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STUDY OF MACRO LEVEL PROPERTIES OF SCC USING SILICA FUME AND FLY ASH BY USING ROBOSAND

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ABSTRACT

One of the major environmental concerns is the disposal of the waste materials and utilization of industrial by products. Many power plants and electro static precipitators will produce millions of tons waste powder every year. Having considerable high degree of fineness in comparison to cement this material may be utilized as a partial replacement to cement. For this purpose an experiment is conducted to investigate the possibility of using fly ash powder in the production of SCC with combined use SILICAFUME and how it affects the fresh and mechanical properties of SCC. First SCC is made by replacing cement with SILICA FUME in 10% and fly ash powder is blended to mix in percentage like 25% as a partial replacement to cement. Here we use manufacture sand as fine aggregate. By taking fineness modulus 2.5,2.7,2.9 .Test results shows that the SCC mix with combination of 10% SILICA FUME and 25% fly ash powder with fineness modulus 2.7 satisfies filling ability and passing ability and hardened properties are also in the limits prescribed by the EFNARC.

Key words: self compacting concrete, SILICA FUME, Fly ash.

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1. INTRODUCTION

The development of self-compacting concrete (SCC) also referred to as "Self-Consolidating Concrete" has recently been one of the most important developments in building industry. Self-compacting concrete (SCC) is a special concrete that can settle into the heavily reinforced, deep and narrow sections by its own weight, and can consolidate itself without necessitating internal or external vibration, and at the same time maintaining its stability without leading to segregation and bleeding. SCC demands a large amount of powder content compared to conventional vibrated concrete to produce a homogeneous and cohesive mix. The common practice to obtain self-compatibility in SCC is to limit the coarse aggregate content and the maximum size and to use lower water–powder ratios together with new generation super plasticizers (SP). During the transportation and placement of SCC the increased flowability may cause segregation and bleeding which can be overcome by providing the necessary viscosity, which is usually supplied by increasing the fine aggregate content; by limiting the maximum aggregate size; by increasing the powder content; or by utilizing viscosity modifying admixtures (VMA) . One of the disadvantages of SCC is its cost, associated with the use of chemical admixtures and use of high volumes of Portland cement. One alternative to reduce the cost of SCC is the use of mineral additives such as limestone powder, natural pozzolans, fly ash and slag, which are finely divided materials added to concrete as separate ingredients either before or during mixing . As these mineral additives replace part of the portland cement, the cost of SCC will be reduced especially if the mineral additive is an industrial by-product or waste. It is well established that the mineral additives, such as fly ash and slag, may increase the workability, durability and long-term properties of concrete.

Therefore, use of these types of mineral additives in SCC will make it possible, not only to decrease the cost of SCC but also to increase its long-term performance. To assess the effectiveness of SILICA FUME in SCC some of the parameters like chemical composition, hydraulic reactivity, and fineness have been carefully examined earlier It was seen that among these, the reactive glass content and fineness of SILICA FUME alone will influence the cementitious/pozzolanic efficiency or its reactivity in concrete composites significantly

Fly ash improves the mechanical and durability features of concretes by providing more compact structure through its pore-filling effect. In the existence of SILICA FUME, it also reacts with cement by binding with free silica by a pozzolanic reaction forming a non-soluble CSH structure. Many researches shown that use of ternary blends of cementitious materials improved the early age and the Long-term mechanical properties.. In this paper an investigation on the combined use of SILICA FUME and Fly ash powder in Self compacting concrete is done to evaluate the fresh and mechanical properties

2. REVIEW OF LITERATURE

Published literature on self-compacting concrete first appeared in 1989, and has been increasing significantly since that time, reflecting the amount of research and practical applications taking place. A vast research is going on the use of various waste materials that can replace cement in self compacting concrete. This chapter summarizes the most important published information of direct relevance to the experimental work reported in this project. As present investigation deals with the replacement of cement with Ground Granulated Blast Furnace Slag and Lime stone powder partially. An attempt has been made to review briefly the available literature

HalitYaz ı c ı had studied the effect of silica fume fly ash on properties of concrete. Test results indicate that SCC could be obtained with a high-volume FA. Ten percent SF additions to the system positively affected both the fresh and hardened properties of high-performance high-volume FA SCSC.

