

# EXPERIMENTAL INVESTIGATION ON SELF CURING OF CONCRETE BY USING POLY ETELYENE GLYCOL

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## ABSTRACT

Curing of Concrete is an important factor in developing the strength characters. Self-curing or internal curing is a technique that can be used to provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation. When concrete is exposed to the environment evaporation of water takes place and loss of moisture will reduce the initial water cement ratio which will result in the incomplete hydration of the cement and hence lowering the quality of the concrete. In this experimental we are finding the strength properties using poly ethylene glycol as a self curing agent and m sand as a replacement for normal sand. The percentage of 0.5%, 1.0% 1.5% of PEG 400 is used to determine the strength of M40 GRADE .And the properties of concrete are compared with normal concrete.

## I. INTRODUCTION

Concrete is the basic engineering material used in most of the civil engineering structures. Its 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.

The concept of self-curing agents is to reduce the water evaporation from concrete, and hence increase the water retention capacity of the sconcrete compared to conventional concrete. It was found that water soluble polymers can be used as self-curing agents in concrete. Self-curing or internal curing is a technique that can be used to provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation. When concrete is exposed to the environment evaporation of water takes place and loss of moisture will reduce the initial water cement ratio which will result in the incomplete hydration of the cement and hence lowering the quality of the concrete.

## Self curing concrete

Self curing concrete is one of the special concretes in mitigating insufficient curing due to human negligence paucity of water in arid areas, inaccessibility of structures in difficult terrains and in areas where the presence of fluorides in water will badly affect the characteristics of concrete.

The concept of self curing agents is to reduce the water evaporation from concrete and hence increase the water retention capacity of the concrete compared to

conventional concrete. It was found that water soluble polymers or water retention polymers can be used as self curing agents in concrete. Concrete incorporating self curing agents will represent a new trend in the concrete construction in the new millennium. Curing of concrete plays a major role in developing the concrete microstructure and pore structure, and hence improves its durability and performance. The use of self curing admixtures is very important from the point of view that water resources are getting valuable every day (i.e., each one cu.m of concrete requires about three cu.m of water for construction most of which is for curing).

Excessive evaporation of water (internal or external) from fresh concrete should be avoided, otherwise the degree of cement hydration would get lowered and there by concrete may develop unsatisfactory properties. Curing operations should ensure that adequate amount of water is available for cement hydration to occur.

### **Need for self curing**

When the mineral admixtures react completely in a blended cement system, their demand for curing water (external or internal) can be much greater than in a conventional ordinary Portland cement concrete. When this water is not readily available, significant autogenous deformation and early-age cracking may result.

Due to chemical shrinkage occurring during cement hydration, empty pores are created within the cement paste, leading to a reduction in its internal relative humidity

and also to shrinkage which may cause early-age cracking. This situation is intensified in HPC (compared to conventional concrete) due to its generally higher cement content, reduced water-cement (w/c) ratio and the pozzolonic mineral admixtures (fly-ash, silica fume).

### **Need and scope of study**

Curing of concrete is maintaining satisfactory moisture content in concrete during its early stages in order to develop the desired properties. However good curing is not always practical in many cases. The aim of this investigation is to evaluate the use of water-soluble polymeric glycol as self-curing agents. The use of self curing admixture is very important from the point of view that the water resources are getting valuable every day. The benefit of self - curing admixtures is more significant in desert areas where water is not adequately available .In this study the mechanical properties of self-curing at different percentages of poly ethylene glycol will be evaluated and compared with conventional concrete specimen. Scope of the study is to identify the effect of polyethylene glycol (PEG) on strength characteristics of self-curing concrete and also to evaluate influence of poly ethylene glycol on mechanical properties which are experimentally investigated.

### **Objectives**

1. To evaluate the workability characteristics of self-curing concrete by addition of self curing agent Poly Ethylene Glycol 400 at different proportions (0.5%, 1%, 1.5%)

2. To study the mechanical characteristic of concrete i.e., compressive strength, split tensile strength and modulus of rupture by varying percentage of PEG from 0% to 1.5% by weight of cement for M40 grade of concrete.
3. To evaluate the optimum percentage of admixture (PEG400) to get the required compressive strength, split tensile strength and flexural strength at 3,7,28 and 56 days.
4. To compare the strength characteristics of self curing concrete and normal curing concrete.

## II. LITERATURE REVIEW

### Hans Reinhardt and Silvia Weber (1998)<sup>1</sup>

They demonstrated on self-cured high Performance concrete that a partial replacement of normal weight aggregates by pre wetted lightweight aggregates leads to an internal water supply for continuous hydration of cement. Despite water loss by evaporation there is continuous strength gain up to 25 percentage more strength after one year compared to standard compressive testing after 28 days.

