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AN EXPERIMENTAL STUDY ON SELF CURING CONCRETE BY USING STEEL FIBER AND POLYETHYLENE GLYCOL

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Abstract - *Concrete curing is one of the most important processes in achieving the desired properties of the concrete. Self-curing concrete should be able to cure on its own without having to provide additional water. Water is the most required substance in the construction field. In general internal water curing can be used to mitigate self-desiccation and self-desiccation shrinkage. The grade of concrete is M20. The present study involves the use of shrinkage reducing admixture polyethylene glycol-PEG 400 in concrete which helps in self-curing and helps in better hydration and hence strength. It was found that PEG-400 could help in self-curing concrete. To enhance the property, fiber reinforcement was provided with steel fiber and also overcome the insufficient curing. The PEG-400 varies from 1%, 1.5% and 2% and the steel fibers 2% added in concrete compared with the conventional mix. In the strength parameters namely Compressive Strength, Split Tensile Strength, and Flexural Strength were determined at 7days, 14 days, and 28 days for different dosage of fiber/self-curing agent and compared with conventional concrete.*

Key Words: self-curing concrete, polyethylene glycol-400, steel fiber, compressive strength, split tensile strength, flexural strength.

1. INTRODUCTION

Concrete curing is one of the most important processes in achieving the desired properties of the concrete. It needs proper curing and moisture contents at a minimum of 28 days for the good heat of hydration and to the desired strength. Curing popularity as basic building material in construction is because of its economy of use, good durability and ease with which it can be manufactured at site. Concrete like other engineering materials needs to be designed for properties like strength, durability, workability.

The traditional external curing method could not achieve desired effect due to low permeability and high chemical reactions in high performance concrete, so the researches focusing to a new method called self-curing. This is done by embedding the water inside the materials used to make concrete. If the water just added as mixing water; this would lead to many other qualities related problems, such as bleeding, segregation, and etc. PEG 400 is widely used in the variety of pharmaceutical formulations and it is water soluble in nature Fibers are generally discontinuous, randomly distributed throughout the cement matrices. . For architectural and decorative concrete products and for prevention of early age cracking, steel fibers may be used. Steel fibers made used for properties of concrete in the hardened stage have to be modified, namely, post crack flexural strength, abrasion resistance, impact resistance and shatter resistance of concrete.

2. LITERATURE REVIEW

Dr.Verma.A.K et.al (2013) was studied about the variation in compressive strength for medium strength self-compacted concrete with three different curing techniques. First batch were cured in a temperature controlled curing tank, whereas the second batch was cured by application of external curing compounds. The third batches were cured by internal curing compounds. The experiment it was found that the 28 day compressive strength of cubes cured by applying curing compounds was 95% of the compressive strength of cubes cured in the laboratory.

Stella Evangeline et.al (2014) was analyzed the some specific water-soluble chemicals such as polyvinyl alcohol added during the mixing can reduce water evaporation from and within the set concrete, making it self-curing. The Compressive and tensile strength of self-curing concrete at 7 and 28 days were found and compared with conventional concrete of similar mix design and the second type is a chemical agent for polyethylene- glycol (Ch.). The results show that the self- curing agent (Ch.) is used in concrete for improving the physical properties compared with conventional concrete.

Patel Manish Kumar, (2014) was studied about the "introducing the self-curing concrete in construction industry". Compressive strength of self-curing concrete is increased by applying self-curing admixtures. The compressive strength of concrete was increased 37% by 1.0% addition of PEG600 and 33.9% by 1.0% addition of PEG1500 as compared with the conventional concrete. The optimum dosage for PEG600 for maximum compressive strength was found to be 1% of weight of cement for M25 grade of concrete. The optimum dosage of PEG1500 for maximum compressive strength was found to be 1% of weight of cement for M25 grade of concrete.

3. MATERIAL PROPERTIES

3.1 CEMENT

The most widely used construction cement is Ordinary Portland Cement. Cement used in the investigation was 43 grades Ordinary Portland Cement confirming to IS: 12269: 1987. The specific gravity of cement is 3.15.

3.2 FINE AGGREGATE

Fine aggregate/sand is an accumulation of grains of material matter derived from the disintegration of rocks. The fine aggregate was passing through 4.75mm sieve and had a specific gravity of 2.68. The fine aggregate conforming to zone III according to IS: 383-1970 was used.

3.3 COURSE AGGREGATE

Coarse aggregate are the crushed stone, which are used for making concrete. The maximum size of aggregate was 20mm and specific gravity 2.78. The coarse aggregate according to IS: 383-1970 is used.

