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Performance and evaluation of Self curing concrete by adding admixtures

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ABSTRACT

As water becomes a scarce material every day, there is an urgent need to explore ways to save water in concrete production and buildings. Curing of concrete is the maintenance of satisfactory moisture content of concrete in its initial stage to develop the desired properties. However, good healing is not always practical in many cases. Hardening of concrete plays an important role in the formation of the microstructure and pore structure of concrete and thus improves its durability and performance. The purpose of this research is to find out the strength and durability properties of concrete using water-soluble polyethylene glycol as a self-hardening agent. The task of self-hardening substances is to reduce the evaporation of water from the concrete, and thus they increase the water resistance of concrete compared to conventionally hardened concrete. The use of self-hardening additives is very important from the point of view that saving water is necessary every day (3m3 of water is used in the building for every cubic meter of concrete, most of which is used for stoning). In this work, the compressive and fracture strengths of concrete containing self-hardening substances are investigated and compared with those of conventionally hardened concrete. In this experimental study, concrete cast with polyethylene glycol as a self-hardening agent was found to be stronger than concrete obtained by spray or immersion curing. In this study, the effect of an additive (PEG 400) on compressive strength, crack tensile strength and fracture layer was investigated for M20 by varying the percentage of PEG by weight of cement between 0% and 2%. It was found that PEG 400 can help in self-healing, providing similar strength to conventional healing. It was also found that 1 wt% PEG 400 cement was optimal for M20 grade concretes to achieve maximum strength without compromising workability.

Key words: *PEG (Poly Ethylene Glycol), Hardened concrete, Fresh concrete, M_{20} grade.*

Introduction

Curing is the process of maintaining the correct moisture content, especially for 28 days, to promote optimal hydration of the cement immediately after application. Hardening plays an important role in the formation of concrete microstructure and pore structure. Good healing is almost impossible in most

([1,2,3,4] Assistant Professor,[5]Associate Professor,[6]P.G Student,[7]P.G Student) cases. Self-hardening concrete means that the concrete does not need external curing.Curing is the name given to methods used to promote cement hydration by controlling the movement of temperature and moisture from and to the concrete.

Hardening allows the cement to continue to hydrate and therefore increase in strength, when hardening stops the strength of the concrete also stops. Correct humidity conditions are critical, because cement hydration almost stops when the relative humidity in the capillaries drops below 80%. Proper hardening of concrete structures is important to meet performance and durability requirements. In traditional curing, this is achieved by external curing applied after mixing, setting and finishing. Self-healing, or internal healing, is a technique that can be used to add moisture to concrete for more effective cement hydration and less self-drying.

When concrete is in contact with the environment, water evaporation and moisture occur, which reduces the initial water-cement ratio, leading to incomplete hydration of the cement and thus deterioration of concrete quality.

Several factors such as wind speed, relative humidity, air temperature, water cement ratio of the mix and type of cement used in the mix. In the initial stage, evaporation leads to plastic shrinkage cracking and in the final stage of curing, drying shrinkage cracking. Cure temperature is one of the most important factors affecting the rate of strength development. At high temperatures, ordinary concrete loses its strength due to the formation of cracks between the two thermally incompatible ingredients, cement paste and aggregates.

Concrete is the most widely used building material. It has the characteristic of being formed into desired shape most conveniently. It is anartificial material consisting of ingredients such as cement, fine aggregates, coarse aggregates and water. Aggregates are the major ingredients of concrete.

Any construction activity requires several materials suchas concrete,steel bricks, stone, glass clay, mud, wood and so on. For its sustainability and adaptability with respect to the changing environment the concrete must be suchthat it can converse resources protected environment, economize and lead to proper utilization of energy.

Ordinary concrete has very low tensile strength, limited ductility and low cracking resistance. Concrete naturally has internal microcracks and its poor tensile strength is due to the propagation of such microcracks, which eventually leads to brittle failure of the concrete.

The most commonly accepted remedy for this flexural weakness of concrete is conventional reinforcement with high-strength steel. Also, RCC reinforcement and effective compaction are very difficult when the workability of the concrete is low, especially for concrete.

