ISSN: 2455 – 4200
International Journal of Engineering Research and Modern Education
Impact Factor 6.525, Special Issue, April - 2017
6th National Conference on Innovative Practices in Construction and Waste Management
On 25th April 2017 Organized By
Department of Civil Engineering, Sri Ramakrishna Institute of Technology, Coimbatore, Tamilnadu

EXPERIMENTAL STUDY ON SELF CURING CONCRETE USING BIOMATERIALS AS ADMIXTURES

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Cite This Article: M. Vidhya, S. Gobhiga & K. Rubini, "Experimental Study on Self Curing Concrete Using Biomaterials as Admixtures" Special Issue, April, Page Number 260-264, 2017.

Abstract:

Concrete is the basic engineering material used in most of the civil engineering structures. Its popularity as basic building material in construction is because of its economy of use, good durability and ease with which it can be manufactured at site. With advent of new generation admixtures, it is possible to achieve higher grades of concrete with high workability levels economically. To attain the target strength proper curing is necessary. Curing is the process of maintaining a satisfactory moisture content and temperature in concrete during its early stages so that desired properties may develop. The concept of self-curing is to reduce the water evaporation from concrete, and hence increase the water retention capacity of the concrete compared to conventional concrete. In this paper, it is planned to investigate the fresh and hardened properties of the concrete by adding Silica Fume, extract from Calotropis Gigantea and Cypress tree bark. The Proportion of Calotropis Gigantea starting from 0.2% to 0.4% with the gradual increase of 0.1%.The cypress bark extract water is used instead of mixing water (15 %).Silica Fume is used instead of cement (15%).

1. Introduction:

When the mineral admixtures react completely in a blended cement system, their demand for curing water (external or internal) can be much greater than that in a conventional ordinary Portland cement concrete. When this water is not readily available, due to de-percolation of the capillary porosity, for example, significant autogenous deformation and (early-age) cracking may result. Due to the chemical shrinkage occurring during cement hydration, empty pores are created within the cement paste, leading to a reduction in its internal relative humidity and also to shrinkage which may cause early-age cracking. This situation is identified in HPC. So we are in a situation to use Self-Curing Concrete to avoid scarcity of water and early age cracking in High Performance Concrete.

2. Material Investigation:

Cement: The cement used is Ordinary Portland Cement confirming to Indian Standards IS 12269 – 1987 of grade 53.The tests conducted on cement are standard consistency, initial setting time, final setting time, and specific gravity. The properties of cement are represented in table 1.

Table 1: Properties of OPC 53 Grade Cement

S.No	Test Particulars	Result Obtained
1	Specific gravity	3.15
2	Consistency (%)	32
3	Initial setting time (min)	28
4	Final setting time (min)	560

Fine Aggregate: Locally available sand zone II conforming to I.S. -383-1970 is used in this experimental study. The properties of fine aggregate are represented in table 2.

Table 2: Properties of Fine Aggregate

S.No	Test Particulars	Result Obtained
1	Zone	II
2	Specific gravity	2.45
3	Fineness modulus	2.67
4	Bulk Density (kg/m^3)	1668

Coarse Aggregate: Coarse aggregate of both size 10 mm and 12 mm confirming to IS 2386-1968 has been selected for this study. The properties of coarse aggregate are represented in table 3.

Table 3: Properties of Coarse Aggregate

S.No	Property	Values
1	Specific gravity	2.8
2	Water Absorption (%)	1.25
3	Bulk Density (kg/m^3)	1735
4	Crushing value (%)	20
5	Impact value (%)	7.84

Silica Fume: Silica Fume also referred to as silica dust, condensed Silica Fume, Micro Silica, and Fumed Silica. Silica fume imparts betterment to rheological, mechanical and chemical properties. It increases the durability of the concrete by reinforcing the microstructure through filler effect and consequently reduces segregation and bleeding. The powdered form of Silica fume with the specific gravity of 2.25 is used in this study as shown in fig-1.

