Effect of Fly Ash On Elastic Properties Of Self Compacting Concrete With Prestressing

[1]Mr.Tushar Harihar Sonawane, [2]Prof. Yuvraj L. Bhirud

[1]Lecturer, [2]Associate Professor and Head
[1]Civil Engineering Department,
[1]SNJB's LSKBJ College of Engineering, Chandwad, Nashik, MH, India.

Abstract:

This report aims to study 'Effect of cementitious powder on fresh and hardened state properties of self compacting concrete. Self compacting concrete does not require vibration for placing and compaction hence considered as 'Most revolutionary development in concrete construction for several decades'. This concrete is able to flow under its own weight, completely filling of formwork and achieving full compaction even in the presence of congested reinforcement. The hardened concrete has same engineering properties as traditional vibrated concrete. The fly ash added in appropriate quantity as replacement. The addition of fly ash imparts properties. Hardened properties like Shrinkage and elastic shortening for prestressing are considered as it has effects on strength and durability of concrete. Effect of the same in a given volume of concrete on above mentioned properties are determined. The elastic properties were studied by varying the powder content as 550 kg/m³, 600 kg/m³ and 650 kg/m³. 7 days, 28 days and 56 days cubes, cylinders and beams were cast, cured and tested. The fly ash is added in appropriate quantity as replacement.

Key Words – Self Compacting Concrete, Fly Ash, powder content, Special Concrete, Prestressing, elastic shortening, shrinkage.

I. INTRODUCTION

Self-compacting concrete is defined as a concrete which is capable of self-consolidating without any external efforts like vibration, floating, poking etc. under its own weight. The mix is therefore required to have ability of passing, ability of filling and ability of being stable. Filling ability is the property of Self Compacting Concrete to flow into and fill all spaces within the formwork completely under its own weight without any honeycombing. Passing ability is the property of the Self Compacting Concrete to pass through congested reinforcement without blocking.Segregation resistance is the ability of Self Compacting Concrete to remain stable in composition. SCC being flowing in nature, it must satisfy all these properties.

SCC is been already used in precast industry and in some commercial constructions. Compared to conventional concrete of same mechanical properties, the material cost of SCC is more due to the relatively high demand of cementacious materials. Typically, the content in cementacious material can vary between 450 to 525 kg/m^3 for filling forms with SCC mix. To achieve desired workability high range water reducing admixture (HRWRA) like Superplasticizer is used. Higher binder content is achieved by replacing cement with fly ash by 20- 40 %. Changes in the binding material, its proportion significantly affects the properties of traditional vibrated concrete as well as Self Compacting concrete. If same concrete used for prestressing work, result also shows changes in prestressing properties.

The studies had been carried out which gives an idea about similarities and changes in properties of self compacting concrete and fly ash. Dhruvkumar H. Patel et al.[10] suggested to make use of Ground granulated blast furnace slag (GGBS) as a replacement of cement and understand its effects on the fresh properties, compressive strength weathering. J.M. Khatib et al. [3] investigated the influence of fly ash on the properties of Self compacting concrete (SCC). Their result indicates that the high volume Fly ash can be used in SCC to produce high strength and low shrinkage concrete. Subhan Ahmad et al. [11] compared hardened properties of normal concrete (NC) and self compacting concrete (SCC). Compressive strength and Split tensile strength of SCC were found slightly higher than NC. However, modulus of rupture and modulus of elasticity of SCC was found to be lower than NC. Addition of glass fibers in SCC had limited effect on compressive strength and modulus of elasticity but increased modulus of rupture and splitting tensile strength significantly. Her-Yung Wang et al [7] examined the properties of freshly poured SCC with a fixed water cement ratio, the results of laboratory test shows that the fresh and engineering properties can be improved, and the water resource can be reused.

In several test series the fresh and hardened properties of concretes with reduced water and cement contents were investigated, especially their workability, strength development, design and relevant mechanical properties as well as durability aspects such as carbonation. It was shown that concretes with cement clinker and slag contents as low as 150 kg/m^3 were able to meet the usual requirements of workability, compressive strength (approx. 40 N/mm^2) and other mechanical properties.

