
Studies on Self-Curing Concrete with the Addition of Polyethylene Glycol – 4000

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ABSTRACT:

Concrete is most widely used construction material due to its good compressive strength and durability. Depending on the nature of the work cement, fine aggregate, coarse aggregate and water are mixed in specific proportions to produce plain concrete. Plain concrete needs congenial atmosphere by providing moisture for a minimum period of 28 days for good hydration and to attain desired strength. The properties of hardened concrete, especially the durability are greatly influenced by curing since it has a remarkable effect on the hydration of cement. Any laxity in curing will badly affect the strength and durability of concrete. Self-curing concrete is one of the special concrete in mitigating insufficient curing due to human negligence paucity of water in arid areas, inaccessibility of structures in difficult terrains and in areas where the presence of fluorides in water will badly affect the characteristics of concrete. The present study involves the use of shrinkage reducing admixture polyethylene glycol (PEG 4000) in concrete which helps in self-curing and helps in better hydration and hence strength. In the present study, the effect of admixture (PEG 400) on compressive strength by varying the percentage of PEG by weight of cement from 0% to 1.5% were studied for M20. It was found that PEG 4000 could help in self-curing by giving strength on par with conventional curing. It was also found that 1% of PEG 4000 by weight of cement was optimum for M20 grade concretes for achieving maximum strength without compromising workability.

KEY WORDS: *Self-curing concrete, Polyethylene glycol, workability*

INTRODUCTION:

Curing is the name given to the procedures used for promoting the hydration of the cement and it consists of a control of temperature, moisture moment from and into the concrete. Curing allows continuous hydration of cement and consequently continuous gain in the strength, once curing stops strength gain of the concrete also stops. Proper moisture conditions are critical because the hydration of the cement virtually ceases when the relative humidity within the capillaries drops below 80%. Proper curing of concrete structure is important to meet performance and durability requirements. In conventional curing this is achieved by external curing applied after mixing, placing and finishing. Self-curing or internal curing is a technique that can be used to provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation. When the concrete is exposed to environment evaporation of water takes place and loss of moisture will reduce the initial water cement ratio which will result in the incomplete hydration of the cement and hence lowering quality of the concrete. Various factors such as wind velocity, relative humidity, atmospheric temperature, water cement ratio of the mix and the type of cement used in the mix. Evaporation in the initial stage leads to plastic shrinkage cracking. Curing temperature is one of the major factor that affects the strength development rate. At elevated temperature ordinary concrete loses its strength due to the formation of the cracks between two thermally incompatible ingredients such as cement paste and aggregates. When concrete is cured at high temperature normally it develops higher early strength than the concrete produced and cured at low temperatures but strength is generally lowered at 28 days and later stage. A durable concrete is one that performs satisfactorily under the anticipated exposure condition during its designed service life. In addition to the normal concrete mix some additional compounds in proper dosage and material such as fly ash are used to increase the durability and strength of the concrete mix.

OBJECTIVES:

To study the effect of curing with the addition of admixture polyethylene glycol 4000 (P.E.G – 4000).

To carry out the mix design of self-curing concrete for M20 grade of concrete as per IS- 10262: 2009.

To determine the fresh properties of concrete with P.E.G 4000.

To determine the optimum percentage of P.E.G – 4000 to be added in the concrete mix.

To attain the compressive strength characteristics of self-curing concrete by adding and varying the percentage of P.E.G- 4000 for M20 grade of concrete with conventionally cured concrete of the same grade.

Literature Review:

➤ Roland Tak Yong Liang, Robert Keith Sun carried work on internal curing composition for concrete which includes a glycol and a wax. The invention provides for the first time an internal curing composition which, when added to concrete or other cementitious mixes meets the required standards of curing as per Australian Standard AS 3799.

➤ Wen-Chen Jau stated that self-curing concrete is provided to absorb water from moisture and from air to achieve better hydration of cement in concrete. It reduces the problem when the degree of cement hydration is lowered due to no curing or improper curing by using poly-acrylic acid as a self-curing agent which has strong capability of absorbing moisture from atmosphere and providing water required for curing concrete.

