A STUDY ON STRENGTH AND DURABILITY OF SELF CURING CONCRETE USING POLYETHYLENE GLYCOL-400

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Abstract

Conventional concrete need water curing for a minimum of 28 days to achieve its target strength. Hence water curing is very much essential to prevent unsatisfactory properties of cement concrete. In order to have good curing, excess of evaporation from the surface need to be prevented. Self-curing concrete is one of the special concretes which is gaining importance in recent days as it avoids errors which were caused by human, structures which are not accessible, terrains where curing becomes difficult and in places where the fluoride content badly influences the property of concrete. This kind of curing technique can widely be practiced in places where there is scarcity of water. Polyethylene glycol is non-toxic, odorless, neutral, lubricating, non-volatile and non-irritating and is used in a variety of pharmaceuticals. Thus, it is a shrinkage reducing admixture. The aim of this investigation is to study the strength and durability properties of concrete using water soluble Polyethylene Glycol (PEG 400) as self-curing agent using M20 grade concrete. The compressive strength at 3 days, 7days and 28 days have been obtained with normal curing and self curing condition. It was found that an average increase in compressive strength of 12.73% and split tensile strength 13.31% with 5% of PEG-400 was observed. This shows that self curing concrete showed a better performance than the conventional concrete. An average increase of 10.68, 16.07 and 7.78% were observed when the self curing concrete with PEG 400 was exposed to HCl, H_2SO_4 and NA_2SO_4 solutions. Thus the self curing concrete ensures a remarkable effect on strength and durable property.

Key words: *Compressive Strength, Durability, PEG-400, Self-Curing Concrete, Split Tensile Strength, Water Retention.*

1. Introduction

Most of the concrete that is produced and placed each year all over the world already does self-cure to some extent. Some of it is not intended to have anything done to its exterior surface, except perhaps surface finishing. Yet the concrete's ability to serve its intended purpose is not significantly reduced [1]. 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. There are cases in which concrete has been greatly assisted in moving toward a self-curing status either inadvertently or deliberately through actions taken in the selection and use of materials [2]. To achieve good cure, excessive evaporation of water from a freshly cast concrete surface should be prevented. Curing can be performed in a number of ways to ensure that an adequate amount of water is available for cement hydration to occur. Curing of concrete without external curing method is not possible at all times [3]. Most paving mixtures contain adequate mixing water to hydrate the cement if the moisture is not allowed to evaporate. To have an sealing surface at the top of the concrete an oil polymer or other compound need to be applied and effectively seal the surface against evaporation [3, 7]. The concept of self curing concrete need to be practised in such a way that it is locally available for an effective implementation in field conditions [4]. Due to the chemical shrinkage occurring during cement hydration, empty pores are created within the cement paste, leading to a reduction in its internal relative humidity and also to shrinkage which may cause early-age cracking. Most of the concrete that is produced and placed each year all over the world already does self-cure to some extent. Some of it is not intended to have anything done to its exterior surface, except perhaps surface finishing. Yet the concrete's ability to serve its intended purpose is not significantly reduced. [4]. Various factors such as wind velocity, relative humidity, atmospheric temperature, water cement ratio of the mix and type of the cement used in the mix.[5, 8]. The function of self-curing agent is to reduce the water evaporation from concrete, and hence they increase the water retention capacity of concrete compared to the conventionally cured concrete [6].

2. Materials

2.1 Cement

The Ordinary Portland cement of 43-grade PPC was used in this study conforming to IS: 12269-1987 [11]. The specific gravity of cement is 3.15. The initial and final setting times were found as 30 minutes and 600 minutes respectively. Standard consistency of cement was 29%.

2.2 Fine Aggregates

The river sand is used as fine aggregate conforming to the requirements of IS: 383-1970 [9], having specific gravity of 2.54 and fineness modulus of 3.25 has been used as fine aggregate for this study.

2.3 Coarse Aggregate

Coarse aggregate obtained from local quarry units has been used for this study, conforming to IS: 383-1970 [9] is used. Maximum size of aggregate used is 20mm with specific gravity of 2.6 and fineness modulus of 7.3.

2.4 Water

The water used for experiments was potable water conforming as per IS: 456-2000 [15].

2.5 Polyethylene Glycol-400(PEG-400)

The polymers added in the mix mainly form hydrogen bonds with water molecules and reduce the chemical potential of the molecules of water which in turn reduces the vapour pressure, thus reducing the rate of evaporation from the surface.

Table-1: *Physical and Chemical Properties – Polyethylene Glycol*

Appearance	Clear liquid or white solid
Odour	Mild odour
Solubility	Soluble in water
Density range	1.1 to 1.2 (increases as molecular weight increases)

3. Methodology

The collection of material for the self curing concrete such as PEG, (HCl, H_2SO_4, Na_2SO_4) are obtained and for M20 concrete mixes were collected and casted. The conventional concrete was cured in water. M20 Grade mixes were designated in accordance with IS: 10262-2009. Conventional concrete was casted with M20 mix and made to water curing. Another set of cubes were casted using PEG-400 with M20 concrete and allowed for atmosphere curing. Similarly cubes were casted for 3, 7, 21 and 28 days for conventional and PEG 400 to study the strength properties (compressive strength and split tensile strength). The durability test were also conducted using different acids such as (HCl, H2SO4, Na2SO4) with 5% concentration in conventional concrete and self curing concrete at an interval of curing 3 days and continuously till 28 day. This helps in understand the durability characteristics. The compressive strength was found for the acid in conventional concrete and self curing concrete. For this experimental study a total of 36 cues were casted for determine the strength and durability properties. After the completion of 28 days curing, the initial weights of the specimens are noted. The specimens are immersed in 5% HCl, 5% H_2SO_4 and 5% Na_2SO_4 solutions. The specimens are taken from the solution after 7 days and visual observations are made, the weight of specimens are noted and again immersed in acid solutions. The test is repeated for 28 days.

