly used in UK in which construction time is faster, provides safety and health benefits, increased workability and ease of flow around heavy reinforcement [2].

As SCC is fluid in nature, it is suitable for placing in difficult conditions and in sections with congested reinforcement. Elimination of mechanical compaction is the main advantage. Uses of SCC can also help in minimizing hearing-related damages on the worksite that are induced by the vibration of concrete. Another advantage of SCC is that the time required to place large sections is considerably reduced.

Self-compacting high performance concrete (SCHPC) is defined as a new generation of concretes on the basis of the concepts of self-compacting concrete (SCC) and of high performance concrete (HPC). A method for proportioning SCHPC aims at fulfilling the self-compact ability requirements of SCC (filling ability, passing ability, and segregation resistance), and of high compressive strength and good durability of HPC by addition of admixtures [3]. To realize this goal, a high volume of Portland cement, a very high dosage of chemical admixtures, i.e. super plasticizer (SP) and Viscosity Modifying Admixtures (VMA), and reactive Mineral Admixtures (MA), e.g. Silica Fume (SF), Fly ash are used[4]. The performance of SCHPC is highly improved by using SF and FA however it is expensive due to the limited availability especially in developing countries. Several studies were made on SCC with different types of admixture and their effects and it has been found that they showed good strength. [5-8].

SCC differ from the ordinary concrete, in that the former has more powder content and less coarse aggregate. The High Range Water Reducing Admixture (HRWRA) helps in achieving excellent flow at low water contents and the use of VMA reduces bleeding and improves the stability of the concrete. It can also bring down the powder requirement and gives more stability. Moreover, SCC includes a mineral admixture, to enhance the deformability and stability of concrete.

II. METHODS AND MATERIAL

2. Materials Used

The materials used for the study were the same as those that of the Conventionally Vibrated Concrete. The variations were done in the use of mineral and chemical admixtures. In this present study M30 grade concrete was used with Ordinary Portland cement of grade 53 was used with a specific gravity of 3.15. The initial setting time and the standard consistency of the cement were 28 minutes and 36% respectively. The natural river sand has been used with a specific gravity of 2.65 and fineness modulus of 2.61. The coarse aggregate with a maximum nominal size of less than 12.5 mm was used. The specific gravity and the fineness modulus of the coarse aggregate was 2.7 and 6.9 respectively.

2.1 Mineral Admixture

Fly ash and silica fume was added in SCC as a partial replacement of cement with different percentage. One of the most beneficial uses for silica fume in concrete is because of its chemical and physical properties [9]. Concrete containing silica fume can have very high strength and can be very durable.

2.2 Chemical Admixture

2.2.1 Superplasticizer

In this study, Super plasticizer named CERAPLAST 100 was used. Super plasticizer is essential for the creation of SCC. The use of SP is to impart a high degree of flow ability and deformability. Super plasticizers, also known as high range water reducers, are chemical admixtures used where well-dispersed particle suspension is required. These polymers were used as dispersants to avoid particle segregation (gravel, coarse and fine sands), and to improve the flow characteristics of suspensions in concrete. This effect improves the performance of the hardening fresh paste.

2.2.2 Viscosity Modifying Agent

The admixtures which modify the cohesion of the SCC without significantly altering its fluidity are called viscosity modifying agent (VMA). These admixtures were used in SCC to minimize the effect of variations in moisture content, fines in the sands or its grain size distribution, making the SCC more robust and less sensitive to small variations. In this study VMA called as Auromix V100 was used.

3. Experimental Program

In order to determine the fresh properties of SCC various tests like Slump flow test, slump flow associated with time T500, L-Box test, V-funnel tests were conducted. The strength tests such as compressive Strength test, split tensile tests were conducted on the hardened SCC. Based on the EFNARC guidelines the mix proportions were taken [11]. The strength obtained by 20%, 30% and 40% replacement of cement with fly ash and silica fume has been observed in this study.

