Strength Behavior of Self-Curing Fly Ash Concrete using Steel Fiber

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ABSTRACT— *Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration. It may be either after it has been placed in position or during the manufacture of concrete products. Good curing is not practically possible in most of the cases. The self-curing concrete means that no external curing required for concrete. Self-curing provides an internal water reservoir throughout the concrete, so that it is more readily available to maintain saturation of the cement paste during hydration, avoiding self-desiccation (in the paste) and reducing autogenous shrinkage. The grade of concrete selected was M30. Self-curing is done by Super Absorbent Polymer (SAP). The effect of variation in strength properties were studied for different dosage of self-curing agent (0.1% – 0.5% weight of cement) steel fiber (1%, 1.5%, 2%) and compared with fly ash concrete. By compression test optimum percentage of SAP is found as 0.3 and steel fiber is 1.5.*

Keywords — Curing, Self-Curing, Concrete, Self-curing Agent.

1, INTRODUCTION

The advances in construction industry have contributed tremendously for the new developments in construction chemicals. The use of various chemicals in concrete alters the properties of strength and durability. A durable concrete is one that performs satisfactorily in the working environment during its anticipated exposure conditions during service. Due to the vast construction activities different grades of concrete with natural and artificial ingredients are in use. It is observed during construction even though supervision is given importance proper care is not taken in the curing and other operations. As an alternative to water curing, different other methods are also available including membrane curing, polymer curing etc. Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration. By proper curing only we can attain desirable strength properties. In practical good curing is not always possible, while poor curing process will affect the strength properties, self-curing methods are developed. By adding self-curing agents an internal water reservoir is created in the fresh concrete. Once the initial free water has been consumed, the water absorbed by the SAP will be gradually released to maximize the heat of hydration.

2, MATERIALS

2.1 Cement

Ordinary Portland cement of 43 grade (IS 8112:1989). The total quantity of cement required was approximately estimated, brought and stored in an air tight container.

2.2 Fine Aggregate

Locally available river bed sand having specific gravity 2.61 and fineness modulus of 3.32 was used.

2.3 Coarse Aggregate

Locally available crushed granite chips having specific gravity 2.6 and fineness modulus of 3.59 was used. The particle size varies from 10 to 20mm was used.

2.4 Fly Ash

Fly Ash collected from Neyveli Lignite Corporation, Neyveli, Tamil Nadu confirms to IS: 3812-1981 is a Class C Fly Ash (High Calcium Fly Ash). The properties of Fly Ash are having 2.41 and fineness of 1.24 m^2/g.

2.5 Silica fume

Silica fume obtained from Moon traders, Madurai, India. The properties of silica fume are specific gravity 2.20 and fineness 20000 m^2/kg.

2.6 Water

Potable water available in the college campus was used for preparing concrete in the entire experimental investigation.

2.7 Super Absorbent Polymer

SAP collected from Boharras pvt. Lt Chennai, India. The absorbing speed of SAP is 30 to 90 sec.

2.8 Fiber

Double end hooked steel fibers with an aspect ratio of 50 were used.

3, MIX PROPORTIONS

The concrete mix was designed for M_{30} grade as per IS 10262-2009 and mix proportion arrived as 1: 1.269: 2.57 with w/c 0.42. Cement replacement of 40% with fly ash and 10% with silica fume (totally 50%) by weight was considered. Totally 6 types of concrete mixes were prepared. The quantities of aggregates, water content, cement and the additives are given in table 3.1

M1- Conventional Concrete
M2- 50% Cement + 40% Fly Ash + 10% Silica fume
M3- Self-curing Fly Ash concrete (50% Cement + 40% Fly Ash + 10% Silica fume+ SAP)
M4- 50% Cement + 40% Fly Ash + 10% Silica fume + SAP + 1% steel fiber
M5- 50% Cement + 40% Fly Ash + 10% Silica fume + SAP + 1.5% steel fiber
M6- 50% Cement + 40% Fly Ash + 10% Silica fume + SAP + 2% steel fiber

4, PREPARATION OF TEST SPECIMENS

The specimens were casted in steel moulds and compacted on a table vibrator. 150mm cube specimens, 100mm diameter x 200mm long cylinder specimens, 100 x 100 x 500mm beam specimens and 150mm diameter x 300mm long cylinder specimens were cast for the determination of compressive strength, split tensile strength, flexural strength and modulus of elasticity of concrete respectively.

4.1 Optimum SAP content

SAP content was varied as 0.1% to 0.5% and the optimum amount of SAP was found by compression test at the age of 7 days. By test results 0.3% was found as optimum.

