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PROCESS FLY ASH EFFECT ON HARDEN PROPERTIES OF SELF COMPACTING CONCRETE

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Abstract*: This research investigated the Self compacting concrete (SCC) with different amount of process fly ash. As it is a remarkable innovation in concrete technology due to its self flow ability but it requires the large amount of powder content. During study cement is replaced by the process fly ash in variation of 30 to 70 percentage and effect of process fly ash on harden properties of Self Compacting Concrete is studied. During the study Compressive strength, and split tensile strength were carried out according to Indian standards. Result shows the reduction in the strength of the concrete as the fly ash percentage increases.*

Key Words*: Self Compacting Concrete, Fly Ash, Compressive strength, Split tensile strength.*

I. Introduction

Self-compacting concrete (SCC) is milestone in concrete research. SCC is a highly flow able and, non-segregating concrete. SCC can spread in to place, fill the formwork and encapsulate the reinforcement without any mechanical vibration for consolidation. SCC was developed by Prof. Okamura at the University of Tokyo, Japan during the year 1986 for improve the quality of construction and also to overcome the problems durability aspect of concrete. It was first completed in 1988 and named as ‘‘High Performance Concrete’’, and later it proposedas ‘‘Self Compacting High Performance Concrete’’.

In India, since last many years fly ash is utilized partially in concrete as cement replacement instead of dumping it as a wastematerial. This is a economically viable solution as a replacement of cement in partly as pozzolana, because of its lowers water demand forsimilar workability, reduces bleeding, and lower evolutionof heat. It is already in practice as a particularly in mass concreteapplications and large volume placement to control expansiondue to heat of hydration and also helps in reducingcracking at early ages.High-volume fly ash concrete has emerged as construction material in its own right. This type of concrete normallycontains more than 50% fly ash by mass of total cementations materials [1]. Many researchers have used high volumesof Class C and Class F fly ashes in concrete. In this article,an effort has been made to present the results of aninvestigation carried out to study the effect ofreplacementof cement with high volumes of Class F fly ash on the properties of concrete.

II. Experimental Program

A. Materials

Various materials like cement, fly ash, coarse aggregate, fine aggregate, water, super plasticizer, velocity modifier agent are require to prepare the self compacting concrete. All materials are discussed in brief as follows.

Cement: Ordinary Portland cement (53grade) with specific gravity of 3.14 conforming to IS 12269-1987 (ASTM C 150 - 85A).

Fly ash: DIRK India’s processed Class F fly ash used, with a properties like specific gravity 2.3 and fineness is less than 18% retained on 45 micron sieve, confirming to IS1727:1967 and (ASTM C 618).

Fine aggregate: Locally available river sand of specific gravity 2.7, bulk density 1800kg/m3 which confirms the Zone II as per IS: 2386 (Part I).

Coarse aggregate: Crushed granite course aggregate of 10 mm down size with specific gravity of 2.8 and bulk density of 1450 kg/m3 confirms to ASTM C 33-86.

Water: Potable water confirms to ASTM D 1129, for mixing the concrete and curing of the specimens.

High range water reducing admixtures (HRWRA): Polycarboxylic ether (PCE) based super-plasticiser confirms to ASTM C 494-92 Type A and Type F in aqueous form to enhance workability and water retention.

Viscosity modifying admixture (VMA): A polysaccharidebased VMA, to enhancesegregation resistance, toimprove the viscosity and to modify cohesiveness ofthe mix.

B. Mix design

In the study, powder content consist cement and fly ash and other materials such as coarse aggregate, fine aggregate, water, super plasticizer, VMA in various proportions. Study conducted on five different mixes as a

ordinary Portland cement is partially replaced with fly ash. Fly ash is replaced in different percentages from 30% to 70%i.e. 30%, 40%, 50%, 60% and 70%. A detail mixproportion is listed in table- 1. A mix with 30% fly ash content is labeled as A30 and in the same manner all other mixes are also labeled.

