ISSN: 2633-4828 Vol. 5 No.4, December, 2023

International Journal of Applied Engineering & Technology

AN EXPERIMENTAL INVESTIGATION OF SELF-CURING CONCRETE INCORPORATED WITH POLYETHYLENE GLYCOL

Twinkal Naresh Bagde[1], Prof. P.S. Mote[2] and Prof. Y. R. Suryavanshi[3]

[1]PG Student (M.E Structural Engineering), Department of Civil Engineering, Imperial College of Engineering and Research, Wagholi, Pune-412207

[2]Assistant Professor, Department of Civil Engineering, Imperial College of Engineering and Research, Wagholi, Pune-412207

[3]Head of, Department of Civil Engineering, Imperial College of Engineering and Research, Wagholi, Pune-412207

ABSTRACT

This study investigates the effects of a self-curing compound, PEG-400, on the compressive strength, flexural strength, and workability of M30 grade concrete. Experimental tests were conducted to compare the performance of concrete mixes with varying dosages of PEG-400 against conventional curing methods. The results indicate that the compressive strength of concrete mixes increases with higher dosages of PEG-400 compared to conventional curing. The optimum dosage of PEG-400 for maximum flexural strength was found to be 1% for M30 grade. Additionally, the workability of concrete was found to increase with the percentage of PEG-400 added. However, flexural strength decreases with dosages exceeding 1% of PEG-400. These findings suggest that the use of PEG-400 as a self-curing compound can enhance the mechanical properties and workability of M30 grade concrete, offering potential benefits for construction practices.

Keywords: self-curing compound, PEG-400, M30 grade concrete, compressive strength, flexural strength, workability, conventional curing, dosage

INTRODUCTION

Concrete curing is important in the early stages because it keeps the wetness at bay. Curing is an essential aspect in the strength and durability of concrete structure in civil engineering. Extra internal water is frequently provided by a small amount of saturated, lightweight polyethylene glycol, hyper absorbent chemical compound particles within the concrete. If this water is not correctly supplied, for example, due to capillary body non percolation, vital autogenic deformation and (early-age) Cracking may occur as a result, chemical shrinkage occurs during the hydration of the cement. Concrete curing is vital in the early phases because it keeps the moisture content and temperature stable, allowing the concrete characteristic to grow. In comparison to traditional concrete polyethylene glycol helps to reduce water loos and improve water perversion capacity. The loss of water in the concrete is reduced with the help of PEG-400, and the water capacity of the concrete is improved the compare to conventional concrete in concrete buildings, curing is necessary for optimal strength and durability. The strength of conventional concrete is acquired through external curing, which is achieved through careful mixing and placement of the concrete.

Fig 1.1: Polyethylene Glycol

LITERATURE REVIEW

Agalya C. et. al (2018) , They studied the role of polyethylene glycol as a shrinkage reducing admixture on steel fiber reinforced concrete. In this 2% steel fibresS by weight of cement were added. The aim of their study is to evaluate the Structural innovative concrete using Steel fiber and Polyethylene Glycol-400. The steel fibres used in this study had an aspect ratio of 50. The compressive strength was high at 1.5% adding of Polyethylene Glycol-400 and 2% of Steel fiber with increased strength in 25.94N/mm 2 compared with conventional concrete. The percentage increasing was 4.13% when compared with conventional mix. The Split Tensile Strength was high at 1.5% adding of Polyethylene Glycol-400 and 2% of Steel fiber with increased strength in 24.8N/mm 2 compared with conventional concrete. The percentage increasing was 4.49% when compared with conventional mix. The Flexural Strength was high at 1.5% adding of Polyethylene Glycol-400 and 2% of Steel fiber increased strength in 5.69N/mm 2 compared with conventional concrete. The percentage increasing was 4.49%

Soorya Tharshini et. al (2018), Concrete is the most widely used construction material nowadays due to its compressive power and hardness. Plain concrete is made by using cement, fine aggregate, coarse aggregate, and water in different proportions based on the form of operation. Plain concrete necessitates a friendly atmosphere of enough moisture for at least 28 days in order to adequately hydrate and reach the desired intensity. If the curing method is sloppy, the quality and hardness of the concrete can suffer. Self-curing concrete is one of the only concretes that can be used to cope with insufficient curing triggered by human error. Water shortage in arid areas, inaccessibility of buildings in difficult terrains, and regions where fluoride deposition in water will negatively impact the properties of concrete, which helps with self-curing, hydration, and thus strength. PEG 400 has been found to help self-curing by delivering strength comparable to conventional curing. It was also discovered that 1% PEG 400 by weight of cement was ideal for M20 grade concretes, while 0.5 percent was ideal for M40 grade concretes for achieving maximum strength without sacrificing workability. As water becomes a limited resource, there is an urgent need to undertake water management studies in concrete and construction. Curing concrete relates to the process of maintaining a consistent moisture content in the early stages of its production in order to produce the best properties.

