International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 3, March - 2014

Introducing the Self-Curing Concrete in Construction Industry

Patel Manishkumar Dahyabhai[1], Prof. Jayeshkumar R. Pitroda[2]
[1]Student of Final Year of M.E. in C.E. & M., B.V.M. Engineering College, Vallabh Vidhyanagar, Gujarat-India
[2]Assistant Professor & Research Scholar, Civil Engineering Department, B.V.M. Engineering College, Vallabh Vidhyanagar, Gujarat-India

***Abstract*— The imagination of a world without concrete is impossible. Concrete is a soul of infrastructures. Concrete is necessary to gain strength in structures. Conventional concrete, which is the mixture of cement, fine aggregate, coarse aggregate and water, needs curing to achieve strength. So it is required to cure for a minimum period of 28 days for good hydration and to achieve target strength. Lack of proper curing can badly affect the strength and durability. Self-curing concrete is one type of modern concrete, which cure itself by retaining water (moisture content) in it. The use of POLYETHYLENE GLYCOL in conventional concrete as an admixture helps better hydration and hence the strength of concrete. In this research paper, the individual effect of admixture PEG600 & PEG1500 on compressive strength by varying the percentage of PEG600 and PEG1500 by weight of cement 0.5%, 1.0%, 1.5% and 2% were studied. The study shows that PEG600 and PEG1500 could help in gaining the strength of conventional curing. It was also found that 1% of both PEG600 and PEG1500 by weight of cement was optimum for M25 grade concrete for achieving maximum strength without compromising workability. The test result indicates that use of water soluble polymers in concrete has improved performance of concrete.**

Keywords*— *Self-curing concrete, Water retention, SCC, Workable Concrete.

I. INTRODUCTION

Proper curing of concrete structures is important to meet the performance and durability requirements. In conventional curing this is 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.

A. Methods of Self-Curing (Internal Curing):

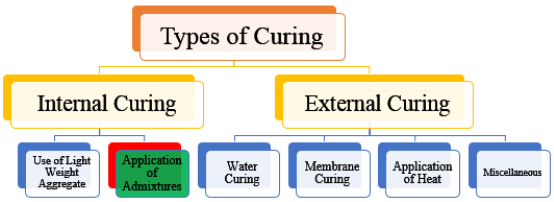

Figure1: Methods of Self-Curing

Currently, there are two major methods available for internal curing of concrete. The first method uses saturated porous lightweight aggregate (LWA) in order to supply an internal source of water, which can replace the water consumed by chemical shrinkage during cement hydration. The second method uses poly-ethylene glycol (PEG) which reduces the evaporation of water from the surface of concrete and also helps in water retention.

B. Contrivance of Self-Curing:

Due to difference in chemical potential between the vapor and liquid phases, continuous evaporation of moisture takes place from external surface of concrete. The polymers added to the concrete mix mainly form hydrogen bonds with water molecules and reduce the chemical potential of the molecules which results in reduction of the vapor pressure, thus reducing the rate of evaporation from the surface.

C. Potential Materials for Self-Curing (Internal) Curing:

The following materials can provide internal water retention:

- Lightweight Aggregate (natural and synthetic, expanded shale)
- Super-absorbent Polymers (SAP) (60-300 nm size)
- SRA (Shrinkage Reducing Admixture) (propylene glycol type i.e. Polyethylene-glycol)

D. Advantages of Self-Curing (Internal) Curing:

• It is the alternate of construction in desert regions where major scarcity of water is there.
• Self-Curing (Internal Curing) is a method to provide the water to hydrate all the cement, accomplishing what the mixing water alone cannot do.
• Provides water to keep the relative humidity (RH) high, keeping self-desiccation from occurring.
• Eliminates largely autogenous shrinkage.
• Can make up for some of the deficiencies of external curing, both human related (critical period when curing is required in the first 12 to 72 hours) and hydration.
• Increases the strength of concrete in some extent.

IJERT

E. Polyethylene Glycol:

Polyethylene Glycol is a condensation polymer of ethylene oxide and water with the general formula H(OCH2CH2)nOH, where n is the average number of repeating oxyethylene groups typically from 4 to about 180. The abbreviation (PEG600 and PEG1500) is termed in combination with a numeric suffix which indicates the average molecular weights. Some features of PEGs are the water-soluble nature, non-toxic, odorless, neutral, lubricating, non-volatile and non-irritating and is used in a variety of pharmaceuticals.

