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An Experimental Use of PEG-400 as a Self-Curing Agent for Concrete.

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Abstract - *Concrete is the most commonly utilized building material worldwide, second only to water. Among its well-known properties are its strong compressive and tensile properties. We recommend self-curing concrete as an alternative to immersion in order to prevent water shortages because curing increases the durability of concrete. The purpose of this study is to determine the effects of adding 1% of the weight of polyethylene glycol-400 as an additive to M30-grade concrete mix. Internal curing is the method we use when exterior curing is not an option, such as in locations with limited water supplies or restricted access for humans. Internal curing, often known as self-curing, is an essential process in the formation of concrete's pore structure and microstructure.*

Key Words*: *Conventional concrete, Self-curing concrete, Self-Curing agent PEG-400, Compressive strength, Tensile strength, Flexural strength, cost comparison.

1.INTRODUCTION:

Because it is inexpensive and has strength and durability, concrete is the most widely used building material. It may be sized and twisted to create bridges, roads, and other infrastructure. Concrete is incredibly hard, resilient, and long-lasting. Any type of building project can benefit from using the most adaptable material. Concrete serves as the main building material for the majority of civil engineering structures. Its great durability, affordability, and ease of on-site manufacturing all play a part in its widespread use as a fundamental building material in construction. The development of concrete's strength, durability, and workability is necessary, just like it is with other technical materials. introduction of admixtures of a new generation. It is possible to get higher grades of concrete with good workability.

1.1 Curing:

Controlling the pace and volume of moisture transfer from concrete during cement hydration is known as curing. It can be done either during the process of making concrete goods or after it has been put in place, giving the cement time to hydrate. In order for the concrete to reach its full strength and durability, curing must be done for a suitable amount of time, as cement hydration does take days or even weeks rather than hours. Temperature regulation may also fall under the category of curing because it influences how quickly cement hydrates. The qualities of the concrete, its intended application, and the surrounding conditions can all affect how long it takes to cure. the intended application and the environmental factors, such as the surrounding atmosphere's temperature and relative humidity.

1.2 Self-curing and its necessity:

Self-curing is a method that helps provide more moisture to concrete so that the cement hydrates more effectively and self-desiccates less. When compared to regular concrete, PEG-400 helps reduce water loss in the concrete and increases its water capacity. Because appropriate mixing and placement of the concrete result in strength, conventional concrete requires external curing. Normal hydration can be accomplished by external curing, which involves applying water to the concrete surface. This is because it has been established that proper hydration of cement concrete projects is highly vital to achieving durability criteria. The idea behind self-curing compounds is to decrease water evaporation from concrete, increasing the material's ability to retain water in comparison to regular concrete. It was discovered that self-curing agents for concrete can be made from water-soluble polymers.

2. AIM:

M-30-grade concrete contains 1% PEG-400 by weight of cement to provide strength without compromising workability.

2.1 OBJECTIVE:

- To examine the impact of PEG-400, the curing agent, on the strength properties of the concrete.
- Analyze the concrete's compressive and tensile strengths. Based on the information, draw conclusions regarding the compressive and tensile strengths of conventional and self-curing concrete.
- Our project's primary goal is to produce concrete with less water while maintaining its simplicity of use and strength-boosting properties.

3. LITRATURE REVIEW:

- **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.

- **Patel and Pitroda (2013)** used PEG 400in conventional concrete as an admixture for better hydration. The effect of admixture (PEG 400) on compressive strength, split tensile strength and modulus of rupture by varying the percentage of PEG by weight of cement from 0% to 2% were studied. The test result indicates that use of water-soluble polymers in concrete has improved performance of concrete. About 1% of PEG 400 by weight of cement was optimum for M20 grade concrete for achieving maximum strength.

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. Condensation polymer PEG-n, which is a mixture of ethylene oxide and water, is frequently used in liquid form in concrete. PEG traps the water particles in concrete by forming a thin shell around the molecules of water. More water is available for the hydration process because the shell that forms around the water particles stops the water from evaporating and reduces the rate of evaporation. Additionally, this contributes to water conservation by lowering the need for external curing. It is well known that this addition lowers shrinkage in concrete. PEG appears to be innocuous, has a density of 1.13 g/cm^2, and has a faint smell.

4.2 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. 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.

4.3 Fine Aggregate: A fine aggregate is one that has a size of no more than 4.75 mm. Sand zone II, which is reachable locally, has a specific gravity of 2.51, a fineness modulus of 2.7, and a water absorption of 1.19%, confirming I.S. 383-1970.