II. EXPERIMENTAL PROGRAM

Workability of SCC is higher than traditional vibrated concrete, being flowable in nature normal workability methods are not suitable for SCC. Various tests have been developed in attempts to characterize the properties of SCC. So far, no single method or combination of methods has achieved universal approval and most of them have their adherents. Similarly, no single method has been found which characterizes all the relevant workability aspects of Self Compacting Concrete, so each mix design should be tested by more than one test method for the different workability parameters. Alternate test methods were adopted for various workability parameters; Slump flow test, T50cm slump flow test for filling ability, V funnel and V funnel at T5min test for segregation resistance and L-box test for passing ability.

To judge hardened properties of concrete tests performed on cube, cylinder and beam samples. For prestressing beams with high tensile strand cables with 5mm dia with 1750MPa and 3% of elongation were used.

Mix proportion for traditional concrete is opted by IS 10262, and for SCC EFNARC guidelines were used. Mix design method and information were available in various researches available. The mix design is done by 40% replacement of fly ash for 550 kg/m^3 powder content. Ordinary Portland cement of 53 grade from the local market was used and tested for physical and chemical properties as per IS: 4031 – 1988 and found to be conforming to various specifications as per IS: 12269-1987. Fly ash confirming to class F was used. The mix proportion used in this study is shown in Table No. 1

Table No. 1 Mix Proportion for the mix

Materials	550kg/m^3	600 kg/m^3	650 kg/m^3
Cement	330	360	390
Fly Ash	220	240	250
Natural Sand	1130.50	1095.5	1060.50
Coarse Aggregate	484.5	459.5	454.50
Coarse Agg.(10mm)	193.8	187.80	250
Coarse Agg.(20mm)	290.70	281.76	204.50
Water	176.00 (32%)	192 (32%)	208 (32%)
Super Plasticizer	7.15 (1.3 %)	8.10 (1.1%)	7.15 (1%)

III. RESULTS AND DISCUSSION

1. Tests on Material

a) Cement – As per 12269-1987 Table No. 2

Sr. No.	Test	Result
1	Fineness Test	2 %
2	Normal consistency	33%
3	Initial setting time	65 min.
4	Final setting time	417 min.
5	Specific gravity	3.15

b) Fine aggregate – As per IS 2386 Table No. 3

Sr. No.	Property	Result
1	Fineness modulus	5.065
2	Specific gravity	2.73
3	Silt Content	0.002
4	Water Absorption	3.09%

c) Coarse aggregate – As per IS 2386 Table No. 4

Sr. No.	Property	10 mm	20 mm
1	Fineness modulus	2.90	3.00
2	Specific gravity	2.67	2.7
3	Water Absorption	2.28	2.28

d) Fly Ash

In the present investigation work, the fly ash used is obtained from Eklahara thermal power station in Nashik (Maharashtra). The specific surface of fly ash is found to be 359.143 m^2/kg, its specific gravity is 2.3 and product P-60.

e) Steel (Tendon)

A steel tendon of 4 mm diameter is used for pre stressing purpose. The breaking stress for strand is 1750 N/ mm^2. Elongation permitted is 5mm/M.

f) Super Plasticizer

In the present investigation SP430 a product of FOSROC Company having a specific gravity of 1.222 is used as water reducing admixture.

2. Tests and results of fresh properties of SCC. Table No. 5

Method	Unit	550 kg/m^3	600	650
Slump-flow test	mm	700	750	780
V-funnel	sec	12	11	10
V-funnel at $T_{5minutes}$	sec	14	13	12
T_{50cm} slump flow	sec	4	4	3
L-box	(H_2/H_1)	0.834	0.945	0.893

