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A COMPARATIVE STUDY ON COMPRESSIVE STRENGTH OF M25 GRADE CONCRETE WITH DIFFERENT CURING TECHNIQUES

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Abstract-Today concrete is most widely used construction material due to its good compressive strength and durability. The aim of this investigation is to study the strength and durability properties of concrete using water-soluble Polyethylene Glycol as self-curing agent. 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. The use of self-curing admixtures is very important from the point of view that saving of water is a necessity everyday (for each cubic meter of concrete requires $3m^3$ of water in a construction, most of which is used for curing). In this study, compressive strength and split tensile strength of concrete containing self-curing agent is investigated and compared with those of other curing techniques and conventionally cured concrete.

***Keywords* -** Self-curing concrete; Water retention; Relative humidity; Hydration; Poly-ethyleneglycol400, Peg 600, wax based curing

I. Introduction

Now a day's many techniques are introduced and rapid improvement in the concrete technology. Self-curing technique is one of the techniques, used in less water resource areas. Many researches are concerned to identify effective self-curing agent. Therefore, several researchers are attracted towards identifying the self-curing agent. Polyethylene-glycol which decreases the surface tension of the water and minimizes the water evaporation from concrete and hence increases the water retention capacity of the concrete. It has been found that water-soluble polymers (Polyethylene Glycol) can be used as self-curing agents in concrete.

II. Methods of Self-Curing

Self-curing concrete has two major methods.

i). Light weight aggregate

ii) Shrinkage reducing admixtures (Propylene glycol)

i) Light weight aggregate In the first method we are using saturated porous lightweight aggregate (LWA) in order to supply an internal source of water

ii) Shrinkage reducing admixtures (SRA) In the second method we are using shrinkage reducing admixtures (SRA). Propylene glycol i.e. poly-ethylene glycol (PEG) or polyvinyl alcohol are the SRA materials. Which reduces the evaporation of water from the surface of concrete and also helps in water retention. Significance of Self-Curing The self-curing technique is more significant in water lacked areas or low water resource. Due to this chemical shrinkage occurring during cement hydration, empty pores are created within the cement paste, its leading to a reduction in its internal relative humidity and also to shrinkage which may cause early-age cracking. So it is very useful in when water is readily not available. Due to control the water evaporation we use light weight aggregate and polyethylene glycol etc.

III. Mechanism of Internal Curing

The mechanism of internal curing is holding the preserved water content of concrete structures within it. So concrete structures are not required any additional water for curing purpose. Continuous evaporation of moisture takes place from an exposed surface due to the difference in chemical potentials (free energy) between the vapors 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 vapors pressure, thus reducing the rate of evaporation from the surface.

Potential Materials for Internal Curing (Ic) Self-curing is also referred as Internal- Curing. Some of the special type of materials used in the internal curing process. They are as follows The following materials can be providing internal water reservoirs: a) Lightweight Aggregate (natural and synthetic, expanded shale) b) Super-absorbent Polymers (SAP) (60-300 mm) c) SRA (Shrinkage Reducing Admixture) (Propylene glycol type i.e. polyethylene- glycol/ polyvinyl alcohol) 1.5 Advantages of Internal Curing The Self-curing or Internal curing process has following advantages. Internal curing (IC) is a method to provide the water to hydrate all the cement, accomplishing what the mixing water alone cannot do.

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Provides water to keep the relative humidity (RH) high, keeping self-desiccation from occurring. Furnished as a ready-to-use, true water-based compound. Produces hard, dense concrete, minimizes hair cracking, thermal cracking, dusting and other defects.

IV. Literature Review

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. Aielstein Rozario, Dr. C Freeda Christy, M Hannah Angelin said that the permeability of concrete decreases with an increase in the replacement of fly ash with cement and in addition of PEG dosages. Ole and Hansen describe a new concept for the prevention of self-desiccation in hardening cement-based materials using fine, super absorbent polymer (SAP) particles as a concrete admixture. A.S. El-Dieb investigated water retention of concrete using water-soluble polymeric glycol 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.