II. SCOPE AND OBJECTIVE:

The scope of the paper is to study the effect of polyethylene glycol (PEG600 and PEG1500) on strength characteristics of Self-curing concrete.
The objective of the study is to check and to compare compressive strength by adding by varying the percentage of PEG600 and PEG1500 from 0% to 2% by weight of cement for M25 grade of concrete each.

III. EXPERIMENTAL WORK:

The experimental program was designed to investigate the strength of self curing concrete by adding poly ethylene glycol PEG600 and PEG1500 @ 0.5%, 1%, 1.5% and 2% by weight of cement to the concrete of each. The experimental program was aimed to study compressive strength. To study the above properties mix of M25 were considered. The scheme of experimental program is following given in Table No.1.

Table No.1: Casting Work

	Concrete Mix M25	**Compressive Strength Test**		
	Mould Size	**150*150*150 Cube**		
	Days	**7**	**14**	**28**
A	Without curing and without admixture (A)	3	3	3
B	With general curing and without admixture (B)	3	3	3
C1	With admixture PEG600 0.50% weight of cement (C1)	3	3	3
C2	With admixture PEG600 1% weight of cement (C2)	3	3	3
C3	With admixture PEG600 1.5% weight of cement (C3)	3	3	3
C4	With admixture PEG600 2% weight of cement (C4)	3	3	3
D1	With admixture PEG1500 0.50% weight of cement (D1)	3	3	3
D2	With admixture PEG1500 1% weight of cement (D2)	3	3	3
D3	With admixture PEG1500 1.5% weight of cement (D3)	3	3	3
D4	With admixture PEG1500 2% weight of cement (D4)	3	3	3
TOTAL MOULD		30	30	30

*All dimensions are in mm.

IJERT

IV. MATERIALS USED:

The different materials used in this investigation are

A. ***Cement:***

Cement used in the investigation was 53 grade Ordinary Portland Cement confirming IS: 12269: 1987.

B. ***Fine Aggregate:***

The fine aggregate used was obtained from a nearby river source. The fine aggregate conforming to zone-I according to IS: 383-1970 was used.

C. ***Coarse aggregate****:*

The coarse aggregate according to IS: 383-1970 was used. Maximum coarse aggregate size used is 20 mm.

D. Polyethylene Glycol-600 and Polyethylene Glycol-1500:

Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula H(OCH2CH2)nOH, where n is the average number of repeating oxyethylene groups 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 PEGs appears to be the water-soluble nature.

E. Water:

Potable water was used in the experimental work for both mixing and curing purposes.

V. CASTING PROGRAMME:

Mix design of concrete was as per IS: 10262:2000. Casting of the specimens was made as per IS: 10086-1982, preparation of materials, weighing of materials and casting of cubes, beams. The mixing, compacting of concrete was according to IS 516: 1959. The plain samples of cubes, are cured for 1 days in water pond and the specimens with PEG600 and PEG1500 were cured for 1 days at room temperature by placing them in the shade. The M25grade of concrete are designed and the material required per cubic meter of concrete is shown in Table 2.

Table 2: Materials required per cubic meter of concrete

Mix	Water (kg)	Cement (kg)	F.A. (kg)	C.A. (kg)
M25	180	360	767.76	1188.84

VI. TESTING:

A. Slump Test:

To find the consistency of concrete, slump test is the best method for it. Slump test can be performed in laboratory as well as at work-site also. All factors contributing to workability are not possible to measure by slump test. However, it is used conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch.

B. Compressive strength: [IS 516:1959]

The cube specimens were tested on compression testing machine of capacity 2000KN. The bearing surface of the machine was wiped off clean and sand or other material removed from the surface of the specimen. The specimen was placed in machine in such a manner that the load was applied to opposite sides of the cubes as a cast 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 maximum load applied on specimen was recorded. Fc = P/A, where, P is applied load & A is area of the specimen.

VII. RESULTS & DISCUSSION:

A. Slump Test: [IS: 1199-1959]

The slump test results are represented in following table-3 and graphical representation is also shown in figure 2. As the % of PEGs (PEG600&PEG1500) are increased the slump is found to increase respectively.

