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Research on Self-Curing Concrete Using Polyethylene Glycol-400

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Abstract
The aim of this investigation is to study the strength and durability properties of concrete using water soluble polyethylene glycol as self-curing agent. The function of self-curing agent is to reduce the water evaporation from concrete. The use of self-curing admixtures is very important from the point of view that water resources are getting valuable every day. Polyethylene glycol in 0.3%, 0.6%, 0.9% and 1.2% place using concrete (i.e.; each 1m3 of concrete required about 3m3 of water for construction. Most of which is for curing Concrete are made up of M30 grade mix and tested for its compressive strength test, split tensile test and flexural test up to 7, 14 & 28 days of age and compared with conventional concrete.

Keywords: *Self-curing concrete, Self-curing agent, Polyethylene Glycol (PEG-400), Water retention, Compressive strength, Workability, Saving of water.*

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I. INTRODUCTION

In the building business, concrete has shown to be the most versatile material. Due to its great compressive strength and longevity, it is the world's second most widely used material. It is a mixture of cement, fine aggregate, coarse aggregate, and water that requires curing to reach the requisite strength. When cement is mixed with water, it undergoes a hydration reaction, which is required for concrete to harden. Curing is the process of preventing concrete from becoming too dry during the hydration process. The curing effect has a significant impact on the qualities of hardened concrete, including increased durability, strength, volume stability, abrasion resistance, impermeability, and resistance to freezing. If water is not available, concrete shrinks, resulting in cracking. Unexpected shrinkage and temperature fissures can also compromise the concrete's strength, durability, and serviceability. In many circumstances, practical concrete curing is not possible owing to a lack of sufficient water quality and a variety of other practical issues. Concrete technology has advanced rapidly during the last two decades. It is possible to construct a reasonably good fast track concrete mixture utilizing ordinary materials and admixtures. Self-Curing Agents can be used to achieve internally cured concrete.

II. LITERATURE REVIEW

2.1 GENERAL

Several studies on self-curing concrete using polyethylene glycol 400 have been undertaken in recent years. The work of various researchers have been studied and discussed below.

2.2 REVIEW OF LITERATURE

Roland Tak Yong Liang and Robert Keith Sun (2002) developed a glycol and wax-based concrete internal curing mixture. For the first time, the innovation provides an internal curing composition that meets the curing criteria of Australian Standard AS 3799 when applied to concrete or other cementitious mixtures.

Wen-Chen Jau (2011) developed self-curing concrete that collects water from the air and improves cement hydration. It uses a self-curing ingredient like poly-acrylic acid, which has a strong ability to absorb moisture from the air and provide the water required for concrete curing, to tackle the problem of low cement hydration due to lack of or improper curing.

John Roberts et al. (2013) internal curing of pervious concrete was found to improve flexural and compressive strength . Except for internal curing, the internally cured regions received no poly protection or additional curing. The use of LWAS increased compressive and flexural strength by 150 and 200 percent, respectively. The preconditioned LWAS used meets ASTM C330 and C33 standards (except for gradation). Only the control slab underwent standard curing for 14 days with a 6 mm poly coating, and the replacements were 50, 100, and 150 pounds of LWAS per cubic yard. Material selection, technique execution, and adequate concrete