4.2 Slump Cone Test

Workability for fresh concrete was found out by slump cone test. Higher slump value gives good workability. The slump values for each mix were given in table 3.1.

4.3 Compression Test

Hardened concrete cubes with size 150 x 150 x 150 mm were tested for their compressive strength using compression testing machine at the age of 7, 28 and 60 days. Three cubes were crushed at each age to get the average value.

Table 3.1 Mix Proportions

Mixes / Materials	M1	M2	M3	M4	M5	M6
Cement (kg/m^3)	484.76	242.38	242.38	242.38	242.38	242.38
Coarse Aggregate (kg/m^3)	1148.58	1148.58	1148.58	1148.58	1148.58	1148.58
Fine Aggregate (kg/m^3)	514.490	514.490	514.490	514.490	514.490	514.490
Fly ash (kg/m^3)	-	193.904	193.904	193.904	193.904	193.904
Silica fume (kg/m^3)	-	48.47	48.47	48.47	48.47	48.47

Water (lit/m^3)	203.6	203.6	203.6	203.6	203.6	203.6
SAP (kg/m^3)	-	-	1.45	1.45	1.45	1.45
Water for SAP (lit/m^3)	-	-	1.015	1.015	1.015	1.015
Steel Fiber (kg/m^3)	-	-	-	4.847	7.27	9.695
Slump (mm)	88	72	114	105	96	90

4.4 Splitting Tensile Strength Test

The split tensile strength was determined by subjecting 100mm diameter x 200mm long cylinders to diametric compression so as to induce uniform lateral tension on the perpendicular plane. At the end of each age of the specimen, the test was conducted as per IS: 5816-1999.

4.5 Flexural Strength Test

The flexural strength tests were carried out on beam specimen of size 100 x 100 x 500mm under two standard point loading at the end of each age of the specimen, flexural testing was conducted under uniform rate of loading of 180kg/cm^2/min. and the procedure was followed according to IS: 516-1959. All the test results reported in this paper represent the average value obtained from a minimum of three specimens.

4.6 Modulus of Elasticity

Cylinders of 150mm diameter x 300mm long specimens were cast and tested at the age of 28days in a compression testing machine. Deformation was measured using 250mm gauge length compressometer fixed on the surface of the cylinder. Readings were taken at regular intervals of load increment. Considering the stress level at twenty five percent of ultimate stress, secant modulus of elasticity was calculated and the variation was shown in fig 4.5

5, RESULTS AND DISCUSSION

Workability and strength properties of conventional concrete (M1), fly ash concrete (M2), self-curing fly ash concrete (M3), self- curing fly ash concrete with 1% steel fiber (M4), self- curing fly ash concrete with 1.5% steel fiber (M5), self- curing fly ash concrete with 2% steel fiber (M6) were compared at the age of 7, 28 and 60 days.

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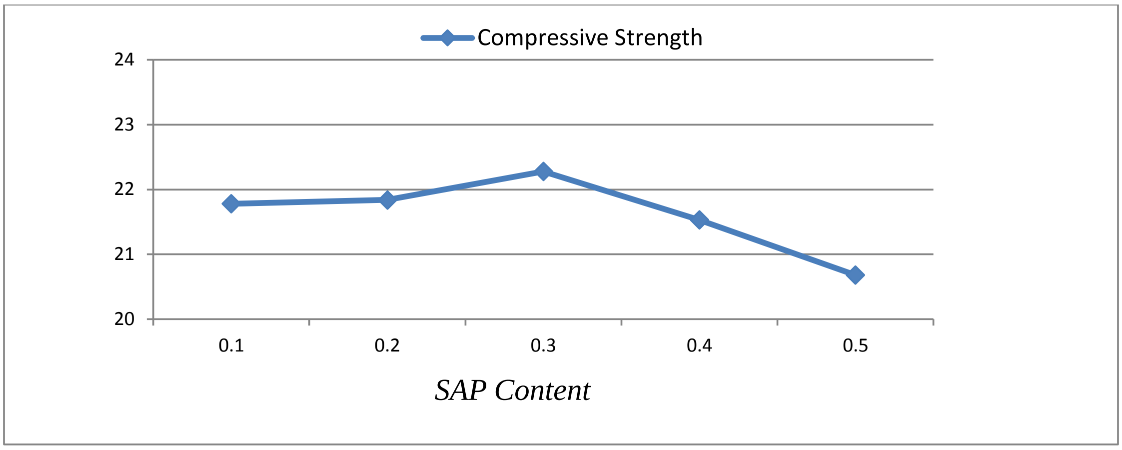

