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Effect of Polyethylene Glycol in Self-Curing of Self Compacting Concrete

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Abstract—The objective of this research is to evaluate the strength characteristics of self-compacting concrete as self-curing material by using water soluble Polyethylene Glycol 400. The objective of self-curing agent is to decrease concrete water disposal, thus increasing concrete's water retention ability in comparison with conventional curing. Self curing Concrete is a modern method, which performed to meet the water needs of the concrete without external curing. This research discusses the compressive, flexural, and split tensile strength of the concrete having the self-curing agent. Polyethylene glycol (PEG) of Molecular Weight 400 (PEG 400).The percentage of self-curing used from 0.5, 0.1, 1.5 and 2 percent by weight of cement. From the experimental results it is observed that optimal dosage PEG 400 is achieved at one percent being maximum strength. It is also found that the increase in PEG dosage decreases the strength of concrete.

Keywords—Self-Curing, Conventional-curing, Polyethylene Glycol, Self-compacting concrete.

I. INTRODUCTION

Internal curing (or) self-curing plays a significant part in the development of the concrete pore structure. The idea of internal curing is to improve the hydration method to preserve temperature evenly [1].Curing helps ongoing hydration of cement and subsequently ongoing boost in strength. Water is the highest commodity used as a result, the water table's daily level drops, if for building works water has to be bought the building price will rise much higher. Continuous curing is also extremely difficult for concrete work on vertical extremities, sloping roofs and floors. Concrete is subjected to the setting, water evaporation occurs and the humidity reduces original Cement proportion of water, incomplete hydration of the concrete [2]. Evaporation in the original phase contributes to cracking plastic shrinkage and it contributes to drying contraction in the final setting phase. Cracks are formed between two heat-incompatible materials, i.e. Paste and aggregates of cement, ordinary concrete loses energy at elevated temperatures. Self-curing agents primarily assist in concrete water retention by decreasing evaporation during concrete hydration. Water soluble Poly Ethylene Glycol (PEG) can be used in concrete as self-healing agents for self-healing. One of the self-curing agents is also Super Absorbent Polymer. Most Super Absorbent Polymer (SAP), are poly electrolytes that are cross-linked. Because of their ionic nature and interconnected composition, they absorb huge amounts of water without dissolving. In today's condition, where water becomes an important asset that cannot be wasted for curing, self-curing admixtures play a crucial role.

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II. LITERATURE REVIEW

1. M V Jagannadahakumar et al.,Concluded that the use of self-healing specialists (polyethylene glycol) in concrete improves the performance features of concretes under the air-healing system that can be ascribed to better maintaining of water and caused further watering of the concrete paste which results in fewer emptying and pores. [4].
2. R. SubrahmanyaPavanet al.,studied two specific self-healing operative such as Polyethylene Glycol 600 and Super Absorbent Polymer, the present subject is invented on the toughness characteristics of self-curing based on the above research. [5]
3. R Udhayan et al., 2017 concluded that self-curing agent PEG can promote effective hydration of cement without any externally applied curing procedure [6]
4. ShaileshVetal et al., 2016 observed that noted increasing the PEG-400 rate increases the weight decrease for the reduced w / c ratio. Hence lower measurement indicating better water maintenance for lower w/c proportion. [7]
5. B.Mohan et al., 2016 concluded that the self-curingself-compacted concrete shows better results compares to conventional, self-curing and self-compacting concrete. [8]

III. EXPERMENTAL METHODOLOGY

A. *Cement*

Ordinary 53 grade Portland cement was used for all IS12269:1987[9] confirmed concrete mix, Physical substances of cement are presented in table 1

TABLE 1. Physical substances of cement

S.NO.	SUBSTANCE	RESULT
1	Specific gravity	3.16
2	Initial setting time	35 min
3	Final setting time	460 min
4	Fineness modulus	8%

B. *Coarse aggregate (ca) and Fine aggregate (fa)*

Sand from river locally accessible is confirming to IS383:1970 [10]. Crushed angular aggregates used conformist to IS383:1970. Properties are presented in table 2.

TABLE 2. Physical properties of fine and coarse aggregate

S.NO.	SUBSTANCE	CA	FA
1	Specific gravity	2.6	2.7
2	Bulk density	1505	1560
3	Surface water	0.6	0.7
4	Water absorption	0.3	0.4

C. *Fly ash*

Fly ash is a by-product of the burning of pulverised carbon by energy stations. The chemical reaction between the cement and water to the formation of other cement products which enhance many of the desired concrete properties reacts with calcium hydroxide. Properties of fly ash are presented in table3.

