A STUDY ON SELF CURING CONCRETE USING PEG-400

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ABSTRACT

Due to its exceptional strength and durability, concrete is currently the most often used building material. To avoid cement concrete having unacceptable qualities, water curing is absolutely essential. Preventing excess evaporation from the surface is necessary for high-quality curing. This study examines the impact of polyethylene glycol on the compressive strength, split tensile strength, and flexural strengths of concrete through manipulation of the polyethylene glycol-400 %. Cement is substituted for polyethylene glycol in varying proportions (0%, 0.5%, 1%, 1.5%, & 2%). The maximum strength of M-20 grade concrete attained at 1% polyethylene glycol by cement weight.

Key words: *self-curing concrete, polyethylene glycol, flexural strength, different mix, split tensile strength, and compressive strength.*

1. INTRODUCTION

For concrete constructions to achieve performance and durability criteria, proper curing is essential. This is accomplished in traditional curing by applying external curing following mixing, putting, and finishing. A method for adding extra moisture to concrete for improved cement hydration and decreased self-desiccation is called self-curing or internal curing.

Methods of self-curing

There are currently two main approaches for curing concrete internally. The first technique replaces the water lost to chemical shrinkage during cement hydration by providing an internal water supply through saturated porous lightweight aggregate (LWA). The second technique makes use of poly-ethylene glycol (PEG), which helps to retain water by reducing the amount of water that evaporates from the surface of concrete.

Mechanisum of internal curing

Because the chemical potentials (free energy) of the vapour and liquid phases differ, moisture continuously evaporates from an exposed surface. The additional polymers in the mixture mostly interact with water molecules by forming hydrogen bonds with them. This lowers the molecules' chemical potential, which lowers the vapour pressure and slows down the pace at which water evaporates off the surface.

Significance of self-curing

The need for external or internal curing water for mineral admixtures might be significantly higher in blended cement systems when they react fully than in regular Portland cement concrete. Significant autogenous deformation and (early-age) cracking may occur when this water is not easily accessible. Empty pores are produced in the cement paste as a result of the chemical shrinkage that takes place during cement hydration. This shrinkage and reduction in internal relative humidity may result in early-age cracking.

By providing enough water to hydrate all of the cement, internal curing (IC) is a technique that does what mixing water alone cannot.

Advantages of internal curing

supplies water to maintain a high relative humidity (RH), preventing the onset of self-desiccation. mostly eliminates autogenous shrinking.

keeps the strengths of concrete and mortar at an early age (12 to 72 hours) above the point at which forces induced from the outside and inside may cause cracking.

can somewhat compensate for the lack of external curing, both hydration-related (the first 12 to 72 hours are a vital time when curing is needed) and human-related.

2. LITERATURE REVIEW

- Jagannadha Kumar, M. V., et al. They investigated the application of polyethylene glycol (PEG-400), a shrinkage-reducing additive that promotes improved hydration and, consequently, strength in concrete by aiding in self-curing. By changing the percentage of PEG by weight of cement from 0% to 2% for M20 and M40 mixes, the effects of admixture (PEG-400) on compressive strength, split tensile strength, and modulus of rupture were investigated. It was also discovered that, in order to achieve maximal strength without sacrificing workability, M20 grade concretes should contain 1% of PEG-400 by weight of cement, whereas M40 grade concretes should contain 0.5%.
- M. Saravanan and K. Vedhasakthi The workability and strength properties of concrete using self-curing agents—both normal strength and high strength—have been examined in this study and contrasted with similar concrete that has been conventionally cured. The dosage of super plasticizer was adjusted based on the concrete grade. For M60, M70, and M80 grades of concrete, trial dosages of 0.8%, 1%, and 1.2% of the cement's weight were utilized; for medium strength concrete, trial dosages of 0.25% and 0.3% of the cement's weight were employed; and for high strength concrete, trial dosages of 0.4% of the cement's weight were utilized. The self-curing agent has better workability, according to the results of the workability test. Concrete treated with this self-curing chemical is shown to yield more
- Shikha Tyagi The current study examines how the curing chemical affects compressive strength and workability (slump and compaction factor). This study fixed the dosage of the internal curing ingredient and varied the proportion of PEG by weight of cement from 0% to 2%. The test findings for the M40 and Mas mixtures were examined. This experiment investigation has shown that PEG-400 aids in self-curing by improving workability and providing strength comparable to that of the traditional curing process.
- Robert Keith Sun and Roland Tak Yong Liang worked on the concrete internal curing composition, which contains wax and glycol. The discovery that adding a mixture of wax and glycol to concrete allows for internal curing—which is comparable to or better than conventional methods of curing concrete in many ways—led to the innovation. For the first time, an internal curing composition is made available by the invention, which when combined with concrete or other cementitious mixes, satisfies the curing requirements outlined in Australian Standard AS 3799. The invention describes a preferable internal curing composition that consists of paraffin wax and PEG with a molecular weight of approximately 200.
- By adding pre-wetted LWA to 25% of the volume of the aggregates, Silvia Weber and Hans W. Reinhardt created a new kind of high-performance concrete. This allowed the concrete to retain water internally, allowing for continuous wet curing. The microstructure of the hardened cement paste and the most significant mechanical characteristics of the concrete under various curing conditions were examined. The outcomes demonstrated that the technique of adding a water reservoir can be used to create High Performance Concretes (HPC) that have better qualities and are less susceptible to curing.