3.4 WATER

Water should be free from acid, oil, alkalis, vegetables or other organic impurities. For manufacturing the concrete, the tap water available in the concrete laboratory was used.

3.5 STEEL FIBRE

Steel fiber is one of the most commonly used fibers. The length of steel fiber is 25mm, and thickness of 0.5mm. Use of steel fiber makes significant improvements in flexural, impact, and fatigue strength of concrete.

Table: 1 Properties of Steel fiber

S.No	Property	Values
1	Fiber Length (L)	25mm
2	Fiber Diameter (D)	0.5mm
3	Aspect Ratio (L/D)	50
4	Deformation	Continuously deformed

3.6 POLYETHYLENE GLYCOL-400

The Polyethylene glycol is a combination of polymer ethylene oxide and water. The general formula of PEG-400 is H (OCH2CH2)nOH, where n is the average number of repeating oxyethylenegroups 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.

Table: 2 Properties of Polyethylene Glycol-400

S.No.	Property	Values
1	Molecular weight	400
2	pH	5-7
3	Appearance	Clear liquid
4	Specific gravity	1.126

3.7 SUPER PLASTICIZERS

Normally the super plasticizer is added to the truck mixer after it arrives at the jobsite and at the last convenient moment before discharge.

4. EXPERIMENTAL WORKS

4.1 COMPRESSIVE STRENGTH TEST

The cube specimens were tested on compression testing machine of capacity 3000KN. The cubical mould size of 150mm ×150mm× 150mm. this concrete is poured in the mould and tempered properly so as not to have any voids.

Calculation

Compressive strength is calculated using the following formula

Compressive strength (fc) = P/A

Where,

P - Load at failure; A - Is area

4.2 SPLIT TENSILE STRENGTH TEST

The split tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The cylinder specimens were tested on compression testing machine of capacity 3000KN. The load was applied the resistance of the specimen to the increasing load breaks down and no longer can be sustained.

Calculation:

Split tensile strength is calculated using the following formula

Split Tensile Strength (fs) = 2P/πDL

Where, P - Load at failure;

D - Diameter of cylinder;

L - Length of the cylinder

4.3 FLEXURAL STRENGTH TEST

The beam specimen of size 100mm x 100mm x 500 mm was casted to determine the Flexural strength of concrete with various percentages of Polyethylene Glycol

400 and Steel Fiber. Apply the load at a rate that constantly increases the maximum stress until rupture occurs. Finally the Flexural strength is calculated by using simple bending equation the bending stress

$$\sigma = Pl/bd^2 \ (N/mm^2)$$

Where,
P = load at failure (N)
d = depth of specimen (mm)
l = length of specimen (mm)

5. RESULTS AND DISCUSSION

5.1 COMPRESSIVE STRENGTH OF CONCRETE

The Compressive Strength Results of Concrete cube Specimens for 7, 14 and 28 days are presented in the Table and the comparisons of the results.

Table: 3 Compressive Strength Test Result for Cubes

	7 days	14 days	28 days
Control mix	17.36	18.06	19.95
Polyethylene glycol (400)	With fiber (2%)	With fiber (2%)	With fiber (2%)
1%	19.67	20.92	21.67
1.5%	21.88	22.89	24.94
2%	20.15	21.34	23.18

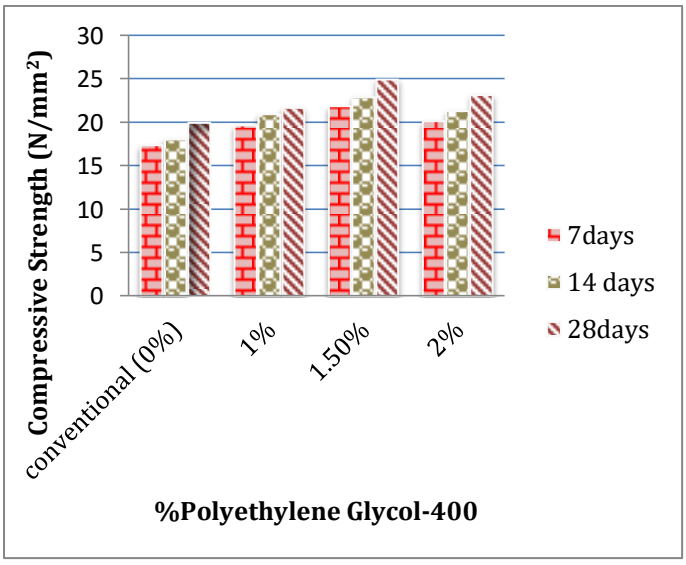

Fig.1 Compressive Strength Test Results

5.2 SPLIT TENSILE STRENGTH OF CONCRETE

The Split Tensile Strength Results of Concrete in cylinder Specimens for 7, 14 and 28 days are presented in the Table and the comparisons of the results.