No. 3: Slump Test Results

SLUMP TETS	
Concrete Mix	M25
	Slump (mm)
A	58
B	71
C1	84
C2	107
C3	133
C4	171
D1	82
D2	103
D3	132
D4	170

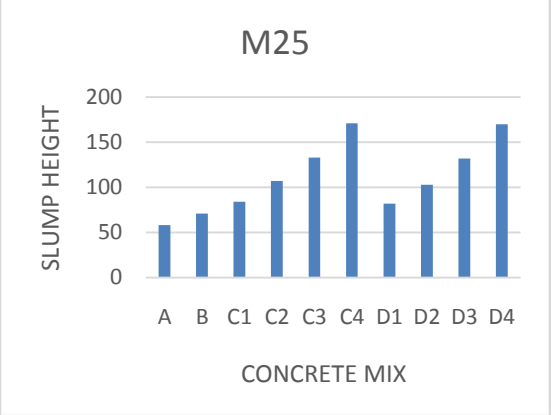

Figure 2: Slump Test

B. Compressive Strength: [IS: 516-1959]

The results of the compressive strength are represented in table-4 and the graphical representation is shown in Fig 3. The compressive strength was found to increase up to 1% both PEG600&PEG1500 and then decreased for M25 grade.The compressive strength of concrete mix increased by 37% by adding 1.0% of PEG600 and 33.9% by adding 1.0% of PEG1500 as compared to the conventional concrete.

IJERT

Table No. 4: Compressive strength Test Results

AVERAGE COMPRESSIVE STRENGTH N/mm^2			
CONCRETE Mix	7 DAYS	14 DAYS	28 DAYS
A	13.19	18.07	24.15
B	16.30	23.11	24.89
C1	18.52	26.37	33.04
C2	21.33	28.30	34.22
C3	19.56	26.52	32.30
C4	19.26	25.33	31.85
D1	18.96	26.37	32.30
D2	21.63	28.59	33.33
D3	19.56	26.22	32.30
D4	18.96	25.48	31.70

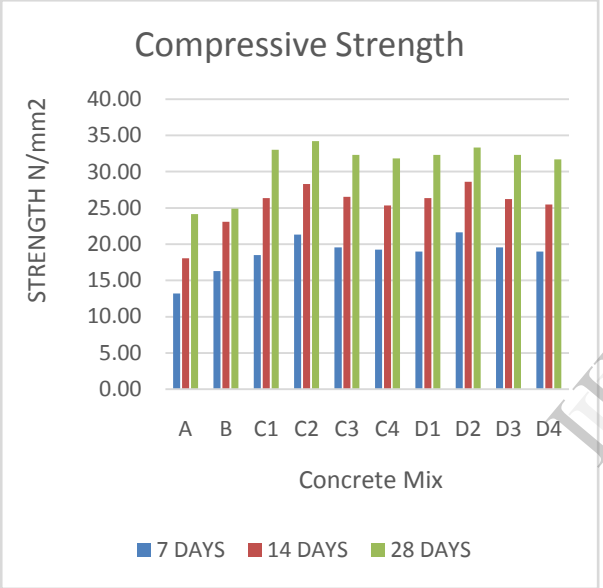

Figure 3: Compressive Strength Test

VIII. CONCLUSIONS:

1. Compressive strength of self curing concrete is increasedby applying the self-curing admixtures.
2. The compressive strength of concrete mix increased by 37% by adding 1.0% of PEG600 and 33.9% by adding 1.0% of PEG1500 as compared to the conventional concrete.
3. The optimum dosage of PEG600 for maximum compressive strengths was found to be 1% of weight of cement for M25 grades of concrete.
4. The optimum dosage of PEG1500 for maximum compressive strengths was found to be 1% of weight of cement for M25 grades of concrete.
5. Self curing concrete is the best solution to the problems faced in the desert region and faced due to lack of proper curing.

ACKNOWLEDGEMENT

The Authors thankfully acknowledge to Dr. C. L. Patel, Chairman, CharutarVidyaMandal, Er.V.M.Patel, Hon. Jt. Secretary, CharutarVidyaMandal, Dr. F. S. Umrigar, Principal, Dr. L. B. Zala, Professor and Head of Civil Engineering Department, Prof. J. J. Bhavsar, Associate Professor and PG Coordinator (Construction Engineering and Management), B.V.M. Engineering College, Vallabh Vidyanagar, Gujarat, India for their motivations and infrastructural support to carry out this research.