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Figure 1: Silica Fume

Calotropis Gigantea:

- ✓ The latex consist of Polyethylene Glycol
- ✓ Increases water retention capacity
- ✓ Improves internal curing property of concrete

Cypress Bark Extract:

- ✓ The addition of plant extract increased the setting time of concrete and hence the plant extract can be used as a retarder in hot climate.
- ✓ The plant extract increased the workability of concrete at constant liquid to cement ratio, hence fresh concrete properties are improved by the use of cypress plant extract.
- ✓ The plant extract increased the strength of concrete at constant slump; hence hardened concrete properties are improved by the use of cypress plant extract.

3. Concrete Mix Proportions:

The M60 grade of proportioning was done according the Indian Standard Recommended Method IS 10262- 2009 and with reference to IS 456-2000 .The total binder content was 395 Kg/m^3, fine aggregate was taken 673 Kg/m^3 and coarse aggregate was taken 1255 Kg/m^3. Water absorption capacity and moisture content were taken into consideration and the Mix ratio for conventional M60 grade of concrete is 1:1.72:3.18.

4. Experimental Investigation:

Workability:

Table 4: Self Curing Concrete Trials

SCC Trials	Cement Kg/m^3	F.A Kg/m^3	C.A Kg/m^3	Water lit/m^3	Silica Fume (%)	Calotropis Gigantea (%)	Cypress bark water (%)
S1	395	673	1255	140	15	0.2	15
S2	395	673	1255	140	15	0.3	15
S3	395	673	1255	140	15	0.4	15

Slump Test: Mould in the shape of a truncated cone with the internal dimensions 200 mm diameter at the base, 100 mm diameter at the top and a height of 300 mm, conforming to EN 12350-2 is shown in fig. 5.Base plate of a stiff non-absorbing material, at least 700mm square, marked with a circle marking the central location for the slump cone, and a further concentric circle of 500mm diameter. About 6 litres of concrete is needed to perform the test, sampled normally. Moisten the base plate and inside of slump cone, Place base plate on level stable ground and the slump cone centrally on the base plate and hold down firmly. Fill the cone with the scoop. Do not tamp, simply strike off the concrete level with the top of the cone with the trowel. Remove any surplus concrete from around the base of the cone. Raise the cone vertically and allow the concrete to flow out freely. Simultaneously, start the stopwatch and record the time taken for the concrete to reach the 500mm spread circle. (This is the T50 time). Measure the final diameter of the concrete in two perpendicular directions. Calculate the average of the two measured diameters. (This is the slump flow in mm).Note any border of mortar or cement paste without coarse aggregate at the edge of the pool of concrete.

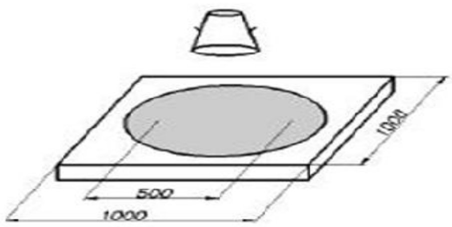

Figure 2: Slump test

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Compaction Factor Test: Work-ability of concrete is the ability/ease with which concrete can be mixed, transported and placed. This is a major factor which contributes to the other properties of concrete also. If concrete is workable enough then it can be compacted with less compacting effort. So there is a relation between the amount of work required to compact a given fresh concrete and the work-ability of the concrete. This relation is well suited for the concrete of the low water cement ratio. Slump cone test is also used to find out the work-ability of the concrete but only recommended for the concrete of higher work-ability. For less workable concrete (having less water cement ratio), compaction is standardized by various standards. Oil the inner sides of the top and bottom cone frustum. Prepare the required grade of concrete. Fill the top cone frustum with the fresh mix of concrete and then open the gate and let the concrete fall on the second frustum. Open the gate of second frustum and let it fall on the cylinder to fill up to top of cylinder. Measure the weight of the cylinder filled with the concrete (partially compacted) and then empties this. Again fill the cylinder with the same sample of the concrete but this time, do the compaction using the mechanical vibrator to do the compaction. Again measure the weight of the cylinder filled with the concrete (Fully compacted). Clean all the apparatus and put them at their places as before. The apparatus is shown in fig.3

