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"EXPERIMENTAL INVESTIGATION ON MECHANICAL PROPERTIES OF INTERNALLY CURED CONCRETE USING PEG-400"

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ABSTRACT :

Concrete is most widely used construction material due to its good compressive strength and durability. Concrete can be cured by water curing and by self curing agent. Conventional concrete require water curing for a minimum of 28 days to complete its target strength. Therefore water curing is very much necessary to prevent unsatisfactory properties of cement concrete. In this research, the affect of admixture (PEG 400) on compressive strength, split tensile strength, flexural strength and durability test by varying the percentage of Polyethylene Glycol (PEG) by weight of cement from 0% ,0.8%,1.6%,2.4% & 3.2% are studied for M25 mixes

Keywords: PEG-400, water cement ratio, compressive strength, Flexural Strength, Tensile Strength

1. INTRODUCTION :

Concrete is the most widely used construction material due to its high compressive strength and durability. However, traditional curing methods are often insufficient in maintaining the optimal hydration levels throughout the concrete, leading to shrinkage and cracking. Internal curing is a method to mitigate these issues by providing additional water from within the concrete matrix. Polyethylene glycol (PEG-400), a hydrophilic polymer, has been identified as an effective internal curing agent due to its ability to retain water and gradually release it during the hydration process. Proper curing of concrete structures is very important to fulfill performance and durability necessities. In typical curing this can be achieved by external curing applied when combination, putting and finishing. Self-curing or internal curing could be a technique that may be wont to give extra wetness in concrete for simpler hydration of cement and reduced self-desiccation. The ACI-308 Code states that "internal curing refers to the method by that the association of cement happens due to the supply of extra internal water that's not a part of the blending water". the extra internal water is usually provided by using comparatively little amounts of saturated, lightweight weight, polythene Glycol, super absorbent chemical compound particles within the concrete.

2. PROJECT OBJECTIVE :

The primary objective of this study is to evaluate the impact of PEG-400 on the mechanical properties of concrete. Specific objectives include:

1. Determining the optimal dosage of PEG-400 for internal curing.
2. Assessing the compressive, tensile, and flexural strengths of the concrete.
3. To compare the strength between conventional and self curing concrete.

3. MATERIAL USED :

3.1 Cement:

Cement is a material which is one of the key ingredients of concrete. Cement is a binding material which helps in bonding, when water is added to it. The cement used in the work was Ordinary Portland Cement (OPC) grade 43 confirming to Indian Standard Specification IS: 8112. The cement had specific gravity of 3.12.

3.2 Fine Aggregate:

Locally available sand passing through 4.75 mm sieve was used in the present work. The fine aggregate confirmed to Indian Standard Specifications IS: 383-2016 were used.

Natural aggregate:

The aggregates retained from 4.75 mm sieve were used as coarse aggregates. They were hard, strong and durable and were in pure form without any impurities. The requirements were governed by IS: 383-2016. The aggregate size was 20 mm.

3.4 PEG-400:

It is a low molecular weight polymer belonging to the polyethylene glycol family, which are compounds derived from ethylene oxide and water. PEG-400 is characterized by its average molecular weight of approximately 400 g/mol. It is a clear, colorless, and odorless liquid with a slightly viscous consistency. PEG-400 is used as an internal curing agent. Its hydrophilic nature allows it to retain water and gradually release it during the hydration process of cement, leading to improved hydration and reduced shrinkage.

4. EXPERIMENTAL WORK AND TEST :

4.1 Slump Cone Test

The purpose of this test is to determine the workability of concrete mix. Workability means the ease with which mixing, handling, placing of concrete can be done. Concrete is filled in the standard slump cone which consists of a vessel whose shape is frustum of cone. Filling the slump cone with concrete is done in layers of thickness 8cm. After laying each layer, it is compacted with 25 strokes using a rod of 16mm, diameter of 60 cm, long whose striking end is bullet-pointed. After filling the vessel with concrete, the vessel is carefully removed, i.e. Lifted. The vertical settlement of the body of concrete is called the slump cone of concrete.