4.4 Coarse aggregate: 20 mm is the nominal size of the aggregate used in construction with a specific gravity of 2.65, as per I.S. 383-1970. In the construction process, this substance is essential.

4.5 Water: Water is an essential component of concrete since it actively participates in the chemical reaction with cement. Water that met IS 456-2000 standards was portable and used for both mixing and curing in the experimental operation.

5. MIX DESIGN FOR CONCRETE:

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

(A) Design Required for concrete:

1. Grade designation = M30
2. Type of cement = OPC-53
3. Size of aggregate = 20 mm nominal size
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/m^3

(B) Test result for material:

1. Specific gravity of cement = 3.13
2. Specific gravity of coarse aggregate = 2.65
3. Specific gravity of fine aggregate = 2.51
4. Water absorption of coarse aggregate = 0.98
5. Water absorption for fine aggregate = 1.19
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 = 209.65 kg/m³

(F) Cement content =421.75 kg/m³

(G) Coarse aggregate (per m³) = 1093.21 kg

(H) Fine aggregate (per m³) = 606.82 kg

5.1 Tests on concrete:

Workability test: concrete can be mixed, transported, and used in a specific application. The most popular method for assessing workability is the slump test. 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. The mix ratio for conventional concrete is C:S:A :: 1:1.42:2.57 and for self-curing concrete is C:S:A :: 1.1.43:2.52

Table-1 Slump Values of Conventional Concrete.

S. No.	W/C Ratio	Slump Value(mm)	Average Value
01	0.45	79	78.66
02	0.45	77	
03	0.45	80	

Table-2 Slump Values of Concrete with PEG-400.

S. No.	W/C Ratio	Slump Value(mm)	Average Value
01	0.45	81	83.00
02	0.45	85	
03	0.45	83	

PEG-400's inclusion improves workability.

6. RESULT AND DISCUSSION:

6.1 CASTING PROGRAM:

The casting of the specimens was done as per IS 10086-1982. 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 strength parameters of self-cured concrete were compared with conventional cured concrete at 7 days, 14 days and 28 days.

Fig-1: Casting of Cube, Beam & Cylinder

Compressive Strength test:

Casted concrete cube 150 ×150 × 150mm size and it was tested for 7, 14 and 28 days. Compressive Strength =P/A where, P is the applied load; A is the cross-sectional area (150 ×150 × 150mm).

Fig-2: Compressive strength test in UTM

Table-3 Compressive Strength results for Conventional Concrete.

S. No.	Age (Days)	Average stress(N/mm²)
01	07	20.85
02	14	28.87
03	28	33.57

Table-4 Compressive Strength results for self-curing concrete:

S. No.	Age (Days)	Average stress(N/mm²)
01	07	20.85
02	14	28.87
03	28	33.57

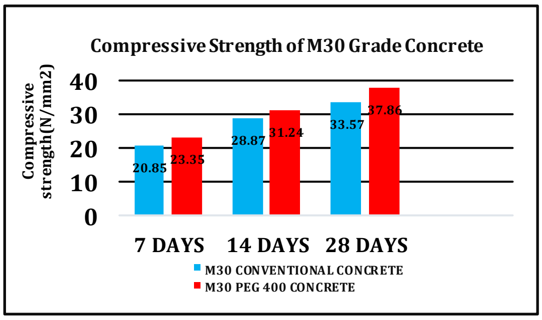

Chart-1: Compressive strength for conventional concrete after 7-, 14-, and 28-days vs Self curing concrete.

Split tensile strength:

Using cylinders of 150mm diameter and 300mm height cylinders. Cylinder was cast and it was tested in 7, 14, and 28 days. Split tensile strength = 2P/πDL, where P= load, D = diameter of cylinder, L= length of the cylinder.

Fig- 3: Split tensile strength test in UTM

Table-5 Tensile Strength results for self-curing concrete:

S. No.	Age (Days)	Average stress(N/mm^2)
01	07	3.52
02	14	4.79
03	28	5.17

Table-6 Tensile Strength results for self-curing concrete:

S. No.	Age (Days)	Average stress(N/mm^2)
01	07	4.16
02	14	5.81
03	28	6.24

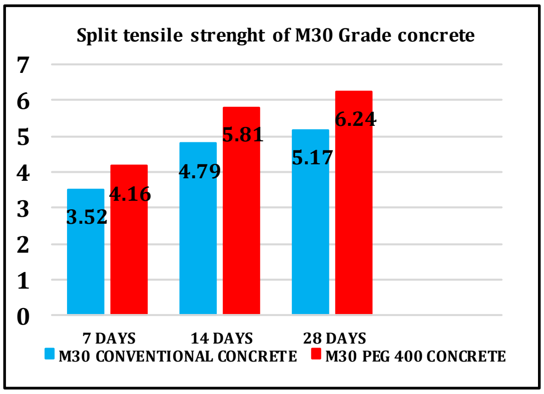

Chart-2: Tensile strength after 7-, 14-, and 28-days vs Self curing concrete.