preparation and curing all contribute to the attributes needed in Pervious Concrete used in infiltration systems.
Patel Manish kumar Dahyabhai, Prof. Jayesh kumar Pitroda (2014) studied on "Introduction of self-curing concrete in the construction industry" was the subject of research. Self-curing admixtures increase the compressive strength of self-curing concrete. In comparison to standard concrete, adding 1.0 percent PEG600 and 33.9 percent PEG1500 raised the compressive strength of the mix by 37 percent and 33.9 percent, respectively. For M25 concrete, the optimum dosage of PEG600 for maximal compressive strength was found to be 1% of cement weight**.** The optimum PEG1500 dosage for maximal compressive strength in M25 grade concrete was found to be 1% of cement weight. In the desert, self-curing concrete is the most effective solution to the problem of poor curing.
M. Manoj Kumar and D. Maruthachalam (2013) by self-curing. For this study, a fantastic permeable polymer was used as the self-curing M40 grade of concrete. This new study was cleared for release. The following conclusion was reached. In comparison to conservative concrete mixes, water preservation for self-curing concrete mixes is higher. As determined by mass reduction over time. The best amount is 0.3 percent SAP lead to a significant increase in mechanical strength. There was a gradual increase in strength from 0.2 to 0.3 percent, followed by a gradual decrease. Self-cured concrete made with SAP was also less expensive than conventionally cured concrete. In the laboratory, cubes were cast and kept at room temperature for curative purposes.
L. Kalaivani, I. Santhiyaraj, A. Robin, S. Lochana Suganthi, T. Siva Santhi (2020) the purpose of this study is to look at the strength and durability of concrete made with water soluble polyethylene glycol as a self-curing agent. The purpose of a self-curing agent is to keep concrete from evaporating.Self-curing admixtures are essential, especially as water resources become increasingly important.Polyethylene glycol at 1%, 1.5%, and 2% concentrations were placed in concrete (i.e., each 1m3 of concrete required approximately 3m3 of water to construct).

III. METHODOLOGY

3.1 Methodology

The study on self-curing concrete using polyethynol glycol. The function of self-curing concrete agent is used to reduce the water evaporation in the concrete. Self-curing admixtures are crucial since water resources are becoming increasingly valuable every day. By using Poly ethylene Glycol improve the water content of mix concrete. We must determine the compressive and tensile strength of concrete by adding polyethylene glycol at various percentages.

IV. MATERIALS AND METHODS

4.1 Cement

In concrete, cement is a binding substance that holds the other materials together to produce a compact mass. OPC is commonly utilised for all engineering construction projects. All grades of OPC have a specific gravity of 3.15. OPC comes in three different grades. The cement utilised in this investigation is OPC 53 grade. The starting setting time for regular Portland cement is 32 minutes, while the final setting time is 600 minutes.

4.2 Aggregate

Fine aggregate is sand, crushed stones, or crushed gravel with a size of less than 4.75 mm. The fine aggregate in this investigation is M sand. Fine aggregate has a specific gravity of 2.64. Fine aggregate has a fineness modulus of 2.85 and a unit weight of 1600kg/m3. The percentage of water absorbed is 3.5 percent. Zone III limits the grading of fine aggregate according to IS: 383-1970.
Coarse aggregate is defined as material with a maximum size of 4.75 mm. The most common size of aggregate is 20 mm. The aggregate size used in this investigation is 20 mm. Coarse aggregate has a specific gravity of 2.66. The fineness modulus is 6.5, and the coarse aggregate unit weight is 1600kg/m3. 0.5 percent of water is absorbed.

4.3 Polyethylene Glycol 400

Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula H(OCH 2CH 2)nOH, where n is the average number of repeating oxyethylene groups typically from 4 to about 180. The abbreviation (PEG) is termed in combination with a numeric suffix which indicates the average molecular weights. One common feature of PEG appears to be the water-soluble nature. Polyethylene glycol is non-toxic, odorless, neutral, lubricating, non-volatile and non-irritating and is used in a variety of pharmaceuticals.

4.4 Mix Proportion

M30 grade of design mix according to IS 10262 was utilized in this research. The cement, fine aggregate, and coarse aggregate proportions in the concrete mix are 1: 1.50: 2.55 by volume, with a water cement ratio of 0.45.

Table-1: Mix proportion

W/C Ratio	Cement	Fine Aggregate	Coarse Aggregate
0.45	1	1.50	2.55

4.5 Casting and Curing

Casting and Curing Detail: Polyethylene Glycol were added in concrete in step of 0.3 % (0%, 0.3%, 0.6%, 0.9% ,1.2%).For each percent of polyethylene glycol by replacing water, 3 cubes, 3 cylinders and 3 prism were casted for 7 days and 28 days and additionally 1 beam were casted. Final strength of cube, cylinder and beam were tested after 7& 28 days self-curing.

