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BEHAVIOUR OF CONCRETE WITH SILICA FUME AND ALUMINIUM OXIDE ALONG WITH SELF CURING COMPOUND OF POLYVYINYL ALCOHOL

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Abstract-The experimental work on concrete is carried out to examine the use of water-soluble and water retains by using polyvinyl alcohol PVA as self-curing agent. In the present work the self-curing compound and aluminium oxide (Al_2O_3) are taken as 0.24%, 0.25% respectively and kept constant for entire experimental work. The silica fume is varied in different proportions of5, 10, 15, 20 and 25% by weight of cement. The results are revealed as strength characteristics of self-curing concrete are provided better results when compared with conventional concrete of similar mix design. .

Keywords: Polyvinyl Alcohol, Self-Curing agent, Aluminium Oxide, Silica fume, Compression test, Spilt tensile test, Flexural test.

I.INTRODUCTION

Curing of concrete is in favour of maintaining adequate moisture content in concrete for the duration of its early stages to build up the required properties [1-5]. But, good curing is not always realistic and often disused in several cases. The idea of self-curing agents is to decrease the water evaporation from concrete and hence raise the water preservation capacity of the concrete which is compared to conventional concrete. The make use of self-curing admixtures is very significant from the point of sight that water resources are reaching precious every day. The advantage of self-curing admixtures is more considerable in wasteland areas anywhere water is not sufficiently obtainable. Curing is the mainly significant movement in concrete structure. Lack of curing has considerable impact on concrete strength and durability. Hydrophilic water--soluble polymers which can be used as self--curing agents in concrete as they can absorb water and keep the surrounding medium moist so that water can be used later by cement.Curing is planned first and foremost to keep the concrete wet, by prevent the loss of moisture from the concrete during the period in which it is gaining strength. In the view of self-curing an experimental program is planned to evaluate the concrete properties of compressive, split and flexural strengths. The detailed experimental program has been furnishing below.

II. EXPERIMENTAL PROGRAM

Standard cubes (150x150x150mm), cylinders (150mm dia and 300mm height) and beams (150x150x750mm) are prepared with to find the compressive, split tensile and flexural strengths. The concrete grade in the present work has been taken as M60 and the mix design designed as per IS code. The main intension of this program is produce as high strength mix and also to study the effect of curing. From the review of literature it is noticed that the optimum of dosage of polyvinyl alcohol is noticed as 0.24% by weight of water and this is to mix in the water. The optimum dosage of Al_2O_3 noticed as 0.25% by weight of cement. Hence these two materials kept constant and the silica fume is varied from 5 to 25% with increment of 5% by weight of cement. Ultimately the silica fume is taken as variable in the present work. The specimens are cast and tested in the laboratory and the results are presented in the analysis of results section. All the specimens are tested at 28 days. The specimens are provided with normal water curing of three times per day (sprinkling of water over specimens. In other way it may understand that, the specimens are not kept under water and these were taken as reference or control specimens for corresponding tests. Total 30 cubes, 30 cylinders and 30 beam specimens are cast and tested in the present experimental work. For each mix three specimens are cast and average of three specimens result has been considered as strength of mix corresponding test.

III. PROPERTIES OF MATERIAL

3.1 Cement

Ordinary Portland Cement (OPC) was used for casting of specimens. The properties of cement are Specific gravity 3.24, Normal Consistency is 26.5%, Initial setting time is 39 mins and Final setting time is 185 minutes. Fineness 3% it is conformed to Indian Standard Specifications IS: 2386-2013 [6].

3.2 Fine aggregate

The sand which is used for the experimental work was locally available and conformed to Indian Standard Specifications IS: 2386-2013. The properties of sand which belongs to Grade Zone II. The different properties of fine aggregate are Specific gravity (2.34), Fineness modulus (3.015), Bulking of sand(27.53%) and Bulk density(16.70 KN/m^3).

3.3 Coarse Aggregate

Granite aggregate used as coarse aggregate for the work. The main properties of angular aggregates are specific gravity of 16 mm (2.629), 10 mm (2.74), Fineness modulus is 2.08, Crushing value 20% Impact value 20.36% and Water absorption 0.50%.

3.4 Polyvinyl alcohol as self-curing agent

Polyvinyl alcoholis formed from the chemical compound of polyvinyl acetate, regularly by continues process [5]. It is clear and white coloured granular powder. It melts in hot water and soluble in ethyl alcohol, PH ranges of a 5% solution of polyvinyl alcohol exhibits 5.0 to 6.5. It has properties like emulsifying and gum properties. VA is fully degradable and dissolves quickly [7-9].

3.5 Nano Al_2O_3

The used Nano aluminium oxide is shown in figure 1. The Chemical Properties are shown in Table 1.