Table 1: Mix proportion of SCC mixes

Mix	W/(C+FA) Ratio	Water Lit/m^3	Cement kg/m^3	Fly Ash kg/m^3	Fine Aggregates kg/m^3	Coarse Aggregates kg/m^3	V.M.A. Lit/m^3	S.P. Lit/m^3
A 30	0.34	190.4	392	168	973.0	595.33	0.56	5.6
A 40	0.34	190.4	336	224	973.0	595.33	0.56	5.6
A 50	0.34	190.4	280	280	973.0	595.33	0.56	5.6
A 60	0.34	190.4	224	336	973.0	595.33	0.56	5.6
A 70	0.34	190.4	168	392	973.0	595.33	0.56	5.6

C. Tests on Hardened SCC

Forty five cubes of (150 x 150 x 150 mm) and forty five cylinders (100 mm in height, 200 mmin diameter) were subsequently cast withoutvibration for five different mixes. The cubes, cylinders were stored in the lab after casting. After thumb impression, all specimens were de-molded, marked and cured in the water at room temperature untilthe date of testing. Every testing was completedon three samples and the average value reported.Tests on the cast specimens include compressive strength, splitting tensilestrength test. Test results are given in Table 2 and Table 3 respectively.

Table: 2 Compressive Strength of SCC

	7 Days	28 Days	56 Days
A30	38.07	49.75	56.81
A40	32.65	43.99	50.37
A50	29.86	40.44	46.79
A60	24.07	31.30	37.37
A70	20.34	25.86	32.45

Table: 3 Split Tensile Strength of SCC

	7 Days	28 Days	56 Days
A30	3.12	3.89	4.41
A40	2.79	3.63	4.12
A50	2.29	2.92	3.31
A60	2.10	2.64	3.00
A70	1.90	2.39	2.71

III. Discussion on the result

A. Compressive Strength of concrete

The effect of process flyash as replacement of cement is shown in the fig.1. Using relatively higher percentage of fly ash replacement of cement reduce the compressive strength of concrete. Study shows the strength reduction from 50 Mpa to 25 Mpa for the fly ash replacement of 30 percentages to 70 percentages at the age of 28 days.