4.2 Compressive Strength Test:

The cubes which were prepared were having the dimension 150 mm x 150 mm x 150 mm. Three cubes without the addition of PEG 400 were prepared. Three cubes with 0.8% of PEG-400, three with 1.6 %, three with 2.4 % & three with 3.2 % of PEG-400 were prepared and cured in the laboratory in room temperature. After curing the samples, the compressive strength test was done on the specimens. The load is gradually increased, and the maximum load at which the sample fails is recorded.

Fig No 4.1. Compressive Testing Machine

4.3 Flexural Strength Test:

Beams of size 10cm*10cm*50cm are casted for determining flexural strength. Test on beams are performed at the age of 7 days, 14 days &28 days of the specimen. Placement of specimen in machine is done as per IS: 516-1959 in the clause no 8.3.1 page no 17. Load is applied at increasing rate of 108KN/min. Load is applied until specimen fails and load at which specimen fails is recorded.

Fig No 4.2 Flexural Testing Machine

5. TEST RESULTS & DISCUSSIONS

5.1 Slump Cone Test

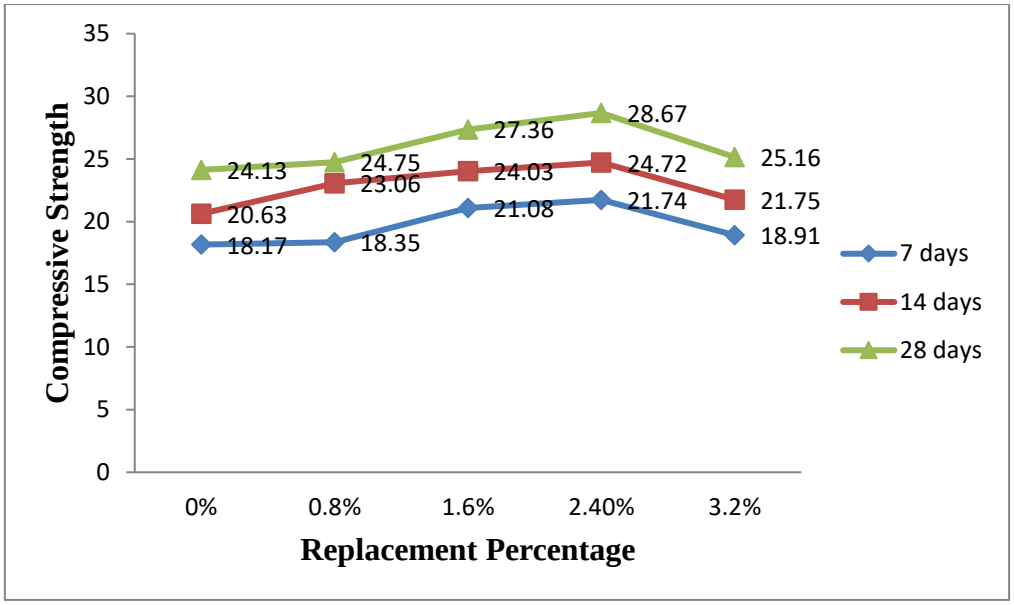
The workability was checked by testing the concrete with the help of slump cone. Slump value and were observed so as to see the effect of addition of dosages of PEG 400.

Table 5.1 Result of Workability for different % of PEG-400

S. NO.	PEG 400 (%)	SLUMP (mm)
1	0	65
2	0.8	79
3	1.6	97
4	2.4	110
5	3.2	120

5.2 Compressive Strength; The below table shows the compressive strength for different percentage of PEG 400 which is vary from 0.8%-3.2%.

Mix Design	% SAP	7 days Compressive Strength	14 days Compressive Strength	28 days Compressive Strength
Mix-01	0	18.17	20.63	24.13
Mix-01	0.8	18.35	23.06	24.75
Mix-02	1.6	21.08	24.03	27.36
Mix-03	2.4	21.74	24.72	28.67
Mix-04	3.2	18.91	21.75	25.16

