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Effect of Self Curing Compound on Strength and Durability of M25 Mix Concrete

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Abstract— **Today concrete is most widely used construction material due to its good compressive strength and durability. Depending upon the nature of work the cement, fine aggregate, coarse aggregate and water are mixed in specific proportions to produce plain concrete. Plain concrete needs congenial atmosphere by providing moisture for a minimum period of 28 days for good hydration and to attain desired strength. Any laxity in curing will badly affect the strength and durability of concrete. Self-curing concrete is one of the special concretes in mitigating insufficient curing due to human negligence paucity of water in arid areas, inaccessibility of structures in difficult terrains and in areas where the presence of fluorides in water will badly affect the characteristics of concrete. So many studies are done about the usage of Self curing concrete. In the present study, the affect of admixture (PEG-200) on compressive strength, split tensile strength at one percentage for M25 mix was studied and it compared with the properties of PEA(Poly Ethylene Alcohol). It was found that Poly Ethylene Glycol-200 is a good self curing agent when compared with Poly Ethylene Alcohol. The present Study was shown about a clear cooperate picture about the strengths of PEG-200 and PEA and its stress strain behaviour also shown clearly. This study gives a clear notation on Durability aspect also.**

Index term **- Self-curing Concrete , PEG-200 , PEA.**

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.

A. 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) and poly-ethylene Alcohol (PEA) which reduces the evaporation of water from the surface of concrete and also helps in water retention.

B. 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.

C. Significance of Self–curing

When the mineral admixtures react completely in a blended cement system, their demand for curing water (external or internal) can be much greater than that in a conventional ordinary Portland cement concrete. When this water is not readily available, significant autogenous deformation and (early-age) cracking may result. 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.

D. Potential Materials for Internal Curing (IC)

The following materials can provide internal water reservoirs:

- Lightweight Aggregate (natural and synthetic, expanded shale)
- Super-absorbent Polymers (SAP) (60-300 nm size)
- SRA (Shrinkage Reducing Admixture) (propylene glycol type i.e. polyethylene-glycol or PEA)

II. LITERATURE REVIEW

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. 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 cementetios 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 self curing 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%, 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 was 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.

III. SCOPE AND OBJECTIVE

- The scope of the paper is to study the effect of polyethylene glycol (PEG-200) on strength characteristics of Self-curing concrete
- The objective is 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 2% by weight of cement for both M20 and M40 grades of concrete.

IV. EXPERIMENTAL PROGRAMME

Table 1- Materials required per cubic meter of concrete

S.No	Mix	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Water
1	M25	1	1	2	0.5%

The experimental program was designed to investigate the strength of self curing concrete by adding poly ethylene glycol PEG-200 @ 1% by weight of cement to the concrete and PEA @ 1% by weight of cement to the concrete. The experimental program was aimed to study the compressive strength, split tensile strength . To study the above properties mix M25 was considered.

- The size of each cube is 150 x150 x150 mm.
- The size of each cylinder is 150 mm in dia and 300 mm in height.
- The size of each prism is 100 x100 x400 mm

V. MATERIALS USED

The different materials used in this investigation are

A. *Cement*

Cement used in the investigation was 53 grade ordinary Portland cement confirming IS: 12269: 1987.

B. *Fine aggregate*

The fine aggregate used was obtained from a nearby river source. The fine aggregate conforming to zone III according to IS: 383-1970 was used.

C. *Coarse aggregate*

Crushed granite was used as coarse aggregate. The coarse aggregate according to IS: 383-1970 was used. Maximum coarse aggregate size used is 20 mm.

D. *Polyethylene Glycol-200*

Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula , where n is the average number of repeating oxyethylenegroups typically from 4 to about 180. The abbreviation (PEG) is termed in combination with anumeric suffix which indicates the average molecular weight. One common feature of PEG appears to be the water-soluble nature. The PEG-200 use in the investigation have Molecular Weight 200, Appearance Clear liquid, pH 5-7, Specific Gravity 1.126.

E. *Water*

Potable water was used in the experimental work for both mixing and curing purposes.

VI. CASTING PROGRAMME

Casting of the specimens were done as per IS:10086-1982, preparation of materials, weighing of materials and casting of cubes, cylinders, beams. The mixing, compacting and curing of concrete are done according to IS 516: 1959. The plain samples of cubes, cylinders and prisms were cured for 28 days in water pond and the specimens with PEG-200 and PEA were cured for 28 days at room temperature by placing them in shade. The M25 grade of concrete are designed and the material required per cubic meter of concrete is shown in Table 1.

VII. TESTING

A. *Compressive strength*

The cube specimens were tested on compression testing machine of capacity 3000KN.The bearing surface of machine was wiped off clean and sand or other material removed from the surface of the specimen. The specimen was placed in machine in such a manner that the load was applied to opposite sides of the cubes as casted that is, not top and bottom. The axis of the specimen was carefully aligned at the centre of loading frame. The load applied was increased continuously at a constant rate until the resistance of the specimen to the increasing load breaks down and no longer can be sustained. The maximum load applied on specimen was recorded.

$$f_c = P/A ,$$

where, P is load & A is area.

