Comparative Study between Conventional Curing and Self Curing of Concrete by using PEG-6000
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Abstract— As curing is the main criteria in getting maximum characteristic strength for concrete. It should be done in a proper way so that every element of the structure gets its strength. Because of the process of heat of hydration between cement and water, concrete is able to attain its full strength. Due to improper curing the structure may not able to get its full strength in order to avoid this imperfection self curing concept was introduced. By using PEG-6000(Poly ethylene glycol) in the concrete it helps in arresting the hydration of water from the concrete so as to retain them in the concrete. With the varying percentages of PEG usage with respect to the weight of cement in concrete from 0.1% to 1.0%. The optimum usage percentage of PEG-6000 can be find out by compressive strength test. So that the mechanical properties like split tensile, flexure and the durability properties like Acid durability factor test for both conventionally cured concrete and the concrete with PEG 6000 can be performed. PEG with higher molecular weight 6000 is best suited for self curing concrete has been shown.

Key words: Plastic Shrinkage Cracks, PEG-6000

I. INTRODUCTION
Curing is the criterion which was practiced from the past days to attain maximum strength to the concrete. curing can be of various kinds like conventional, hot water curing, steam curing etc.. A new technique which was introduced is self-curing. Conventional curing is carried after the concrete was casted and subjected to removal of shuttering. But here in the self curing process the self curing agent PEG 6000 is mixed at the time of mixing the concrete. As the hydration process helps in gaining strength to concrete. Water has to be retained in the concrete for the process to take place and it is done by PEG of high molecular weight 6000. When concrete is mixed evaporation takes place due to the surrounding temperature so that the moisture is reduced which results in the loss of water-cement ratio due to this proper hydration does not takes place which results in the reduction of strength. Due to exposure towards environment plastic shrinkage cracks takes place at the time of casting later after curing period dry shrinkage cracks occurs. So curing temperature is also a main constraint which can lowers or upgrades the strength of concrete.

II. RESEARCH SIGNIFICANCE
As the conventional curing is practised from long back for curing concrete. In order to eliminate the usage of water to cure the concrete here is an attempt of self curing by using Polyethylene glycol (PEG 6000) in concrete mix by varying percentages with respect to the weight of cement for M40 grade of concrete. And also to study the effects of using this PEG 6000 on strength characteristics.

III. EXPERIMENTAL PROGRAMME
This whole research is divided into two phases in phase I mechanical properties of the concrete are known and in phase II durability properties has been found out. For this a total number of 90 cubes were casted of the standard dimension 150 x 150 x 150 mm. To fix the optimum dosage of PEG 6000 usage cubes were casted by varying percentages starting from 0%, 0.5% & 1.0% with respect to the weight of the cement content used. Then after fixing the dosage to know about the mechanical properties of concrete cylinders of size 150 x 300mm were casted for split tensile test, Beams of size 100 x 100 x 500 mm of size were casted. These tests were carried for 7, 14, 28 days. And for durability tests 45 cubes among the 90 were taken which were initially casted.

IV. MATERIALS
Various materials used in this investigation are as follows
Cement: Ordinary Portland Cement OPC 53 grade confirming to IS: 12269 was used and its specific gravity is 3.14.
A. Fine Aggregate:
River sand confirming to IS 383-1970 and its specific gravity is 2.69.
B. Coarse Aggregate:
Crushed granite confirming to IS 383-1970. Which is available from a local quarry and the specific gravity is 2.69.
C. Polyethylene Glycol 6000:
Polyethylene is a polyether compound obtained by the condensation of polymer of ethylene oxide and water. Its Chemical formula is H-(O-CH₂-CH₂)ₓ-OH. Numeric suffix which indicates the average molecular weight, Appearance white flake, pH 5-7, specific gravity 1.09.

V. INSTRUMENTATION AND TEST PROCEDURE
To test the Cubes and cylinders for ultimate load under axial compression a compression testing machine CTM of capacity 2000 KN and for testing beams Universal testing machine UTM of capacity 200KN has been used. Peak load and peak stress are measured for all specimens.
A. Phase-I tests
1) Slump Test & Compaction Factor Test
Slump test is an empirical test measures the consistency or the degree of wetness of the fresh concrete. It is the behaviour of the compacted concrete in an inverted cone under the action of gravity. Workability which describes the state of concrete and the ease with which the concrete flows...
2) **Compressive Strength Test**
This test is carried out as per IS:516-1959 for the specimen size 150x150x150 mm. Compression testing machine of capacity 2000KN is used for testing. Before placing the specimen on the plate the surface of the specimen and the plate is smeared with a brush to remove if any loose sand is there. The specimens are placed exactly at the center of the plate. The rate of loading is applied at the rate of 5.3 N/mm². The ultimate load is noted in KN and the peak stress is noted in Mpa.

\[ f_c = \frac{P}{A} \]

where \( P \) is Load & \( A \) is area of the applied load

3) **Split Tensile Strength**
This test is carried out as per IS:516-1959 for the specimen size 150x300 mm. Compression testing machine of capacity 2000KN is used for testing. Before placing the specimen the surface of the beam and the bearing surface is cleaned if any loose sand is there. The rate of loading is increased continuously on the specimen until the specimen breaks down and no longer can withstand. Maximum load applied on the specimen is noted. The modulus of rupture can be calculated for a rectangular beam with the following formula

\[ f_{rup} = \frac{3FL}{2bd^2} \]

where \( F \)=Load, \( L \)= length of the support span, \( b \)= width, \( d \)= thickness.

