Split Tensile Strength of Self Cured Concrete

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Abstract

In the building sector, concrete is a commonly used material. It needs a large amount of water for curing. This issue can be effectively solved by self-curing (internal curing) of concrete. Self-curing chemicals are employed for curing instead of water. This paper focuses on the effect of self-curing using chemical on concrete's split tensile strength. Polyethylene Glycol (PEG-400) is used as a self-curing agent in the concrete mix in the current investigation. Results show that self-curing is an effective method of curing which results in enhancement in split tensile strength by 36.25% and 18.81% for M20 and M25 grades of concrete respectively in comparison with conventionally cured concrete.

Keywords: Self Curing Concrete, internal curing, Polyethylene Glycol(PEG-400), Split Tensile strength

1. INTRODUCTION

Internal curing is the process through which cement continues to hydrate because of presence of curing ingredient [1]. Curing is traditionally defined as creating conditions that prevent water from evaporating from the surface, implying that curing occurs from the outside to the inside. [2]. The internal reservoirs, which come in the form of saturated lightweight fine aggregates and highly absorbent polymers, enable for internal curing, which allows for curing from the inside to the exterior. [3]. Internal curing is also known as 'Self-curing'.

In the present investigation, Polyethylene Glycol 400 is employed as a self-curing agent. When

compared to regular concrete, the amount of water that evaporates from the concrete is reduced and improved with the use of PEG-400. It improves the bond strength between the cement paste and the aggregate, resulting in smaller voids/ pores and stronger strength characteristics in air-cured concrete. This is due to the fact that it improves water retention. [4].

Curing is required in concrete structures for optimal strength and durability. The strength of normal concrete is achieved through external curing as a result of proper mixing and placement of the concrete [5].

The concrete's tensile strength is a measure of its ability to withstand forces that stretch or bend it. There are a number of indirect procedures that have been devised to assess the tensile strength because the direct tension test has many drawbacks. The splitting test, also known as split tensile strength of concrete, is well-known indirect test for assessing the tensile strength of concrete [6].

2. OBJECTIVES

- To investigate workability and split tensile strength of conventionally cured and self-cured concrete.
- To compare the split tensile strength of traditionally cured concrete with self-cured concrete.
- To find optimum percentage of polyethylene Glycol (PEG-400) in concrete in terms of workability and strength.

3. EXPERIMENTAL METHODOLOGY

The experimental study is carried out on self-curing concrete utilising water soluble polymer, polyethylene glycol acting as a curing agent. The following materials are used in making of concrete.

3.1 Cement

OPC 53 Grade Cement is used conforming to IS:12269-2013.

3.2 Aggregates

Fine aggregate, locally available Zone I crushed sand and coarse aggregate 20 mm in size is used.

3.3 Polyethylene Glycol 400

As a curing agent, Polyethylene Glycol 400 (PEG 400) is used, mixed in concrete during casting along with other ingredients of concrete. It is eco-friendly, non-poisonous, fragrance free, and non- irritant.

3.4 Mix Proportions

A mix design is carried out as per IS 10262:2019 and mix proportions obtained are as follows:

i) For M20 grade - 1:1.76:3.2, w/c ratio = 0.50

ii) For M25 grade - 1:1.96:3, w/c ratio = 0.48

3.5 Number of specimens cast

The I.S. cylinders 150 mm diameter and 300 mm height, 12 numbers are cast for split tensile test. Six cylinders are for conventional curing concrete, 3 each for M20 and M25 grades respectively. Six cylinders are for self-curing of concrete, 3 each for M20 and M25 grades respectively.

3.6 Curing Method

Out of 12 specimens 6 specimens are water cured following the conventional method and remaining 6 are cured using Polyethylene Glycol (PEG) 400 as curing agent.

4. TEST RESULTS

To verify the effectiveness of self-curing, mechanical properties of wet and hardened concrete viz. workability and split tensile tests are performed in the laboratory on conventional concrete and self-cured concrete.

4.1. Workability:

The slump test is used as a control test due to its ability to reveal concrete's consistency from batch to batch [11]. The test results are presented in Table 1.

Table 1: Laboratory Test results of workability of Concrete

Type of Concrete	% of PEG 400 *(by weight of cement)*	Slump (mm)	
		M20	**M25**
Conventionally cured Concrete	-	72	63
Concrete cured with PEG 400	0.75	74	69
	1.25	77	71
	1.75	81	75
	2.5	83	79

Results show that the workability of concrete increases with inclusion of polyethylene glycol. At maximum polyethylene glycol content of 2.5%, for M20 grade concrete, the compaction factor is 0.90 (medium workability). The addition of polyethylene glycol to concrete improves its workability [Fig. 1].