V. TEST PROCEDURE

5.1 Compression Test

The cube specimens were put through their paces on a 3000KN compression testing equipment. The machine's bearing surface was cleaned, and sand or other debris was removed from the specimen's surface. The specimen was put in the machine so that the load was applied to the cubes' opposite sides as casted, rather than top and bottom. The specimen's axis was precisely positioned at the loading frame's centre. The load was increased at a consistent rate until the specimen's resistance to the growing load broke down and it could no longer be sustained. On the specimen, the maximum load was recorded.

Compressive stress was calculated as follows

Compressive strength = P/A x 1000

Where, P = Load in KN

A = Area of cube

5.2 Split Tensile Strength Test

The cylinder specimens were put through their paces on a 3000KN compression testing equipment. The machine's bearing surface was wiped clean, and any loose sand or other material was removed from the specimen's surface. The load was increased at a consistent rate until the specimen's resistance to the growing load broke down and it could no longer be sustained. The maximum load on the specimen was measured.

Tensile Strength=2 P/πLD,

Where, P=load,

D=cylinder diameter

L=Length

5.3 Flexural Strength Test

The purpose of the test is to determine the flexural strength of a prism with dimensions of 100 x 100 x 500 mm. The prism is then placed in the machine such that the load is applied to the uppermost surface of the prism, as it was cast in the mould. While testing the prism, two points loading was used over an effective span of 400mm. The load is applied until the prism breaks down. Using the prism's failure load.

Flexural strength = PL/bd^2

Where,

P = load in Newton shown in dial gauge

l = length of rectangular prism

b = breadth of rectangular prism

h = height of rectangular prism.

VI. RESULT AND DISCUSSION

6.1 Compressive Strength Test

To study the self-curing concrete using the self-curing agent PEG-400.cube specimen were casted and tested this results obtained for test compressive strength for 7 & 28 days were reported in the table. Optimum compressive strength was obtained when the addition is at 1.2%.

Table 6.1 Compressive Strength Test Result

S.No	PEG -400 (%)	Compressive Strength (N/mm^2)	
		7 Days	28 Days
CC	0	22.07	30.07
SCC1	0.3	23.02	31.05
SCC2	0.6	24.66	32.10

SCC3	0.9	24.98	32.67
SCC4	1.2	25.20	33

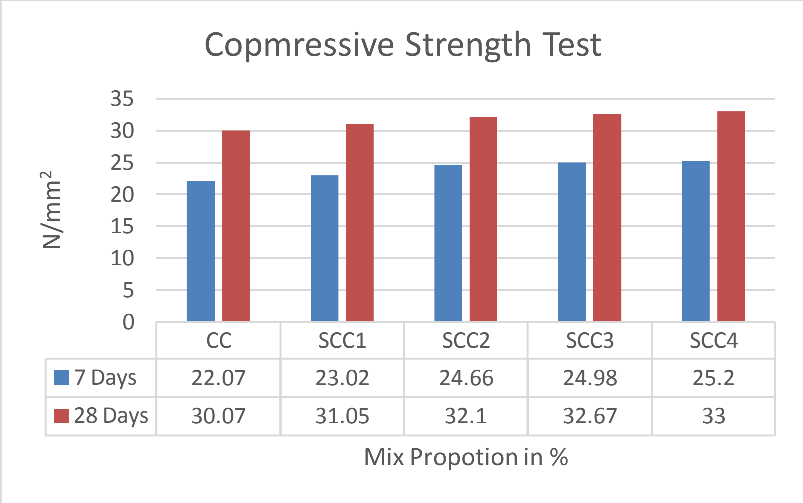

Chart 6.1 Compressive Strength Test Result

6.2 Split Tensile Strength Test

To study the self-curing concrete using the self-curing agent PEG-400 cylinder specimen were casted and tested this results obtained for test split tensile strength for 7 & 28 days were reported in the table. Optimum split tensile strength was obtained when the addition is at 1.2%.

