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Experimental Investigation of High – Strength Characteristics of Self Curing Concrete

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ABSTRACT

In concrete structures exposed to the ambient air at early ages, the moisture content in concrete decreases due to moisture diffusion. In addition, self-desiccation due to hydration of cement causes an additional decrease of moisture content in concrete at early ages, especially for high-strength concrete. In this study, the internal relative humidity in drying concrete specimens was measured at early ages. Furthermore, the variation of relative humidity due to self-desiccation in sealed specimen was measured. The moisture distribution in low-strength concrete with high water/cement ratio was mostly influenced by moisture diffusion due to drying rather than self-desiccation. In high-strength concrete with low water/cement ratio, however, self-desiccation had a considerable influence on moisture distribution. The results obtained from the moisture diffusion theory were in good agreement with experimental results.

KEYWORDS: *Self-curing concrete - Poly ethylene glycol – Lightweight aggregate - self curing – Internal curing – special concrete*

I. Introduction

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.

Methods of self-curing

Currently, there are two major methods available for internal curing of concrete. The first method uses saturated porous lightweight aggregate (LWA) in order to supply an internal source of water, which can replace the water consumed by chemical shrinkage during cement hydration. The second method uses poly-ethylene glycol (PEG) which reduces the evaporation of water from the surface of concrete and also helps in water retention.

Mechanism of Internal Curing

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.

A. *Influence of Various Parameters on Concrete Strength*

Effect of Water Cement Ratio

Of all the factors which affect the compressive strength of concrete the w/c ratio is the most critical

- It reacts chemically with the cement and forms a gel which binds the aggregate particles together
- It needs to give mobility to the mixture in order to facilitate the placement and compaction of concrete on an average 1g of cement requires 0.253g of water for complete hydration
- However, the actual quantity of water that a mix requires to give it adequate workability will depend upon the surface area of the

aggregate to be wetted and the type of equipment available for compaction and this quantity exceeds the requirement for hydration.

- The excess of water required for hydration increases the property of the cement paste and there by reduces the strength.

Effect of Aggregate

The effect of aggregate on compressive strength of concrete is related indirectly through a charge in w/c ratio. The direct effect of aggregate on strength can come through two sources, texture and the mechanical strength of the aggregate itself.

According to the experimental observation it is seen that size of the coarse aggregate affect the concrete strength independent of the w/c ratio the strengthdecreases as the maximum size of the coarse aggregate is increased.

Effect of Specimen Size and Shape

Researchers have found that, the measured strength of cylindrical and prismatic specimens were higher but more variable as the specimen size is reduced and that the variability increased proportionatelyandquite significantly as strength increase.As the specimen cross section and the length is reduced in size, fewer stress concentrations will exist as potential sources of failure.

B. Scope & Objective

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 characteristics of concrete such as compressive strength, split tensile strength and modulus of rupture by varying the percentage of PEG from 0% to 15% by weight of cement for both M_{20}.

II. Experimental Work

In this study an attempt has been made to evaluate the strength characteristics of concrete mix with the application of curing compound on different percentages. Therefore test for mechanical properties such as compressive strength of cube and cylinder for various % of PEG of concrete specimens to be studied. The testing machine may be of reliable type, of sufficient capacity the test and capable of applying the load at the specified rate. The permissible error shall be not greater than +2 or -2 per cent of the maximum load.

A. Methods for Testing Materials

Sieve Analysis

Sieve analysis is also termed as fineness modulus. Sieve analysis is conducted to determine the particle size distributions in a sample of aggregate. The aggregate used concrete are normally of the maximum size of 80 mm , 40 mm, 20mm, 10 mm,4.25mm, 2.36 mm, 600 microns and 150 microns .The aggregate fractions from 80 mm, to 4.75 mm are termed as Coarse aggregate and those fractions from 4.75 mm, to 150 mm are termed as Fine aggregate.

Sieve Analysis of Coarse Aggregate

The weight of coarse aggregate retained in each sieve size the percentage weight retained, cumulative percentage of weight retained and the present cumulative amount passed through various sieve are given below

Fineness modulus of coarse aggregate=7.88

The results of the percentage cumulative passing of coarse aggregate through various IS Sieve size were compacted with grading limit chart for coarse aggregate. IS 383 – 1970 shows that the coarse aggregate taken forthe present study falls under 20 mm.