➤ Pietro Lura The main aim of his study was to reach a better conception of autogenous shrinkage in order to be able to model it and possibly reduce it. Once the important role of self-desiccation shrinkage in autogenous shrinkage is shown, the benefits of avoiding self-desiccation through internal curing become apparent.

➤ Patel Manishkumar Dahyabhai, Prof. Jayeshkumar Pitroda studied on “introducing the self-curing concrete in construction industry”. Compressive strength of self-curing concrete is increased by applying self-curing admixtures. The compressive strength of concrete mix increased by 37% by adding 1.0% of PEG600 and 33.9% by adding 1.0% of PEG1500 as compared to the conventional concrete. The optimum dosage of PEG600 for maximum compressive strength was found to be 1% of weight of cement for M25 grade of concrete. The optimum dosage of PEG1500 of maximum compressive strength was found to be 1% of weight of cement for M25 grade of concrete. Self-curing concrete is the best solution to the problem faced in the desert region and faced due to lack of proper curing.

➤ Mohanraj Rajendran M Studied on “self-curing concrete incorporated with polyethylene glycol”. The compressive strength of cube by compression testing machine for Self-cured concrete is higher than of concrete cured by full curing and sprinkler curing. The split tensile strength of self-cured cylinder specimen is higher than that of the conventionally cured specimen. Self-cured concrete is found to have less water absorption values compared with concrete cured by other methods. Self-cured concrete thus have a fewer amount of porous. The success of the initial studies highlights the promise of additional work. In planned studies the mix design will be optimized for self-curing agent in concrete mix.

➤ M. Manoj Kumar, D. Maruthachalam Studied on self-curing. Super absorbent polymer was used as self-curing agent. M40 grade of concrete is adopted for investigation. Based on this experimental investigation was carried out. The following conclusions were drawn. Water retention for the concrete mixes incorporating a self-curing agent is higher compared to conventional concrete mixes. As found by the weight loss with time. The optimum dosage is 0.3 % addition of SAP leads to a significant increase of mechanical strength. Compressive strength of self-cured concrete for the dosage of 0.3% was higher than water cured concrete. Split tensile strength of self-cured concrete for dosage of 0.3% is higher than water cured concrete. Flexural strength of self-cured concrete for dosage of 0.3% is lower than water cured concrete. Performance of the self-curing agent will be effected by the mix proportions mainly the cement content and w/c ratio. There was a gradual increase in the strength for dosage from 0.2 to 0.3 % and later gradually reduced. Self-cured concrete using SAP was more economical than conventional cured concrete. In the study cubes were casted and kept for curing in room temperature about 25 to 300 c practically feasibility of self-cured member is

needed to be checked in hot regions. The effectiveness of internal curing by means of SAP applied to concrete was the highest if 45 kg/m³ water is added by mean of 1 kg/m³ SAP.

- Basil M Joseph Studied on self-curing concrete and PEG400 were used as a self-curing agent in concrete. M20 grade of concrete is adopted for investigation. He added 0-1.5% of PEG400 by weight of cement for M20 grade concrete from that © 2017 IJEDR | Volume 5, Issue 1 | ISSN: 2321-9939 IJEDR1701106 International Journal of Engineering Development and Research (www.ijedr.org) 683 he found 1% of PEG400 by weight of cement was optimum for M20 grade of concrete for achieve maximum strength. He also found that if percentage of PEG400 gets increased slump as well as compaction factor also increased.
- Stella Evangeline had use poly vinyl alcohol as self-curing agent in concrete. He added 0.03-0.48% by weight of cement from that he found 0.48% of poly vinyl alcohol by weight of cement provides higher compressive, tensile as well as flexural strength than the strengths of conventional mix.
- Mohammed Shafeeque Sanofar.P.B, Praveen.K.P., Jitin Raj, Nikhil.V.P, Gopikrishna has used PEG600 as a self-curing agent in concrete. M20 and M25 grade of concrete are adopted for investigation. They added 0-2% of PEG600 by weight of cement for M20 and M25 grade concrete. From that they found 1% of PEG600 by weight of cement was optimum for M20 and M25 grade of concrete for achieve maximum strength.
- Shikha Tyagi Studied on self-curing concrete and had use PEG400 as a self-curing agent in concrete. M25 and M40 grade of concrete are adopted for investigation. She added 1-2% of PEG400 by weight of cement for M25 and M40 grade concrete. She was concluded that the optimum dosage of PEG400 for maximum Compressive strength was to be 1% for M25 and 0.5% for M40 grades of concrete.
- Dayalan J had used super absorbent polymers as a self-curing agent in concrete. He was added 0.0-0.48% of super absorbent polymer by weight of cement for M25 grade concrete. He was found that super absorbent polymer 0.48% by the weight of cement provides higher compressive, tensile as well as flexural strength than the strength of conventional mix.