### Selvamony (2010)<sup>10</sup>

He investigated on self-compacted self-curing Concrete using limestone powder and clinkers. In this study, the effect of replacing the cement, coarse aggregate and fine aggregate by limestone powder (LP) with silica fume(SF), quarry dust(QD) and clinkers respectively and their combinations of various proportions on the properties of SCC has been compared.

### Ravi Kumar (2011)<sup>8</sup>

In his study an experimental investigation was conducted to make a comparative study on the properties of High Performance Concrete with kiln ash (25% and 50% replacement) and without kiln ash (control concrete) in normal and aggressive environment using self-curing instead of water curing.

## III. METHODOLOGY

Experimental program is carried out in different stages. First preliminary tests are conducted on fine aggregate, coarse aggregate and cement. The tests include particle size distribution of fine aggregate and coarse aggregate, specific gravity of cement, specific gravity of fine aggregate, specific gravity of coarse aggregate. With the test of the material obtained, the concrete mix design for M40 grade concrete is designed using IS codes: IS 10262:2009, IS 1026:1982, IS 456:2000.

Compressive strength test, Split tensile and flexural strength test are conducted to determine the properties of normal concrete of M40 grade by using normal sand and M-sand as fine aggregate.

The five mixes are as follows:

1. M40 concrete+ Normal river sand
2. M40 concrete + manufactured sand
3. M40 concrete + manufactured sand + 0.5% of PEG 400
4. M40 concrete + manufactured sand + 1% of PEG 400
5. M40 concrete + manufactured sand + 1.5% of PEG 400

Fresh concrete tests such as Slump flow value, Compaction factor value are investigated and hard concrete tests such as compressive strength for cube of standard size 150mm x 150mm x 150mm (length x breadth x depth), split tensile strength for cylinder of size 150mm x 300mm (diameter x height) and flexural strength for prism of size 500mm x 100mm x 100 mm (length x breadth x depth) were tested for 3, 7 & 28 and 56 days.

The following specimens were cast for hardened concrete tests:

Number of cubes cast for compressive strength = 60 samples

Number of cylinders cast for split tensile strength = 48 samples

Number of prisms cast for flexural strength = 48 samples

Total number of samples cast = 156 samples

#### IV. EXPERIMENTAL INVESTIGATION

##### Materials used

**Cement** ZAURI OPC Cement of 43 Grade was used.

##### Fine aggregate

**River sand** River sand of zone II was used.

**Manufactured sand** Manufactured sand of Zone-II was used.

**Coarse aggregate** Crushed granite metal with 60% passing 20 mm and retained on 10 mm sieve and 40 % passing 10mm and retained on 4.75 mm sieve was used.

**Water** Potable fresh water, which is free from concentration of acids or organic substances, was used for mixing the concrete.

**Admixture** PEG 400 type is used.

#### TESTS ON CONCRETE

##### Tests on fresh concrete

##### Workability

Workability is one of the physical parameters of concrete which affects the strength and durability as well as the cost of labor and appearance of the finished product. It is defined as the relative ease with which concrete can be mixed, transported, moulded and compacted.

##### Slump cone test

A Slump test is a method used to determine the consistency of concrete. The consistency or stiffness indicates how much water has been used in the mix. The stiffness of the concrete mix should be matched to the requirements for the finished product quality.



Slump cone test

##### Compaction factor test

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 – 1959. The compacting factor test works on the principle of determining degree of compaction achieved by a standard amount of work done by allowing

the concrete to fall through a standard height.



Compaction factor test

## Tests on hardened concrete

### 1. Cube compressive strength

The test set up for conducting cube compressive strength test is depicted in figure. Compressive test on the cubes is conducted on the 200T compressive testing machine. The cube was placed in the compression testing machine and the load on the cube is applied at a constant rate upto the failure of the specimen and the ultimate load is noted. The cube compressive strength of the concrete mix is then computed.



Cube compressive strength test

### 2. Split tensile strength

This test is conducted on 200T compression testing machine as shown in figure. The cylinders prepared for testing are 150mm in diameter and 300mm height. Diametrical lines are drawn on the two ends, such that they are in the same axial plane. Then the cylinder is placed on the bottom

compressive plate of the testing machine and is aligned such that the lines marked on the ends of the specimen are vertical. Then the top compression plate is brought into contact at the top of the cylinder. The load is applied at uniform rate, until the cylinder fails and the load is recorded.