B. *Split tensile strength*

The cylinder specimens were tested on compression testing machine of capacity 3000KN.The bearing surface of machine was wiped off clean and looses other sand or other material removed from the surface of the specimen. The load applied was increased continuously at a constant rate until the resistance of the specimen to the increasing load breaks down and no longer can be sustained. The maximum load applied on specimen was recorded.

$$f_{split} = 2 P/(\pi DL),$$

where P=load, D= diameter of cylinder, L=length of the cylinder.

VIII. RESULTS & DISCUSSION

A. *Compressive Strength*

The results of the compressive strength are represented in below Table and the graphical representation is shown in Fig.

The compressive strength was found to 1% PEG-200 and also 1% of PAE for M25 grade. The increase of compressive strength was found for both PEG and PEA at 1% compared to conventional concrete for M25, while the increment is more in case of PEG and less in PEA that is shown in below table. Initially Compressive strength found for 7 days and later for 28 days

For 7 days,

CUBE NO	LOAD (kN)	Compressive Strength (N/mm²)	Average Comp Strength (N/mm²)
1	410	18.22	17.11
2	360	16	

PEG-200		
Cube No	Load (kN)	Compressive strength (N/mm²)
1	400	17.77
2	425	18.89
Durability		
In Acid		
1	375	16.67
In Base		
1	380	16.89

For PEA		
Cube No	Load (kN)	Compressive strength (N/mm²)
1	395	17.55
2	415	18.44
Durability		
In Acid		
1	360	16
In Base		
1	365	16.22

For 28 days,

CUBE NO	LOAD (kN)	Compressive Strength (N/mm²)	Average Comp. Strength (N/mm²)
1	825	36.67	36.225
2	805	35.78	

PEG-200		
Cube No	Load (kN)	Compressive strength (N/mm²)
1	815	36.22
2	790	35.11
Durability		
In Acid		
1	645	28.67
In Base		
1	655	29.11

For PEA		
Cube No	Load (kN)	Compressive strength (N/mm²)
1	690	30.67
2	675	30
Durability		
In Acid		
1	535	23.77
In Base		
1	570	25.3

B. Split Tensile Strength

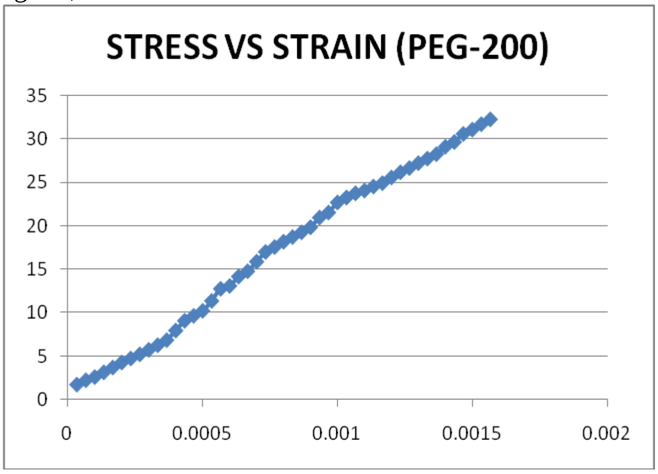
The results of the split tensile strength are represented in below Table. The split tensile strength was found for 1% of PEG-200 and PAE for M25 grade. The increase in split tensile strength was found at 1% of PEG-200 and PAE compared to conventional concrete for M25.

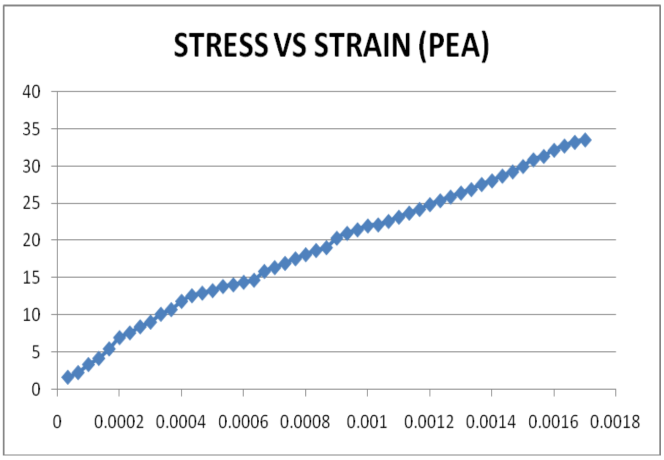
Plain concrete	
Period	Split tensile load (kN)
7 days	130
28 days	190

PAE	
S.No	Split tensile load (kN)
1	135
2	155

PEG-200	
S.No	Split tensile load (kN)
1	150
2	175

Stress strain behaviour of Concrete for both self curing agents,





IX. Conclusion

1. Optimum Strength values for both the Self curing agents were found and among both the agents PEG-200 is a best and good self curing agent because in the durability and normal compressive strength aspects it was giving good results when compared with both conventional concrete and Poly Ethylene Alcohol (PAE).
2. At the place of Water scarcity areas these type of agents will give a better result.
3. Young's Modulus of concrete is also in a rage of safe
4. Crepe formation also will get reduce due to adding these agents.

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