A.A.Magsoudhi, F.Arabpour examined the relationship between the nano technology and the study of properties of self compacting concrete. Their results show that mix containing both micro silica and nano silica improves the engineering properties of the self compacting concrete.

Ali Nazari , ShadiRiahi In this work, compressive, flexural and split tensile strengths together with coefficient of water absorption of high strength self compacting concrete containing different amount of SiO_2 Nano-particles have been investigated. Results indicate that SiO_2 nano-particles up to 4 wt% could improve the mechanical and physical properties of the specimens.

Ali Nazari, Shadi Riahi had studied strength assessments and coefficient of water absorption of high performance self compacting concrete containing different amounts of TiO_2 nano particles have been investigated. The results indicate that the strength and the resistance to water permeability of the specimens are improved by adding TiO_2 nano particles in the cement paste up to 4.0 wt%.

Prajapati Krishnapal, Chandak Rajeev had studied the properties of self compacting concrete, mixed with fly ash. The test results for acceptance characteristics of self-compacting concrete such as slump flow; V- funnel and L-Box are presented. Further, compressive strength at the ages of 7, 28 days was also determined. They concluded that addition of fly-ash in SCC increases filling and passing ability of concrete, Increase in fly ash, super plasticizer content in SCC reduced water demand and compressive strength of concrete.

J.Guru Jawahar, et.al had studied the effect of coarse aggregate blending on short term mechanical properties of concrete. Their investigation mainly focused on finding the unit weight, compressive strength, modulus of elasticity(MOE) and split tensile strength(STS) of SCC mixes with different coarse aggregate blending(60:40 and 40:60) (20mm and 10mm) and coarse aggregate content (28% and 32%). They concluded that the coarse aggregate blending did not affect the compressive strength of SCC mixes, but it affected the unit weight, MOE and STS of SCC mixes.

Mucteba Uysal.et.al (2010) had studied the effectiveness of various mineral admixtures in producing self-compacting concrete (SCC). For this purpose, fly ash (FA), granulated blast furnace slag (GBFS), limestone powder (LP), basalt powder (BP) and marble powder (MP) were used. It was concluded that among the mineral admixtures used, FA and GBSF significantly increased the workability of SCC.

H.A.F. Dehwah (2012) His paper presents the results of a study conducted to evaluate the mechanical properties of self-compacting concrete (SCC) prepared using quarry dust powder (QDP), silica fume (SF) plus QDP or only fly ash (FA). The results indicated that the mechanical properties of SCC incorporating QDP (8–10%) were equal to or better than those of SCC prepared with either SF plus QDP or FA alone.

Beeralingegowda, V. D. Gundakalle (2013) had studied the effect of addition of limestone powder on properties of self compacting concrete. In this study, cement content in the SCC mix is replaced with various percentages of limestone powder (LP) (0 to 30%), the fresh and hardened properties and also the durability characteristics of SCC such as acid attack and chloride attack are studied. The experimental results were validated by regression analysis. It is observed that limestone powder can be effectively used as a mineral additive in scc.

Anthony Nkem Ede.et.al (2014) They had made attempts enhance the flow-ability of SCC by replacement of cement with varying dosage of limestone and super-plasticizer. To validate the improvement of SCC fresh properties, slump test is used to assess workability, L-box test for passing ability and V-funnel test for filling ability. Test results analyzed with statistical tools confirmed that the workability and rheological properties of self-compacting concrete can be improved through the adoption of various dosages of limestone powder.