The effect of corrosion on self-curing concrete was studied by A.S. El-Dieb et. al (2018), Polyethylene glycol and polyacrylamide were adopted to prepare the self-curing concrete to assess the corrosion behavior. The protection to reinforcement studies was then interrelated to durability features such as electric resistivity, chloride

ion permeability, and water perviousness. Mixes were prepared in conjunction with PEG and PAM at various dosages. Self-cured concrete specimens gave better performance against corrosion potential and current. The studies on the microstructure of self-cured concrete also indicated that durability and corrosion protection was enhanced. The self-cured concrete shown lower permeability as compared to the conventional concrete.

Awham M. Hameed et. al (2017), Studied the impact of addition of PEG400 and Polyacrylamide blend (PEG/PAA) on cement mortar. These additives alter the physical and mechanical properties of cement mortar. The studies demonstrate that polymer modified mortar possesses higher strength compared to reference mortar. Mortar with 1% and 3 % of PEG400 and (PEG/PAA) dosage gives higher compressive strength, as compared to conventionally cured mortar. It has been observed during testing, internally cured mortar PEG400 and (PEG/PAA) demonstrates lesser cracks than the mortar. Addition of PEG400 and (PEG/PAA) effectively enhances its tensile and flexural strength. Hence, PEG400 and (PEG/PAA) modifier can be a good candidate for infrastructure utilizes particularly those subjected to the flexural stress and interface shear stress, such as bridge overlays and pavements.

G. Thrinatheal et. al (2017), There is now a planet-wide preference for concrete as the world's most durable and long-lasting building material. Since concrete curing is critical for achieving good strength, we use the self-curing concrete concept rather than immersion or sprinkle curing to prevent water shortages. Water solvent polymers, such as polyethylene glycol, have been discovered to be useful as a self-curing agent (PEG-400). Different amounts of PEG-400 in cement weight as curing agent were added to the effect of admixture polyethylene glycol (PEG-400) on compression, split strength and bending strength. in this research, ranging from zero to two percentages. The results of the M30 concrete mix tests were analyzed. The ideal PEG-400 proportion for compressive and break tensile strength was estimated to be 1%. As the PEG-400 dosage is raised to more than 1%, the compressive and split tensile pressure decreases. The maximum PEG-400 percentage for flexural strength, on the other hand, was discovered to be 0.5 percent. As the dosage of PEG-400 is raised by more than 0.5 percent, the flexural resistance decreases.

Mohanraj A et. al 2016, Studied on “self-curing concrete incorporated with polyethylene glycol”. The compressive strength of cube for Self cured concrete is higher than of concrete cured by conventional curing method. The split tensile strength of self-cured concrete 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.

Basil M Joseph et. al (2016) , Studied on self-curing concrete and PEG400 were used as a self-curing agent in concrete. M20 grade of concrete is adopted for investigation. The author added 0-1.5% of PEG400 by weight of cement for M20 grade concrete from that he found 1% of PEG400 by weight of cement was optimum for M20 grade of concrete for achieve good maximum strength. The author found that the percentage of PEG400 gets increased slump as well as compaction factor also get increased.

Akshara O. S. Set. al (2016), The concrete is still the most frequently used construction tool because of its high compression strength and toughness. Because water conservation is a daily necessity, the use of self-curing admixtures is critical (3m3 of water in the building, most of which are used for curing, are required for each cubic meter of cement). The project aims to study the mechanical and durable characteristics of concrete in aquatic polyethylene glycol (PEG-400). In this study, the mechanical characteristics of self-treatment concrete are examined and contrasted with conventionally treated concrete. In terms of cement weight, the number of self-curing agents used ranges from 0.5% to 2.0%. According to test results, self-curing concrete outperforms conventionally cured concrete. The 11 optimum PEG-400 dose for full strengths was discovered to be 1%.

Mousa MI et.al (2015) , In their study water retention and durability of concrete with or without silica fume along with self-curing agents such polyethylene-glycol, and leca is investigated and compared to conventional concrete. The concrete mass loss and the volumetric water absorption were measured, to evaluate the water retention of the investigated concrete. significant improvement in all considered concrete properties due to the

addition of 15% SF along with self-curing agents has been achieved, especially with 2% of Polyethylene-glycol which absolutely ensured the best results and good durability properties.