MATERIALS AND METHOD:

MATERIALS USED:

The various materials used are Cement (OPC- Grade), fine aggregate (confirming to zone I of IS: 383- 1970), coarse aggregate of 20mm size and Polyethylene Glycol- 4000 with specific gravity 1.08.

MIX PROPORTION:

The mix was proportioned according to IS 10262: 2009 to obtain a compressive strength of 20MPa. The identification, mix proportion and quantity of material are done for one meter cube of self-curing concrete mixes. The mixes were obtained by adding PEG 4000 content in 0.5%, 1% and 1.5% of weight of cement.

CUBE CASTING:

Casted as per IS: 10086- 1982. Cubes were casted of size 150mm*150mm*150mm.

EXPERIMENTAL WORK:

In this investigation, fresh concrete properties were determined and the cube compressive strength of conventionally cured concrete has been compared with self-cured concrete.

MATERIALS USED	QUANTITY PER CUBE for 0.5% of PEG 4000	QUANTITY PER CUBE for 1% of PEG 4000	QUANTITY PER CUBE for 1.5% of PEG 4000
CEMENT	1.184 kg	1.184 kg	1.184 kg
WATER	0.52 liter	0.6318 liter	0.69 liter
FINE AGGREGATE	3.2 kg	3.189 kg	3.182 kg
COARSE AGGREGATE	4.2 kg	4.20 kg	4.18 kg
PEG- 4000	5.90 g	11.8 g	17.7 g
WATER-CEMENT RATIO	0.40	0.40	0.40

FRESH CONCRETE PROPERTIES AND WORKABILITY:

SLUMP TEST: Followed as per IS: 1199-1959

Vee-Bee CONSISTOMETER TEST: Followed as per IS: 1199- 1959.

COMPACTING FACTOR TEST: Followed as per IS: 1199- 1959.

COMPRESSIVE STRENGTH TEST: Followed as per IS: 516- 1959.

RESULTS AND DISCUSSION:

The results of fresh concrete properties of self-curing concrete and the compressive test for various mixes are presented below;

SLUMP TEST: Slump values of self-curing concrete

CONCRETE MIX	Dosage of PEG- 4000 by weight of cement	SLUMP (mm)
A	0.5% PEG- 4000	3.7
B	1.0% PEG- 4000	4.0
C	1.5% PEG- 4000	4.8

Vee-Bee CONSISTOMETER TEST: Vee-Bee consistometer values of self-curing concrete

CONCRETE MIX	Dosage of PEG- 4000 by weight of cement	TIME(s)
A	0.5% PEG- 4000	14
B	1.0% PEG- 4000	11
C	1.5% PEG- 4000	09

COMPACTION FACTOR TEST: Compaction factor values of self-curing concrete

CONCRETE MIX	Mix A	Mix B	Mix C
COMPACTION FACTOR	0.984	0.9545	0.940

COMPRESSIVE STRENGTH CHARACTERISTICS:

Comparison of compressive strength of normal concrete and self-curing concrete with 0.5% of PEG- 4000 by weight of cement.

Concrete Grade: M20

Ratio: 1:1.5:3

PEG(4000): 0.5%

GRADE	3 DAYS	7 DAYS	28 DAYS
M20	18.66 N/mm ²	22.22 N/mm ²	26.22 N/mm ²
M20 + PEG- 4000	15.11 N/mm ²	16.88 N/mm ²	24.44 N/mm ²

Comparison of compressive strength of normal concrete and self-curing concrete with 1.0% of PEG- 4000 by weight of cement.