Figure 1: Nano Al_2O_3

Table 1: Chemical Properties of Nano Al_2O_3

Molecular Formula	Al_2O_3
Molecular Weight	101.96
Color and Form	White Powder
Specific Surface Area (BET)	≥550 m^2/g
True Density	2.9 g/cc
Crystallite Size	Amorphous
Mean Aggregate Size	5μm
Average Pore Diameter	110Å
Loss on Ignition	≤13%
Total Pore Volume	≥1.5 cc/g
Moisture Content	≤12%
Bulk Density	0.20 g/cc
Al Content (Based on Metal)	>99.2%

3.6 Silica Fume

The silica fume is obtained from the Elkem India limited company at Mumbai. The specific gravity of silica fume is 2.20. The silica fume is in conformity with the general requirements of pozzolana. The results are tabulated in Table 2. The used silica fume is viewed in figure 2

Figure 2: Silica Fume

Table 2: Properties of Silica Fume

S.No.	Property	Value
1.	Specific Gravity	2.20
2.	Bulk Density	150 – 350 Kg/M^3
3.	Specific Surface Area	15000-30000 M^2/Kg
4.	Chemical Analysis, % Loss on Ignition Silica (SiO_2) Corban (C) Moisture (H_2O)	 Max. 4.0 Min. 84% Max. 2.5 Max. 1.0

IV. RESULTS AND DISSCUSION

4.1 Cube Compressive Strength

28 days cube compressive strengths is presented in Table 3, these values are obtained from cube compressive strength test. The test conducted on cube can be viewed in figure 3. From the Table 3, it was observed that for normal curing the compressive strength of concrete (M60) with aluminium oxide and silica fume is 68.27, 68.49, 69.07, 70.13, 71.24, 69.46 and 69.29MPa.From the results it is noticed that more strength is noticed for mix SF 15% when compared with other mixes. From the previous studies it is observed that the 0.25% of Al_2O_3 is effective, so in this work this has been consider as constant for entire experimental work. With addition of this, it would like to know the effect of silica fume in concrete mixes. From the obtained results it is known that, the 15% of silica fume dosage as replacement to cement is more effective. From the past research works also observed that, the silica fumes is optimum at 15% and here also it once again proved herein.

The cube compressive strength results with self-curing compound have been noticed form table 3. In this also the compressive strength results are varying from 75.00 to 81.30MPa. The maximum compressive strength is noticed for SF-15 mix. When compared with normal curing compressive strength for SF-15, by suing self-curing compound of Polyvinyl alcohol the 28 days strength is enhanced about 14%. From the results it came to know that, the use of self-curing compound is more effective than the normal curing.

Table 3: 28 days Compressive Strength (MPa)

Nomenclature	Normal Curing	With self-curing compound
Control Specimen (M_{60})	68.27	75.00
SF-5	69.07	75.28
SF-10	70.13	75.75
SF-15	71.24	81.30
SF-20	69.46	74.35

Figure 3: Cube compression test

4.2 Split tensile strength

The 28 days split tensile strength results are depicted in Table.4 and the test conducted on compressive ion testing machine (figure 4). The split tensile strengths for normal curing are varying from 4.39 to 6.80. The maximum strength is achieved for SF-15 mix. For mixes with self-curing compound the split tensile strengths are varied from 4.83 to 7.65MPa. Here also maximum strength is noticed for SF-15. The split tensile strength for SF-15 is increased by 12.5% for self-curing compound mix when compared with normal curing. The behavior of increase/ decrease in strengths is proportions to compressive strengths. This observation is holds good for corresponding and respective mix.

Table 4: Split tensile strength (MPa)

Nomenclature	Normal Curing	With self-curing compound
Control Specimen (M_{60})	4.39	4.83
SF-5	5.70	6.32
SF-10	6.20	7.00
SF-15	6.80	7.65
SF-20	6.72	7.35

Figure 4: Split tensile test

4.3 Flexural Strength

The flexural strength results are presented in Table 5 and test conducted on beam specimen with two points loading can be viewed in figure 5. Without provision of steel reinforcement in the beam, the beam was failed with sudden failure and appeared in two pieces. To evaluate flexural strength of concrete mix in general the beam is tested without reinforcement hence herein also the beam cast and tested without reinforcement. From Table 5 the flexural strengths for normal curing is varying from 6.28 to 7.20MPa whereas for self-curing compound specimens the strengths are varied from 6.90 to 8.28MPa. The maximum flexural strengths are observed for SF-15 mix and the enhancement of strength for SF-15 mix is about 15% for self-curing specimens when compared with normal curing. Here also the specimens with self-curing compound shown good results with similar observations what we observed in the above two discussions. From the experimental work it is noticed that the compressive, split and flexural strengths are enhancing for SF-15 mix. This may due to the SF may participate in chemical reaction but this effect may be less at the age of 28 days and the self-cuing compound is major one to enhance the strengths. The curing compound may act as barrier to escape of water from the concrete mass and the water in the mix may effectively use for chemical reaction in better way.

Table 5: Flexural Strength (MPa)

Nomenclature	Normal Curing	With self-curing compound
Control Specimen (M_{60})	6.28	6.90
SF-5	6.45	7.00
SF-10	7.00	7.91
SF-15	7.20	8.28
SF-20	6.80	7.48

Figure 5: Flexural test

V. CONCLUSIONS

The following conclusions are drawn from the present experimental work.

1. The maximum compressive strength is obtained for SF-15 mix for normal and self-curing compound specimens. The cube compressive strength for SF-15 mix is 71.24 and 81.30MPa respectively for normal and self-curing specimens.
2. The maximum compressive strengths for self-curing specimens is more than 14% strength of normal curing specimens.
3. The maximum split tensile strength is noticed for SF-15 mix and the strengths are 6.80 and 7.65 MPa for normal and self-curing specimens.
4. The maximum split tensile strength for self-curing specimens is more than 12.5% strength of normal curing specimens
5. The flexural strengths for mix SF-15 are 7.20 and 8.28MPa respectively for normal and self-curing specimens
6. The maximum flexural strength for self-curing specimens is more than 15% strength of normal curing specimens

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