- In order to lessen autogenous shrinkage by IC, M.R. Geiker, D.P. Bentz, and 0.M. Jensen investigated two internal water supply sources. First, partially saturated lightweight fine aggregate is substituted for some of the sand, and second, superabsorbent polymer particles (SAP) are added. The SAP system is seen to be more effective at reducing autogenous shrinkage at later ages at equal water addition rates, most likely because the additional curing water is distributed more uniformly within the three-dimensional mortar microstructure.

3. PROJECT OBJECTIVE

1. The primary goal is to investigate the self-curing concrete's strength properties.
2. To research the M20 grade concrete's strength properties. It cast beams, cylinders, and cubes.
   The qualities were examined starting with a set of plain and increasing the percentage of PEG by0.5,1,1.5, and 2 by weight of cement in cubes, cylinders, and beams.
3. The self-cured samples were stored in the shade for 28 days, whereas the plain samples were water cured for the same duration.
4. Over the course of 28 days, the samples' mechanical attributes were examined.
   i. Cube's compressive strength.
   ii. Beam flexural strength
   iii. Split tensile strength of cylinders

4. MATERIALS

MATERIALS USED

The different materials used in this investigation are

- 53 Grade Portland pozzolona cement
- Fine Aggregate
- Coarse Aggregate
- Polyethylene Glycol-400
- Water

Cement: Cement used in the investigation is 53 grades Portland pozzolona cement confirming IS: 12269: 1987. The cement used for experiments was obtained from a single consignment and of same grade and same source after procuring the cement it was stored properly.

Fine aggregate: The fine aggregate conforming to zone II according to IS: 383-1970 was used. The fine aggregate used was obtained from a crushed stone source. The specific gravity of the sand used was 2.52. The sand obtained was sieved as per IS sieves (i.e. 4.75mm, 2.36mm, 1.18mm, 600microns, 300 microns, and 150 microns).

Coarse aggregate: Crushed granite was used as coarse aggregate. The coarse aggregate according to IS: 383. 1970 was used. Maximum coarse aggregate size used is 20 mm.

Polyethylene Glycol-400: Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula H(OCH2CH2), OH, where n is the average number of repeating oxy ethylene groups typically from 4 to about 180. The abbreviation (PEG) is termed in combination with a numeric suffix which indicates the average molecular weight. One common feature of PEG appears to be the water-soluble nature. Specifications of PEG-600 are listed in table.

Water : potable water was used in experimental work for both mixing and curing.

5. EXPERIMENTAL PROGRAMME

The purpose of the experimental program was to add polyethylene glycol PEG400 to concrete at weights of 0.5%, 1%, 1.5%, and 2% in order to test the strength of self-curing concrete. The workability, compressive strength, split tensile strength, and rupture modulus were the main objectives of the experimental program. The qualities mentioned above were studied using mix M20. Table No. 1 provides the experimental program's layout.

Table 1: details of specimens cast.