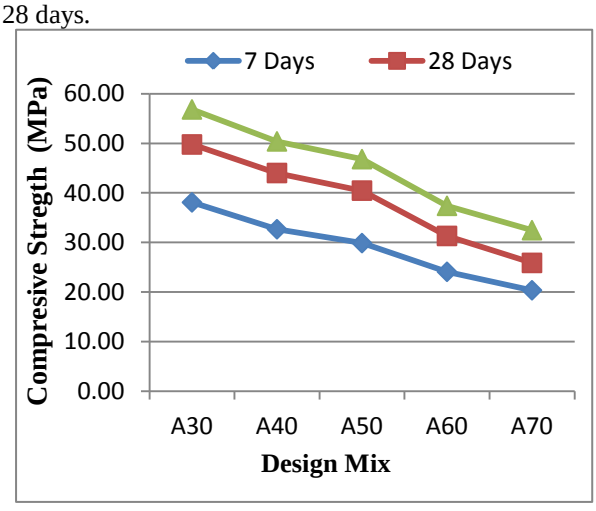

Fig. 1: Compressive strength of SCC

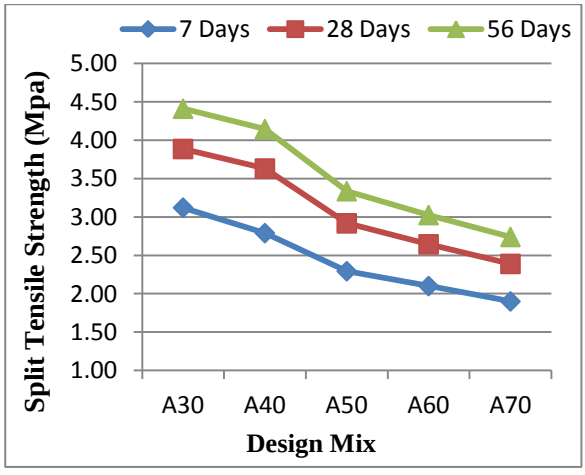

Fig. 2: Split Tensile strength of SCC

B. Split Tensile Strength of concrete

Split tensile strength study with different percentage of process fly ash as replacement of cement is shown in the fig. 2. Using relatively higher percentage of fly ash replacement of cement reduce the Split tensile strength of

concrete. Study shows the strength reduction from 3.89Mpa to 2.39Mpa for the fly ash replacement of 30 percentages to 70 percentages at the age of 28 days.

C. Relationship Between compressive strength and split tensile strength of SCC

Based on the result of the compressive strength and the split tensile strength of various grades of different SCC mixes at ages of 28 days curing, graph are plotted with tensile strength vs. compressive strength and suitable linear relations are developed between tensile strength and compressive strength for various grades of SCC ranges from 25 to 50 Mpa. Fig.3 shows the relationship between split tensile strength and compressive strength.

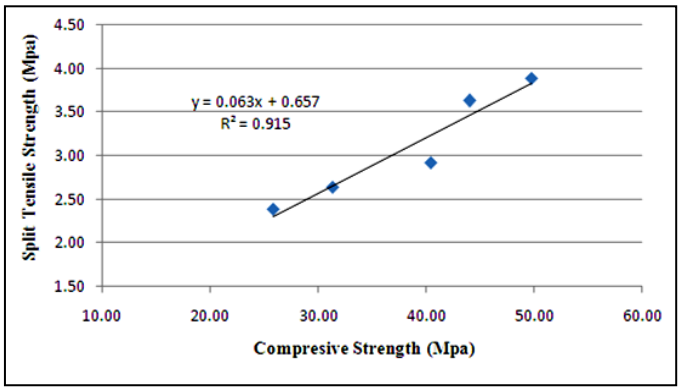

Fig. 3: Relationship between Compressive strength and Split Tensile strength of SCC

The proposed equation is y = 0.063x + 0.657

Where depended variable Y is Split Tensile Strength in Mpa and Independed variable X is compressive strength in Mpa.

Table 4: Comparison of proposed relation with the experimental results.

Sr No.	As per test results		As per proposed equation	
	Compressive Strength (Mpa)	Split Tensile Strength (Mpa)	Split Tensile Strength (Mpa)	Percentage error
1	20.34	1.9	1.94	1.98
2	24.07	2.1	2.17	3.37
3	25.86	2.39	2.29	4.54
4	29.86	2.29	2.54	9.77
5	31.3	2.64	2.63	0.42
6	32.45	2.71	2.70	0.32
7	32.65	2.79	2.71	2.81
8	37.37	3	3.01	0.37
9	38.07	3.12	3.06	2.11
10	40.44	2.92	3.20	8.88
11	43.99	3.63	3.43	5.88
12	46.79	3.31	3.60	8.17
13	49.75	3.89	3.79	2.61
14	50.37	4.12	3.83	7.56
15	56.81	4.41	4.24	4.1
Average percentage error				4.19

IV. Conclusions

1. SCC mixes are prepaid for different amount of flyash as a cement replacement, ranging from 30 to 70 percentages. During the study reduction in compressive strength observed as the fly ash percentage got increase.
2. It is observed that the split tensile strength of SCC got reduced as the flyash percentage increased. About 60 percentage split tensile strength got reduced at the age of 28 days.

3. A single relation is developed for the tensile strength of all design mix of SCC, which is given by $y = 0.063x + 0.657$.
4. The percentage error of the proposed relation in comparison to the experimental result is found to be less than 4.19% on an average, which shows the reliability of the proposed equation.

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