An Experimental Investigation on Internally Cured Concrete

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Abstract - As water is becoming a scarce material day-by-day, there is an urgent need to do research work pertaining to saving of water in making concrete and in constructions. 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. Curing of concrete plays a major role in developing the concrete microstructure and pore structure and hence improves its durability and performance. Keeping importance to this, an attempt has been made to develop self-curing concrete by using Poly Ethylene Glycol (PEG-400). In this experimental investigation the strength characteristics of Normal Strength Concrete, cast with the self-curing agent PEG-400 have been studied and compared with the corresponding conventionally cured concrete. IS method of mix design was adopted. For the Normal Strength Self Curing Concrete of grade M20. For producing self-curing concrete trial dosage of 1%, 2% and 3% of PEG-400 by weight of cement was used and tested.

Keywords - *self-curing concrete, self-curing agent, PEG-400.*

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I. INTRODUCTION

Concrete has been and will be, for a considerable number of years, the most versatile materials used in construction. Conventional concrete, which is the mixture of cement, fine aggregate, coarse aggregate and water, needs curing to achieve proper strength. So it is required to cure for a minimum of 28 days for good hydration and to achieve target strength. Curing of concrete is maintaining satisfactory moisture content in concrete during its early ages in order develop the desired properties. Curing of concrete place a major role in developing the strength and hardness of concrete, which lead to its improvement in durability and performance. Curing is a process of promoting the hydration of the cement, and consists of a control of temperature and of moisture movement from and into the concrete. Techniques used in concrete curing are mainly divided into two groups namely, Water adding techniques and Water- retaining techniques. Reliability and effectiveness of such curing methods are still under debate. Therefore, the method of using self-curing agents will be a good alternative. Internal curing refer to the process by which the hydration of cement occurs because of availability of additional internal water that is not part of the mixing water, "INTERNALLY CURING" is often also referred as self-curing. Internal curing concrete can be achieved by adding SELF CURING AGENTS. The concept of self-curing agents is to reduce the water evaporation from the concrete and hence increasing the water retention capacity of the concrete.

II. LITERATURE REVIEW

There are various studies that have been accounted for in the writing in admiration of self-curing concrete. A percentage of the critical commitments are quickly said in the writing.

Swamy et. al. (1990) introduced a straightforward strategy to acquire a 50MPa 28-day quality cement having 50 and 65 percent by weight concrete supplanting with slag having a moderately low particular surface. The compressive and flexural qualities and the versatile modulus of these two cements as influenced by curing conditions are then introduced. With no water curing, concrete with 50 percent slag substitution came to almost 90 percent of its objective quality of 50MPa at 28 days 14 and kept on indicating unassuming quality change up to 6 months. The outcomes underlined that even 7day wet curing was lacking for large amounts of slag substitution, and that proceeded with introduction to a drying situation can have unfavorable impact on the long haul solidness of deficiently cured slag concrete.

Dhiret. al. (1996) reported that amid the advancement of self-curing solid, it was observed that one specific self-curing admixture deliver various impacts concerning specific physical properties and powder X-RAY diffraction qualities. Two PC models, at low measurements, great quality and enhanced penetrability attributes were watched. At high measurements it gives the idea that the admixture detrimentally affects the solid's compressive quality because of a change of the regular of calcium hydroxide and the C-S-H gel structure was adjust advantageously delivering an exceedingly impermeable solid it is proposed that in spite of the fact that a bringing down of quality occurred at high dose, a much lower penetrability of given quality could be acquired.

Hans W. Reinhardt et. al. (1998) they exhibited on self-cured elite solid that a fractional substitution of customary weight totals by pre-wetted lightweight totals prompts an interior water supply for consistent hydration of bond. In spite of water misfortune by vanishing there is nonstop quality increase up to 25% more quality following 1 year contrasted with standard compressive testing following 28 days. Typical weight total cement achieved extensively less quality at the same stockpiling condition. Use of such cement by and by implies that no curing because of terrible workmanship would not impede the solid, i.e., it would be strong amid development. Ebb and flow research manages transport properties (dispersion, penetrability) and long haul quality. Barrita et. al. (2004) assessed elite solid blends that can be utilized effectively as a part of hot dry atmospheres. In this exploration attractive reverberation imaging(MRI) was utilized to quantify the viability of expanding the clammy curing period by fusing some immersed light weight totals into a solid blend being put in hot dry climatic conditions. A progression of solid blends were readied and sodden cured for 0, 0.5, 1 or 3 days, or by utilizing a curing compound, trailed via air drying at 38°C and 40% relative stickiness. To finish this, 11% by volume of the aggregate total substance was supplanted with lightweight total. Sort I white Portland bond and quartz total in addition to the lightweight total were all chosen for their low iron substance to minimize antagonistically influencing the MRI estimations. The solid blends were low quality solid (W/C=0.60), self-combining solid (W/C=0.33 containing 30% fly fiery debris), and high quality solid (W/C=0.30 containing 8% silica seethe).

