TECHNICAL PAPER 5

An Influence of Industrial and Agricultural By- Products on Self- Curing Concrete – A Review.

Rashmi H R[1], Preethi P[2], Salman Bashir[3], Siddanna Gouda[4], Suhail Altaf Dar[5]

1Associate Professor, KSSEM, Bangalore 2, 3, 4, 5- UG Students, KSSEM, Bangalore.

Abstract

Due to the rapid growth of the urban development projects, Concrete is the most commonly used construction material of the twenty-first century. Concrete's mechanical characteristics are influenced by its curing state. According to the ACI- 308(2014) Code, internal curing describes the process through which cement is hydrated due to the availability of additional internal water that is not included in the mixing water; curing concrete is thought to occur from the outside to the inside. Concrete's strength and durability will be hampered by any carelessness with the curing process. Shrinkage-reducing chemicals and lightweight aggregates like Leca, Polyethylene-glycol, Silica fume, and stone chips are used, to achieve effective curing results. This paper explains self-curing concrete techniques and earlier works carried out by the researchers on the subject. Super absorbent polymers, polyethylene glycol, and lightweight particles are among the components most frequently used to make self-curing concrete.

KEYWORDS: Self-Curing Concrete, PEG 400 , Rice husk, Pumice, Polymers.

1 INTRODUCTION

Proper and adequate curing is required to attain the optimum strength and performance of concrete. In traditional concrete, curing occurs after number of steps, including mixing, placing, and finishing. Self-curing methods give the right amount of moisture content for optimum long-term hydration (Sharma et al., 2016). The concrete's self-desiccation content is decreased by the self-curing agent. The demand for curing water (internal or external) compared to a normal regular Portland cement concrete, the rate at which mineral admixtures completely react in a blended cement system may be much higher(Aielstein et al., 2013). When this water is not readily available, considerable autogenous deformation and (early-age) cracking may develop. The chemical shrinkage that occurs during cement hydration reduces the relative humidity within the substance and results in shrinkage that could cause early-age cracking, which results in the development of empty holes in the cement paste.

Although self-cured concrete is not frequently adopted in construction, work is continuously carried out. In the earlier research, the effectiveness of self-curing has been assessed using physical criteria such as intrinsic relative humidity, autogenous deformation, ring test strain, cracking, degree of hydration, compressive strength, and x-ray absorption (Alexopoulou et al., 2013). Self-curing method is often utilized in low water-cement ratio mixtures to improve the early-age behavior of concrete structures and to improve the qualities of high-performance concrete. For the purpose of enhancing the qualities of heat-cured concrete, internal curing is also used (Bentz et al., 2016). Additionally, concrete mixes with a water-to-cement ratio greater than 0.42 are used for self-curing. Self-compacting concrete also employs self-curing (Cusson et al., 2005).

Pumice, paraffin wax, crushed recycled concrete aggregates, crushed waste ceramic, demonstrated well as self-curing agents. To improve the of concrete quality, Diatomaceous earth, perlite, and lightweight expanded clay aggregates made of bentonite clay, polyethylene-glycol are used in various percentages by weight of cement, together with zeolite aggregates, rotary kiln expanded shale, C class fly ash, and crushed over burnt clay brick (Ruhal et al., 2018). To enhance internal curing, wet lightweight aggregates are used in place of some of the sand.

2 METHOD OF SELF-CURING

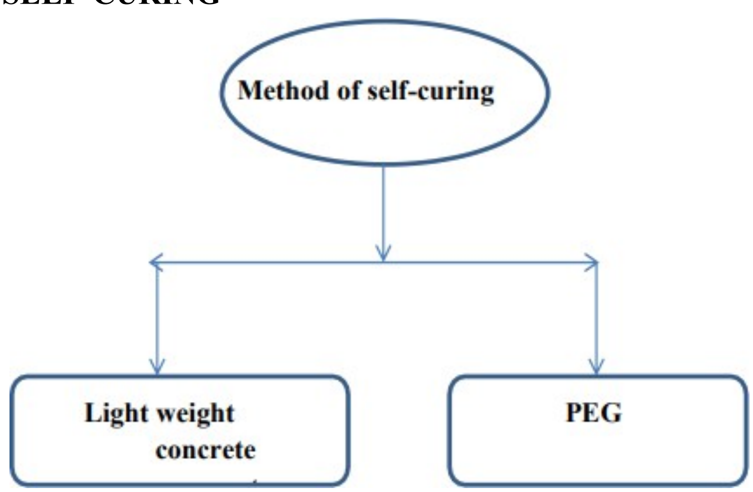

Figure 1: Methods of Self-Curing

2.1 Polyethylene Glycol

The common formula for polyethylene glycol is $H(OCH_2CH_2)nOH$, where n denotes the typical repetition of oxyethylene groups, which typically runs from 4 to about 180. A numerical suffix that identifies the average molecular weights is placed after the abbreviation (PEG). PEG is water soluble. Polyethylene glycol is non-toxic, odorless, neutral, lubricating, non-volatile, and non-irritating (Kartini et al., 2012).

The molecular weight of a substance affects a wide range of physical qualities, such as solubility, hygroscopicity, vapour pressure, melting or freezing point, and viscosity. Solubility of PEG in water and solvents decreases as its molecular weight increases (Nishant et al., 2017). Many polar organic solvents, including acetone and alcohols, are also compatible with PEG (Liu et al., 2017).

