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Use of PEG-400 as a Self-Curing Agent For M-30 Grade of Concrete.

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Abstract - *Concrete is the most utilized building material worldwide, after water. It is well-known for having strong compressive and tensile properties. Concrete curing contributes to its durability; therefore, in order to prevent water shortages, we propose the idea of self-curing concrete as an alternative to immersion. This study aims to determine the impact of adding polyethylene glycol-400 as an additive to concrete with a weight percentage of 1% for M30 grade concrete mix. We choose internal curing where external curing is not possible, such as in places with limited water supplies or when human access is restricted. A significant factor in the development of the concrete's microstructure and pore structure is internal curing, often known as self-curing.*

Key Words*: *conventional concrete, Self-curing concrete Self-Curing agent PEG-400, Compressive strength, Tensile strength.

1.INTRODUCTION

Concrete is the most common building material due to its strength and durability, making it a low-cost option. It may be bent and sized to form highways, bridges, and other infrastructure. Concrete is extremely durable, tough, and hard. The most versatile material is suitable for any form of building project. The bulk of civil engineering structures use concrete as their primary engineering material. Its low cost, high durability, and convenience of on-site fabrication contribute to its popularity as a basic building material in construction. Concrete, like other engineering materials, must be developed for strength, durability, and workability. introduction of new generation admixtures. Higher grades of concrete with good workability are achievable.

1.1 Curing:

Curing is primarily intended to maintain the moisture content of the concrete by avoiding its loss of moisture while it is strengthening. Controlling the pace and amount of moisture movement in concrete during cement hydration is known as curing.

1.2 Self-curing:

Concrete can be internally cured, also known as self-curing, to introduce more moisture for improved cement hydration and decreased self-desiccation. With the use of PEG-400, concrete's water loss is reduced and its water capacity is increased as compared to regular concrete. Because the concrete is mixed and placed correctly, typical concrete gains its strength through external curing. In order for concrete construction to have adequate strength and longevity, curing is necessary.

1.3 Mechanism of Internal Curing Concrete:

Because of the disparity in chemical potentials, moisture evaporation from an exposed surface occurs continuously. When cement hydrates, chemical shrinkage takes place, resulting in the creation of empty holes and a drop in relative humidity. This causes the cement paste to self-desiccate and lose its moisture content, which results in the formation of microcracks and capillary pores, the weak areas in the matrix.

In order to prevent self-desiccation and preserve relative humidity, self-curing is employed. free energy that exists between the liquid and vapor phases. The content and characteristics of the self-curing agents, such as water absorption, pore structure, grain size distribution, and mechanical properties, are closely linked to the performance of the self-curing concrete system. 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.

Initially, self-curing was suggested as a way to deal with the self-desiccation of the concrete. The mechanism by which tiny inclusions scattered throughout concrete retain water during mixing and up to setting time then release it after cement hydration is known as self-curing. Maintaining the moisture content of concrete is essential because cement hydration loses effectiveness when relative humidity falls below 80%. Insufficient water availability during concrete curing can

cause cement hydration to stop and result in unfavorable characteristics.

A novel method for keeping concrete warm and moist for increased strength and durability has emerged recently: self-curing concrete. The idea behind self-curing concrete is that admixtures, which have the capacity to absorb huge amounts of water during mixing, are used to supply water from an internal source.

2. AIM:

To achieve strength without compromising workability, M-30-grade concrete contains 1% PEG-400 by weight of cement.

2.1 OBJECTIVE:

- to investigate how the curing ingredient (PEG-400) affects the concrete's strength characteristics.
- Enhancing the concrete with PEG-400. Utilizing PEG-400.
- Determine the compressive and tensile strengths of the concrete.
- Make inferences about the compressive and tensile strengths of conventional and self-curing concrete based on the data.
- The main objective of our project is to make concrete while simultaneously using less water.
- It is easy to use, and it will increase strength at the same time.