Tarun R. Naik *et. al.* (2006) Influence of microstructure on the physical properties of self-curing concrete has been studied. The Potential benefits from concrete using lightweight aggregate include: Better thermal properties, Better fire resistance, improved skid-resistance, reduced autogenous shrinkage, reduced chloride ion penetrability, improved freezing and thawing durability, an improved contact zone between aggregate and cement matrix and less micro-cracking as a result of better elastic compatibility.

Md. Safiuddin *et. al.* (2007) carried out experiments to study the effect of this types of curing on the properties of Micro silica Concrete (Micro silica was used as a 10% weight replacement of cement) with a water binder ratio of 0.35. Dry-air curing produced 15.2%, 6.59% and 3.36% reduction in compressive strength, dynamic modulus of elasticity and ultrasonic pulse velocity respectively, this was owing to the early drying of concrete which virtually ceased hydration of the cement because the relative humidity within capillaries drop below 80%(Neville 1996) and thus the formation of major reaction product Calcium silicate hydrate the major strength providing and porosity reducer stops before the pores are adequately blocked by it. Also, it caused 12.4% and 46.53% increase in initial surface absorption after 10 and 120 minutes respectively. This might be due to micro cracks or shrinkage cracks resulting from the early drying out of the concrete (Fauzi 1995)

C. Selvamony *et. al.* (2010) 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. Fresh properties, flexural and compressive strength and water absorption of concrete were determined. The use of SF in concrete significantly increases the dosage of super plasticizer (SP). At the same constant SP dosage (0.8%) and mineral additives content (30%), LP can better improve the workability then that of control and fine aggregate mixture by (5% to 45%). However the results of this study suggested that certain QD, SF and LP combination can improve the workability of SCCs, more QD, SF and LP alone. LP can have influence on the mechanical performance at early strength development while SF improved aggregates matrix bond resulting from the formation of a less porous transition zone in concrete. SF can better reducing effect on total water absorption while QD and LP will not have the same effect, at 28 days.

Ravi Kumar M.S. *et. al.* (2011), 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 conventional and aggressive environment using self-curing instead of water curing. It is concluded that high performance kiln ash self-curing concrete performs well both in normal and aggressive condition when compared to control cement concrete without kiln ash.

Mateusz Wyrzykowski *et. al.* (2012), analyzed the modeling of water migration during internal curing with superabsorbent polymers. The SAP are supposed to be uniformly distributed in the concrete and act as internal water reservoirs, which first absorb water during mixing and release it to the surrounding cement paste By adding SAP, it is possible to provide water curing in low water-to-cement ratio (w/c) mixtures.

John Roberts *et. al.* (Jan, 2013) demonstrated internal curing improves flexural and compressive strength of pervious concrete. The internally cured sections did not receive poly protection or any special curing, other than internal curing by using light weight aggregate (LWAS).

Sathanandham T *et. al.* (Nov 2013, 2014) preliminary studies of self-curing concrete with the addition of polyethylene glycol (PEG) were done by them. They studied due excess of hydration in plain concrete shrinkage occurs which affect the durability hence introduced shrinkage reducing admixture polyethylene glycol (PEG 4000) which results in self-curing and helps in better hydration and hence good strength.

Amal Francis k *et. al.* (2013) the scope of the research included characterization of super absorbent polymer for use in self-curing. Experimental measurements were performed on to predict the compressive strength, split tensile strength and flexural strength of the concrete containing Super Absorbent Polymer (SAP) at a range of 0%, 0.2%, 0.3%, and 0.4% of cement and compared with that of cured concrete. The grade of concrete selected was M40.

Magda I. Mousa *et. al.* (2014) the mechanical properties of concrete containing self-curing agents are investigated in his paper. In this study, two materials were selected as self-curing agents with different amounts, and the addition of silica fume was studied. The self-curing agents were, pre-soaked lightweight aggregate (LECA) and polyethylene-glycol PEG (CH). The result shows that concrete used polyethylene-glycol as self-curing agent, attained higher values of mechanical properties than concrete with saturated LEC.