Sona K.S.et. al (2015) , studied Internal curing technique that can be used to provide additional moisture in concrete for effective hydration of cement. The effect of variation in strength parameters i.e., compressive strength, split tensile strength, flexural strength and durability were studied for different dosage of self-curing agent and compared with that of conventional cured concrete. The optimum dosage of SAP for maximum compressive strength split tensile strength, flexural strength was found to be 0.5% of weight of cement for M25 and M30.Also determine Self curing concrete was the best solution to the problems faced in the desert region and faced due to lack of proper curing.

RESULT AND DISCUSSION

Comparison of Compressive Strength

Table Avg. strength (N/mm2) of 7 days

	PEG-400 (0.5%)	**PEG-400 (1.0%)**	**PEG-400 (1.5%)**
Normal Concrete	25.19	25.19	25.19
PEG-400 Concrete	25.08	25.38	25.41
% Increase in Strength	-0.41%	0.76%	0.88%

The table describes the compressive strength of normal concrete and concrete with different percentages of PEG-400 (Polyethylene Glycol-400) as an additive. The percentages of PEG-400 used are 0.5%, 1.0%, and 1.5%.

- For normal concrete, the compressive strength is consistent at 25.19 MPa.
- For PEG-400 concrete, the compressive strength varies slightly, with values of 25.08 MPa, 25.38 MPa, and 25.41 MPa for the 0.5%, 1.0%, and 1.5% PEG-400 mixes, respectively.
- The table also shows the percentage increase in strength compared to normal concrete, which ranges from -0.41% to 0.88%.

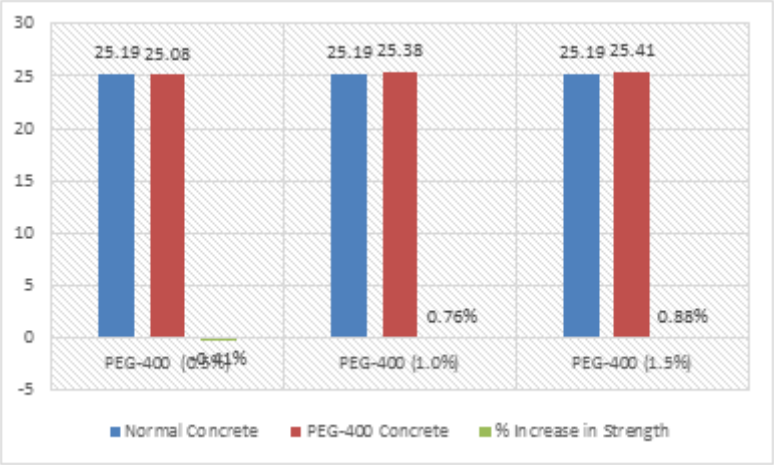

Figure 1: Compressive Strength Comparison on 7th day

Table: Avg. strength (N/mm2) of 28 days

	PEG-400 (0.5%)	**PEG-400 (1.0%)**	**PEG-400 (1.5%)**
Normal Concrete	38.43	38.43	38.43
PEG-400 Concrete	38.31	38.52	38.59
% Increase in Strength	-0.30%	0.23%	0.42%

The table provided describes the average strength (in N/mm²) at 28 days for normal concrete and PEG-400 concrete mixes with different concentrations of PEG-400. PEG-400 is a type of polyethylene glycol used in concrete as a water-reducing admixture. Here's a breakdown of the table:

- Normal Concrete: The average strength for normal concrete is 38.43 N/mm² across all concentrations of PEG-400.
- PEG-400 Concrete: For PEG-400 concrete, the average strength varies slightly with different PEG-400 concentrations:
- 0.5% PEG-400: 38.31 N/mm²
- 1.0% PEG-400: 38.52 N/mm²
- 1.5% PEG-400: 38.59 N/mm²
- % Increase in Strength: This column shows the percentage increase in strength of PEG-400 concrete compared to normal concrete. The values indicate:
- 0.5% PEG-400: -0.30% (a slight decrease in strength compared to normal concrete)
- 1.0% PEG-400: 0.23% (a slight increase in strength compared to normal concrete)
- 1.5% PEG-400: 0.42% (a slight increase in strength compared to normal concrete)