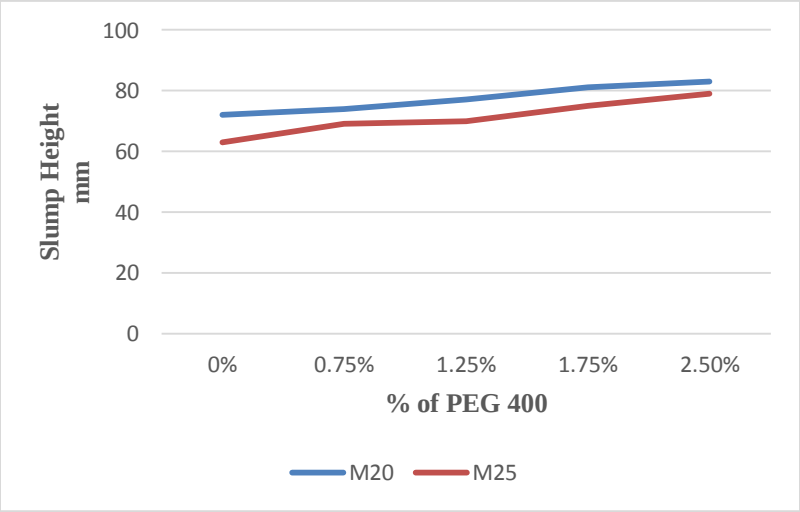

Fig. 1 Variation in Slump value with varying PEG 400 percentage by weight of cement.

4.2 Split Tensile strength of concrete:

The split tensile test is performed as per IS 5816-1999 (Reaffirmed 2004) [Fig.2, 3].

I.S. specifies following relationship for computing split tensile strength of concrete.

$$f_t = 2Pl/\pi DL$$

Fig.2: Split Tensile Test on Concrete Cylinder

Fig.3: Splitting of cylinder along axis

The split tensile strength results of concrete for different PEG percentage levels are presented in Table 2.

Table 2: Laboratory Test results of Split Tensile Strength of concrete

Type of Concrete	% of PEG 400 *(by weight of cement)*	M20		M25	
		Split tensile Strength N/mm^2	**% increase in comparison with conventional concrete**	**Split tensile Strength N/mm^2**	**% increase in comparison with conventional concrete**
Conventionally Cured Concrete	-	3.31	-	4.89	-
Self Cured Concrete	0.75%	3.47	4.83	4.91	0.40
	1.25%	3.62	9.36	5.23	6.95
	1.75%	4.51	36.25	5.81	18.81
	2.5%	4.13	24.77	4.97	16.35

Table 2 shows that as the dosage of polyethylene glycol increases, the split tensile strength of concrete also increases.

PEG 400 content of 1.75% produces maximum strength in case of split tensile strength. Beyond this percentage it is observed that split tensile strength of concrete decreases. Hence it is found that Self Curing Concrete with 1.75% of polyethylene glycol is the workable mix with maximum polyethylene glycol content.

For workable mix with maximum PEG 400 content of 1.75%, when compared to conventional concrete, the improvement in split tensile strength of M 20 and M25 concrete is 36.25% and 18.81% respectively. This demonstrates that the addition of polyethylene glycol improves the split tensile strength of concrete. This is due to the proper curing of concrete, cracks do not form easily.

Fig.4 shows the variation in split tensile strength of concrete as the percentage of polyethylene glycol is increased.

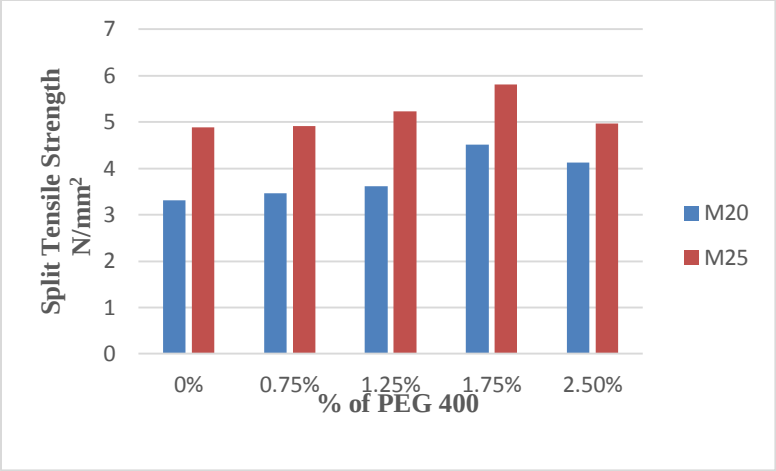

Fig.4: Variation in split tensile strength of M20 and M25 grade concrete with varying PEG 400 percentage by weight of cement

5. CONCLUSIONS

The following conclusions are drawn from the current study.

- Workability and split tensile strength of concrete is observed to increase with increase in dosage of polyethylene glycol (PEG) up to 1.75% by weight of cement.
- A concrete mix containing 1.75% polyethylene glycol (PEG 400) is found to be the optimum mix in terms of workability and strength.
- The split tensile strength of self-cured concrete using Polyethylene Glycol is found to increase by 36.25% and 18.81% for M20 and M25 grades of concrete, respectively, at optimum mix.
- The use of self-curing agent (polyethylene glycol 400) in concrete mixes for curing of concrete is an effective method of curing. It saves water and makes eco-friendly and sustainable concrete.

6. REFERENCES

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