Siddiqui M. Junaid *et. al.* (2015) presented the use of shrinkage reducing admixture i.e. polyethylene glycol (By adding 1% & 1.25% of PEG-4000 by weight of cement) in M40 grade of concrete (Grade ratio =1:2.23:3.08) which helps in self-curing with better hydration which reduces shrinkage cracks and hence increases strength and is compared with that of conventional cured concrete of the same grade.

Based on the afore-mentioned literature review, an effort is made in the present investigation to compare the conventional cured concrete with internally cured concrete by adding water retaining admixture “polyethylene glycol” (PEG-400 1%, 2% and 3% weight of cement) in M20 grade of concrete (grade ratio = 1:1.92:3.49) which helps in self-curing and in better hydration.

III. EXPERIMENTAL INVESTIGATION

A. Materials

1. Cement: PPC of 53 grades.
2. Fine Aggregate: Crushed aggregate (Zone-I).
3. Coarse Aggregate: Locally available quarry stone in good strength passing through 20 mm and retain in 10mm sieve.
4. Water: Ordinary potable water without acidity and alkanity available in the laboratory was used.
5. Polyethylene glycol-400: PEG-400 are added at rate of 1%, 2% & 3% weight of cement.

B. Mix Design of Self-Curing Concrete

Using the properties of materials as listed above the mix design has been adopted from IS 10262:2009 to design grade ratio = 1:1.92:3.49 (M20) of concrete. Based on the various design stipulations the mix ratio was obtained for all the specimens and the following table shows the results obtained:

TABLE NO I
PROPORTION BY RATIO

CEMENT	WATER	SAND	CA (12.5 mm to 20mm)	CA (10mm to 12.5mm)
1	0.62	1.92	2.09	1.4

TABLE NO II
PROPORTION BY WEIGHT

CEMENT	WATER	SAND	CA (12.5 mm to 20mm)	CA (10mm to 12.5mm)
341.58	213.7	656.71	716.55	477.7

IV.RESULTS AND DISCUSSION

The strength parameters of self-cured concrete were compared with conventional cured concrete at 3days, 7days, 14 days and 28 days. Concrete cured internally using 1%, 2% and 3% PEG-400 attained more compressive strength than conventional cured concrete.

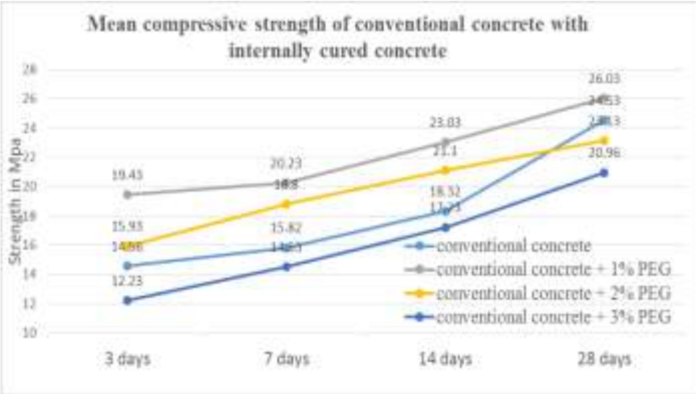

Fig 1: compressive strength for internally cured and conventional mixes

V. CONCLUSION

Based on the experimental work carried out following conclusion were drawn

TABLE NO III
MEAN STRENGTH OF CONCRETE

DAYS	MSCC (MPA)	MSCC + 1% PEG (MPA)	MSCC + 2% PEG (MPA)	MSCC + 3% PEG (MPA)
3	14.56	19.43	15.93	12.23
7	15.82	20.23	18.8	14.53
14	18.32	23.03	21.1	17.23
28	24.53	26.03	23.13	20.96

*MSCC: Mean Strength of Conventional Concrete

- Compressive strength of concrete with 1% and 2% PEG-400 dosage gives higher compressive strength as compared to conventionally cured concrete.
- As the dosage of PEG-400 increases the strength of concrete reduces.
- The compressive strength of conventional concrete at 28 days can be obtained in 7 days and 14 days by adding 1% and 2% PEG-400 respectively with conventional concrete.
- By the use of PEG-400 it is observed that the workability of concrete also increases and concrete becomes flowable.
- Up to certain dosage of PEG we can save water which is required for external curing.
- It has been observed during testing, internally cured concrete (conventional mix + PEG-400) shows lesser cracks than the conventional concrete.

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