Analysis of Compressive Strength of Self Curing Concrete made using Poly-Ethylene Glycol

Rohit Chippa[1], Dipak Patil[2], Anil Khetre[3], Yash Shelot[4]

[1, 2, 3, 4]*Under-Graduate Students, Department of Civil Engineering, ICEM, Pune, Maharashta, India*

Abstract - *Concrete is most widely used construction material due to its strength, permanence and durability. Since the concrete is open to atmosphere, the water used in concrete evaporates and the water available in concrete will not be sufficient for effective hydration. If the hydration is to continue unbated, extra water must be added to replenish the loss of water on account of absorption and evaporation. Alternatively, some measure must be taken to prevent the loss of water from the surface of concrete. Therefore, curing can be considered as creation of a favorable environment during the early period for uninterrupted hydration. The present study involves the use of shrinkage reducing admixture like POLYETHYLENE GLYCOL (PEG400) as internal curing compound. This curing compound used in concrete which helps in self-curing and helps in better hydration and hence good compressive strength. They trap the moisture within the structure and prevent it from evaporation which normally occurs due to the hydration process. The paper aim about the analysis of the mechanical proper of self-curing concrete.*

***Key Words*: Self-Curing Concrete, Compressive Strength, Hydration, Polyethylene Glycol (PEG400)**

1. INTRODUCTION

Curing is the name given to the procedure used for promoting the hydration of the cement and consists of a control of temperature and of moisture movement from and into the concrete. Curing allows continuous hydration of cement and consequently continuous gain in the strength, once curing stop strength gain of the concrete also stops. Proper moisture conditions are critical because the hydration of the cement virtually cases when the relative humidity within the capillaries drops below 80%. Proper curing of concrete structure is important to meet performance and durability requirements. In conventional curing this achieved by external curing applied after mixing, placing and finishing.

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 cement and hence lowering the quality of the concrete. Various factor such as wind velocity, relative humidity, atmospheric temperature, water cement ratio of the mix and type of the cement used in the mix. Evaporation in the initial stage leads to plastic shrinkage cracking and the final stage of setting it leads to drying shrinkage cracking.

Curing temperature is one of the major factors that affect the strength development rate. At elevated temperature ordinary concrete losses its strength due to the formation of the cracks between two thermally incompatible ingredients, cement paste and aggregates. To study the mechanical characteristics of concrete i.e., compressive strength, split tensile strength and modulus of rupture by varying the percentage of PEG from 0% to 1.5% by weight of cement for both M20 grade of concrete.

1.1 Mechanism and Significance of Curing Concrete

Continuous evaporation of moisture takes place from an exposed surface due to the difference in chemical potential between the vapor and liquid phases. The polymer added in the mix mainly from hydrogen bonds with water molecules and reduces the chemical potential of the molecular which in turn reduces the vapor pressure, thus reducing the rate of evaporation from the surface. When the mineral admixture react completely in a blended cement system, their demand for curing water (external or internal) can be much greater than that 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 the 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.

2. TEST SPECIMEN

2.1 Materials used

1. *Cement*: Ordinary Portland cement (OPC) of 53 grade of ACC Cement is used in this experimental work. Weight of each cement bag is 50 kg.
2. *Fine aggregates*: The aggregate which pass from 4.75mm sieve and retained at 75 micron are known as fine aggregate. Crushed sand having specific gravity of 2.6gm/cc is used and Fineness modulus as 3.15
3. *Coarse aggregate*: Consist of 10 mm and 20 mm crushed aggregate. 10 mm aggregate having specific gravity 2.91gm/cc and FM as 2.012. 20mm aggregate having specific gravity 2.88gm/cc and FM as 2.1.

2.2 Chemical used

Polyethylene Glycol (PEG400) used as an internal curing compound. Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula $H(OCH_2CH_2)_nOH$, where n is the average number of repeating polyethylene groups typically from 4 to about 180. One common feature of PEG appears to be the water-soluble nature. Polyethylene glycol is non-toxic, odorless, pharmaceuticals. Thus, it is a shrinkage reducing admixture.

Table -1: Chemical Details

Sr.no.	Description	Properties
1.	Molecular weight	400
2.	Appearance	Clear fluid
3.	Moisture	0.2%
4.	PH	6
5.	Specific gravity	1.12

2.3 Mix Proportion and Casting Procedure

Hand mixing over a mixing tray was done throughout. Coarse aggregates were placed first in the tray followed by crushed sand, and then cement. The materials were dry mixed thoroughly for 1 min. before adding water. Mixing continued for further few minutes after adding water. Concrete was then placed in IS specified moulds in three layers, each layer was being compacted by standard tamping road with more than 35 strokes. Exposed surface was finished with trowel to avoid uneven surface.