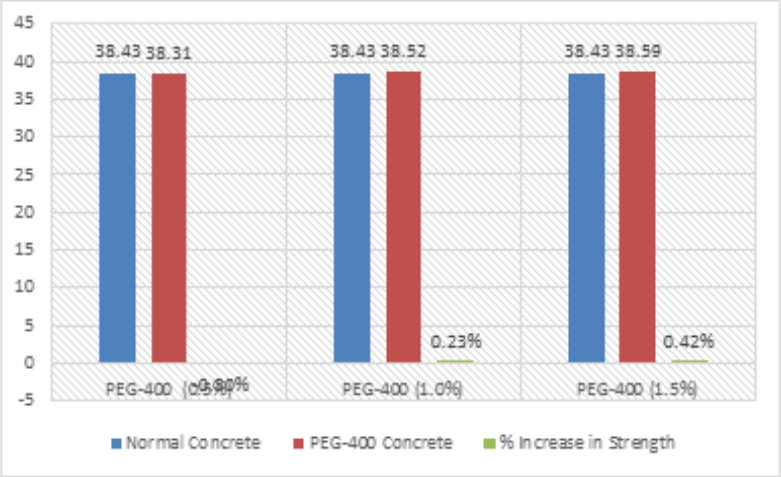

Fig 3.20 Comparison of Compressive Strength of Specimens

Comparison of Flexural Strength

Table 3.19 Flexural Strength Comparison on 7th day

	PEG-400 (0.5%)	PEG-400 (1.0%)	PEG-400 (1.5%)
Normal Concrete	3.95	3.95	3.95
PEG-400 Concrete	4.17	5.3	4.84
% increase in Strength	0.57%	3.41%	2.25%

This table describes the compressive strength of normal concrete and concrete with different percentages of PEG-400 (Polyethylene glycol) content. The table shows the compressive strength values for normal concrete and PEG-400 concrete at three different PEG-400 concentrations: 0.5%, 1.0%, and 1.5%.

- For normal concrete, the compressive strength is 3.95 MPa across all three PEG-400 concentrations.

- For PEG-400 concrete, the compressive strength values vary:
- At 0.5% PEG-400, the compressive strength is 4.17 MPa.
- At 1.0% PEG-400, the compressive strength is 5.3 MPa.
- At 1.5% PEG-400, the compressive strength is 4.84 MPa.
- The table also calculates the percentage increase in strength for PEG-400
- 0.57% for 0.5% PEG-400.
- 3.41% for 1.0% PEG-400.
- 2.25% for 1.5% PEG-400.

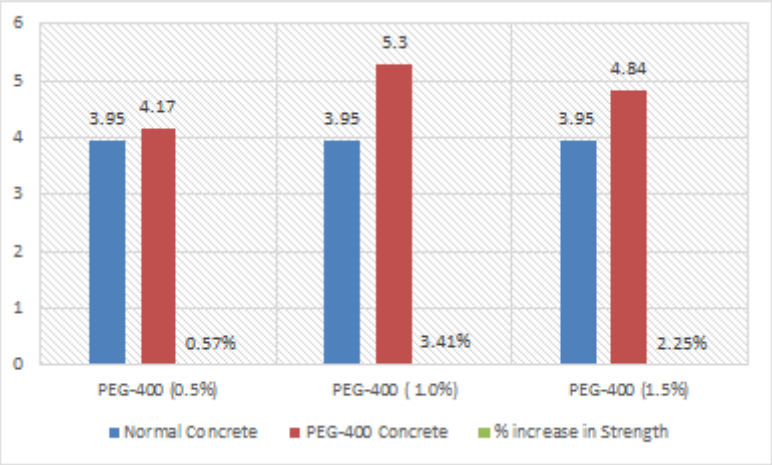

Fig 3.20 Comparison Flexural Strength of Specimens 7 days

Table 3.19 Flexural Strength Comparison on 28th day

	PEG-400 (0.5%)	PEG-400 (1.0%)	PEG-400 (1.5%)
Normal Concrete	2.89	2.89	2.89
PEG-400 Concrete	2.85	3.44	3.24
% increase in Strength	-1.40%	7.49%	3.95%