V. Scope and Objective

Some specific water-soluble chemicals such as poly-ethylene glycol is added during the mixing can reduce water evaporation from and within the set concrete, making it "self-curing." The scope of the paper is to study the effect of polyethylene glycol (PEG 400) on strength characteristics of Self-curing concrete. The objective is to study the mechanical characteristic of concrete i.e., compressive strength and tensile strength by varying the percentage of PEG from 0.5%, 1% and 1.5% by weight of cement for both M25 grade of concrete. The dosage of polyethylene glycol is taken as 0.3% of total weight of cement used in mix.Polyethylene Glycol In this project we are using Polyethylene glycol as self curing agent. Polyethylene-glycol is a condensation polymer of ethylene oxide and water with the general formula H (OCH2CH2) nOH, where n is the average number of repeating oxyethylene groups typically from 4 to about 180.

The strength of concrete is affected by a number of factors, one of which is the length of time for which it is kept moist, i.e. cured, another being the method by which it is being cured. Inadequate or insufficient curing is one of main factors contributing to weak, powdery surfaces with low abrasion resistance. In the present paper we have chosen three different methods of curing:

1. Traditional immersion or ponding method 2. Application of Wax based external coating 3. Using chemical for internal curing leading to self-compacted, self-curing concrete.

Ponding or immersion (M3I): This is the most common and inexpensive method of curing flat surfaces such as floor slabs, flat roofs, pavements and other horizontal surfaces. A dike around the edge of the slab, which may be sub-divided into smaller dikes, is erected and water is filled to create a shallow pond. Care must be taken to ensure that the water in the pond does not dry up, as it may lead to an alternate drying and wetting condition. The concrete surface remains continuously moist. This prevents the moisture from the body of concrete from evaporating and contributes to the strength gain of concrete

Curing compounds (M2c) - Curing compounds are wax, acrylic and water based liquids which are sprayed over the freshly finished concrete to form an impermeable membrane that minimizes the loss of moisture from the concrete. When used to cure concrete the timing of the application is critical for maximum effectiveness. They must be applied when the free water on the surface has evaporated and there is no water sheen on the surface visible. Too early application dilutes the membrane, where as too late application results in being absorbed into the concrete. Curing compounds may also prevent the bond between the hardened and the freshly placed concrete overlay. For example Curing compounds should not be applied to two lift pavement construction. Similarly, curing compounds should not be applied to concrete surface which will be receiving plasters, decorative & protective paints, etc, as it affects the adhesion.

VI. Materials

Ordinary Portland cement In this project we are used Ordinary Portland cement (OPC53 grade) conforming to IS: 8112-198986. The specific gravity of cement is 3.15.

Sand In this project we are using the locally available river sand is conforming to Zone II of IS: 383- 19707 was used as fine aggregate with specific gravity 2.89.

Coarse Aggregate The coarse aggregates are naturally occurring material from divided rock material and crushed granite stone. In this project we use angular coarse aggregates of maximum size is 20mm are tested as per IS: 383-1970 and having specific gravity is 2.69.

Polyethylene Glycol Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula H (OCH2CH2) nOH, where n is the average number of repeating oxyethylene groups typically from 4 to about 180. The abbreviation (PEG) is termed in combination with a numeric suffix which indicates the average molecular weights. It is water-soluble in nature.

Chemical properties

PEG 400 = strongly hydrophilic.

partition coefficient b/w hexane& water = 0.000015 (log P = 4.8),

Physical properties

PEG Depend on molecular weight the wide range of the physical property such as solubility, Hygroscopic, vapour pressure, freezing point and viscosity are variable: Solubility- Increasing the molecular weight of PEG results in decreasing solubility in water & solvents. PEG is also soluble in many polar organic solvents such as acetone, alcohols. Stability- PEGs have low volatility and are thermally stable for a limited period of time below 300°c and without O2.

Polyethylene Glycols, PEG - 600: It is a liquid chemical with specific gravity 1.12 and transparent color. Dosages of PEG's was decided with reference to relevant literature review and fixed as 0.5% of cementitious material. The product was procured from finechem Ltd, Mumbai.