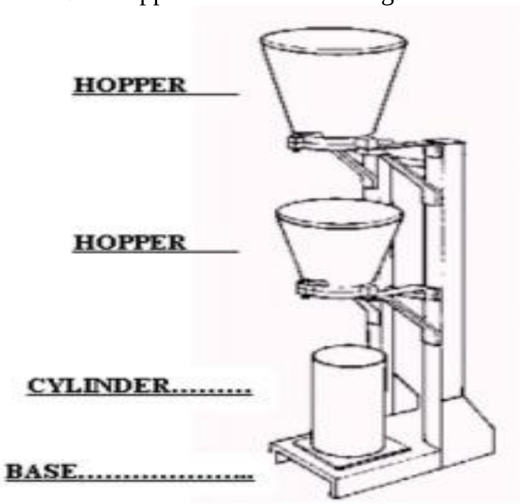

Figure 3**:** Compaction factor test

The workability tests results are shown in table 5.

Table 5: Workability Test Results for SCC

S.No	Trials	Slump(mm)	Compaction factor
1	CC	80	0.84
2	S1	80	0.82
3	S2	90	0.86
4	**S3**	**90**	**0.90**

Hardened Concrete Test:

Preparation of Specimens: Cement, Sand and Coarse aggregate were suitably mixed together in the ratio of 1:1.72:3.18, with the dry mix suitable percentage of silica fume is added. After that selected percentage of Calotropis Gigantea and Cypress bark water along with mixing water is added and mixed properly to get uniform quality of self curing concrete. Mould is first coated with oil and then uniformly mixed concrete is poured in it and allowed to hard for a period of 24 hours. After that specimens were demolded and poured in water for curing.

Compressive Strength Test: The cube specimens were tested on compression testing machine of capacity 1000KN.The bearing surface of machine was wiped off clean and sand or other material removed from the surface of the specimen. The specimen was placed in machine in such a manner that the load was applied to opposite sides of the cubes as casted that is, not top and bottom. The axis of the specimen was carefully aligned at the center of loading frame. The load applied was increased continuously at a constant rate until the resistance of the specimen to the increasing load breaks down and no longer can be sustained. The maximum load applied on specimen was recorded. The compressive strength was calculated by using the formula,

$$fck = P/A \text{ (N/mm}^2\text{)}$$

Where, P= Failure load (kN)
A= Surface area of the specimen (mm2)
Compression test setup is given below in Fig 4.

Figure 4: Compressive Strength Test Setup

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The test results are listed in table 6.

Table 6: Compressive Strength Test Results

Description	Compressive strength (N/mm^2)		
	7 days	*14 days*	*28 days*
CC	37.42	56.46	67.13
S1	33.66	52.63	62.34
S2	36.87	53.97	64.54
S3	38.86	57.35	68.23

From the table 9, the compressive strength test results for conventional concrete and various self curing concrete specimens of cubes at 7 days, 14 days and 28 days have been observed which is represented in the chart 1.

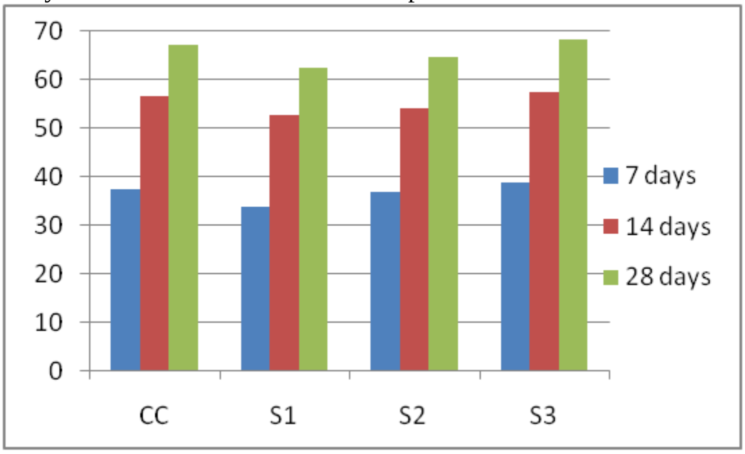

Chart 1: Comparison of Compressive strength test results

From the above test results, it is observed that the S3 specimen which contains 15 % of Silica Fume, 0.4% of Calotropis Gigantea and 15 % of Cypress bark extract gains more Compressive strength compared to other mixes taken.