4. Result and Discussion

1. Compressive strength of conventional curing concrete (CC) is 11.1N/mm^2 when compared to self curing concrete (SC) of 13.2N/mm^2 as shown in Table 2. This is 15.9% is higher than the conventional curing concrete at the end of 3 days. Similarly there was a greater compressive strength at the end of 7 and 28 days namely 17.7 and 23.8 N/mm^2 respectively as shown in Fig.1.
2. Split tensile strength of self curing concrete is 11 N/mm^2 at the end of 3 days as shown in Table 3. This was 9.27 % higher than the conventional curing concrete at the end of 3 days. At the end of 7 and 28 days the split tensile strength was 12.84 and 17.82 respectively as shown in Fig 2.
3. At the end of 28 days it was observed that the compressive strength of self curing concrete was 22, 5.56 and 5.78 N/mm^2 as shown in Fig 3 which was higher than the conventional cured concrete when it was exposed to HCl, H2SO4 and Sulphate respectively.

Table-2: *Compressive strength of cubes*

Type of Curing	Compressive Strength N/mm^2		
	3 Days	7 Days	28 Days
CC	11.1	15.6	22.2
SC	13.2	17.7	24.8

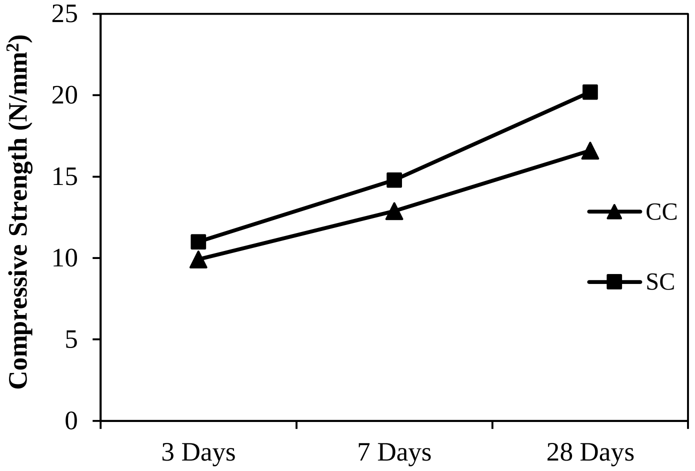

Figure 1: *Compressive Strength of Cubes*

Table-3: *Split Tensile Strength of Cylinder*

Type of Curing	Split Tensile Strength N/mm^2		
	3 Days	7 Days	28 Days
CC	9.93	12.9	16.6
SC	11	14.8	20.2

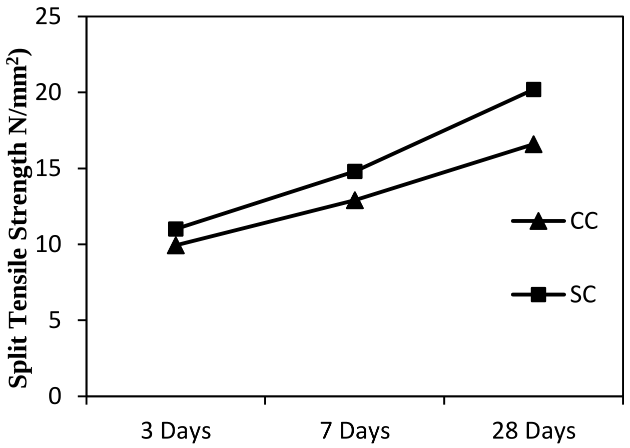

Figure 2: *Split Tensile Strength of Cylinder*

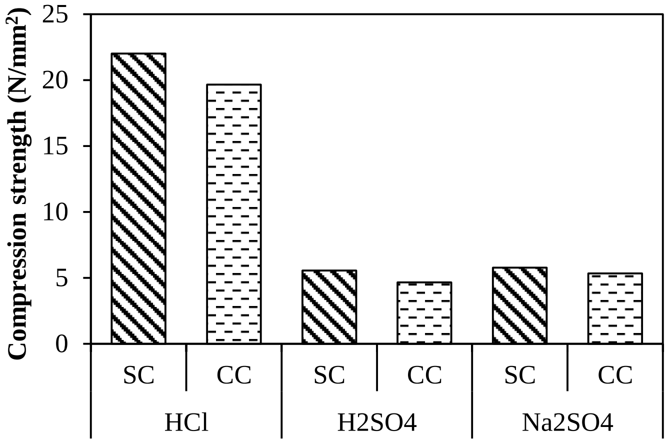

Fig-3: *Compressive Strength of Cubes for 28 Days under Acid Attack*

5. Conclusion

An average increase in the compressive strength of 12.73% was found when self curing concrete of PEG 400 was used in curing than the conventional curing of concrete. The split tensile strength of self curing concrete with PEG-400 showed an increase of 13.31 % when compared to conventional concrete. Hence self curing concrete showed a better performance with respect to its strength properties. Also the durability characteristics of the self curing concrete showed a promising effect when they were exposed to acidic conditions. An increase of 10.68, 16.07 and 7.78% were observed when the self curing concrete with PEG 400 was exposed to HCl, H2SO4 and NA2SO4 solutions. Thus Self-cured concrete is thus found to be less porous compared to the conventional types. It shows that the self curing concrete is able to withstand extreme conditions and corrosion effects. Viewing the above strength properties and durability characteristics it can be concluded that self curing concrete is a better option in field conditions where there is scarcity of water.

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