

Effect of Organosilane Compound on Workability, Strength and Water Absorption Characteristics of Concrete Mix

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Abstract— Experimental study on the effect of organosilane compounds on the workability, strength and on water absorption characteristics of concrete has been carried out. Various concrete grades like M15, M20, M25 and M30 are prepared with variation in organosilane concentration as 0%, 0.25%, 0.50% and 1.00%. Fresh concrete is tested for workability. Compressive and tensile strength are calculated after 28 days of curing. Water absorption is calculated by placing specimens in oven for two days and then completely immersing the specimen in water for two days and calculating increase in weight of specimen.

Key words: Concrete, Organosilane Compound, Workability, Compressive Strength, Tensile Strength, Water Absorption

I. INTRODUCTION

Silanes— They are silicon compounds consisting of one or multiple silicon atoms linked to each other or one or multiple atoms of other chemical elements as the tetrahedral centers of multiple single bonds. Silane compounds will include silicone atoms with four valences.

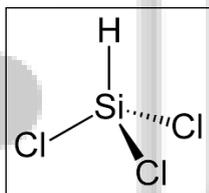


Fig. 1: Silane

Any organic derivative of a silane containing at least one carbon to silicon bond is called organosilanes.

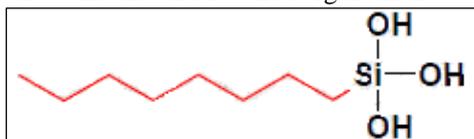
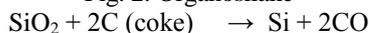


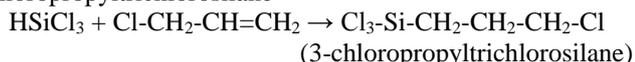
Fig. 2: Organosilane



Silicone obtain in the above process is reduced by chlorine in the presence of hydrogen gas.



Trichlorosilane is then reacted with allyl chloride to form 3-chloropropyltrichlorosilane



II. MATERIALS

The raw materials that were used to prepare the various grout mixes are mentioned below:

A. Cement

Ordinary Portland cement (OPC) of 53 grade was used to prepare concrete confirming to IS:10262-2009.

B. Sand

Specific gravity of sand used is 2.65 with Zone II gradation confirming to IS:383-1970.

C. Aggregate

Specific gravity of aggregate used is 2.70 with nominal maximum size of aggregate as 20 mm confirming to IS:383-1970.

D. Water

The normal tap water was used for the mixing and curing of the concrete.

E. Organosilane

Chemical is a clear pale yellow liquid with specific gravity of 1.05. Chemical has a flash point of about 900 C. The chemical is easily soluble in water.

III. PROPORTIONS

The concrete mix is prepared according to concrete mix proportioning guidelines IS:10262-2009. Various concrete grades prepared were M15, M20, M25 and M30 and their proportioning is shown in Table 1.

Concrete Grade	Cement	Sand	Aggregate	Water
M15	1.00	2.12	3.56	0.57
M20	1.00	1.83	3.04	0.50
M25	1.00	1.73	2.82	0.47
M30	1.00	1.57	2.61	0.44

Table 1: Mix Proportions of Concrete

For each mix design 4 variations, one control and 3 different variation of organosilane dose namely 0.25%, 0.50% and 1.00% of weight of cement are used.

After 24 hours of casting specimens are submerged in curing tank and allowed to be cured for a total period of 28 days. After curing specimens are taken out of curing tank and immersed in 5% organosilane solution for surface saturation.

IV. EXPERIMENTAL PROGRAM

A. Workability Test

The workability was tested as per the procedure laid down in I.S:1199-1959. Two basic tests are done namely slump test and compaction factor test to study the workability of concrete prepared with organosilane compound.

Slump Test- The slump test is a means of assessing the consistency of fresh concrete. It is used, indirectly, as a means of checking that the correct amount of water has been added to the mix.



Fig. 3: Slump Test

The Slump Value of different concrete batches is shown in Table 2.