Table: 4 Split Tensile Strength Test Result for Cylinders

	7 days	14 days	28 days
Control mix	1.726	1.95	2.05
Polyethylene glycol (400)	With fiber (2%)	With fiber (2%)	With fiber (2%)
1%	1.81	2.10	2.24
1.5%	2.19	2.27	2.56
2%	2.02	2.19	2.32

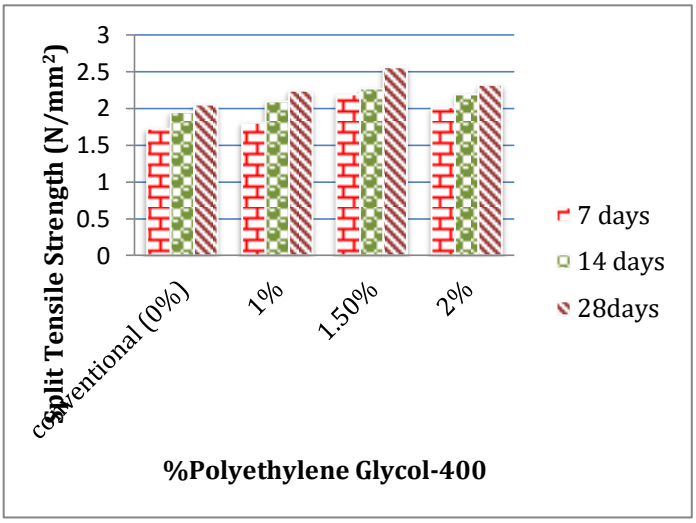

Fig.2 Split Tensile Strength Test Results

5.3 FLEXURAL STRENGTH OF CONCRTE

The Flexural Strength Results of Concrete in beam Specimens for 7, 14 and 28 days are presented in the Table and the comparisons of the results.

Table: 5 Flexural Strength Test Result for Beams

	7 days	14 days	28 days
Control mix	4.52	4.83	5.09
Polyethylene glycol (400)	With fiber (2%)	With fiber (2%)	With fiber (2%)
1%	4.43	4.74	4.86
1.5%	4.76	4.95	5.38
2%	4.58	4.81	4.93

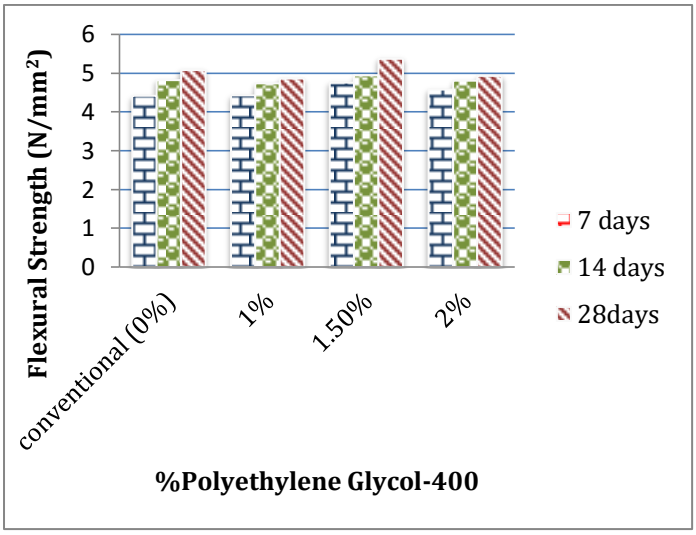

Fig.3 Flexural Strength Test Results

6. CONCLUSIONS

The objective of this study is to evaluate the Structural innovative concrete using Steel fiber and Polyethylene Glycol-400. The following conclusions are drawn from the experimental investigations.

- The workability of concrete is maintained by adding 0.5% of super plasticizer.
- The compressive strength was high at 1.5% adding of Polyethylene Glycol-400 and 2% of Steel fiber with increased strength in 25.94N/mm² 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/mm² 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 with increased strength in 5.69N/mm² compared with conventional concrete. The percentage increasing was 4.49% when compared with conventional mix.

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