3. Tests and results of Hardened Properties of SCC

a) Compressive Strength of concrete

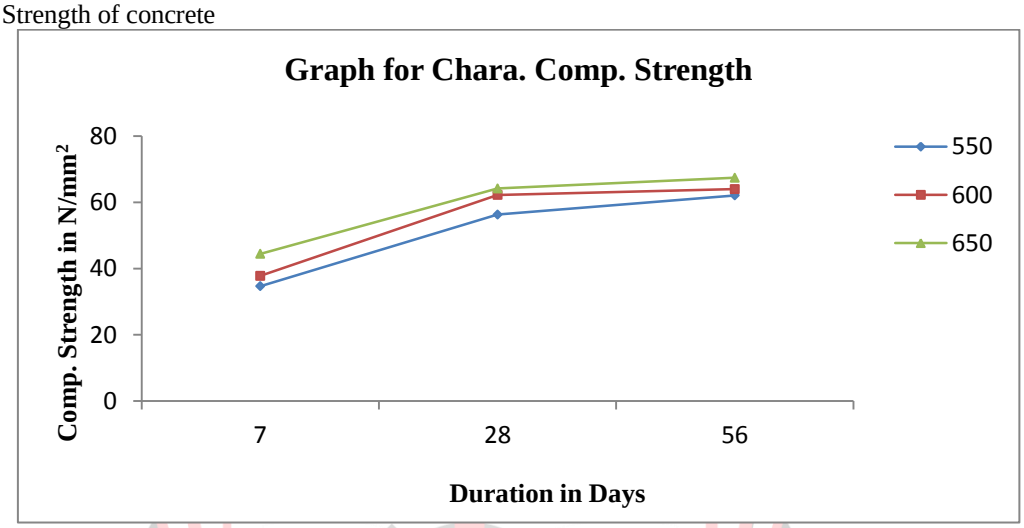

Figure 1: Variation in compressive strength for different powder contents in kg/m³

From figure 1 it is observed that as powder content in self-compacting concrete increases Characteristic Compressive Strength is also increases.

At 7 days curing is observe that strength of 550 powder mix is 34.67 N/mm^2, 600 powder mix is 37.78N/mm^{2}and 650 powder mix 44.44 N/mm^2. At28 days curing is observe that strength of 550 powder mix is 56.30N/mm^2, 600 powder mix is 62.22 N/mm^{2}and 650powder mix 64.187 N/mm^2.At 56 days curing is observe that strength of 550 powder mix is 62.074 N/mm^2, 600 powder mix is 64 N/mm^{2}and 650powder mix 67.43 N/mm^2.

b) Flexural Strength of concrete

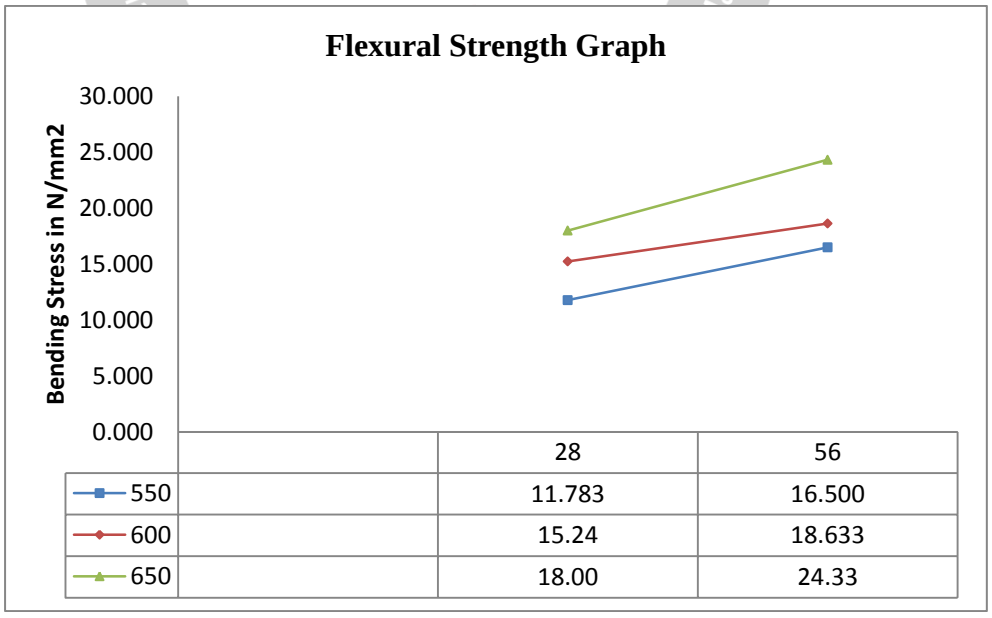

Figure 2 : Variation in bending stress for different powder contents in kg/m³.