4. Tests of Fresh SCC

The tests results obtained for fresh properties of self-compacting concrete are discussed below. The slump flow test was conducted to determine the filling ability of concrete and its resistance to segregation. The spread diameter T50 and the general visual appearance are recorded and it is shown in Fig 4.1. To evaluate the viscosity of SCC, V-funnel tests were carried out and the time taken to drain the funnel was measured in seconds and the test set up is shown in Fig 4.2. To assess the filling and passing ability of SCC L-box tests was conducted and the blocking ratio was determined. The L-box test setup is shown on Fig 4.3. The test values obtained satisfy the recommended value and they are listed in the Table 4.1.

Table 4.1 Test Results for Fresh SCC

Test Method	Test Results	Recommended values	
Slump	680	650	800

flow (secs)			
T-500 slump flow (sec)	4	2	10
V-funnel test (sec)	11	6	12
V-funnel at 5 minutes (sec)	12	0	+3
L-box test (H2/H1)	0.85	0.8	1

Figure 4.1 Measurement of slump

Figure 4.2 V-Funnel Test

Figure 4.3 L-Box test

III. RESULTS AND DISCUSSION

5. Test Results and Discussions

5.1 Compressive Strength

In order to evaluate the compressive strength of the concrete, cubes were made with 20%, 30% & 40% replacement of cement with fly ash and silica fume. The 7th and 28th day's compressive strength of the concrete has been observed. The results obtained showed that the compressive strength increases with increase in 30% of fly ash (15%) and silica fume (15%) and beyond that it decreases. It also has been noted that the compressive strength of SCC was more than that of the control mix. The maximum compressive strength has been observed for the mix with 15% replacement of fly ash and silica fume as shown in Fig 5.1. The compressive strength results are shown in the Table 5.1.

Table 5.1 Compressive strength test result

MIX DESIGNATION	COMPRESSIVE STRENGTH N/mm²	
	7 days	28 days
CONTROL MIX	16.34	18.46
10% FA & 10% SF	15.21	19.11
15% FA & 15% SF	20.45	26.52
20% FA & 20% SF	21.65	23.19

5.2 Split Tensile Strength

The split tensile strength has been conducted on the cylinder specimen and the results obtained from the tests showed that the value of compressive strength was more than that of the control mix. The split tensile strength increases with increase in percentage of fly ash and silica fume. The 15% replacement of cement with fly ash and silica fume gave good splitting tensile strength which is shown on Fig 5.2 and the test results are shown in the Table 5.2.

Table 5.2 Split Tensile Strength test Result

MIX DESIGNATION	SPLIT TENSILE STRENGTH N/mm² (28 DAYS)
CONTROL MIX	1.98
10% FA & 10% SF	2.07
15% FA & 15% SF	2.38
20% FA & 20% SF	2.05

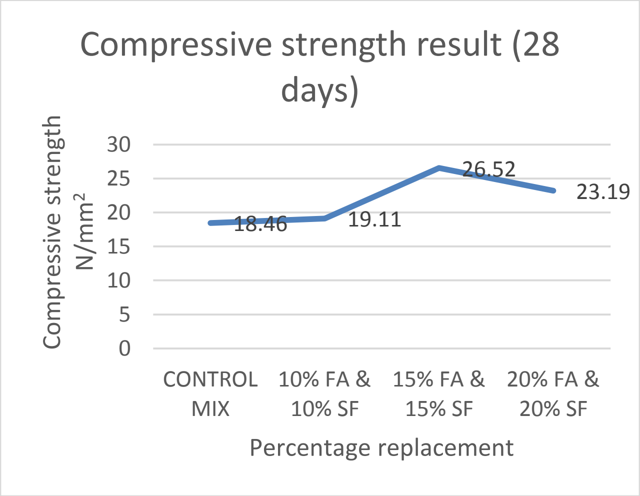

Figure 5.1 Compressive strength of SCC with 15% Fly ash and Silica Fume

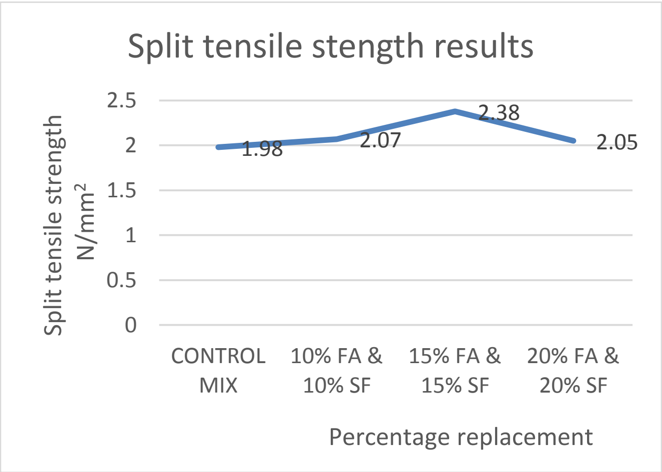

Figure 5.2 Split Tensile strength of SCC with 15% Fly ash and Silica Fume

IV. CONCLUSION

Based on the various tests performed and from the results obtained, it has been found that