Fig 5.1 Compressive Strength for optimum SAP content

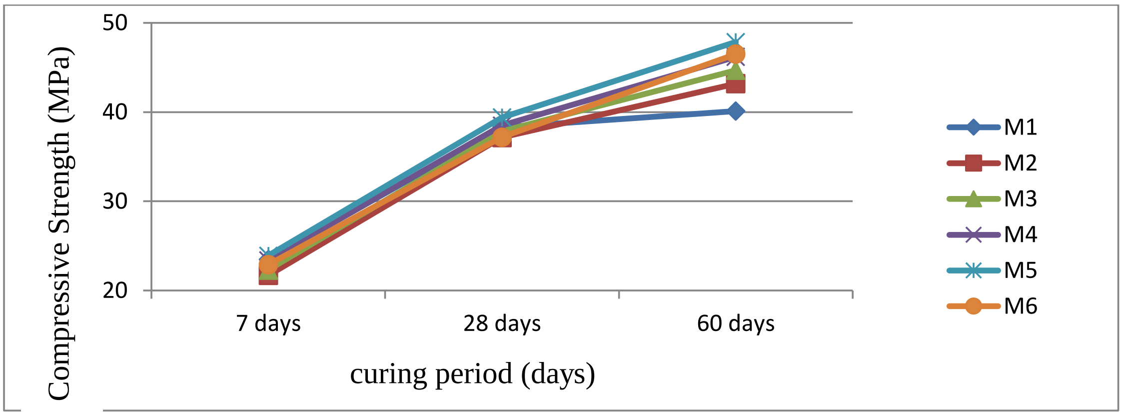

Fig 5.2 Compressive Strength of varies mixes

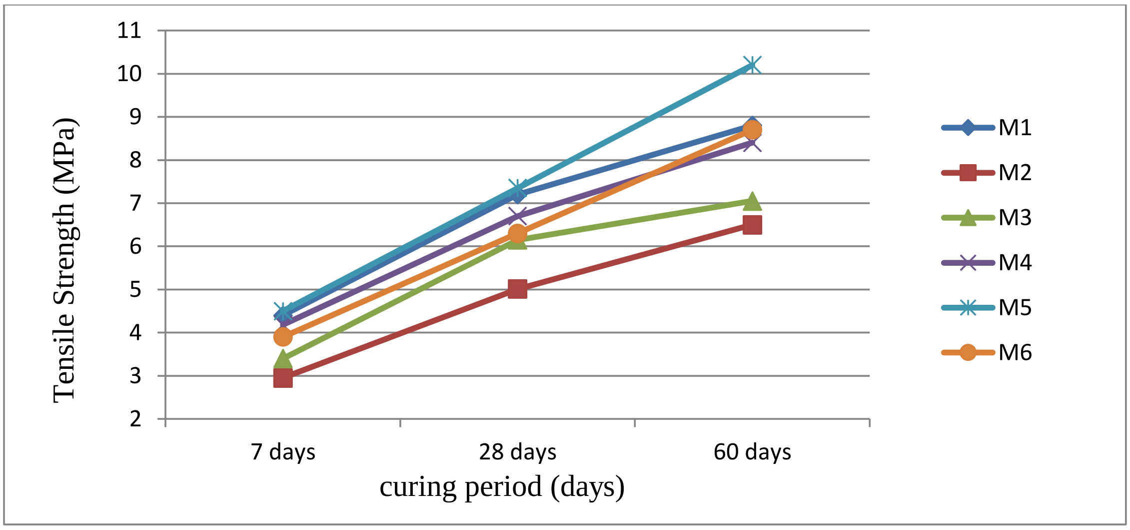

Fig 5.3 Split Tensile Strength of varies mixes

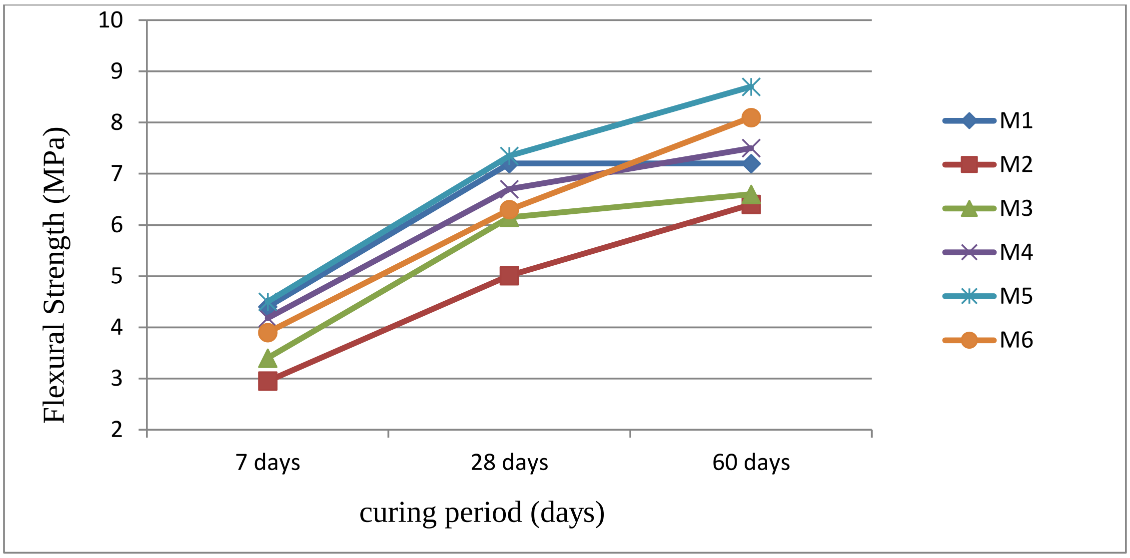

Fig 5.4 Flexural Strength of varies mixes

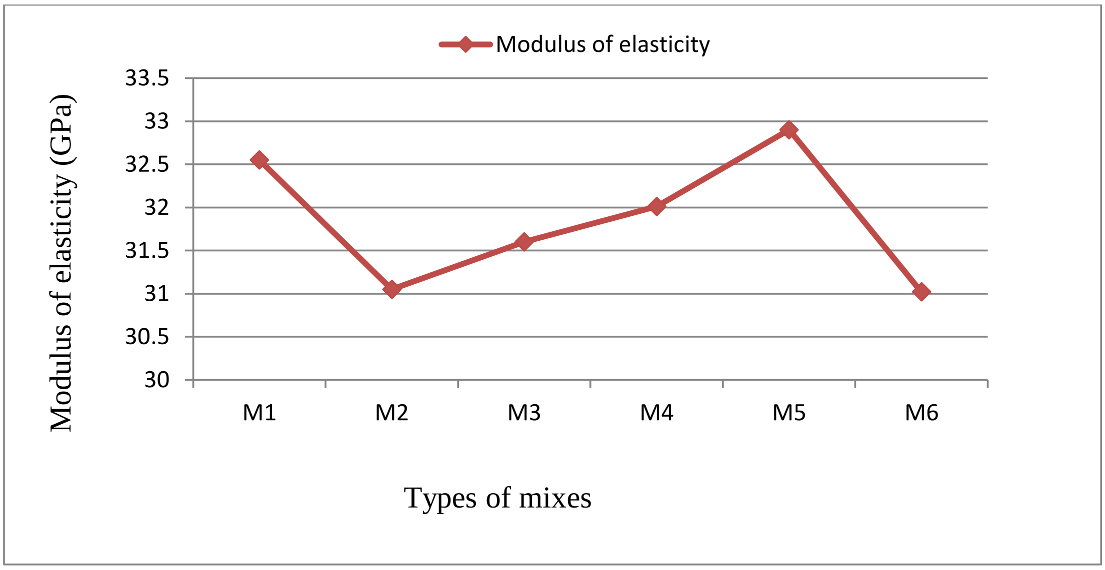

Fig 5.5 Modulus of Elasticity of varies mixes at the age of 28 days

VI. CONCULSION

By the above testing results following conclusions are made:

- By varying the SAP content as 0.1% to 0.5% the optimum amount of SAP was found as 0.3% by compression test at the age of 7 days.
- Self-curing Fly ash Concrete (M3) gives high Compressive Strength, Tensile Strength and Flexural Strength when compared to externally cured Fly ash Concrete.
- When Steel Fiber is added to the Self-Curing Fly Ash Concrete the strength properties goes on increasing for 1% and 1.5% addition.
- When 2% Steel Fiber is added the Strength properties suddenly decreases.

- All the Self-curing Fly Ash concrete mixes with steel fibers (M4, M5, M6) give high Strength compared to normal curing mix.
- Addition of 1.5% Steel Fiber in Self-curing Fly Ash concrete gives high strength than conventional concrete.

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