A total of 18 concrete specimens of 150x150x150mm was designed and fabricated. Specimens were prepared to obtain characteristic cube strength of 20 MPa. In particular, 3 specimens of different curing day criteria were prepared. Specimens were cured by immersing them in curing tank for 7 days and 28 days.

Table -2: Chemical Details

Grade	Cement (kg/m3)	Aggregate (kg/m3)		Water (lit/m3)
		Fine	Coarse	
M20	383.16	624.55	1252.93	191.58

3. RESULTS AND ANALYSIS

3.1 The result of compressive strength

The cube specimens were tested on compression testing machine of capacity 3000KN. The bearing surface of machine was wiped off clean and sand or other material removed from the surface of specimen. The specimen was placed in a machine a manner that the load was applied opposite side of the cube as casted that is, not top and bottom. The axis of the specimen was carefully aligned at the center of loading frame. The load applied was increased continuously at a constant rate until the resistance of the specimen to the increasing load breaks down and no longer can be sustained. The load applied on specimen was recorded.

Table - 3: Compressive strength using PEG400 (N/mm^2)

% of PEG 400	7 Day	28 Day
0%	23.77	37.49
0.5%	20.75	31.79
1%	22.09	32.78

3.2 Comparative study

For M20 concrete M- stands for MIX; 20 – stands for characteristics compression strength of concrete is 20N/mm2 after 7 days and 28 days

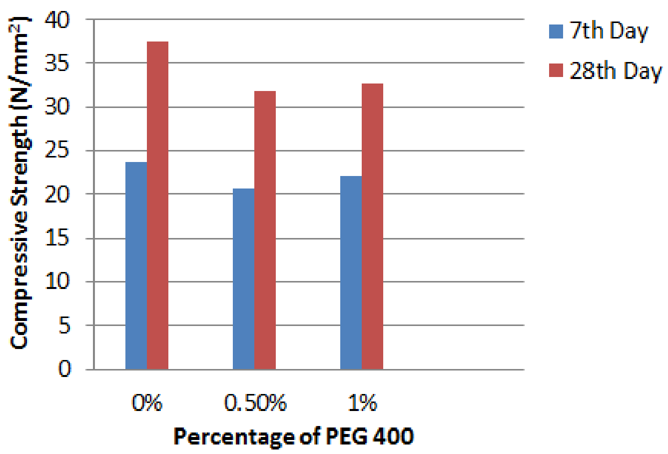

Chart 1 – Comparison of Compressive Strength

3. CONCLUSIONS

[1] It can be seen that the minimum strength as per the codal provision has been achieved by the specimens cured through curing compounds. The strength achieved by the PEG400 is comparable for both type of mix i.e. M20.

[2] Water retention for the concrete mixes incorporating self-curing agent is higher compared to conventional mixes.

[3] From the workability test results, it was found that the self-curing agent improved workability.

[4] As 7 days compressive strength of self-cured concrete (normal mix + PEG400) gives mean strength 28.97 MPa which is almost 10.1% greater than that of water cured concrete (normal/conventional mix) 21.43 MPa.

[5] As 28 days compressive strength of self-curing concrete gives mean strength 34.20 MPa which is almost 17% grater than that of water cured concrete 28.87 Mpa.

[6] It has been observed during testing, cubes of (normal mix + PEG400) shows less cracks and doesn't broke down even after throwing from almost 1m of height which is not in case of conventional mix alone.

[7] There is less shrinkage and good bonding observed in normal + PEG400 which is not in case of conventional mix alone.

REFERENCES

[1] D. P. Bentz, "Capillary Porocity Depercolation Repercolation in Hydrating Cement Paste via Low Temperature Calorimetry," Journal of the American Ceramic Society, 89 (8), 2606-2611, 2006.

[2] R. K. Hawlett, P. C. Dyer, Mechanisms of water retention in cement pastes containing a self-curing agent, Magazine of concrete Research, volume no 50, Issue no 1, 1998, pp85-90.

[3] M. V. JAGANNADHA KUMAR, volume 1, issue 1 strength characteristics of self-curing concrete.

[4] A. S. EI-Dieb, construction of building materials, self-curing concrete, water retention, hydration & moisture transport.

[5] M. S. SHETTY Concrete technology.

[6] IS: 10262:1982, Indian standard concrete mix proportion guideline, bureau of Indian standards, New Delhi.

[7] IS: 12269:1987, Indian Standard Ordinary Portland cement, 53 grade Specification.

[8] IS: 383-1970, Indian Standard Specification for Course and Fine Aggregate from natural sources for concrete.

BIOGRAPHIES

Rohit Chippa
T.E. Civil
Indira College of Engineering and Management, Pune

Dipak Patil
T.E. Civil
Indira College of Engineering and Management, Pune

Anil Khetre
T.E. Civil
Indira College of Engineering and Management, Pune

Yash Shelot
T.E. Civil
Indira College of Engineering and Management, Pune