- The use of fly ash and silica fume effectively increased the strength of the concrete. By the use of fly ash Bleeding and Segregation property was reduced and filling & passing ability was increased.
- Silica fume effectively increased the mechanical and physical properties of the Self compacting Concrete.
- The fresh properties of SCC was checked by various tests and the results from the tests satisfied the recommended value which showed that the SCC provides good workability which is an important characteristic of SCC.
- With the replacement of 15% of fly ash and 15% of silica fume in cement, the compressive strength and split tensile strength of the SCC was effectively increased up to 10% when compared to that of the normal conventional concrete.

Hence from this experimental study it can be concluded that the use of fly ash and silica fume blends well to improve the strength of the Self-Compacting concrete and it can be used for future construction works.

V. REFERENCES

[1] DeepaBalakrishnan S., Paulose K.C (2013), "Workability and strength characteristics of self-compacting concrete containing fly ash and dolomite powder", American Journal of Engineering Research, Vol. 2, pp. 43-47.

[2] Heba A. Mohamed (2011), "Effect of fly ash and silica fume on compressive strength of Self-compacting concrete under different curing conditions", Ain Shams Engineering Journal, Vol. 2,pp. 79–86.

[3] Eva Vejmelkova, Milena Pavlikova, Martin Keppert, ZbynekKersner, PavlaRovnanikova, Michal Ondracek, Martin Sedlmajer, Robert C erny (2010), "High performance concrete with Czech metakaolin: Experimental analysis of strength, toughness and durability characteristics", Construction and Building Materials, Vol. 24, pp. 1404–1411.

[4] Sabry A. Ahmed (2013),"Properties and mesostructural characteristics of linen fiber reinforced Self-compacting concrete in slender

columns", Ain Shams Engineering Journal, Vol. 4, pp. 155–161.
[5] TosmaszPonikiewski and JacekGolaszewski (2013),"The Rheological and Mechanical properties of High Performance Self-Compacting Concrete with High Calcium Fly ash", Procedia Engineering, Vol. 65, pp. 33-38.
[6] BeataLazniewska-Piekarczyk (2014), "Influence of Antifoaming Admixture Type on Several Properties of High-Performance Self-Compacting Concrete", Journal of Materials in Civil Engineering, pp. 1-11.
[7] SelcukTurkel and Ali Kandemir (2010), "Fresh and Hardened Properties of SCC Made with Different Aggregate and Mineral Admixtures", Journal of materials in civil engineering, Vol. 22, pp. 1025-1032.
[8] Mostafa Jalal, MojtabaFathi, Mohammad Farzad (2013), "Effects of fly ash and TiO2 nanoparticles on rheological, mechanical, microstructural and thermal properties of high strength self-compacting concrete", Mechanics of Materials, Vol. 61, pp. 11–27.
[9] Salah A. Abo-El-Enein, Hamdy A. El-Sayed, Ali H. Ali, Yasser T. Mohammed, Hisham M. Khater, Ahmed S. Ouda (2014), " Physico-mechanical properties of high performance concrete using different aggregates in presence of silica fume", Housing and Building National Research Center (HBRC) Journal, Vol. 10, pp. 43–48.
[10] Mohammad Soleymani Ashtiani, Allan N. Scott, Rajesh P. Dhakal (2013), "Mechanical and fresh properties of high-strength self-compacting concrete containing class C fly ash", Construction and Building Materials, Vol. 47, pp. 1217–1224.
[11] EFNARC (2002), "Specification and Guidelines for Self Compact Concrete" EFNARC (European Federation of producers and Applications of Specialist Products for Structures).