Split tensile strength test

### 3. FLEXURAL STRENGTH TEST

This test is conducted on 10T Universal Testing Machine (UTM). The loading arrangement to test the concrete beam specimens for flexure is shown in figure. The beam element is simply supported on two steel rollers of 38mm in diameter these rollers should be so mounted that the distance from center to center is 400mm for 10cm specimens. The load is applied through two similar rollers mounted at the third points of the supporting span, which is spaced 1.3 cm center to center.



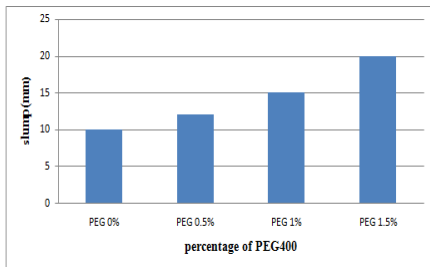
Flexural strength test

### IV. RESULTS AND DISCUSSIONS

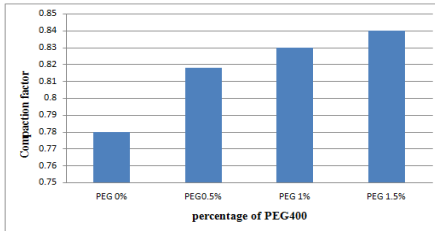
#### Results of workability

##### Slump cone test

S.No	Mix designation	Slump(mm)	Compaction factor
1.	PEG400-0%	10	0.78
2.	PEG400-0.5%	12	0.82
3.	PEG400-1%	15	0.83
4.	PEG400-1.5%	20	0.84



Variation of slump with increase in percentage of PEG400



Variation of compaction factor with percentage increase in PEG400

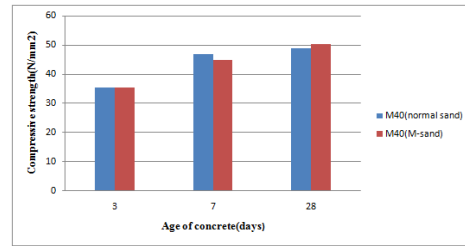
#### Vee-bee consistometer

S.No	Mix designation	Vee-bee time(seconds)
1.	PEG400-0%	12.80
2.	PEG400-0.5%	12.71
3.	PEG400-1%	10.58
4.	PEG400-1.5%	10.00

### COMPRESSIVE STRENGTH

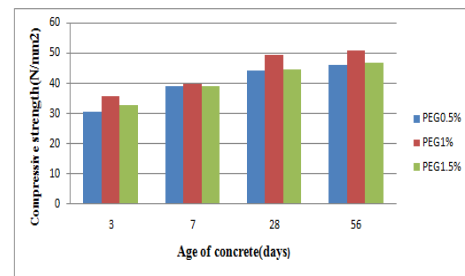
#### Compressive strength results of concrete (normal sand Vs M-sand)

Age of concrete(days)	Compressive strength (Conventional curing)(N/mm <sup>2</sup> )	
	M40-(normal sand)	M-40(M-sand)
3	35.56	35.406
7	46.89	44.74
28	48.89	50.37



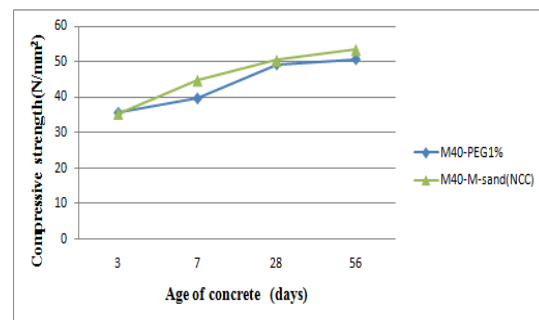
#### Compressive strength of SCC (PEG400)

S.No	Type of concrete	Compressive strength(N/mm <sup>2</sup> )			
		3days	7days	28days	56days
1.	M40+M-sand+PEG 0.5%	30.66	38.93	43.997	46.19
2.	M40+M-sand+PEG 1%	35.7	39.706	49.18	50.65
3.	M40+M-sand+PEG 1.5%	32.89	38.96	44.44	46.62



#### Compressive strength of NCC VS SCC (1%peg400)

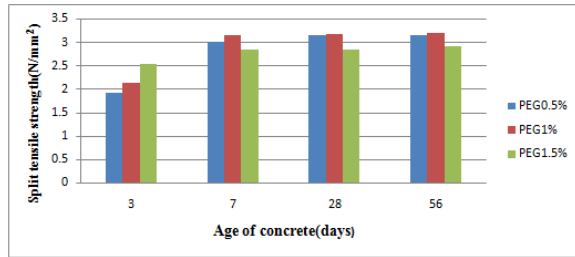
Age of concrete(days)	Compressive Strength(N/mm <sup>2</sup> )	
	Normal curing	Self curing
	M40 + Manufacture sand	M40 + Manufacture sand + 1% PEG400
3	35.406	35.7
7	44.74	39.7
28	50.37	49.18
56	53.39	50.65