Concrete Grade: M20

Ratio: 1:1.5:3

PEG(4000): 1.0%

GRADE	3 DAYS	7 DAYS	28 DAYS
M20	18.66 N/mm ²	22.22 N/mm ²	26.22 N/mm ²
M20 + PEG- 4000	20.00 N/mm ²	23.33 N/mm ²	28.00 N/mm ²

Comparison of compressive strength of normal concrete and self-curing concrete with 1.5% of PEG- 4000 by weight of cement.

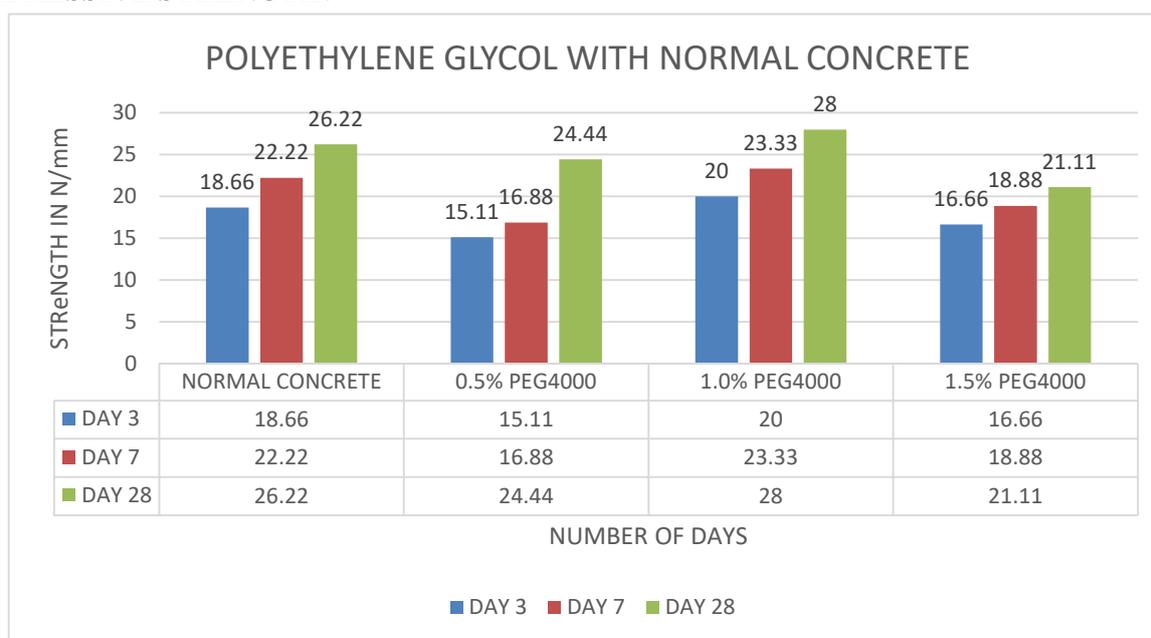
Concrete Grade: M20

Ratio: 1:1.5:3

PEG(4000): 1.5%

GRADE	3 DAYS	7 DAYS	28 DAYS
M20	18.66 N/mm ²	22.22 N/mm ²	26.22 N/mm ²
M20 + PEG- 4000	16.66 N/mm ²	18.88 N/mm ²	21.11 N/mm ²

COMPRESSIVE STRENGTH:



CONCLUSION:

The following could be concluded from the results presented in this study:

- The use of self-curing agent PEG-4000 in concrete mix can eliminate the requirement of curing and the strength of self-curing concrete was found to be on par with that of conventionally cured of the same grade.
- Better internal curing provides more and continuous hydration process of cement which produces less porous and more compact concrete.
- From the workability test results, it was found that self-curing agent improved workability.
- The optimum dosage of PEG-4000 for maximum compressive strength was found to be 1.0% for M20 grade of concrete.

- From the compressive strength results, it was found that self-curing concrete has given more strength than that of conventionally cured concrete.
- Self-curing concrete is the answer to many problems faced due to lack of curing.

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