3. MATERIALS AND THEIR PROPERTIES

In the present investigation materials used are

- Ordinary Portland cement 53 Grade
- SILICA FUME as partial replacement to cement
- Fly ash powder as partial replacement to cement
- Manufacture sand as fine aggregate
- Crushed Stone as coarse aggregate of size not greater than 12 mm
- super plasticizer(poly carboxylate based)
- Water

4. MATERIAL PROPERTIES

(1) Ordinary Portland Cement (OPC) 53 grade conformingtoIS12269:1987 is used in this work. The properties of used cement were

Table 1

TYPE	OPC 53 grade (Zuari)
Normal consistency	32%
Specific Gravity	3.15
Compressive strength	55.6MPa

(2) SILICA FUME brought from ASTRRA chemicals having specific gravity 2.63

(3) Fly ash powder brought from ESP having specific gravity 2.12

(4) The physical properties of fine aggregate (manufacture sand) were.

Specific gravity – 2.60

Water absorption – 1%

Fineness modulus – 2.7

Maximum nominal size – 4.75 mm

(5)The physical properties of Coarse aggregate (Crushed granite) were

Table 2

Specific gravity	2.58
Fineness modulus	4.6
Water absorption (%)	0.3%
Maximum nominal size	12mm

(6) Master Glenium Sky Super plasticizer (poly carboxylate based) having specific gravity 1.03 (as given by the manufacturer)

5. MIX PROPORTIONING

The mix proportion is a key factor to be considered to achieve SCC. Though the SCC was first developed in 1980"s there is no standard mix design adopted or developed to achieve SCC. The European Federation of Specialist Construction Chemicals and Concrete systems (EFNARC) provide the guideline for development of SCC. But no method of mix design specifies the grade of concrete in SCC. In this work mix design is developed based on the EFNARC guidelines and simple tool developed by J.Guru Jawahar. In this work SILICA FUME and Fly ash powder are used as mineral additives which replace cement and water-powder ratio of 0.36 is maintained constant throughout the experiment. First cement is replaced with SILICA FUME in 10% percentage and fly ash is mixed in 25% using fineness modulus of fine aggregate are 2.5, 2.7, 2.9. Fresh properties are checked for each fineness modulus. Fresh properties like filling and passing ability is satisfied only for 2.7 fineness modulus remaining 2.5 and 2.9 fineness modulus will not satisfy fresh properties. 2.5 fineness modulus fails in filling ability and it does not get slump as specified in EFNARC guidelines. Whereas 2.9 fineness modulus have some segregation and it is likely seem to segregated. I tested for hardened properties for all the three fineness modulus. As fineness modulus increases compressive, split tensile and flexure strength goes on decreases. As SCC main criteria is passing and filling ability so we take 2.7 fineness modulus as optimum

6. TESTING PROCEDURES

6.1. Fresh Properties

Slump flow, V-funnel, L-box, were used to test the workability, passing ability, of SCCs. Workability of the SCCs was controlled through the slump flow test such that slump flow diameters of all of the mixtures were designed to be in the range of 650-800 mm as to satisfy the EFNARC limitations. For this, trial batches were produced for each mixture till the desired slump flow was obtained by adjusting the dosage of the super plasticizer. Flowability of the mixtures was inspected through the V-Funnel test. L-box test was carried out as an indication of passing ability, or the degree to which the passage of concrete through the bars is restricted. Slump flow, L-box, and V-funnel tests were performed according to the procedure recommended by EFNARC committee. The results of fresh properties for each mix were tabulated below.

6.2. Fresh Properties of SCC

Table 3

FINENESS MODULUS	SLUMP FLOW IN MM	T_{500} IN SEC	V FUNNEL IN SEC	L BOX H_2/H_1
EFNARC STANDARDS	650 TO 800 IN MM	2 TO 5 IN SEC	6 TO 12 IN SEC	0.8 TO 1
2.5	610	6	18	0.78
2.7	670	5	10	0.86
2.9	820	3	6	0.89