Organosilane Concentration	Slump value (mm)			
	M15	M20	M25	M30
Control (0%)	60	55	55	45
0.25%	55	50	45	50
0.50%	55	60	60	40
1.00%	65	65	60	50

Table 2: Slump value

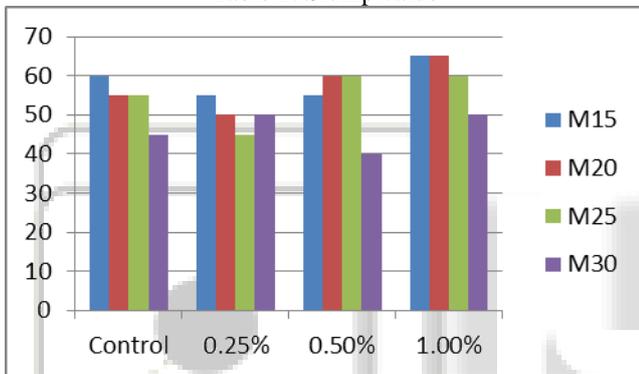


Fig. 4: Slump Test Results

Compaction Factor Test- This test works on the principle of determining the degree of compaction achieved by a standard amount of work done by allowing the concrete to fall through a standard height. The compaction factor is calculated by dividing the weight of partially compacted concrete to the weight of fully compacted concrete.



Fig. 5: Compaction Factor Test

The Compaction factor value of different concrete batches is shown in Table 3.

Organosilane Concentration	Compaction Factor Value			
	M15	M20	M25	M30
Control (0%)	0.88	0.87	0.87	0.86
0.25%	0.87	0.88	0.86	0.88
0.50%	0.88	0.89	0.88	0.85
1.00%	0.89	0.89	0.89	0.88

Table 3: Compaction Factor Value

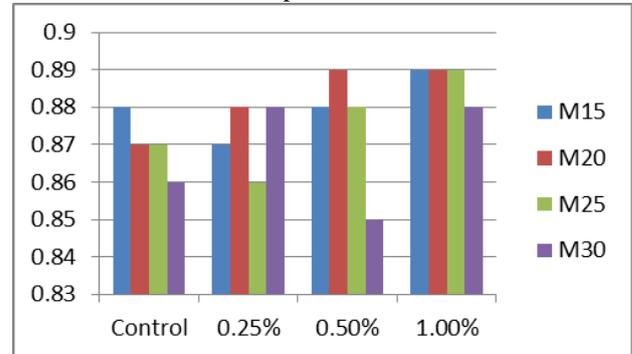


Fig. 6: Compaction Factor Test Results

B. Compressive Strength Test

The cube specimens were tested on compression testing machine of capacity 2000kN. The bearing surface of the machine was wiped off clean and any loose sand or other material removed from the surface of the specimen. The specimen was placed in the machine in such a manner that the load was applied to sides of the cubes as cast that is, not top and bottom.

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 the specimen was recorded. The details of compressive strength results for specimens with different concentration of organosilane compound are compared.



Fig. 7: Compressive Strength Test

The 7-days and 28-days compressive strength of different concrete batches are shown in Table 4 and Table 5 respectively.

Organosilane concentration	7 days compressive strength (N/mm ²)			
	M15	M20	M25	M30
Control	15	19.5	22	28
0.25%	15.2	19.33	23.5	27.7
0.5%	14.5	18.5	21	30.5
1.0%	14.1	18.5	20	29

Table 4: 7-days compressive strength

Organosilane concentration	28 days compressive strength (N/mm ²)			
	M15	M20	M25	M30
Control	15	19.5	22	28
0.25%	15.2	19.33	23.5	27.7
0.5%	14.5	18.5	21	30.5
1.0%	14.1	18.5	20	29

Control	24	23.7	29	32.5
0.25%	23.5	24.5	26.33	35.5
0.5%	20	25.33	28.5	33.11
1.0%	21	22	27.2	33.3

Table 5: 28-days compressive strength

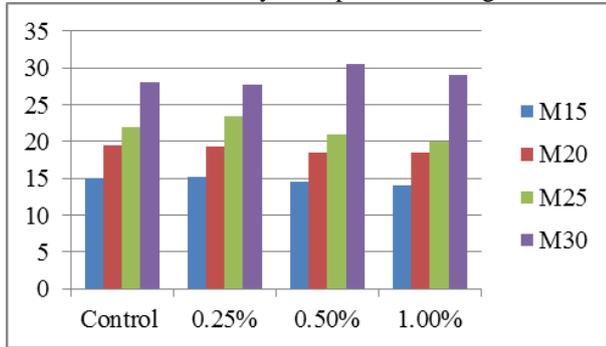


Fig. 8: 7-days compressive strength

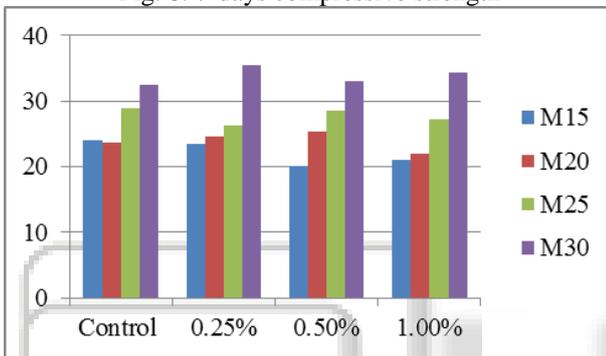


Fig. 9: 28-days compressive strength

C. Split Tensile Strength Test

Split tensile test of cylinder specimens 150 mm in diameter and 300 mm in height were done after 28 days after concrete has achieved complete hydration.