Specific Gravity of Course Aggregate

Specific gravity of coarse aggregate =dry wt of sand/wt of Equal volume of water

$$=(W_2- W_1)/(W_2- W_1) - (W_3- W_4)$$
$$=600 / 230$$
$$= 2.6$$

Sieve analysis of fine aggregate:

The weight of fine aggregate retained in each sieve size the percentage weight retained, cumulative percentage of weight retained and the present cumulative amount passed through various sieve are given in the table given below

Fineness modulus of fine aggregate= 2.88

The results of the percentage cumulative passing of fine aggregate through various IS Sieve size were compacted with grading limit chart for fine aggregate. IS 383 – 1970 shows that the fine aggregate taken for the present study comes under zone II.

D. Cement

Portland pozzolanic cement (PPC) has been used throughout this investigation. Cement is the most widely used cementations ingredient in present day concrete. The function of cement is first, to bind the fine aggregates and coarse aggregates together and second to fill the voids in between fine aggregate and coarse particles to form a compact mass. Although cement constitutes only about 10% of the volume of the concrete mix it is the active portion of the binding medium and the only scientifically controlled ingredient of concrete.

Specific gravity and fineness of cement is calculated as

Specific gravity of cement = 3.1
Fineness of cement = 95%

CONCRETE MIX DESIGN (as per IS 10262 – 2009)
Data for Mix design M_{20}
Design stipulations:
Characteristic compressive strength required at 28 days: 20 Mpa
Maximum size of aggregate: 20 mm
Degree of workability : 0.9compacting Factor
Type of exposure : mild
Degree of quality control : good

Test data for materials:
Specific gravity of cement : 3.15
Compressive strength of cement at 7 days: Satisfies the requirement of IS 269- 1989
Specific gravity of fine aggregate: 2.57
Specific gravity of coarse aggregate: 2.57
Water absorptions of fine aggregate: 0.50%
Water absorptions of coarse aggregate: 1.0%

Target Mean Strength of Concrete
Target mean strength of concrete for M_{20} grade concrete

$F_{ck} = f_{ck} + tXs = 20 + 1.65 X 4 = 26.6 N/mm^2$

Selection of Water Cement Ratio
For mild exposure the water cement ratio does not exceed 0.55

W/C ratio = 0.5

Selection of Water Content and Sand

From table of IS 10262-1982 for mix. Size of aggregate as 20mm for one cum of M_{20} absolute volume of the concrete (assuming ssdagg) =186 kg these values are as per standard conditions Sand to Total aggregate =35%
After corrections is appliedWater content (assuming ssdagg) =186 kg
Sand to Total aggregate =31.5%

Calculations of Cement Content
Cement Content =186/0.5 = 372 kg
Cement Content is adequate as per table 5 of IS456-2000 assuming for RCC 300Kg

Calculations of Aggregate Content
As per the formula given vide 3.5.1 of IS 10262-2009 usual notations
V =(W + C/Sc+1/p.fa/Sfa) x 1/1000 (for calculating fine aggregate content)
Fine aggregate content (FA) = 554.02kg
Coarse aggregate content (CA) = 1204.77 kg

Table 1: Mix proportion as per 10260-1982

Water	Cement	Fine Aggregate	Coarse Aggregate
186kg	372kg	554.02kg	1204.77kg

III. RESULTS AND DISCUSSION

Table 2: Slump test results

Mix	Chemical (PEG)%	w/c ratio	Slump (cm)
M_{20} Grade	0	0.5	6.1
	5	0.5	9.2
	10	0.5	8.8
	15	0.5	5.5

Table 3: Compressive strength of cubes after 7 days

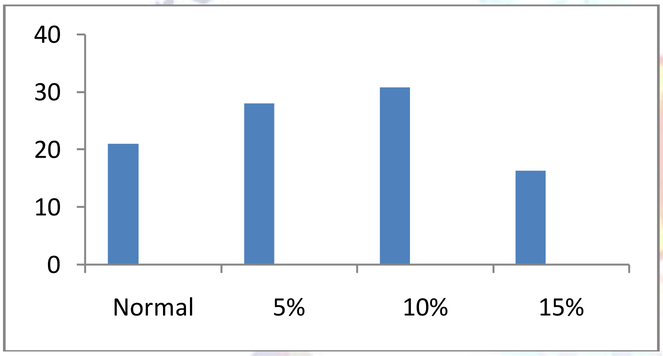
Sl. No	Mix(% Chemical in cement wt)	Compressive load in KN				Compressive Strength in N/mm²
		1	2	3	Avg	
1	Normal Mix of M_{20}	540	486	390	472	20.97
2	5% added by chemical	630	460	800	630	28.0
3	10% added by chemical	670	640	760	690	30.7
4	15% added by chemical	350	360	390	366.7	16.26