Wax based Curing Compound: I was procured from FAIR MATE chemical Pvt. Ltd. With the brand name FAIRCURE WX WHITE (wax based).

Sorptivity:

Sorptivity measures the rate of penetration of water into the pores in concrete by capillarity suction. After curing, the specimens of each batch were taken and side surfaces were sealed, and kept in contact with water up to a depth of 5mm from bottom. To determine the absorption of water, weights of specimens are taken at regular intervals of 3 hrs, 6 hrs, 24 hrs, 48 hrs, 72 hrs, 7days, 14days and 28days. Thus Sorptivity is plotted against the square root of time of exposure. The sorptivity was obtained by using the following expression:

$$\frac{W}{A} = k\sqrt{t}$$

Where W = the amount of water adsorbed in (kg); A = the cross-section of specimen that was in contact with water (m2); t = time (min); S = the sorptivity coefficient of the specimen (kg/m2/min0.5).

VII. Results

Variation of compressive strength shown below (M3A)

SNO	Grade of Mix)	% of PEG400	Average Compressive Strength at 7 days (N/mm2)	Average Compressive Strength at 28 d (N/mm2)
1.	M25	0	17.34	29.89
2.		0.5	18.85	32.81
3.		1	19.94	36.55
4.		1.5	18.11	35.11
5.		2	21.52	30.32

Variation of split tensile strength shown below

SNO	Grade of Mix)	% of PEG400	Average split tensile Strength at 7 days (N/mm2)	Average split tensile Strength at 28 d (N/mm2)
1.	M25	0	1.75	2.60
2.		0.5	1.70	2.79
3.		1	2.12	3.00
4.		1.5	2.5	3.12
5.		2	2.0	2.69

variation of compressive strength shown below for different curing compounds

S NO	Grade of Mix)	Name of curing compound	%of curing compound	Average compressive Strength at 7 days (N/mm2)	Average compressive Strength at 28 d (N/mm2)
1	M25	M3I	1.5	17.34	29.89
2		M3C	1.5	18.11	33.23
3		M3CC	1.5	20.20	38.10
4		M3AA	1.5	17.11	34.11

M2i- immersion

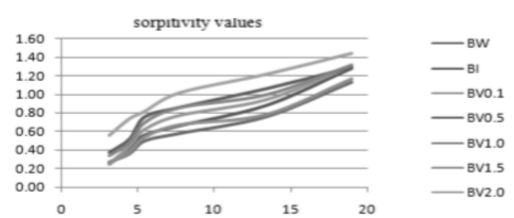
M2c – internal curingpeg 400

M2cc- internal curing peg 600

M2a-wax polish

Sorptivity values for varying peg percentage with time

MIX	10 min	20 min	30 min
BW	0.27	0.36	0.50
BI	0.24	0.42	0.56
BV0.1	0.24	0.44	0.62
BV0.5	0.38	0.52	0.76
BV1.0	0.34	0.48	0.70
BV1.5	0.26	0.38	0.54
BV2.0	0.56	0.74	0.82



Sorptivity values in mm with respect to time above

VIII. Conclusions

Based on the experimental investigations,

1. Strength of self-curing concrete is high when compared with conventional concrete.

2. Self-curing concrete is reducing the improper curing problems.
3. The optimum dosage of PEG-400 for maximum Compressive strength was found to be 1.0% for M25 of concrete.
4. Wrapped curing is less efficient than Membrane curing and Self-curing it can be applied to simple as well as complex shapes.
5. In compression strength aspect the incremental change in the strength was observed and it is more than 1.25 times than the conventional concrete.
6. In the split tensile strength aspect we observed the incremental change which is 1.1times more than the conventional concrete. Higher dosage of curing compound is required for lower grades of conventional concrete.
7 Sorptivity decreased with increase in dosage of PEG -600 in low molecular weights of 8.PEG. This is true in case of general curing also. • 1.5 % is optimum dosage for M25grade mix considering all the factors viz., compressive strength, water retention and sorptivity.
9. The specimens which have more water retention capacity have shown better superior compressive strength, sorptivity values. Hence, it can be concluded that minimum water loss leads to better gel formation thus increasing strength.

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