TABLE 3. Physical properties

S.NO	PROPERTY	RESULT
1	Specific gravity	2.8
2	Fineness modulus	350 m^3/kg
3	colour	Gray

D. *Super plasticizer*

To increase the workability of concrete by super plasticizer is used. The super plasticizer used in the experiment was Master EasEe-3705 from BISF Bangalore, was used... As per IS9103-1999[11]. Properties of EasEe are presented in table 4.

TABLE 4. Properties of chemical admixtures.

S.NO.	PROPERTY	RESULT
1	Specific gravity	1.20

E. *Polyethylene glycol(peg)400*

Atomic weight 400 polyethylene glycol (PEG) is selected as a self-curing specialist. Polyethylene-glycol is an ethylene oxide and water buildup material with the overall equation $HO(C_2H_4O)$ nH, where n is the regular amount of rehashing ox ethylene group from 4 to about 180. Polyethylene glycol 400 is emphatically hydrophilic. Properties are presented in table 5.

TABLE 5. Property of peg 400

S.NO	PROPERTY NAME	PROPERTY VALUE
1	Molecular weight	400
2	Appearance	Clear liquid
3	Nature	Water soluble

F. *Water*

Drinking water is used to test the experimental work to the mixing properties.

G. *Mix proportion*

The mixed concrete design is available for self-compacting concrete (SCC). The blend design for the M60 grade is accomplished using the Nansu method. Super plasticizer is added to the mix weight of cement at a dosage of 1.2 percent in this layout. The fly ash admixtures are added to the blend at 4.87% and PEG 400 at 0, 0.5 to 2% by weight of concrete. Mix properties used for the concrete production are conferred in table 6

TABLE 6. Mix proportion for M60 grade concrete for 1m3

Cement (kg/m^3)	Fly ash (kg/m^3)	FA	CA	Water (lit/m^3)	Super plasticizer (%)
390	120	1100	810	163	1.2

IV. RESULT AND DISCUSSION

I. Workability test

Workability is easy evaluation to place and compact new concrete. it is a complicated combination mix of fluidity, uniformity, transportability, compactness, and stickiness characteristics.

TABLE 7. Test result of workability test

Test	M_1	M_2	M_3	M_4	M_5	M_6
Slump flow test	630	630	635	640	645	650
L-box	0.7	0.7	0.72	0.75	0.78	0.8
V-funnel	15	15	14	13	12	10

II. Mechanical properties

The test outcomes will be conducted for the next 7 days and 28 days. The test results for both water curing (WC) and air curing (CA) at various specimens are observed. The 2000-kn compressors test machine has been used for compression testing, tensile strength and flexural strength.

*i. **Compressive strength***

Table 8 shows compressive strength test results of various dosages of Polyethylene Glycol.

TABLE 8. Test result of compressive strength

Details of the specimen		Compressive strength (N/mm^2)	
		7 days	*28 days*
PEG 0% (WC)	Traditional curing(Water Curing)	47	70.5
PEG 0% (AC)	Traditional curing (Air Curing)	25	37
PEG 0.5%	Self curing	32	46
PEG1%	Self curing	48	71
PEG 1.5%	Self curing	43	63.5
PEG 2%	Self curing	37	55

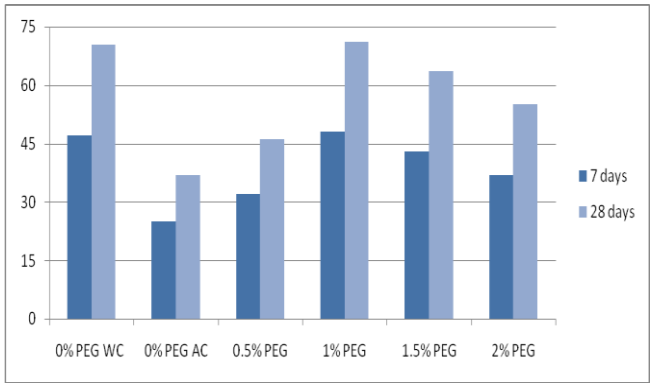

FIG 1. Graphical view for Compressive strength test results

*ii. **Split tensile strength***

Table 9 shows the split tensile strength test result of various dosages of Polyethylene Glycol at 7 days and 28 day.

