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An Experimental Investigation on Strength Parameters of Self-Curing Concrete

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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. 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) 0.5%, 1%, 1.5% and 2% as self-curing agent using for M40 grade concrete. The compressive strength at 7 days, 14 days and 28 days have been obtained with normal curing and self curing condition. The cement hydration problem due to improper curing, which can be successfully overcome by using self curing concrete. Hence no traditional way of curing is required in self curing concrete.**

***Keywords*: polyryhylene glycol, durability, odorless, neutral, hydration**

1. Introduction

Curing is the name given to the procedures used for promoting the hydration of the cement, and consists of a control of temperature and of moisture movement from and into the concrete. Curing allows continuous hydration of cement and consequently continuous gain in the strength, once curing stops strength gain of the concrete also stops. Proper moisture conditions are critical because the hydration of the cement virtually ceases when the relative humidity within the capillaries drops below 80%. 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. When concrete is exposed to the environment evaporation of water takes place and loss of moisture will reduce the initial water cement ratio which will result in the incomplete hydration of the cement and hence lowering the quality of the concrete. Evaporation in the initial stage leads to plastic shrinkage cracking and at the final stage of setting it leads to drying shrinkage cracking. Curing temperature is one of the major factors that affect the strength development rate. At elevated temperature ordinary concrete losses its strength due to the formation of the cracks between two thermally incompatible ingredients, cement paste and aggregates Steel slag is the viable alternative to cement, which can be mixed and poured to make concrete with strength of concrete. In reality, Steel slag is actually quite a bit stronger than Portland cement, by far the leading type in use today. Steel slag hardness comes from the fact that as it dries, the material absorbs and irreversibly binds large amounts of atmospheric CO_2.

2. Literature review

Ole and Hansen describe a new concept for the prevention of self-desiccation in ardening cement-based materials using fine, super absorbent polymer (SAP) particles as a concrete admixture. The SAP will absorb water and form macro inclusions and this leads to water entrainment, i.e. the formation of water-filled macro pore inclusions in the fresh concrete. Consequently, the pore structure is actively designed to control self-desiccation. In this work, self-desiccation and water entrainment are described and discussed.

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 from air to achieve better hydration of cement in concrete. It solves the problem when the degree of cement hydration is lowered due to no curing or improper curing by using selfcuring agent like poly-acrylic acid which has strong capability of absorbing moisture from atmosphere and providing water required for curing concrete.

A.S. El-Dieb investigated water retention of concrete using water-soluble polymericglycol as self-curing agent. Concrete weight loss and internal relative humidity measurements with time were carried out, in order to evaluate the water retention of self-curing concrete. Water transport through concrete is evaluated by measuring absorption%, permeable voids%, and water sorptivity and water permeability. The water transport through self-curing concrete is evaluated with age. The effect of the concrete mix proportions on the performance of self-curing concrete were investigated, such as, cement content and water/cement ratio.

PietroLura The main aim of his study is to reach a better comprehension 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.

3. Materials

The basic tests are conducted on various materials like fine aggregate with partial replacement of steel slag in various percentage namely 5%, 10%, 15%, 20%, 25%, coarse aggregate, Polyethylene Glycol (PEG 400) 0.5%, 1%, 1.5% and 2% as self-curing agent for M40 grade concrete to check their suitability for making concrete. The experimental investigation has been carried out on the test 3 specimens of Cubes, Cylinders, and Prisms each to study the strength properties.

4. Experimental investigation of materials

Cement: Ordinary Portland cement of 53

Grade conforming to IS 12269-1987, and the cement should be clean, dry and free from impurities and steel slag is partially replaced in various percentage namely 5%, 10%, 15%, 20%, 25% used in the concrete speciment 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 is 29%.

Table 1
Physical properties of cement

S. No.	Properties	Obtained values
1	Consistency test	34%
2	Initial setting time	35 Minutes
3	Final setting time	370 Minutes
4	Fineness test	6%
5	Specific gravity	3.14

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

Coarse Aggregate: Coarse aggregate obtained from local quarry units has been used for this study, conforming to IS: 383-1970 is used. Maximum size of aggregate used is 20mm with specific gravity of 2.6 and fineness modulus of 7.3. The aggregates were tested as per IS: 2386- 1963.

Water: According to IS 3025, Water to be used for mixing and curing should be free from injurious or deleterious materials. Potable water is generally considered satisfactory. In the present investigation, available water within the campus is used for mixing and curing purposes.

Steel slag: Steel slag is obtained from Agni Steels Private Limited, Ingur, TamilNadu, India and its specific gravity in fine form is found to be 2.95. The predominant compounds are dicalcium silicate, tricalcium silicate, dicalcium ferrite, merwinite, calcium aluminate, calcium-magnesium iron oxide, and some free lime and free magnesia (periclase).

Table 2
Chemical Composition of Steel Slag

Constitution	Composition (%)
CaO	40-52
SiO_2	10-19
FeO	10-14
MnO	5-8
MgO	5-10
Al_2O_3	1-3
P_2O_3	0.5-1
S	<0.1
Metallic Fe	0.5-10

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. The physical and chemical properties of PEG-400 are shown in Table 3.

Table 3
Physical properties of PEG-400

S. No.	Physical Properties of PEG-400	
1	odour	Mild colour
2	Solubility	Soluble in water
3	Density range	1.1 to 1.2 (increase as molecular weight increases)

Concrete Mix Proportions: The mixes were designed in accordance with IS 10262-2009 mix design method. Based on the result, the mix proportions M40 is designed. Concrete mix with the W/C ratio of 0.45 is prepared. The details of mix proportion and materials required for 1m^3 of concrete.

Table 4
Mix proportion

Grade	Cement (kg)	FA (kg)	CA (kg)	Water
M40	430	600	1039	197
Mix ratio	1	1.3	2.6	0.45

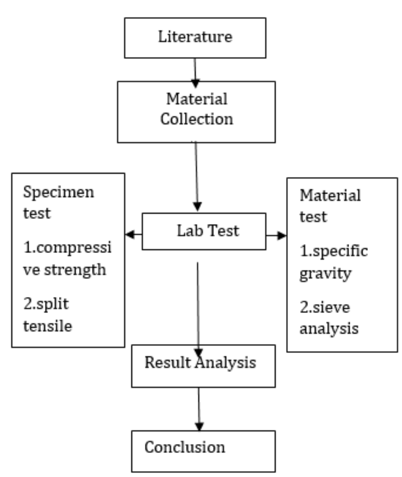

Fig. 1. Methodology

5. Conclusion

The experiment will be carried by next phase and our future plan to do strength and durability properties of concrete and compare the results with conventional concrete.

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