Tensile strength of concrete can be given by formula
 $T_{sp} = 2 * (\text{load}) / (\pi * \text{diameter} * \text{length})$



Fig. 10: 28-days Split Tensile Strength Test

The 28-days Split Tensile Strength of different concrete batches is shown in Table 6.

Organosilane concentration	28 Days Tensile Strength (N/mm ²)			
	M15	M20	M25	M30
Control	2.33	2.78	2.84	3.18
0.25%	2.57	2.63	2.47	3.56
0.5%	2.23	2.50	2.66	3.44
1.0%	2.25	2.36	2.77	3.33

Table 6: 28-days Split Tensile strength

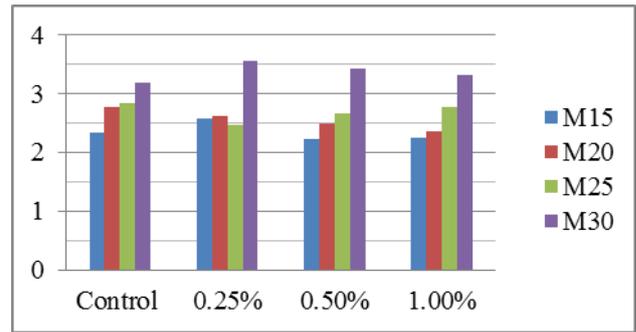


Fig. 11: 28-days Split Tensile strength

D. Water Absorption Test

Water absorption test on concrete was done according to ASTM standards (C 642 - 06). After 28 days of curing cubes are taken out from the curing tank and allowed to dry at room temperature for 3-4 hours. After the cubes are visibly dry they are immersed for about 1 minute in 1:20 solution of organosilane compound and water for surface saturation of concrete cubes.

First specimen is placed in oven for 24-48 hours until its decrease in mass becomes less than 0.5% of last checked value. Designate the lowest value obtain as A.

Then the specimen is immersed in water in curing tank for 24-48 hours until its increase in mass becomes less than 0.5% of last checked value. Designate the highest value obtain as B.

Percentage water absorption can be given by:

$$\% \text{ water absorption} = (B - A) * 100 / A$$

The Percentage Water Absorption of different concrete batches is shown in Table 6.

Organosilane concentration	Percentage Increase in Weight			
	M15	M20	M25	M30
Control	8.57	6.89	6.62	6.66
0.25%	6.51	6.63	6.13	5.9
0.5%	4.86	4.61	4.29	4.2
1.0%	2.61	4.13	4.11	4.06

Table 7: Water Absorption Test

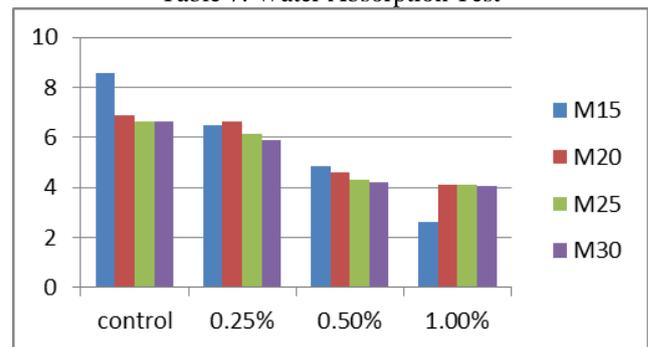


Fig. 12: Water Absorption Test

V. CONCLUSIONS

- Organosilane molecule reacts with hydroxyl groups inside the concrete. But concrete will become hydrophobic only in the absence of moisture. So, until the concrete is wet it will not become hydrophobic.
- Because of above property curing of concrete is not affected and concrete gains strength naturally. And once

the curing process is complete concrete is allowed to dry and it becomes hydrophobic.

- Adding organosilane compound doesn't affect the workability of concrete and we are able to achieve 40 to 60 mm slump.
- Adding organosilane compound doesn't affect the strength of concrete. And we are able to achieve our characteristic compressive and tensile strength of concrete.
- Water absorption of concrete specimens decreases drastically as the dose of organosilane compound is increased.
- The decrease of 70%, 40%, 38% and 39% is observed for 1% organosilane dose for M15, M20, M25 and M30 grade of concrete.

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