Sl.no	Nature	M20		
		Cube	Cylinder	Prism
1.	PCC	2	2	2
2.	0.5%	2	2	2
3.	1.0%	2	2	2
4.	1.5%	2	2	2
5.	2.0%	2	2	2

- The size of each cube is 150 X 150 X 150mm.
- The size of each cylinder is 150mm in dia & 300mm in height.
- The size of each prism is 100 X 100 X 500mm.

6. CASTING PROGRAMME:

The specimens were cast in accordance with IS:10086-1982. material preparation, material weighing, and cube, cylinder, and beam casting. Concrete is mixed, compacted, and cured in accordance with IS 516: 1959. The PEG400 specimens were cured for 28 days at room temperature under cover, whereas the plain cube, cylinder, and prism samples were cured for 28 days in a water pond. Table 2 displays the amount of material needed per cubic meter of concrete for the M20 grades of concrete that have been designed.

Table 2: materials required per cubic meter of concrete.

Sl.no	Mix	Cement	Fine aggregate	Coarse aggregate	Water
1.	M20	345 kg/m^3	750 kg/m^3	1170 kg/m^3	190 kg/m^3

7. TESTING

Slump test & compaction factor:

The most popular technique for determining the consistency of concrete is the slump test, which can be performed at the job site or in a laboratory. Not every element that affects workability is measured. Nonetheless, it serves as a practical control test and provides information about the consistency of concrete across batches. Although it is primarily intended for use in laboratories, the compacting factor test can also be applied in the field. Compared to the slump test, it is more accurate and sensitive, and it is especially helpful for very low workability concrete mixes, which are typically employed when vibration compaction is intended for the concrete. Slump test insensitivity applies to such dry concretes.

Compressive strength:

The cube specimens underwent testing on a 3000KN compression testing apparatus. Sand or other dirt was cleared off the specimen's surface and the machine's bearing surface was thoroughly cleaned. The specimen was positioned in the machine so that the weight was imparted to the cubes' opposing sides—that is, their top and bottom—as they were being cast. The specimen's axis was precisely positioned in the loading frame's center. Up until the specimen's resistance to the rising load failed and could no longer be maintained, the applied load was increased steadily and at a consistent rate. The highest load that was placed on the specimen was noted.

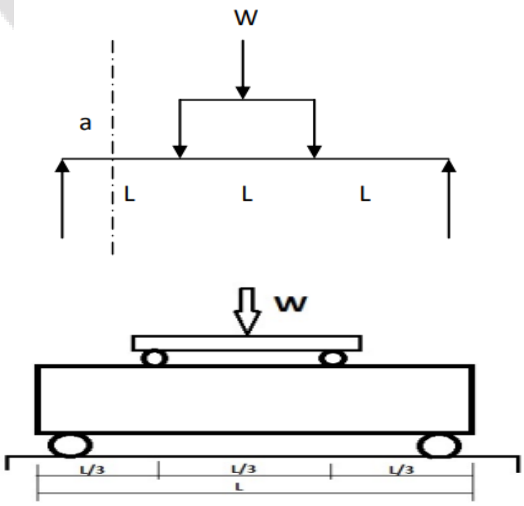
$f_c = P/A$, where, P is load & A is area

Split tensile strength

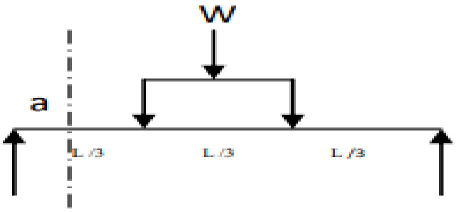
The cylinder specimens were testing on a 3000KN compression testing apparatus. Clean sand or other material removed from the specimen's surface was wiped from the machine's bearing surface. Up until the specimen's resistance to the rising load failed and could no longer be maintained, the applied load was increased steadily and at a consistent rate. The highest load that was placed on the specimen was noted.

$f_{split} = 2P/\pi DL$, where, P is load, D is dia of cylinder, L is length of cylinder.