From figure 2 it is observed that as powder content in self-compacting concrete increases, flexural strength is also increases. At 28 days of curing is observe that strength of 550 powder mix is 11.783N/mm^2, 600 powder mixes is 15.24 N/mm^2 and 650 powder mix 18 N/mm^2. At 56 days of curing is observed that strength of 550 powder mix is 16.50 N/mm^2, 600 powder mix is 18.63 N/mm^{2}and 650 powder mix 24.33 N/mm^2.

c) Shrinkage

The shrinkage represents a time dependent deformation which reduces the volume of Concrete, without the impact of external forces. The time flow and the final values of shrinkage are influenced by numerous factors: temperature and humidity, dimensions of elements, the type and quantity of cement, w/c factor, granulometric and mineralogical composition of aggregates, concrete strength, method of workability and curing, concrete age at the end of curing and many other factors.

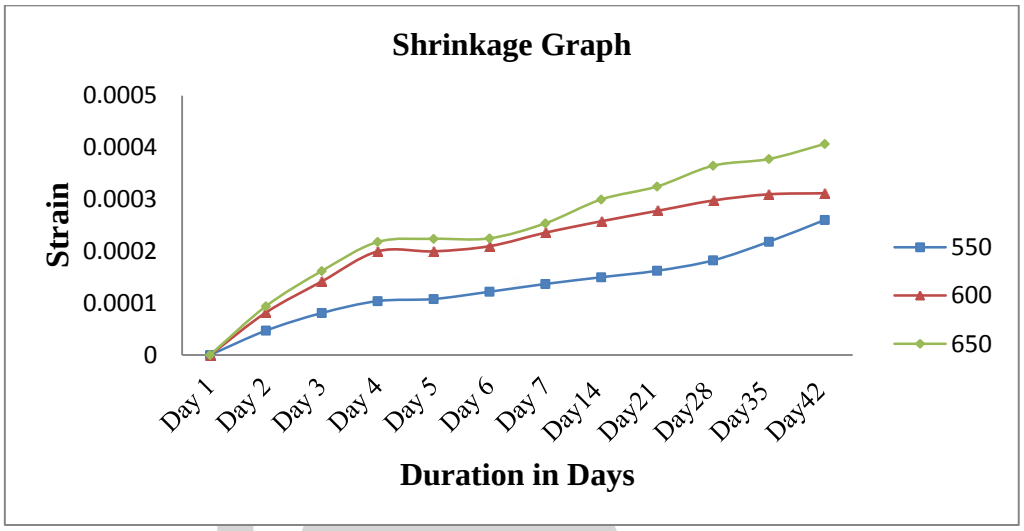

Figure 3 : Shrinkage for different powder content against duration in days

From figure 3 it is observed that as powder content in self-compacting concrete increases, shrinkage also increases. Shrinkage of 650 Kg/m^3 powder mix is greater than 550 Kg/m^3 and 600 Kg/m^3 powder mix concrete, and shrinkage of 600 Kg/m^3 mix concrete is greater than 550 Kg/m^3.

d) Elastic shortening

When the pre stress is transmitted to the concrete member, there is contraction due to pre stress. This contraction causes a loss of stretch in the wire. When some of the stretch is lost, pre stress gets reduced.