Flexural Strength test:

The beam specimen of size 150×150×700 mm is tested on universal testing machine with a 2000 KN load for point loading to create a pure bending. The maximum applied load on specimen is recorded. Observed that the strength of the concrete mix at 7, 14, and 28 days. f strength =WL/bd^2

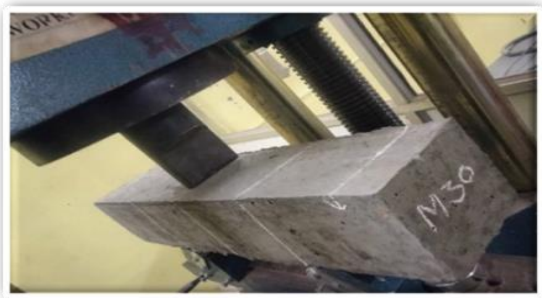

Fig-4: flexural strength test in UTM

Table-7 Flexural Strength results for conventional concrete:

S. No.	Age (Days)	Average stress(N/mm^2)
01	07	0.46
02	14	0.90
03	28	1.76

Table-8 Flexural Strength results for self-curing concrete:

S. No.	Age (Days)	Average stress(N/mm^2)
01	07	1.24
02	14	1.80
03	28	2.18

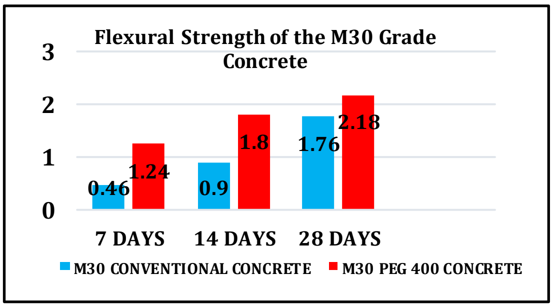

Chart-3: flexural strength after 7-, 14-, and 28-days vs Self curing concrete.

7. RATE ANALYSIS AND COST COMPARISON:

It was found that 1m³ of concrete require 3m³ of water for curing [1]. The attempt was made to find out the rates and comparison between the conventional concrete and internal cured concrete having 1% of dosage of PEG-400 including the cost of water required for curing and a labor.

Total Material Required
sand = 121.688 kg. =1.40 Rs/kg
Aggregate = 217.728 kg. = 2.81 Rs/kg
Cement requirement = 86.40 kg. = 7 Rs/kg
Volume of cube = 3.375×10^{-3} m^{-3}, Cube cast =6
Volume of cylinder = 5.310×10^{-3} m^{-3}, Cylinder cast = 6
Volume of beam = 15.75×10^{-3} m^{-3}, beam cast = 6

Cost of construction for Conventional Concrete:

Grade	Requirement	Quantity	Analysis (Rs.)	Amount (Rs.)
M30	Concrete	$0.0732m^3$	8470	620
	Water for curing	$0.21m^3$	800 Rs/m^3	175
	Labor for curing	2 hrs./day	300×7	2100
	Total = 2895 Rs.			

Cost of construction for Internal cured concrete:

Grade	Requirement	Quantity	Analysis (Rs.)	Amount (Rs.)
M30	Concrete	0.0732 m^3	8470	620
	PEG-400	390 ml	1.20	468
	Labor for curing	0	0	0
	Total = 1088 Rs.			

The cost of internally cured concrete is less as compare to conventional concrete.

8. CONCLUSION:

1. The aforementioned result indicates that PEG-400 achieves 1% of the mix-30's compressive, tensile, and flexural strengths.
2. Using self-curing PEG-400 concrete instead of traditional concrete curing at the ages of 7 and 28 resulted in an average increase in compressive strength of 11.99% and 12.77%, respectively.
3. There is a significant expansion in the construction sector, which leads to more construction activities. The construction industry also uses a lot of water, and the curing process wastes more water every day. The use of alternative methods, such as self-curing mechanisms, is required to attain sustainability in water management.
4. Utilizing PEG-400 was determined to be the superior choice in order to produce internally cured concrete without sacrificing its strength.

9. SCOPE OF RESEARCH:

- The chemical addition needs to make the concrete more workable.
- to contrast the strength characteristics of concrete produced using a curing compound—polyethylene glycol—with concrete produced using traditional curing.

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