Compressive strength of SCC were measured according to ASTM C 39 by means of a compression testing machine. The test was conducted on three 150 mm cubes at the ages of 7,28,90 days normal water curing and the average of them was reported herein. Splitting tensile strength of the SCCs was determined on 150 mm dia and300 mm height cylinder specimens at 7,28,90 days. The splitting tensile strength reported in the study was the average of three cylinders. Flexural strength of the SCC was determined on 500 mm x 100 mm x100 mm beam specimens. The test was conducted on one beam specimen after 7,28,90 days of normal water curing. Test results were tabulated below Compressive strength of SCC were measured according to ASTM C 39 by means of a compression testing machine. The test was conducted on three 150 mm cubes at the ages of 7,28,90 days normal water curing and the average of them was reported herein. Splitting tensile strength of the SCCs was determined on 150 mm dia and300 mm height cylinder specimens at 7,28,90 days. The splitting tensile strength reported in the study was the average of three cylinders. Flexural strength of the SCC was determined on 500 mm x 100 mm x100 mm beam specimens. The test was conducted on one beam specimen after 7, 28 and 90 days of normal water curing. Test results were tabulated below.

6.3. Hardened Properties

Table 4

FINENESS MODULUS	COMPRESSIVE STRENGTH IN N/MM²			SPLIT TENSILE STRENGTH IN N/MM²			FLEXURE STRENGTH IN N/MM²		
	7 Days	28Days	90Days	7 Days	28Days	90Days	7 Days	28Days	90Days
2.5	32	43.84	47.65	3.12	5.10	6.25	5.58	7.65	8.40
2.7	30.8	41.66	45.78	3.01	5.09	6.12	5.40	7.4	8.13
2.9	29	40.41	43.45	2.98	4.91	6.05	5.11	7.21	7.75