3. Literature Review

- **Sudharson G et.al, 2021** studied the effect of self-curing agent PEG-400 on fresh and hardened properties of M30 grade of concrete and compared with conventional concrete. It is concluded that the increases in dosage of PEG increases the workability of concrete. Compressive strength, split tensile strength and Flexural Strength of self-cured concrete is found to be higher when compared with conventional concrete. Also, the performance of the concrete can be improved with the addition PEG as a self-curing agent.
- **Azhagarsamy and Sundaraman 2016** studied the strength and durability properties of concrete using water soluble polyethylene glycol (PEG 400) 0.5% as self-curing agent using M20 grade concrete. The compressive strength at 3, 7 and 28 days have been obtained with normal curing and self-curing condition. It was found that an average increase in compressive strength of 12.73% and split tensile strength 13.31% with 0.5% of PEG-400. This shows that self-curing concrete showed a better performance than the conventional concrete.
- **Tyagi (2015)** Various proportions of PEG-400 (0.5 to 2) percent of the cement weight in concrete were investigated. In the current investigation, OPC cement was used in accordance to IS 12269-1987. The experiments were conducted on M25 and M40 grades to link the outcomes of both grades with conventional concrete. The optimum value for M40 grade was observed at 0.5% and 1% for the M25 grade of PEG-400 in concrete. However, the indicated values significantly enhance concrete strength properties and durability.
- **Wen-Chen Jau (2008)** the study used self-curing concrete to reduce the usage of a high percentage of freshwater in the concrete. The purpose of self-curing concrete is to eliminate the need for manual curing after casting and finishing the concrete. Self-curing concrete engrosses moisture from the air and retains the water for proper hydration of cement. In a conventional technique, the hydration process continuously evaporates water from the surface of the concrete, which results in losses of strength characteristics. The results signified the addition of a self-curing agent improved the compressive strength properties by about 10% compared to the non-cured properties of conventional concrete.

4. MATERIAL AND METHDOLOGY:

4.1 PEG, or polyethylene glycol: Substances that are difficult to dissolve in water are mixed with low-molecular-weight solvents, including polyethylene glycol, or PEG. A typical liquid condensation polymer used in concrete is PEG, which is made of ethylene oxide and water. It dissolves easily in water and is insoluble in ether, paraffin, oil, and fats, but is readily soluble in ethanol, glycol, water, chloroform, and acetone. PEG is a common ingredient in medicinal products, largely for hygienic reasons. It is nontoxic, odorless, neutral, lubricating, non-volatile, and non-inflaming. When PEG is added to concrete, it forms a thin shell around the water molecules, trapping the water particles. Since the shell that forms around the water particles prevents the water from evaporating and lowers the rate of evaporation, more water is available for the hydration process. Early-age shrinkage cracks will decrease since water is available throughout the strength-gain phase. Additionally, by

reducing the requirement for external curing, this helps conserve water. It is widely recognized as an additive used in concrete to reduce shrinkage. PEG has a density of 1.13 g/cm3, a slight odor, and appears to be harmless. When polyethylene glycol is added to concrete, it improves both the material's ability to store water and its compressive strength. The PEG-400 was employed in this study. A low-molecular-weight type of PEG is called PEG-400.

4.2 Cement: Every type of construction requires cement. The key component of concrete-forming paste that binds aggregate and fills in spaces between it is water. Cement is a highly rounded substance with cohesive and adhesive qualities that acts as a binding medium for the individual components. Ordinary Portland cement is utilized in the design mix. The mix designs for grades M–30 is prepared using the chemical compositions of ordinary Portland cement. There were no lumps in the freshly used cement. Using IS 456:2000, the water-to-cement ratio for this mix design is 0.45.

S. No.	Property	Result Permissible limit
1	Specific gravity	3 (confirming to IS 4031-1988 part 11)
2	Normal consistency	33% (confirming to 4031-1988 part 4)
3	Initial setting time final setting time	32 mins 420 mins to 9 hours (confirming to 4031-1988 part 5)
4	Fineness of cement (By 90micron sieve)	3.6% retained Not exceed 10% confirming to (4031-1988 part 3)

Table:1 Properties of Cement

Properties of Cement

4.3 Fine Aggregate: A fine aggregate is one that has a size of no more than 4.75 mm. The fine aggregate fills in the spaces left by the binding of the material. This experiment employed natural river sand that had a maximum size of 4.75 mm. Sand zone II, which is reachable locally, has a specific gravity of 2.5, a fineness modulus of 2.7, and a water absorption of 1.18%, confirming I.S. 383-1970.