Split Tensile Strength Test: The cylinder specimens were tested on compression testing machine of capacity 1000KN.The bearing surface of machine was wiped off clean and looses other sand or other material removed from the surface of the specimen. The load applied was increased continuously at a constant rate until the resistance of the specimen to the increasing load breaks down and no longer can be sustained. The maximum load applied on specimen was recorded. The Split tensile strength was calculated by using the formula,

$$f_{split} = 2\ P/\pi DL \quad (N/mm^2)$$

Where, P=load (kN)
D= diameter of cylinder (mm)
The experimental setup is shown in fig-5.

Figure 5: Split tensile Strength Test Setup

The test results are listed in table 7

Table 7: Split Tensile Strength Test Results

Description	Split tensile strength (N/mm^2)		
	7 days	14 days	28 days
CC	2.12	3.37	4.69
S1	1.97	3.13	4.69

S2	2.10	3.37	4.74
S3	2.32	3.48	4.89

From the table 7, the Split tensile strength test results for conventional concrete and various self curing concrete specimens of cylinders at 7 days, 14 days and 28 days have been observed which is represented in the chart 2.

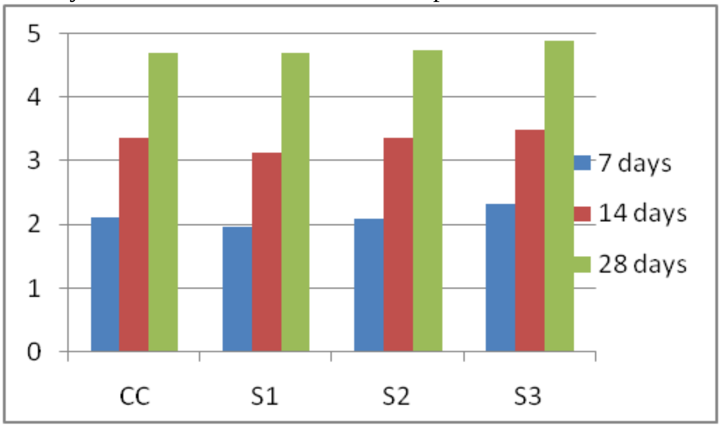

Chart 2: Comparison of Split tensile strength

From the above test results, it is observed that the S3 specimen which contains 15 % of Silica Fume and 0.4% of Calotropis Gigantea and 15 % of Cypress bark extract gains more Split tensile strength compared to other mixes taken.

5. CONCLUSION:

On the basis of experimental test results and observations, following conclusions are made As per the results obtained, the compressive and split tensile strength of the self curing concrete with addition of 0.2% of Calotropis gigantea,15% Cypress bark extract and 15% silica fume at the age of 7 days and 28 days is less than the conventional concrete. The compressive and split tensile strength of the self curing concrete with addition of 0.3% of Calotropis Gigantea, 15% Cypress bark extract and 15% silica fume at the age of 7 days and 28 days is less than the conventional concrete but greater than the self curing concrete with addition of 0.2% of Calotropis Gigantea, Cypress bark extract and 15% silica fume. The compressive and split tensile strength of the self curing concrete with addition of 0.4% of Calotropis Gigantea, 15% Cypress bark extract and 15% silica fume at the age of 7 days and 28 days is greater than the conventional concrete. So it is concluded that 0.4% of Calotropis Gigantea is the optimum percentage of bio-admixture can be used as Self Curing Agent.

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