**B. Phase-II Tests**

1) **Acid Durability Factor Test**
In this durability test, concrete towards the chemical resistance has been studied. For acid attack test from each batch of casted cubes 3 cubes were taken and immersed in 5% HCL solution. This test is carried out only after the 28 days of respective curing of the cubes. Acid durability factor can be known in terms of relative strengths ie., compared with respect to 28 days value.

**VI. RESULTS & DISCUSSION**

**A. On Phase-I**

1) **Slump Test & Compaction Factor Test**
Slump for M40 is found to be increased with increase in the percentage of PEG-6000. The test results for slump test and compaction factor test is given in the below Table-1. And the graphical representation for the slump and compaction factors are also shown in the below Graph-1.

<table>
<thead>
<tr>
<th>S No</th>
<th>PEG 6000</th>
<th>Slump (mm)</th>
<th>Compaction factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 %</td>
<td>40</td>
<td>0.75</td>
</tr>
<tr>
<td>2</td>
<td>0.10%</td>
<td>47</td>
<td>0.80</td>
</tr>
<tr>
<td>3</td>
<td>0.50%</td>
<td>55</td>
<td>0.85</td>
</tr>
<tr>
<td>4</td>
<td>1.00%</td>
<td>65</td>
<td>0.87</td>
</tr>
</tbody>
</table>

Table 1: Slump & Compaction factor Results

Graph 1: Variation of slump with % of PEG 6000

Graph 2: Variation of Compaction Factor with % of PEG 6000

2) **Compressive Strength Test**
From the below results the maximum average strength was gained by PEG 6000 - 0.5% over air curing, 0.1%,1.0%. And the graph for average compressive strength Vs age is drawn below.

<table>
<thead>
<tr>
<th>Nomenclature</th>
<th>7 Days (N/mm²)</th>
<th>14 Days (N/mm²)</th>
<th>28 Days (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional curing</td>
<td>37.40</td>
<td>45.85</td>
<td>48.8</td>
</tr>
<tr>
<td>Air curing</td>
<td>26.60</td>
<td>33.30</td>
<td>36.45</td>
</tr>
<tr>
<td>0.10%</td>
<td>29.20</td>
<td>38.70</td>
<td>41.55</td>
</tr>
<tr>
<td>0.50%</td>
<td>32.35</td>
<td>43.65</td>
<td>45.10</td>
</tr>
<tr>
<td>1.00%</td>
<td>27.9</td>
<td>33.25</td>
<td>35.60</td>
</tr>
</tbody>
</table>

Table 2: Compressive Strength Results

Graph 3: Average compressive strength with age
3) **Split Tensile Strength**
   By the results of compressive testing an optimum percentage of PEG 6000 is obtained as 0.5%. And the graph between split tensile and age is drawn below. In this test the maximum average split tensile strength is obtained at 0.5%.

![Graph 4: Average Split Tensile strength with age](image)

![Table 3: Split tensile strength results](table)

4) **Flexural Strength Test**
   Flexural strength test is conducted for point loading for the beam. Maximum flexural strength is obtained at PEG 6000-0.5%. Graph between flexural strength and age of curing are drawn below.

![Graph 5: Average Flexural strength with age](image)

![Table 4: Flexural strength results](table)

**B. On Phase-II**

1) **Acid Durability Factor Test**
   For acid durability factor test a total number of 45 cubes were casted. Standard dimension of size 150x150x150 mm are used in this test. These cubes are taken from the each batch of compressive testing cubes which were casted earlier. Conventionally cured, air cured and 0.1%, 0.5% & 1.0% mix cubes are immersed in 5% HCL solution. These cubes were again immersed in 5% HCL solution for a period of 28 days. After subjected to acid immersion compressive strength test was conducted at 7, 14, 28 days of immersion in acid. The graph between acid durability factor and age of curing were plotted below. Difference between the compressive strengths of acid cured and Non acid cured cubes are noted. Percentage loss of strengths are calculated per 7, 14, 28 days and the readings are tabulated as follows.

![Graph 6: Average strength loss with age](image)

![Table 5: Values of % Loss of Strength when acid cured](table)

![Graph 7: Average Acid Durability factor values with age](image)

**Table 5: Values of % Loss of Strength when acid cured**

**Table 6: Values of Acid Durability factor**

**VII. CONCLUSIONS**

1) As the percentage of PEG 6000 is increased slump values also increased for M40 grade of concrete.
2) The optimum percentage is arrived at 0.5% by the weight of cement for all compression, Split tensile and...
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modulus of rupture tests. For compression test the average compressive strength value at 28 days is obtained as 45.1 Mpa, for split tensile strength the average value at 28 days is obtained as 2.63 Mpa and for modulus of rupture test the average value at 28 days is obtained as 7.43 Mpa.

3) In acid durability factor test the least percentage loss of strength is obtained for 0.5 % mix of PEG 6000 at 28 days.

4) So self curing concrete is preferable for complex shaped structures and in arid zone areas which reduces the wastage of water at the time of curing.

REFERENCES