4.4 Coarse aggregate: 30 to 40 percent of concrete with coarse particles is void. I.S. 383-1970 states that 20 mm-sized crushed granite stone with a specific gravity of 2.5 and a fineness modulus of 2.7 is acceptable. They work in many different areas of the construction industry. This substance is essential to the building process. Construction aggregate has a size range of 4.75 to 20 mm.

4.5 Water: Concrete acquires its strength and workability from the hydration of cement in the presence of water. It is advisable to add water to concrete sparingly, even if adding too much water can lead to segregation. Water is an essential component of concrete since it actively participates in the chemical reaction with cement. It is vital to carefully evaluate both quantity and quality because it helps make the cement gel that gives strength. Water that met IS 456-2000 standards was portable and used for both mixing and curing in the experimental operation.

4.6 Mix Design for Concrete:

For this project mix design by Indian standard recommended method for concrete mix design based on {IS10262-2019} M30 grade of concrete mix is taking by me.

(A) Design Required:

1. Grade designation = M30
2. Type of cement = OPC-53
3. Maximum Size of aggregate = 20 mm
3. Degree of site control = Good
4. Exposure condition = Severe
5. Workability = 75 mm
6. Method of concrete placing = manual
7. Minimum cement content = 320 kg/m3

(B) Test result for material:

1. Specific gravity of cement = 3.01
2. Specific gravity of coarse aggregate = 2.61
3. Specific gravity of fine aggregate = 2.5
4. Water absorption of coarse aggregate = 0.99 %
5. Water absorption for fine aggregate = 1.18 %
6. Conforming zone of sand = zone II
7. Type of aggregate = uniformly graded aggregate.

(C) Target mean strength = 38.25 N/mm^2

(D) Selection of water cement ratio = 0.45

(E) Selection of water content = 207.26 kg/m^3

(F) Cement content =425.73 kg/m^3

(G) Coarse aggregate (per m3) = 1066.75 kg

(H) Fine aggregate (per m3) = 600.10 kg

4.7 Tests on concrete:

Workability test: Constructing a concrete workability test is necessary since concrete can be mixed, transported, and used in certain applications. The slump test is the method most often used to assess workability. This test, which can be conducted at the construction site or in a laboratory, is the most widely used technique for determining the consistency of concrete. Three layers of freshly mixed concrete are added to the slump cone, and each layer is tamped 25 times using a normal rod. It doesn't measure every element that affects workability. Nonetheless, it serves as a practical control test and provides information about the consistency of concrete across batches. The mis ratio for conventional concrete is C:S:A :: 1:1.40:2.50 and for self-curing concrete is C:S:A :: 1.1.41:2.52

Table -2 Slump Values of Conventional Concrete.

S. No.	W/C Ratio	Slump Value(mm)	Average Value
01	0.45	78	77.66
02	0.45	75	
03	0.45	80	

Table- 3 Slump Values of Concrete with PEG-400:

S. No.	W/C Ratio	Slump Value(mm)	Average Value
01	0.45	81	80.00
02	0.45	83	
03	0.45	76	

Prepare the concrete using PEG-400, just like you would conventional and self-curing concrete, based on the results of the slump cone. PEG-400's inclusion improves workability.

RESULT AND DISCUSSION:

5.1 CASTING SCHEDULE: The casting of the specimens was done as per IS 10086-1982: preparation of materials, weighing of materials, and casting of cubes, cylinders, and beams. The mixing, compacting, and curing of concrete are done according to IS 516:1959. The plain samples of cubes, cylinders, and beams were cured for 28 days in a water pond, and the specimens with PEG400 were cured for 28 days at room temperature by placing them in shade. The M30 grades of concrete are designed, as is the material required per cubic meter of concrete.

Fig-1: Casting of Cube

Fig-2: Casting of Cylinder

Compressive Strength test:

Concrete's ability to support a compressive load while braking is one of its qualities. Aggregate properties, such as strength, grading, and size and shape, affect concrete's compressive strength. Uniformly graded aggregate provides increased performance and better interlocking.

