Self-Curing Concrete – Literature Review

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***Abstract*—- The strength and durability of concrete depends on the curing of concrete. The ACI-308 Code states that "internal curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing Water." Conventionally, curing concrete means creating conditions such that water is not lost from the surface i.e., curing is taken to happen 'from the outside to inside'. In contrast, 'internal curing' is allowing for curing 'from the inside to outside' through the internal reservoirs (in the form of saturated lightweight fine aggregates, superabsorbent polymers, or saturated wood fibres) Created. 'Internal curing' is often also referred as 'Self–curing.' Any negligence in in curing will interfere in the strength and durability of concrete. Shrinkage reducing agents and lightweight aggregates such as Polyethylene-glycol and Leca, Silica fume and stone chips are used respectively to achieve effective curing results.**

Index Terms— Self-curing concrete; Internal curing; Leca; Polyethylene-glycol; Silica fume.

1. Introduction

Proper curing of concrete structures is important to meet 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.

Construction industry use lot of water in the name of curing. The days are not so far that all the construction industry has to switch over to an alternative curing system, not only to save water for the sustainable development of the environment but also to promote indoor and outdoor construction activities even in remote areas where there is scarcity of water.

Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration. It may be either after it has been placed in position (or during the manufacture of concrete products), thereby providing time for the hydration of the cement to occur. Since the hydration of cement does take time – days, and even weeks rather than hours – curing must be undertaken for a reasonable period of time. If the concrete is to achieve its potential strength and durability Curing may also encompass the control of temperature since this affects the rate at which cement hydrates.

The curing period may depend on the properties required of the concrete, the purpose for which it is to be used, and the ambient conditions, i.e. the temperature and relative humidity of the surrounding atmosphere. Curing is designed primarily to keep the concrete moist, by preventing the loss of moisture from the concrete during the period in which it is gaining strength. Curing may be applied in a number of ways and the most appropriate means of curing may be dictated by the site or the construction method. Curing is the maintenance of a satisfactory moisture content and temperature in concrete for a period of time immediately following placing and finishing so that the desired properties may develop. The need for adequate curing of concrete cannot be overemphasized. Curing has a strong influence on the properties of hardened concrete; proper curing will increase durability, strength, water tightness, abrasion resistance, volume stability, and resistance to freezing and thawing and deicers.

A durable concrete is one that performs satisfactorily under the anticipated exposure condition during its designed service life. In addition to the normal concrete mix some additional compounds in proper dosage and materials such as fly ash is used to increase the durability and strength of the concrete mix.

2. Method of self-curing:

Currently, the method uses poly-ethylene glycol (PEG) which reduces the evaporation of water from the surface of concrete and also helps in water retention

3. Mechanism of Internal Curing:

Continuous evaporation of moisture takes place from an exposed surface due to the difference in chemical potentials (free energy) between the vapour and liquid phases. The polymers added in the mix mainly form hydrogen bonds with water molecules and reduce the chemical potential of the molecules which in turn reduces the vapour pressure, thus reducing the rate of evaporation from the surface.

4. **Potential Materials for Internal Curing (IC):**

- **Cement:** OPC (53 grade).
- **Fine aggregate**: Locally available natural river sand passing through 4.75mm sieve was used for all of the mixes of self-curing concrete. The fine aggregate was free from organic impurities.
- **Coarse aggregate:** Crushed stone was used as a coarse aggregate passing through 20 mm and retaining on 4.75mm was used for all of the mixes of self-curing concrete.
- **Water:** Water used was fresh, colorless, odorless and tasteless, convenient water that was free from cause early-age cracking organic matter of any type.
- **Polyethylene-Glycol(PEG):** Polyethylene glycol is produced by the interaction of ethylene oxide with water, ethylene glycol, or ethylene glycol oligomers The reaction is catalyzed by acidic or basic catalysts. It is used as water reducing agent.