Structural cracks (microcracks) occur in ordinary concrete and similar brittle materials even before loading, mainly due to shrinkage or other causes of volume changes. Curing of concrete is important to meet performance and durability requirements.

Internal Curing (IC) is a very promising technique that can provide additional moisture in concrete for a more effective hydration of the cement. During hydration of cement, empty pores are created within the cement paste, leading to areduction in its internal relative humidity and cause cracks to develop at the early-age.

Concrete

Concrete is a composite construction material composed of cement (commonly Portland cement) and other cementious materials such as fly ash and slag cement, aggregate (generally a coarse aggregate made of gravels or crushed rocks such as limestone, or granite, plus a fine aggregate such as sand), water, and chemical admixtures.

Self Curing

Internal hydration refers to the process by which cement hydration occurs due to the presence of other internal fluids that are not part of the mixing fluid. Internal medicine benefits include increased hydration and strength, reduced shrinkage and auto genous damage, reduced permeability, and increased strength.

In contrast, self-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 fibers) created. Self-curing is often also referred as Internal–curing.

Potential Materials for Self Curing

The following materials can provide internal water reservoirs:

- Lightweight Aggregate (natural and synthetic, expanded shale),
- LWS Sand (Water absorption =17 %)

- LWA 19 mm Coarse (Water absorption = 20%)
- Super-absorbent Polymers (SAP) (60-300 mm size)
- SRA (Shrinkage Reducing Admixture) (propylene glycol type i.e. polyethylene-glycol) Wood powder.

Chemicals to Achieve Self–curing

Some specific water-soluble chemicals added during the mixing can reduce water evaporation from and within the set concrete, making it self- curing. The chemicals should have abilities to reduce evaporation from solution and to improve water retention in ordinary Portland cement matrix.

Water Required for Self–curing

It depends upon chemical and auto genous shrinkages expected during hydration reactions. Types of Shrinkage Drying Shrinkages may occur at early ages or at later ages over a longer period; different types of shrinkages may be identified as: Drying shrinkage, auto genous shrinkage, thermal shrinkage, and carbonation shrinkage.

Reason for Chemical Shrinkage

Chemical shrinkage is an internal volume reduction due to the absolute volume of the hydration Products being less than that of the reactants (cement and water). For example: Hydration of tricalcium silicate:

C3S + 5.3 H > C1.7SH4 + 1.3 CH.

Necessity of Self Curing

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. Self-curing is also referred as internal curing.

Self-curing Concrete

The concept of curing and recognition of its contribution to obtain desirable properties of concrete is not novel. This technique has been adopted to maintain moisture and temperature conditions in a freshly placed cementious mixture to allow hydraulic cement hydration and pozzolanic reactions to occur so that the potential properties of the mixture may develop.

Improvements to concrete due to self-curing:

- Reduces autogenous cracking
- Reduces permeability
- Protects reinforcing steel
- Increases mortar strength
- Provides greater durability
- Higher early age flexural strength
- Higher early age compressive strength
- Higher modulus of elasticity

Need and Scope of Study

- 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.
- The aim of this investigation is to evaluate the use of water-soluble polymeric glycol as self-curing agents. The use of self-curing admixture curing admixtures is very important from the point of view that the water resources are getting valuable every day.

Mechanism and Significance of Self Curing Concrete

- 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.

Advantages of self-curing concrete

- Reduces autogenously cracking.
- self-curing
- Reduce the permeability.
- Increases mortar strength and early age strength sufficient to withstand strain.
- Greater utilization of cement.
- Lower Maintenances.

Advantages of Internal Curing

- IC provides water to keep the relative humidity (RH) high, keeping self-desiccation from occurring.
- IC eliminates largely autogenous shrinkage.

- IC maintains the strengths of mortar/concrete at the early age (12 to 72 hrs.) above the level where internally and externally induced strains can cause cracking.

Polyethylene Glycol

Introduction

Polyethylene Glycol (PEG) is family of water-soluble linear polymers formed by the additional reaction of Ethylene Oxide (EO) with Monoethylene Glycols (MEG) or Ethylene Glycol. The generalized formula for polyethylene glycol is: H″ (O″CH2"CH2) n″OH.