Modulus of rupture:



To produce a pure bending, the beam specimens were put through two-point loading tests on a universal testing equipment. Sand or other dirt was cleared from the specimen's surface and the machine's bearing surface was thoroughly cleaned. The applied two-point bending stress was increased steadily and at a steady rate until the specimen failed and could no longer support the strain. The highest load that was placed on the specimen was noted. In Fig. 2, the test setup is displayed. The specimen's breaking point along the span determines the modulus of rupture. Fig. 3 shows the specimens under test for modulus of rupture, split tensile strength, and compressive strength.



if the specimen breaks at the middle third of the span then the modulus of rupture is given by

$f_{rup} = (WL)/(bd^2)$

if the specimen breaks at a distance of 'a' from any of the support then the modulus of rupture is given by

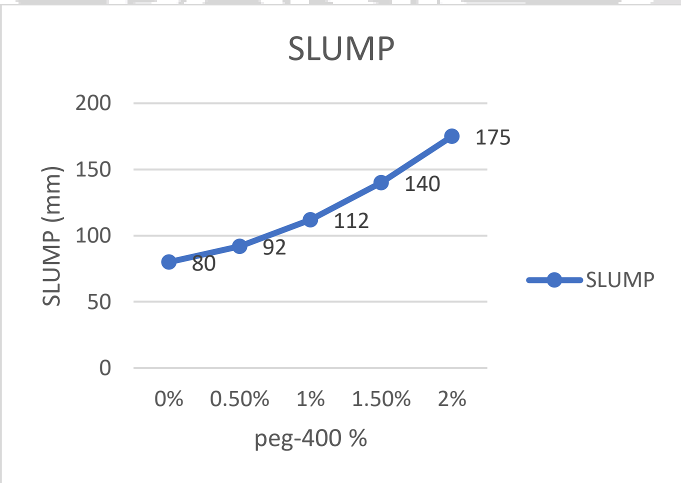
$f_{rup} = (3Wa)/(bd^2)$,
where,
W is load at failure
L is length of specimen
b is width of specimen
d is depth of specimen

8. RESULTS & DISCUSSION

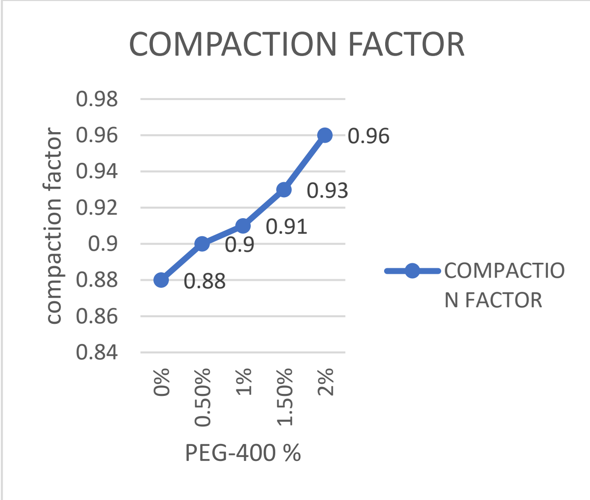
Slump and compaction factor test:

The findings of the Slump & Compaction factor are displayed graphically in Fig., respectively. It is discovered that the slump and compaction factor increase as the percentage of PEG400 increases. However, the rate at which M20 concrete's slump and compaction factor are increasing.

Table 3: results of workability



Variation of slump

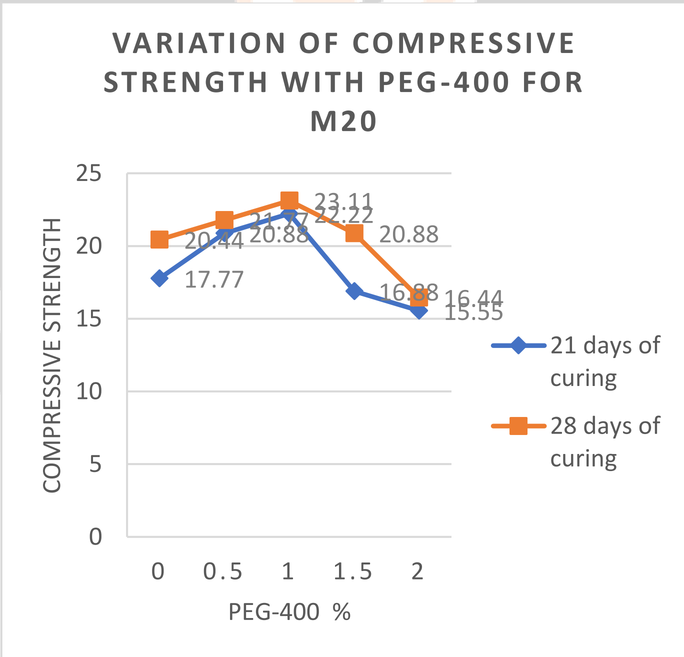


Variation of compaction factor

Compressive strength:

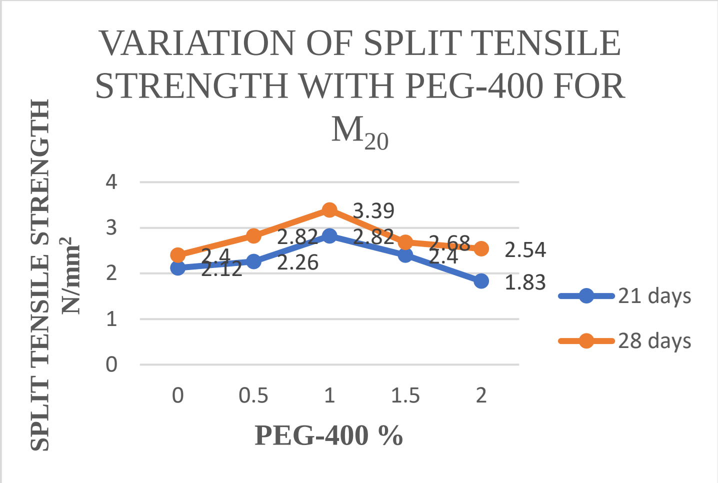
Fig. 6 displays the graphical depiction. It was discovered that the compressive strength rose up to 1% PEG400 before declining for M20 grade. For M20 grade of concrete, the improvement in compressive strength was 23.11 at 1% of PEG 400 compared to standard concrete.

Mechanical properties



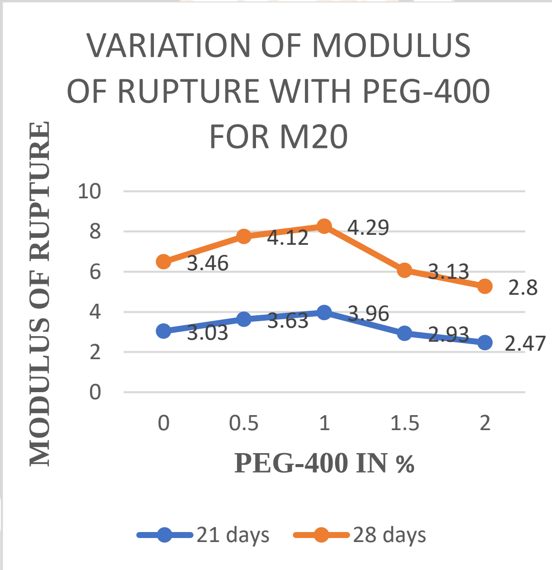
Split tensile test:

Fig. 7 displays the graphical depiction of the data. It was discovered that the split tensile strength rose up to 1% PEG400 before declining for M20 grade. For M20 grade of concrete, the increase in split tensile strength was 3.39 at 1% of PEG400 compared to standard concrete.



Modulus of rupture:

Fig. 8 displays the graphical representation. It was discovered that the modulus of rupture rose up to 1% PEG400 before declining for M20 grade. For M20 grade concrete, the modulus of rupture increased by 8.57% at 1% of PEG 400 in comparison to standard concrete.



CONCLUSIONS

1. The following findings are drawn from the results of the experimental testing and observations: PEG-400, the self-curing agent, was shown to be successful.
2. It has been noted that the application of PEG-400 improves concrete's workability and makes it flowable.
3. It was determined that 1% of the cementitious material's weight was the ideal PEG dosage.
4. The maximum compressive strength of 23.11 N/mm2 was achieved for M20 grade concrete using self-curring agents in the concrete mix containing 1% PEG-400.
5. When 1% of PEG 400 was added to the self-curing chemicals used in concrete, the maximum split tensile strength of 3.39N/mm2 was achieved.
6. The maximum flexural strength of concrete is determined by the self-curing chemicals utilized in it.

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5]. Book code is 456-2000

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6]. BOOK CODE: 10262-205