5. Literature Review:

- Roland Tak Yong Liang, Robert Keith Sun carried work on internal curing composition for concrete which includes a glycol and a wax. The invention provides for the first time an internal curing composition which, when added to concrete or other cementitious mixes meets the required standards of curing as per Australian Standard AS 3799.
- Wen-Chen Jau stated that self-curing concrete is provided to absorb water from moisture and from air to achieve better hydration of cement in concrete. It reduces the problem when the degree of cement hydration is lowered due to no curing or improper curing by using poly-acrylic acid as a self-curing agent which has strong capability of absorbing moisture from atmosphere and providing water required for curing concrete.
- PietroLura The main aim of his study was to reach a better conception of autogenous shrinkage in order to be able to model it and possibly reduce it. Once the important role of self-desiccation shrinkage in autogenous shrinkage is shown, the benefits of avoiding self-desiccation through internal curing become apparent.
- Patel Manishkumar Dahyabhai, Prof. Jayeshkumar Pitroda studied on "introducing the self-curing concrete in construction industry". Compressive strength of self-curing concrete is increased by applying self-curing admixtures. The compressive strength of concrete mix increased by 37% by adding 1.0% of PEG600 and 33.9by adding 1.0% of PEG1500 as compared to the conventional concrete. The optimum dosage of PEG600 for maximum compressive strength was found to be 1% of weight of cement for M25 grade of concrete. The optimum dosage of PEG1500 of maximum compressive strength was found to be 1% of weight of cement for M25 grade of concrete. Self-curing concrete is the best solution to the problem faced in the desert region and faced due to lack of proper curing.
- Mohanraj Rajendran M Studied on "self-curing concrete incorporated with polyethylene glycol". The compressive strength of cube by compression testing machine for Self-cured concrete is higher than of concrete cured by full curing and sprinkler curing. The split tensile strength of self-cured cylinder specimen is higher than that of the conventionally cured specimen. Self-cured concrete is found to have less water absorption values compared with concrete cured by other methods. Self-cured concrete thus have a fewer amount of porous. The success of the initial studies highlights the promise of additional work. In planned studies the mix design will be optimized for self-curing agent in concrete mix.
- M. Manoj Kumar, D. Maruthachalam Studied on self-curing. Super absorbent polymer was used as self-curing agent. M40 grade of concrete is adopted for investigation. Based on this experimental investigation was carried out. The following conclusions were drawn. Water retention for the concrete mixes incorporating a self-curing agent is higher compared to conventional concrete mixes. As found by the weight loss with time. The optimum dosage is 0.3 % addition of SAP leads to a significant increase of mechanical strength. Compressive strength of self-cured concrete for the dosage of 0.3% was higher than water cured concrete. Split tensile strength of self-cured concrete for dosage of 0.3% is higher than water cured concrete. Flexural strength of self-cured concrete for dosage of 0.3% is lower than water cured concrete. Performance of the self-curing agent will be effected by the mix proportions mainly the cement content and w/c ratio. There was a gradual increase in the strength for dosage from 0.2 to 0.3 % and later gradually reduced. Self-cured concrete using SAP was more economical than conventional cured concrete. In the study cubes were casted and kept for curing in room temperature about 250 to 300 c practically feasibility of self-cured member is needed to be checked in hot regions. The effectiveness of internal curing by means of SAP applied to concrete was the highest if 45 kg/m3 water is added by mean of 1 kg/m3 SAP.
- Basil M Joseph Studied on self-curing concrete and PEG400 were used as a self-curing agent in concrete. M20 grade of concrete is adopted for investigation. He added 0-1.5% of PEG400 by weight of cement for M20 grade concrete from that

he found 1% of PEG400 by weight of cement was optimum for M20 grade of concrete for achieve maximum strength. He also found that if percentage of PEG400 gets increased slump as well as compaction factor also increased.

- Stella Evangeline had use poly vinyl alcohol as self-curing agent in concrete. He added 0.03-0.48% by weight of cement from that he found 0.48% of poly vinyl alcohol by weight of cement provides higher compressive, tensile as well as flexural strength than the strengths of conventional mix.

- Mohammed Shafeeque Sanofar.P.B, Praveen.K.P., Jitin Raj, Nikhil.V.P, Gopikrishna has used PEG600 as a self-curing agent in concrete. M20 and M25grade of concrete are adopted for investigation. They added 0-2% of PEG600 by weight of cement for M20 and M25 grade concrete. From that they found 1% of PEG600 by weight of cement was optimum for M20 and M25 grade of concrete for achieve maximum strength.

- Shikha Tyagi Studied on self-curing concrete and had use PEG400 as a self-curing agent in concrete. M25 and M40 grade of concrete are adopted for investigation. She added 1-2% of PEG400 by weight of cement for M25 and M40 grade concrete. She was concluded that the optimum dosage of PEG400 for maximum Compressive strength was to be 1% for M25 and 0.5% for M4O grades of concrete.

- Dayalan J had used super absorbent polymers as a self-curing agent in concrete. He was added 0.0-0.48% of super absorbent polymer by weight of cement for M25 grade concrete. He was found that super absorbent polymer 0.48% by the weight of cement provides higher compressive, tensile as well as flexural strength than the strength of conventional mix.

6. Conclusion:

Based on literature review, following conclusions are obtained:

- The optimum dosage of PEG400 for maximum strength (compressive, tensile and modulus of rupture) was found to be 1% for the M20.
- As percentage of PEG400 increased slump increased for M20 grade of concrete.
- Strength of self-curing concrete is on par with conventional concrete.
- Self-curing concrete is the answer to many problems faced due to lack of proper curing.
- Self-curing concrete is an alternative to conventional concrete in desert regions where scarcity of water is a major problem.

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