6.4. Compressive Strength in N/MM^2

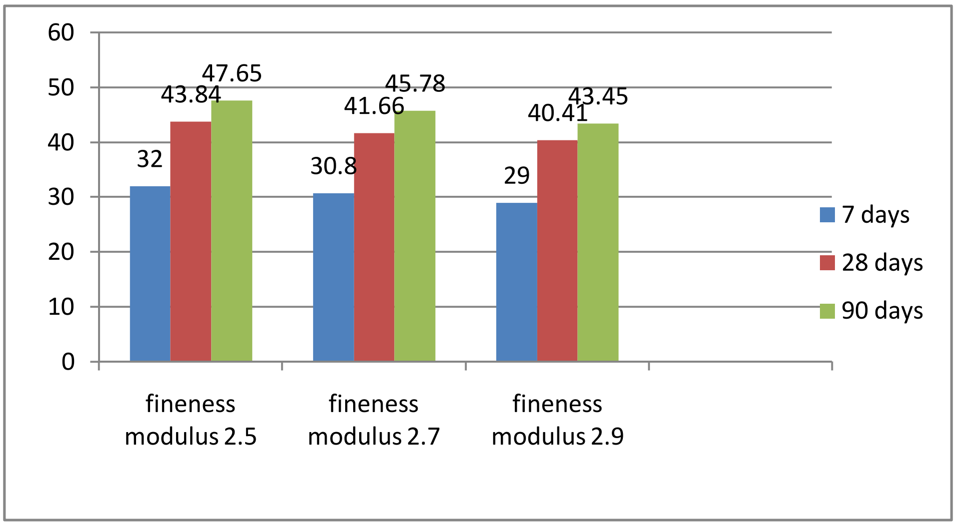

Figure 1 Compressive Strength in N/MM^2

6.5. Split Tensile Strength in N/MM^2

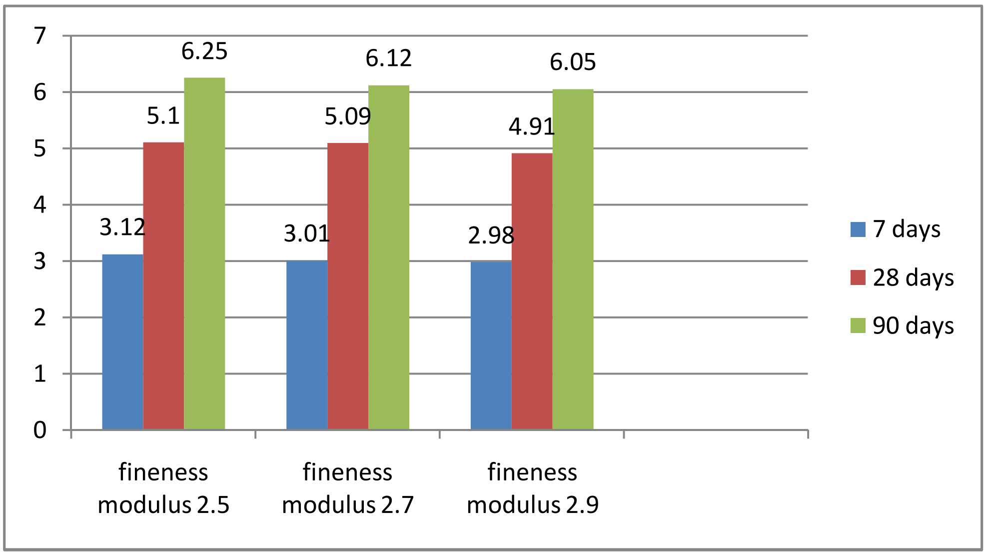

Figure 2 Split Tensile Strength in N/MM^2

6.6. Flexure Strength in N/MM^2

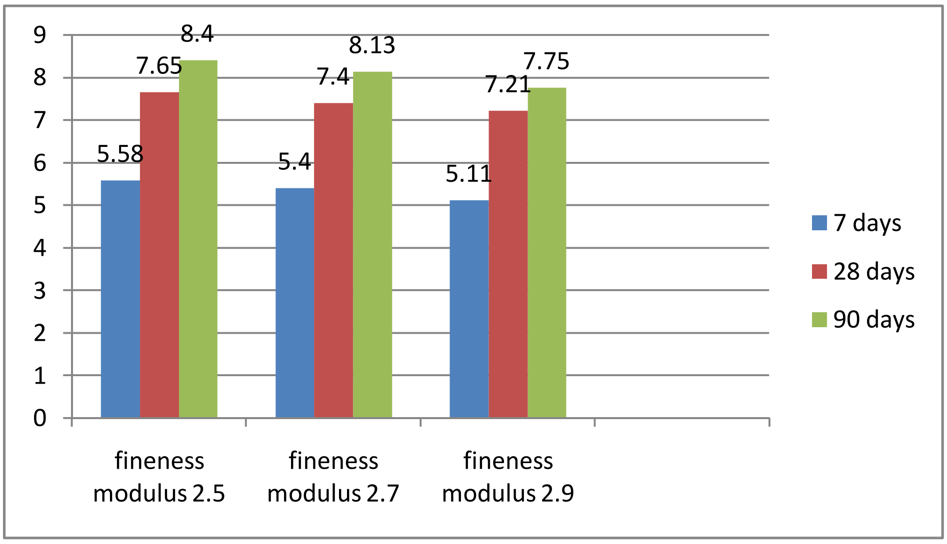

Figure 3 Flexure Strength in N/MM^2

7. CONCLUSIONS

- From the test results it was concluded that when cement is replaced with SILICAFUME by 10% and Fly ash 25% both fresh and hardened properties were optimum and having compressive strength of 43.84 Mpa for the phase of SILICAFUME. Beyond 35% replacement of SILICA FUME and Fly ash strength properties were tend to decrease. Hence the optimum replacement percentage of SILICA FUME and Flyash that can replace cement is 35%.
- Combined mix of 10% SILICAFUME and 25% Fly ash powder gives maximum strength parameters and fresh properties for the mix is also in the limits prescribed by the EFNARC.
- Mix (10% Silica fume, 25% Fly ash powder, and 65% Cement) has the maximum compressive strength.(43.84 MPa), maximum split tensile strength (5.1 MPa) and maximum flexural strength (7.65 MPa).
- The percentage increase in compressive strength for the mix with 2.7 fineness modulus is found to be satisfactory.

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