### SPLIT TENSILE STRENGTH

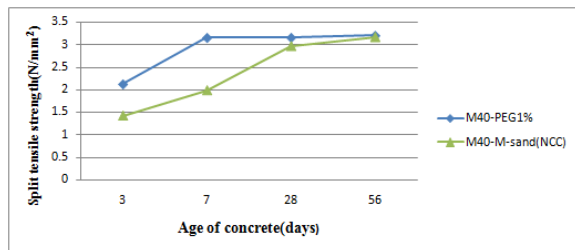
#### Split tensile strength of SCC (PEG400)

Age of concrete(days)	split tensile strength (N/mm <sup>2</sup> )		
	M40+M-sand+0.5%PEG	M40+M-sand+1%PEG	M40+M-sand+1.5%PEG
3	1.916	2.120	2.540
7	3.013	3.156	2.829
28	3.15	3.159	2.829
56	3.16	3.203	2.900



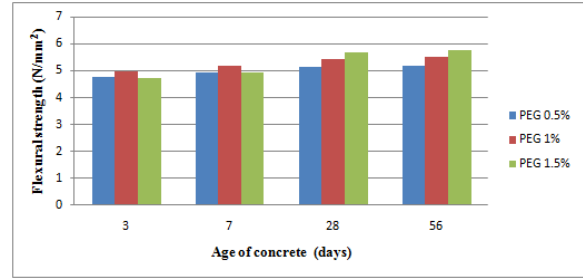
#### Split tensile strength of NCC Vs SCC(1% PEG400)

Age of concrete(days)	Split tensile strength(N/mm <sup>2</sup> )	
	Normal curing	Self curing
	M40 + Manufacture sand	M40 + Manufacture sand + 1% PEG400
3	1.414	2.12
7	1.98	3.156
28	2.969	3.159
56	3.17	3.203



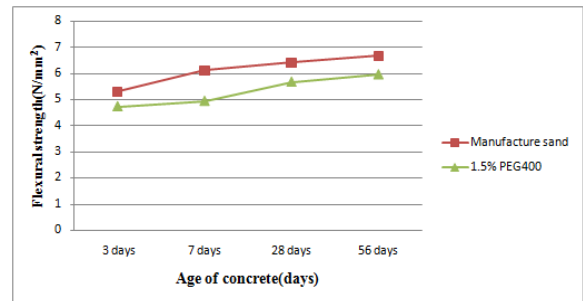
### FLEXURAL STRENGTH

Age of concrete(days)	Flexural strength(N/mm <sup>2</sup> )		
	M40 + Manufacture sand + 0.5% PEG	M40 + Manufacture sand + 1% PEG	M40 + Manufacture sand + 1.5% PEG
3	4.76	4.95	4.73
7	4.94	5.18	4.94
28	5.12	5.41	5.67
56	5.18	5.49	5.77



#### Flexural strength of NCC Vs SCC (1.5% PEG400)

Age of concrete(days)	Flexural strength(N/mm <sup>2</sup> )	
	Normal curing	Self curing
	M40 + Manufacture sand	M40 + Manufacture sand + 1.5% PEG400
3	5.29	4.73
7	6.10	4.94
28	6.40	5.67
56	6.67	5.95



### V. CONCLUSIONS

Based on the experimental investigation carried out and the results drawn from there upon following conclusions were drawn.

- At the place of water scarcity areas these types of self curing agents will give better results
- As the percentage of self curing agent increased, the workability of concrete increased due to the availability of additional moisture.
- There is an increase of 3.02% in compressive strength by complete replacement of fine aggregate with M-sand

- The optimum percentage of PEG400 for maximum compressive strength of M40 grade under the study is 1% by weight of cement.
- There is a decrease of 2.36% and 5.13% in compressive strength when self curing concrete compared with normal curing concrete at 28 and 56 days.
- The optimum percentage of PEG400 for maximum split tensile strength of M40 grade under the study is 1% by weight of cement.
- There is an increase of 6.39% and 1.04% in split tensile strength when self curing concrete compared with normal curing concrete at 28 and 56 days.
- The optimum percentage of PEG400 for maximum flexural strength of M40 grade under the study is 1.5% by weight of cement.

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