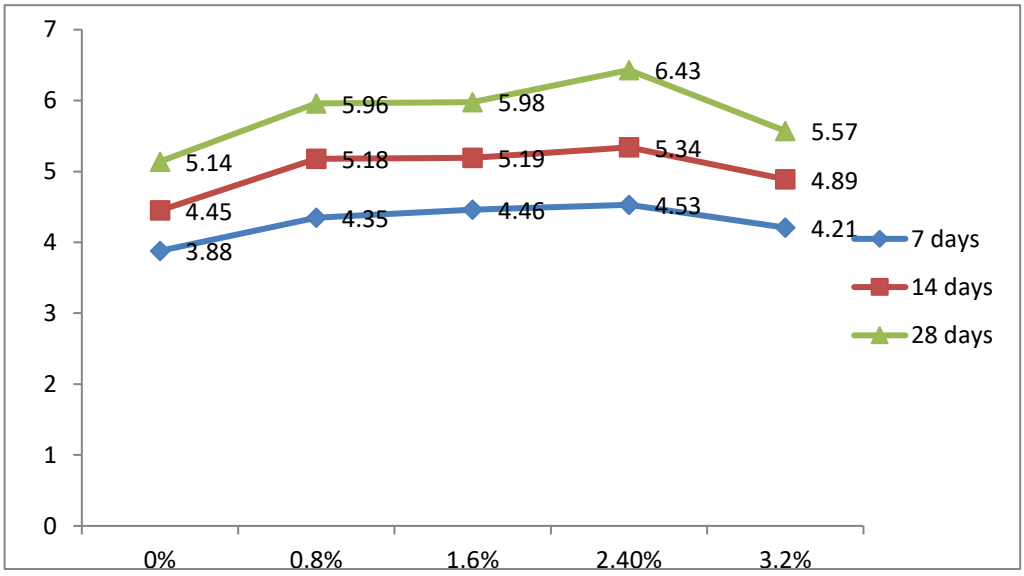


Graph 1: Combined Compressive strength of cubes with PEG 400 at 7, 14 & 28 days

As shown in the graph (7 days strength), when cement is partially replaced 2.4% by PEG, compressive strength is increased by 27.68%. Afterwards when addition of % of PEG is replaced, strength starts decreasing, a minimum strength is achieved. When graph (14 days strength) is analyzed, 2.4 % replacement of Polyethene glycol- 400 gives 24.5% more strength when compared with conventional concrete. 28 days strength in graph show an increment of 26.85% of strength of 2.4% replacement of Polyethene glycol- 400 as compared with conventional concrete. Again strength is decreased when addition of percentage of Polyethene glycol- 400 As discussed here, it can be said that an increment in compressive strength of 15 % replacement of Polyethene glycol- 400 gives 27% strength is achieved as compared with conventional concrete mix i.e. Mix-01.

5.3 Flexural Strength

Mix Design	% SAP	7 days Flexural Strength	14 days Flexural Strength	28 days Flexural Strength
Mix-01	0	3.88	4.45	5.14
Mix-01	0.8	4.35	5.18	5.96
Mix-02	1.6	4.46	5.19	5.98
Mix-03	2.4	4.53	5.34	6.43
Mix-04	3.2	4.21	4.89	5.57



Graph: 2. Flexural Strength in N/mm^2 at various age (Days)

As shown in the graph (7 days strength), when cement is partially replaced 2.4% by PEG i.e. Mix-04, flexural strength is increased by 20%. Afterwards when % of PEG is increased the strength starts decreasing. When graph (14 days strength) is analyzed, 2.4% replacement of PEG gives 25.39% more flexural strength when compared with normal concrete. Here also, when % of PEG is increased, strength starts decreasing. 28 days strength in graph shows an increment of 22.10% of strength of 2.4% replacement of Polyethene glycol- 400 as compared with conventional concrete. Again strength is decreased when % of Polyethene glycol- 400 is increased.

5. CONCLUSIONS :

Based on the various tests conducted on concrete with varying proportion of PEG-400 the following conclusions are drawn.

1. From the workability test results, it was found that the self-curing agent improved workability
2. It can be concluded that the 28 days compressive strength of M25 cubes with 2.4% PEG 400 dosage was maximum. It was followed by the dosage of 3.2% of PEG in a decreasing order. At 7 and 14 days the same trend was followed. It can be therefore concluded that the 2.4% dosage was optimum for the addition of PEG 400.
3. It can be concluded that the 28 days flexural strength of M25 cubes with 2.4% PEG 400 dosage was maximum. It was followed by the dosage of 3.2% of PEG in a decreasing order. At 7 and 14 days the same trend was followed. It can be therefore concluded that the 2.4% dosage was optimum for the addition of PEG 400.

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