PEGs are hygroscopic, which indicates that they draw and hold onto atmospheric moisture. Reduction in hygrometry as molecular weight rises. Viscosity: Because PEGs are Newtonian fluids, their kinematic viscosity reduces with rising temperature (Jagannadha et al., 2012). Due to their low volatility, PEGs are thermally stable for a brief period of time below 300 °C and without oxygen.

2.2 Benefits of Self-Curing

The major benefit of self-curing is to provide moisture content so as to maintain the cement's hydration. Internal curing is a technique to hydrate the cement with water, to overcome the limitations of mixing water alone due to hydration and external curing. If self- curing admixtures are employed in the recommended dosage, concrete strength can be increased or maintained. If the optimum dosage is administered it creates a film that maximizes water retention. This also reflects sunlight to shield the concrete surface from heat and keep it cooler, which reduces the risk of thermal cracking. The self-curing concrete also has a compressive strength that is noticeably higher than that of normally cured concrete. Self-cured concrete also has increased resistance to salts and chemicals as well as corrosive and abrasive effects.

3 LITERATURE REVIEW

Paraffin was used as an external agent in concrete at weight percentages of 0%, 0.1%, 1%, and 2% for both liquid and solid cement, with a water-cement ratio of 0.35 and 0.45. Paraffin wax is a soft, white, or colorless material produced from petroleum, coal, or oil shale. It is made up of a mixture of hydrocarbon molecules with twenty to forty carbon atoms (Reddy et al., 2016). At room temperature, it is solid; however, at around 37 °C (99 °F), it starts to melt. When used sparingly as a self-curing ingredient in higher grade concrete, liquid paraffin wax has its advantageous. Due to its softness, it is not useful at high dosages, but at low dosages, it traps the water and prevents it from evaporating from concrete. It is a polymeric substance with the ability to absorb water from its environment and hold it within one of its structures (Jensen and Lura, 2006). SAP, a crushed crystalline partial sodium salt of cross-linked polypromancic acid, may absorb 2,000 times more clean water than regular water. To make handling easier and reduce gel clumping during initial polymer hydration, the polymer is coated with ground silica and blast furnace slag. The angular un-hydrated polymer has particles that range in size from 50 to 300 m. The SAP loses its ability to rehydrate and once it hydrates it expands, and releases the water it has retained. The newly laid concrete is cured with water and then dry SAP is added. During routine mixing, absorption takes place.

Lignin makes up the majority of wood-derived materials, but cellulose can be found in plant fibers as well as non-woody fibers like Kenaf. Wood-derived materials are employed in the form of fibers of various lengths and powder form too. Particles from kenaf served as a natural absorbent material. Kenaf core is regarded as a suitable raw material in binder-less board. When making bricks, kenaf core powder, which has a density of 0.1 to 0.2 g/cm3, is used to minimize the self-weight of the bricks (Ravikumar et al., 2011).

Kenaf is also used in the field of concrete technology to produce stronger and more resilient concrete utilized in polymeric composites and reinforced concrete beams. Kenaf fibre is also used as a self-curing agent due its high water absorption rate. Malaysia introduced kenaf as a partial tobacco replacement in the year 2010.

SAP, a crushed crystalline partial sodium salt of cross-linked polypromancic acid, has the potential to absorb 2,000 times more clean water. To make handling easier and reduce gel clumping during initial polymer hydration, blast furnace slag and ground silica are applied to the polymer. The angular un-hydrated polymer has particles that range in size from 50 to 300 nm. The SAP loses its ability to rehydrate once it hydrates, expands, and releases the water it has retained. The newly laid concrete is given more water, then dry SAP is added (Subramanian et al., 2015). During routine mixing, absorption takes place. It makes up 0.375% of the cement weight in earlier concrete.

The porous volcanic rock known as pumice resembles a sponge. The porosity and sorption characteristics of various pumice portions vary. The smaller portions absorb less water, but the relative humidity ranges are of practical importance. They exhale a larger proportion of the absorbed water. In mortar studies and simulation studies, it was found that the inclusion of tiny saturated pumice aggregates might produce mortars with increased strength, increased degree of hydration, and decreased autogenous shrinkage (Selvamony et al., 2009).

Rice husk ash has high glassy silica content, large pore volume, and specific surface area (SSA). RHA has a mesoporous structure, which considerably increases its capacity to absorb water compared to SF. In a Portland cement mixture including RHA-blend, it can absorb some of the free water to increase compressive strength. The mechanical properties of concrete can benefit greatly from the use of affordable, easily accessible RHA as mineral fillers. RHA produces environmentally friendly concrete composite that is durable, strongly resistant to harsh conditions, sustainable, and practical from an economic standpoint. The results of recent research provide comprehensive understandings of the potential use of RHA as a raw building material, for making greener concrete composites toward green buildings (Amran et al.,2021). RHA-based concretes with biomass can be created as a class of unique, lightweight fireproofing, which is a new application of RHA concretes that is worth researching.

4 CONCLUSIONS

1. Self-curing concrete is as strong as traditional concrete. Concrete that cures itself is the solution to many issues that arise from improper curing.

2. Concrete that self-cures can be used in arid areas where lack of water is a serious issue. In earlier studies natural, synthetic, recycled, or chemical materials were utilized as self-curing agents. As a result, it's not always possible to find enormous quantities of natural and recycled aggregates. Artificial aggregates and chemicals are hazardous, time-consuming, and bad for the environment. Therefore, it is necessary to introduce environmentally friendly, non-harmful self-curing agents.

3. Normal concrete has adequate water for hydration, but in some places, such hot climates, there may not be enough water accessible, and due to the position of the construction, such as on an incline or in a mountainous area, curing may be difficult.

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