Table 6.2 Split Tensile Strength Test Result

S.No	**PEG – 400 (%)**	**Split Tensile Strength (N/mm^{2})**	
		7 Days	**28 Days**
CC	0	2.46	3.36
SCC1	0.3	2.30	2.39
SCC2	0.6	2.36	2.45
SCC3	0.9	2.64	2.74
SCC4	1.2	2.78	3.50

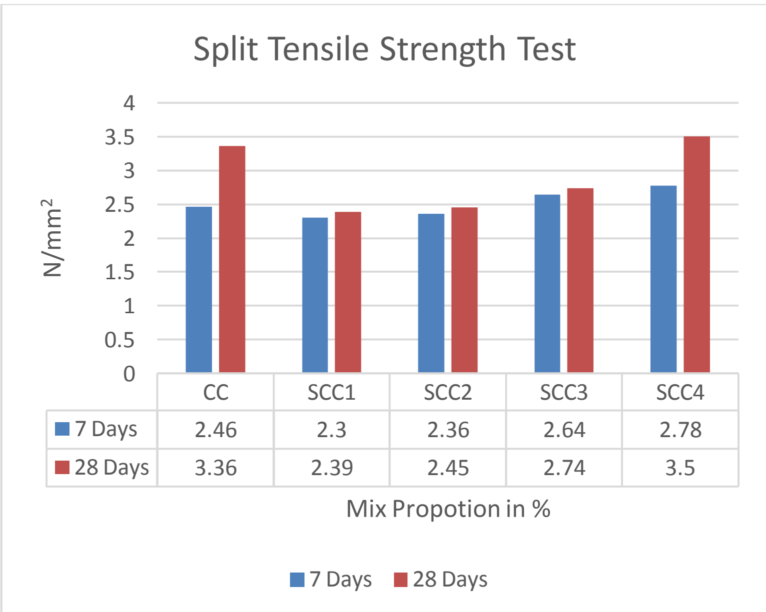

Chart 6.2 Split Tensile Strength Test Result

6.3 Flexural Strength Test

To study the self-curing concrete using the self-curing agent PEG-400.prism specimen were casted and tested this results obtained for test flexural strength for 7 & 28 days were reported in the table. Optimum flexural strength was obtained when the addition is at 1.2%.

Table 6.3 Flexural Strength Test Result

S.No	PEG – 400 (%)	Flexural Strength (N/mm^2)	
		7 Days	28 Days
CC	0	3.82	4.56
SCC1	0.3	3.15	3.88
SCC2	0.6	3.22	4.10
SCC3	0.9	3.30	4.60
SCC4	1.2	3.90	5.02