A concrete sample measuring 150 × 150 × 150 × 150 mm was cast, and it was tested for 3, 7, 14, and 28 days to determine its compressive strength. A universal testing machine serves as the apparatus for determining compressive strength.

Equation (1) allows us to calculate the compressive strength. Compressive strength is equal to P/A.

A is the cross-sectional area (150 × 150 × 150 mm), and P is the applied load. The outcome showed that PEG-400 treatment enhanced the mechanical properties of self-curing concrete.

Fig-3 Compressive strength test in UTM

Table- 4 Compressive Strength results for Conventional Concrete.

S. No.	Age(days)	Average stress(N/mm²)
01	03	12.48
02	07	20.78
03	14	29.48
04	28	32.56

TABLE-5 Compressive Strength results for sample PEG-400 as self-curing concrete:

S. No.	Age(days)	Average Stress(N/mm²)
01	03	13.56
02	07	22.38
03	14	32.81
04	28	36.91

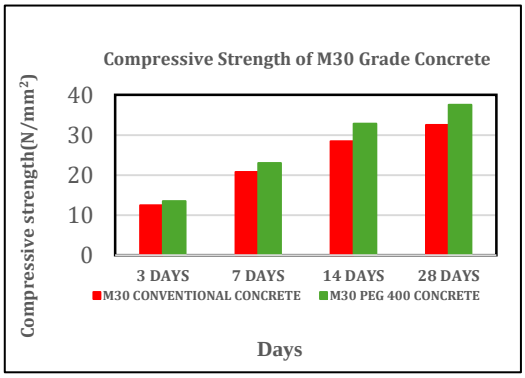

Chart-1: Compressive strength after 3-, 7-, 14-, and 28-days vs Self curing concrete.

Split tensile strength:

To find the split tensile strength using cylinders of 150 mm in diameter and 300 mm in height. The cylinder was cast, and it was tested in 3, 7, 14, and 28 days. The sample is examined using a universal testing machine with a 2000KN capacity. On the specimen, the maximum load that was applied is noted. By using equations, we can determine the split tensile strength. Split tensile strength = $2P/\pi DL$, where P = load, D = diameter of the cylinder, and L = length of the cylinder.

Fig- 4: Split tensile strength test in UTM

Table- 6 Tensile Strength results for Conventional Concrete

S. No.	Age(days)	Average Stress(N/mm²)
01	03	1.86
02	07	3.68
03	14	6.16
04	28	8.71

Table -7 Tensile Strength results for sample PEG-400 as self-curing concrete

S. No.	Age(days)	Average Stress(N/mm²)
01	03	3.13
02	07	5.85
03	14	7.38
04	28	9.56

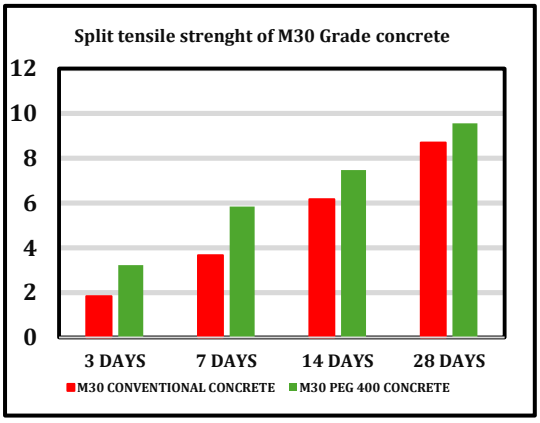

Chart-2: Tensile strength after 3-, 7-, 14-, and 28-days vs Self curing concrete.

3. CONCLUSIONS

- With respect to mix-30, PEG-400 achieved 1% compressive, and tensile strengths based on the previously indicated result.
- Chemical admixtures should be used to make high-quality concrete.
- The average 7.73% increase in compressive strength was obtained by using PEG-400 self-curing concrete as opposed to conventional concrete curing at a 7-day age.
- The average increase in compressive strength measured at 28 days was 13.33% when self-curing PEG 400 concrete was used in place of conventional concrete curing.
- Because the building industry is expanding faster, there is more construction taking place. For the curing process, the construction industry also uses a lot of water.

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