TABLE 9. Test result of split tensile strength

Details of the specimen		Split tensile strength (N/mm^2)	
		7 days	*28 days*
PEG 0% (WC)	Traditional curing(Water Curing)	4.5	6.5
PEG 0% (AC)	Traditional curing (Air Curing)	3.3	4.6
PEG 0.5%	Self curing	4.2	5.7
PEG1%	Self curing	4.9	6.6
PEG 1.5%	Self curing	4.3	5.9
PEG 2%	Self curing	3.7	5.1

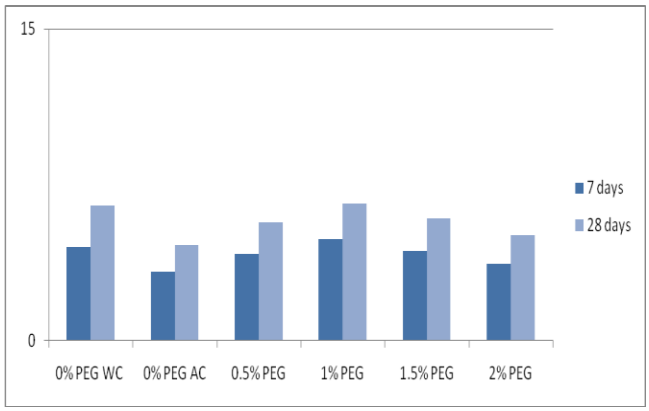

FIG 2. Graphical view for split tensile strength test results.

iii. ***Flexural strength***

Table 8 shows compressive strength test results of various dosages of Polyethylene Glycol.

TABLE 10. Test result of flexural strength

Details of the specimen		Flexural strength (N/mm^2)	
		7 days	*28 days*
PEG 0% (WC)	Traditional curing(Water Curing)	4.79	5.85
PEG 0% (AC)	Traditional curing (Air Curing)	3.5	4.2
PEG 0.5%	Self curing	4.3	4.8
PEG1%	Self curing	4.9	5.89
PEG 1.5%	Self curing	4.5	5.89
PEG 2%	Self curing	4.2	5.21

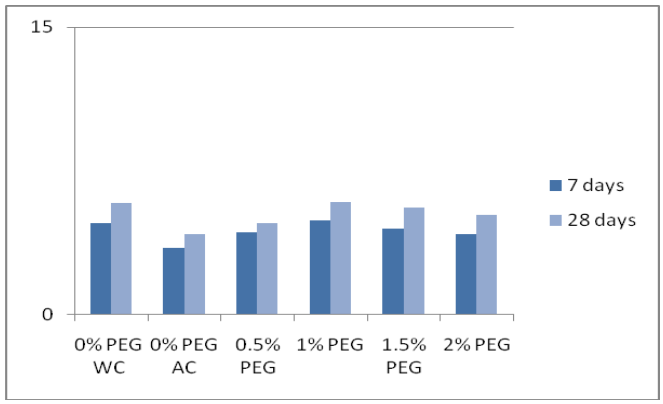

FIG 3. Graphical view for flexural strength test results.

V. CONCLUSION

From the outcomes of this research, the following findings can be observed:

1. The use of self-curing agent in concrete blends increases the strength characteristics of concrete under an air curing system that can be ascribed to better retention of water and causes continuing hydration of cement paste resulting in reduced voids and pores.
2. It has been observed that 2% PEG provides a lower compressive, split tensile and flexural strength compared to 1% PEG, so it is found that adding PEG at a high dose of over 1% of cement would not produce expected strength and would not be practically applicable,
3. Compared to standard curing concrete, setting time of self-compacting self-curing concrete is slow when percentage of PEG increases.
4. In this experiment 1 percent PEG gives better result when compared to 0.5%, 1.5%, 2% of PEG as a self curing agent.
5. Self-curing concrete is an option to conventional cured concrete in desert regions where water shortages are a major problem.

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AUTHORS PROFILE

Dr.V.Mallikarjuna Reddy,has received Ph.D JNTU Hyderabad, Telangana.He has over 31Years of teaching & 1 year of industrial experience.He is actively involved in Research work for the last 8 years. He worked in TGLG Polytechnic ADONI for 16 years and for 4years in ERITREA(NE AFRICA). He worked for JNTUH College of Engineering as Visiting Faculty for PTPG Structural Engineering for 5years. Presently he working as Professor& HoD of Civil Engineering Department in Gokaraju Rangarau Institute of Engineering and Technology.

Rathod Praveen, has completed engineering from Viswa Bharathi college of engineering and technology , Hyderabad, Telangana, in the batch of 2011-2015 with first class degree. Presently pursuing masters in Structural Engineering Gokaraju Rangaraju Institute of Engineering and Technology (Hyderabad) attentively interested to conduct Study on Research of Self-Curing Self Compacting Concrete Utilizing Polyethylene Glycol as Self-Curing Agent.