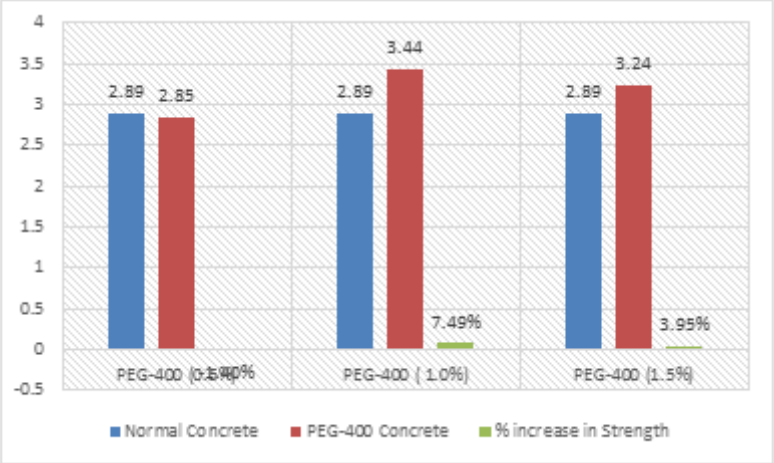

Fig 3.20 Comparison Flexural Strength of Specimens 30 days

- Normal concrete: the strength remains constant at 2.89 for all percentages of peg-400.
- Peg-400 concrete: the strength varies depending on the percentage of peg-400 additive used. For 0.5% peg-400, the strength decreases slightly to 2.85, for 1.0% peg-400, the strength increases to 3.44, and for 1.5% peg-400, the strength is 3.24.
- % increase in strength: this column shows the percentage increase in strength compared to normal concrete for each percentage of peg-400 used. For 0.5% peg-400, there's a decrease in strength of 1.40%. For 1.0% peg-400, there's an increase in strength of 7.49%, and for 1.5% peg-400, there's an increase in strength of 3.95%.
- Overall, it seems that adding 1.0% peg-400 to the concrete mix yields the highest increase in strength, while 0.5% peg-400 leads to a slight decrease in strength.

CONCLUSION

On the basis of Experimental tests result and observations, following Conclusions are made:

i. As per the results compressive strength of various mixes for M30 grade of concrete we conclude that the compressive strength of mixes using self-curing compound (PEG-400) are increased with increase of dosage with respect of conventional curing.

ii. The optimum dosage of PEG 400 for maximum flexural strength was found to be 1% for M30 grade.

iii. As per the percentage of PEG-400 increase, the workability of concrete also increases and it was found by workability test.

iv. The flexural strength value gets increased by adding 1% of PEG-400 and strength decreases by adding more than 1% of PEG-400.

REFERENCES

1. Vikram M B, Vijay B V et al. (2014) Utilization of Chemical Agent in Concrete for Self Curing. International Research Journal of Engineering and Technology, Volume 5e-ISSN: 2395-0056.
2. Malathy, Ramalingam, Ill-Min Chung, and Mayakrishnan Prabakaran. "Characteristics of fly ash based concrete prepared with bio admixtures as internal curing agents." Construction and Building Materials 262 (2020): 120596
3. Madduru, Sri Rama Chand, et al. "Hydrophilic and hydrophobic chemicals as self-curing agents in self-compacting concrete." Journal of Building Engineering 28 (2020): 101008

4. Hameed, A. M., R. R. Rawdhan, and S. A. Al-Mishhadani. "Effect of self-curing agents on the different properties of cement and mortar." International Journal of Current Research 9.7 (2017): 54586-54594
5. Rizzuto, Joseph P., et al. "Effect of self-curing admixture on concrete properties in hot climate conditions." Construction and Building Materials 261 (2020): 119933.
6. Vijayan, D.S., et al. "An experimental study on mechanical and durable properties of self-curing concrete by adding admixture." Materials Today: Proceedings (2020).
7. Agalya, C., and G. Dr Dhanalakshmi. "An experimental Study on Self Curing Concrete by using Steel Fiber and Polyethylene Glycol." International Research Journal of Engineering and Technology 5 (2018): 2065-2069
8. C., and G. Dr Dhanalakshmi. "An experimental Study on Self Curing Concrete by using Steel Fiber and Polyethylene Glycol." International Research Journal of Engineering and Technology 5 (2018): 2065-2069
9. Madduru, Sri Rama Chand, et al. "Hydrophilic and hydrophobic chemicals as self curing agents in self-compacting concrete." Journal of Building Engineering 28 (2020): 101008
10. Mix design IS 10262-2019
11. Plain Concrete and Reinforced Cement Concrete IS 456-2000
12. Vicat apparatus conforming to IS: 5513 – 1996, Balance, Gauging trowel conforming to IS: 10086 – 1982
13. To determine the aggregate crushing value of coarse aggregates as per IS: 2386 (PartIV) – 1963
14. To determine the aggregate impact value of coarse aggregates as per IS: 2386 (Part IV)– 1963.
15. Determine Fineness modulus of Fine and Coarse aggregates by sieve analysis as per IS2386 (part4) -1963
16. To calculate the initial and final setting time as per IS: 4031 (Part 5) – 1988.
17. Concrete Technology theory and practice M. S. Shetty
18. IS: 2386 Methods of test for aggregates for concrete:

(Part Is)- I963 Particle size and shape

(Part II)-1963 Estimation of deleterious materials and organic impurities(Part III)-1963 Specific gravity, density, voids, absorption and bulking (Part IV)-1963 Mechanical properties