Fig. 1. Polyethylene Glycols

It is a polyether compound with many applications from industrial manufacturing to medicine. PEG is also known as **Polyethylene Oxide** (**PEO**) or **Polyoxy Ethylene** (**POE**), depending on its molecular weight.

There are many grades of PEGs that represents them by their average molecular weight. For example PEG 4000 consists of a distribution of polymers of varying molecular weight with an average of 4000.

Polyethylene glycols are available in average molecular weight ranging from 200 to 8000 this wide range of products provides flexibility in choosing properties to meet the requirements of many different applications.

One common feature of PEG appears to be the water soluble nature. Poly ethylene glycol is non-toxic, odorless, neutral, lubricating, non- volatile, non – irritating and is used in a variety of pharmaceuticals.

The Most Important Physical Property

Depend on molecular weight the wide range of the physical property such as solubility, hygroscopic, vapour pressure, melting or freezing point and viscosity are variable:

- Solubility
- Hygroscopic
- Viscosity
- Stability

Applications

- Pharmaceuticals
- Cosmetics
- Household products
- Ceramics & tiles
- Adhesives and textile
- Other applications
- Handling and storage

Uses

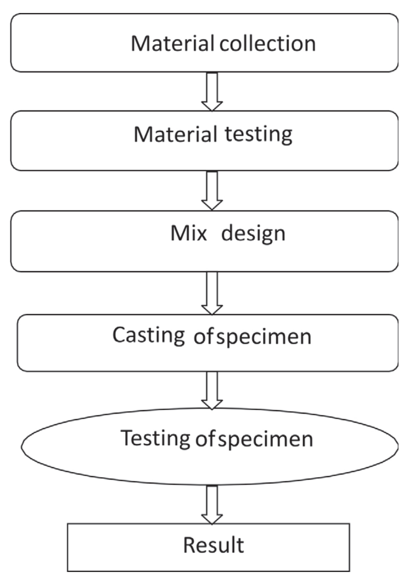
- Medical uses
- Chemical uses
- Biological uses
- Commercial uses
- Industrial uses

Experimental Methodology

General

In this work, it was proposed to study the effect of polyethylene glycol (PEG 400) on strength characteristics of self-curing concrete by adding PEG by weight of cement for M_{20} grade of concrete.

The experimental procedure is to be suitably designed to achieve the goals mentioned above and this chapter explains in details about the experimental work carried out so far during the study.



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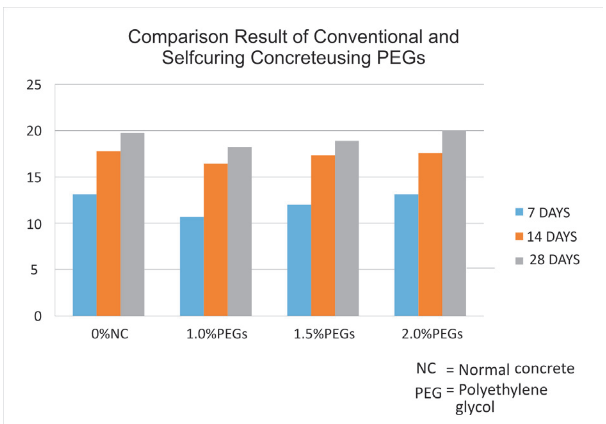
Results and Discussion

Until now, the compressive strength is still the major factor to control the quality of concrete in practice.

The cube compressive strength test has been carried out with the dosage of 1.0%, 1.5% and 2.0% of polyethylene glycol as curing agent by volume of water.

The specimen has been subjected to applied load to induce initial crack which is then cured to ambient atmospheric condition for a period of 7days, 14days and 28days specimens were tested and the compressive strength test was determine.

It is found that the strength has been attained when 2.0% of polyethylene glycol is used.



If the strength has been attained to 99% for the self-cured specimen while comparing with the conventional concrete.

Conclusion

The optimum dosage of PEG400 for maximum strengths (compressive, tensile and modulus of rupture) was found to be 1%. If dosage exceeds 1% there is a slight decrease in the strengths mentioned above.

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