Table 4: Compressive strength of cubes after 28 days

Sl. No	Mix(% Chemical in cement wt)	Compressive load in KN				Compressive Strength in N/mm²
		1	2	3	Avg	
1	Normal Mix of M_{20}	540	560	550	550	24.44
2	5% added by chemical	1000	920	1010	976.67	43.40
3	10% added by chemical	900	980	990	956.67	42.51
4	15% added by chemical	880	910	790	860	38.22

X-Axis chemical in %; Y-Axis strength in N/mm²

Compressive strength of cubes after 7 days graph



Compressive strength of cubes after 28 days graph

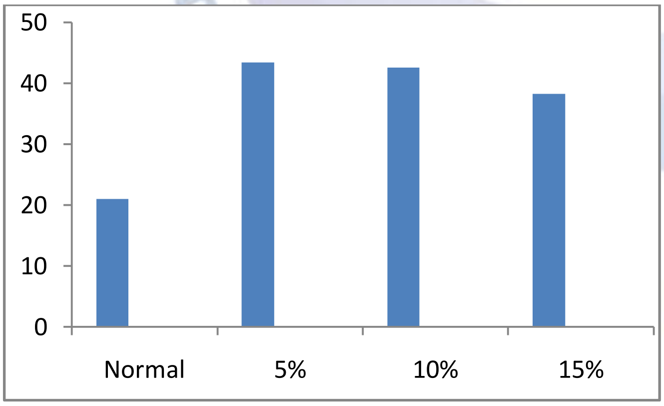


Table 5: Compressive strength of cylinder after 7days

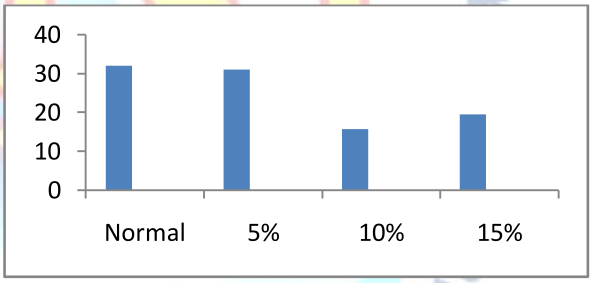
Sl. No	Mix(% Chemical in cement wt)	Compressive load in KN				Compressive Strength in N/mm2
		1	2	3	Avg.	
1	Normal Mix of M_{20}	600	520	570	563.3	31.87
2	5 % added by chemical	550	530	560	546.6	30.93
3	10 % added by chemical	220	340	270	276.6	15.65
4	15 % added by chemical	370	320	340	343.3	19.42

Table 6: Compressive strength of cylinder after 28 days

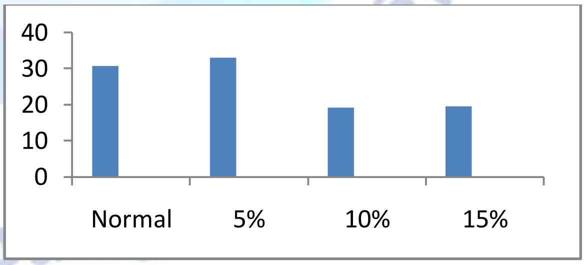
Sl. No	Mix(% Chemical in cement wt)	Compressive load in KN				compressive strength in N/mm²
		1	2	3	Avg.	
1	Normal Mix of M20	580	590	610	593.33	33.71
2	5% added by chemical	580	650	520	583.3	33.0
3	10% added by chemical	320	370	330	340.0	19.24
4	15% added by chemical	390	310	340	346.6	19.61

X-Axis chemical in %; Y-Axis strength in N/mm²

Graph of compressive strength of cylinder after 7 days



Graph of compressive strength of cylinder after 28 days



IV. CONCLUSION

In this research project various tests were conducted to study the characteristic behaviour and strength of self-curing concrete by using the chemical admixture. Compressive strength is increased up to 10% by adding the PEG to the self-curing concrete. The maximum strength is achieved at 10% of PEG at cement weight so it is considered as the optimum percentage. The usage of the water can be reduced by using this self-curing concrete in the construction filed

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