REFERENCES

1. Bentz, D.P., *"Influence of Curing Conditions on Water Loss and Hydration in Cement Pastes with and without Fly Ash Substitution,"* NISTIR 6886, U.S. Dept. Commerce, July 2002
2. Bentz, D.P., and Snyder, K.A., *"Protected Paste Volume in Concrete: Extension to Internal Curing Using Saturated Lightweight Fine Aggregates,"* Cement and Concrete Research. 29, 1863-1867, 1999
3. Cusson, D., and Hoogeveen, T., *"Internally-Cured High- Performance Concrete under Restrained Shrinkage and Creep,"* CONCREEP 7 Workshop on Creep, Shrinkage and Durability of Concrete and Concrete Structures, Nantes, France, Sept. 12-14, 2005, pp. 579-584
4. Dhir, R.K. Hewlett, P.C. Dyer, T.D., *"Mechanisms of water retention in cement pastes containing a self-curing agent,"* Magazine of Concrete Research, Vol No 50, Issue No 1, 1998, pp85-90
5. Geiker, M.R., Bentz, D.P., and Jensen, O.M., *"Mitigating Autogenous Shrinkage by Internal Curing,"* High Performance Structural Lightweight Concrete, SP-218, J.P. Ries and T.A. Holm, eds., American Concrete Institute, Farmington Hills, MI, 2004, pp. 143-154
6. Hammer, T.A.; Bjontegaard, O.; Sellevold, E.J., *"Internal curingrole of absorbed water in aggregates, High-performance structural lightweight concrete."* ACI fall convention, Arizona, October 30, 2002. ACI SP 218
7. Hoff, G. C., *"The Use of Lightweight Fines for the Internal Curing of Concrete,"* Northeast Solite Corporation, Richmond, Va., USA, August 20, 2002, 37 pp
8. Kovler, K.; et.al., *"Pre-soaked lightweight aggregates as additives for internal curing of high-strength concrete"s,* Cement, Concrete and Aggregates, No 2, Dec. 2004, pp 131-138
9. Lura, P., *"Autogenous Deformation and Internal Curing of Concrete,"* Ph.D. Thesis, Technical University Delft, Delft, The Netherlands, 2003
10. M.V.Jagannadha Kumar, M.Srikanth, Dr.K.Jagannadha Rao "STRENGTH CHARACTERISTICS OF SELF-CURING CONCRETE"IJRET | SEP 2012
11. Patel ManishkumarDahyabhai, Prof. Jayeshkumar R. Pitroda "Self-Curing Concrete: New Technique for Concrete Curing – A Literature Review" JOURNAL OF INTERNATIONAL ACADEMIC RESEARCH FOR MULTIDISCIPLINARY, Impact Factor 1.393, Volume 1, Issue 9, October 2013
12. Ravikumar M.S., Selvamony. C., Kannan S.U., Basil Gnanappa .S *"Behaviour of Self Compacted Self Curing Kiln Ash Concrete with Various Admixtures"* ARPN Journal of Engineering and Applied Sciences, October 2009, ISSN 1819-6608
13. Ravikumar M.S., Selvamony. C., Kannan S.U., Basil Gnanappa .S *"Investigations on Self-Compacted Self-Curing Concrete using Limestone Powder and Clinkers"* ARPN Journal of Engineering and Applied Sciences, VOL. 5, NO. 3, March 2010, ISSN 1819-6608
14. Ravikumar M.S., Selvamony. C., Kannan S.U., Basil Gnanappa .S *"SELF COMPACTED / SELF CURING / KILN ASH CONCRETE"* International Journal on Design and Manufacturing Technologies, Vol. 5, No.1, January 2011
15. Selvamony. C., Ravikumar M.S., Kannan S.U., Basil Gnanappa .S *"DEVELOPMENT OF HIGH STRENGTH SELF-COMPACTED SELF-CURING CONCRETE WITH MINERAL ADMIXTURES"* International Journal on Design and Manufacturing Technologies, Vol.3, No.2, July 2009.

IJERT