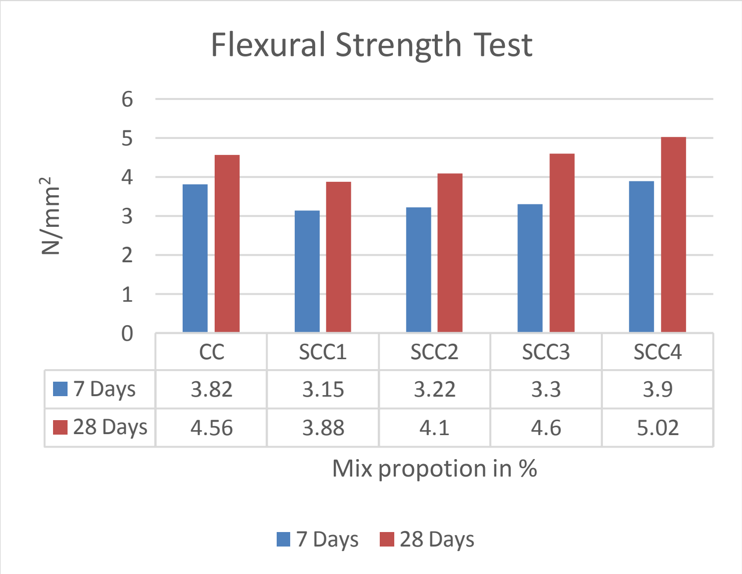

Chart 6.3 Flexural Strength Test Result

6.4 Test on Concrete Specimen Beam

Beam is casted for the 1.2 % replacement of water for which the compressive strength and split tensile strength was higher.

Ultimate load = 57.5 kN

Table 6.4 Result on Structural Specimen Testing for SCC4 at 28 Days

S.No	Load (kN)	Deflection (mm)
1	0	0
2	2.5	0.129
3	5	0.185
4	7.5	0.255
5	10	0.31
6	12.5	0.345
7	15	0.37
8	17.5	0.4
9	20	0.465
10	22.5	0.54
11	25	0.61
12	27.5	0.695
13	30	0.83
14	32.5	0.84
15	35	0.89
16	37.5	0.94
17	40	0.98

18	42.5	1.025
19	45	1.055
20	47.5	1.095
21	50	1.195
22	52.5	1.335
23	55	1.5
24	57.5	1.76

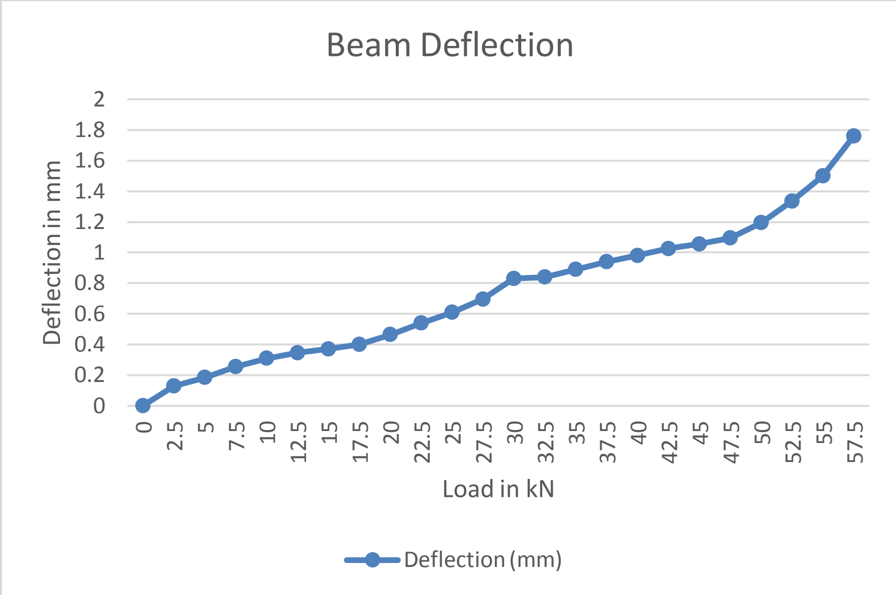

Chart 6.3 Structural Specimen M3 at 28 Days

VII. CONCLUSION

- The addition of polyethylene glycol up to 1.2% by water in concrete increases the compressive strength, split tensile strength, and flexural strength.
- Compressive strength, Split Tensile strength, and Flexural strength are all reduced after 2%.
- In both laboratory and real-world applications, the self-curing process works for both normal and self-compacting concrete.
- The use of self-curing admixtures improves the concrete's durability and workability.
- Self-curing concrete has a better strength than traditional concrete with the same mix design in almost all circumstances.
- Self-curing concrete is the solution to a slew of problems caused by a lack of proper concrete curing.
- Self-curing concrete is used in deserts and other areas where water scarcity is a serious issue.
- Self-curing concrete is employed in simple as well as complex buildings shape. Where there is an issue with using another way of cure.

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