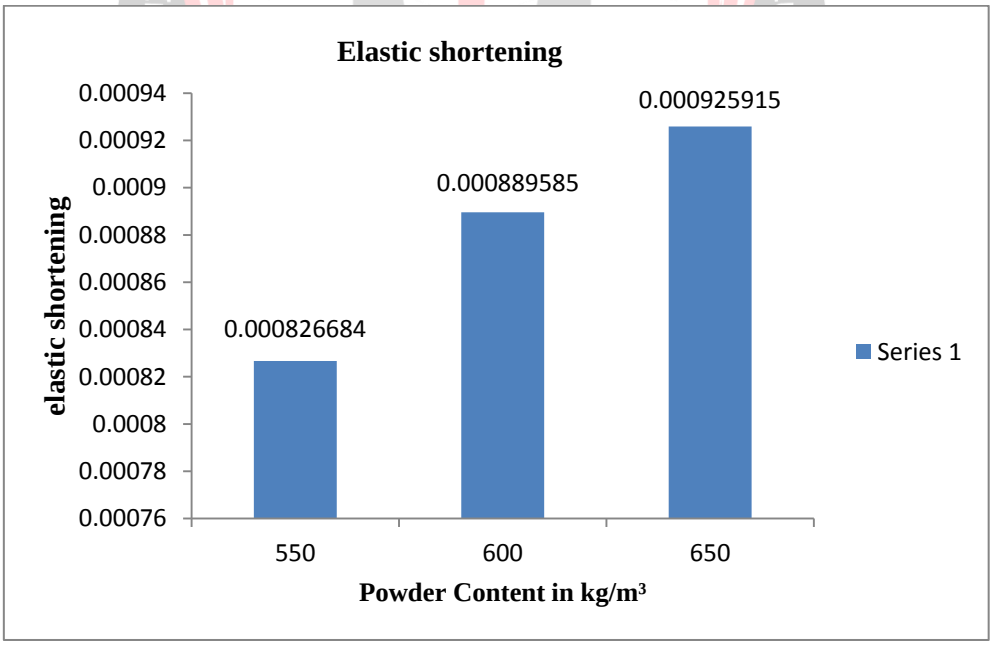

Figure 4 : Elastic shortening experienced for different powder contents in kg/m³.

From graph it is observed that as powder content increases elastic shortening of self-compacting concrete is increases. Elastic shortening of 650Kg/m^3 powder mix concrete is greater than 550Kg/m^3 and 600Kg/m^3 concrete

IV. Conclusions

This investigation shows that it is possible to design prestressed concrete beams and other structures using self compacting concrete using fly ash. The fresh and hardened properties of SCC like workability, compressive strength, shrinkage and elastic shortening were determined and analyzed. From results we can conclude that,

- Increase in powder content improves workability significantly, viz., essential considering flowable concrete.

- Increase in powder content increases compressive strength of given volume of concrete.
- Also the addition of fly ash in SCC improves microstructure of concrete which enhances mechanical properties of concrete.
- Rate of shrinkage decreases with increase in age of concrete
- Rate of shrinkage increases with increase in powder content of given volume of concrete.
- Elastic shortening seen increased with increase in powder content.

REFERENCES

[1]. Bertil Persson et al *'A Comparison between Mechanical Properties of Self-Compacting Concrete and the Corresponding Properties of Normal Concrete'* Cement and Concrete Research 31 (2001) 193±198 4 December 2000

[2]. D. Saradhi Babu et al 'Properties of Lightweight Expanded Polystyrene Aggregate Concretes Containing Fly Ash' Cement and Concrete Research 35 (2005) 1218–122323 January 2004

[3]. J. M. Khatib et al *'Performance of Self-Compacting Concrete Containing Fly Ash*' Construction and Building Materials 22 (2008) 1963–1971 24 September 2007

[4]. C.M. Tam et al *'Assessing Drying Shrinkage and Water Permeability of Reactive Powder Concrete Produced In Hong Kong'* Construction and Building Materials 26 (2012) 79–8923 May 2011

[5]. Lino Maia et al *'Early-Age Creep Deformation of A High Strength Self-Compacting Concrete'* Construction and Building Materials 34 (2012) 602–610 11 May 2012

[6]. Antonios Kanellopoulos et al *'Durability Performance of Self-Compacting Concrete'* Construction and Building Materials 37 (2012) 320–325 3 September 2012

[7]. Her-Yung Wang et al *'A Study of Fresh and Engineering Properties of Self-Compacting High Slag Concrete (SCHSC)'* Construction and Building Materials 42 (2013) 132–136, 21 February 2013

[8]. Petr Hunka et al *'Test and Technological Influences on Modulus of Elasticity of Concrete-Recapitulation'* Procedia Engineering 65 (2013) 266 – 272

[9]. Batham Geeta et al *'A Review: Recent Innovations in Self Compacting Concrete'* International Journal of Scientific & Engineering Research, Volume 4, Issue 11, November-2013

[10]. Dhruvkumar H. Patel et al *'Literature Review on Self Compacting Concrete'* International Journal for Technological Research in Engineering Volume 1, Issue 9, May-2014

[11]. Subhan Ahmad[1], Arshad Umar[2], Amjad Masood[3], "*Properties of Normal concrete, Self compacting concrete and Glass Fibre-reinforced Self-Compacting concrete: An Experimental Study*" 11th International Symposium on plasticity and Impact Mechanics, Implast 2016

