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Effect of Self Curing Agents on Mechanical Properties of Concrete

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***Abstract*— Curing of concrete is the process involved in maintaining satisfactory moisture content and maintain favourable temperature for hydration in concrete so as to develop the desired properties of concrete. However, perfect curing is not always possible in all cases. Self-curing concrete is the type of concrete that can cure itself with its retained moisture content. It is prepared with the addition of certain chemicals as self curing agents. Earlier works conducted on self curing concrete have indicated that these types of concretes have better strength, reduces rate of evaporation from surface, thermal properties, fire resistance, skid-resistance property improves, reduction in autogenous shrinkage, reduced chloride ion penetrability, improvement in freezing and thawing durability as well as the contact zone between aggregate and cement matrix and reduction in micro-cracking which results in better elastic compatibility compared to conventionally cured concretes. In this research paper, the individual effect of curing agents like PEG 4000 & PVA on strength properties by varying the percentage of PEG4000 and PVA by weight of cement 1.0%, 2% and 3% were studied. The study shows that PEG4000 and PVA could help in gaining the strength of conventional curing. It was found that 1% of both PEG4000 and PVA by weight of cement was optimum for M30 grade concrete for achieving maximum strength without compromising workability. The test results showed that self curing concrete is best option in places where water scarcity exists.**

Keywords*— Self Curing Concrete, Autogenous Shrinkage, Freezing, Thawing.

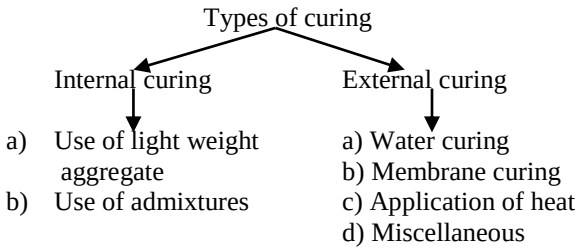
I. INTRODUCTION

Concrete is a composite mixture of cement, aggregates and water with or without suitable admixtures. Curing is one of the major phenomena involved to attain desirable strength and other properties. Curing is the process of maintaining the proper moisture content to promote the required cement hydration immediately after placement. Proper moisture conditions are not possible always because water is very important for the hydration of cementitious materials. The concept of self curing is the reduction of water evaporation from concrete and hence increase the water retaining capacity of the concrete by providing additional moisture in concrete for more improved rate of hydration compared to conventional concrete. It was found experimentally that water soluble polymers can be used as self curing agents in concrete. These polymers reduce the amount of water required for curing processes.

II.SELF CURING CONCRETE

A. Methods of Self Curing (Internal 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.



B. Self curing mechanism of concrete

Due to difference in chemical potential between the vapour and liquid phases, continuous evaporation of moisture takes place from external surface of concrete. The polymers added to the concrete mix mainly form hydrogen bonds with water molecules and reduce the chemical potential of the molecules which results in reduction of the vapour pressure, thus reducing the rate of evaporation from the surface.

II. RESEARCH SIGNIFICANCE

The principal aim behind of this paper is to evaluate the effects of different types and percentage of self-curing agents on the mechanical properties of concrete mainly compressive, tensile and flexural strength. The self-curing agents employed in this paper were added into mixing water and dissolved well. Self curing agents were added in different proportions (0 to 3% by weight of cement) and cured at room temperature during the experiment. The results should help to explain the effect or action of self-curing agents on the mechanical properties of concrete. Also, the results provide more knowledge about the finalisation of self-curing agent ratios and the best type to optimize the mechanical properties of concrete.

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III. EXPERIMENTAL PROGRAMME

A. Materials Used

The different materials used in this investigation are

1. ***Cement:*** Cement used in the investigation was 53 grade Sankar Portland Pozzolana Cement confirming IS: 12269: 1987. The specific gravity of cement was 2.7.
2. ***Fine Aggregate:*** The fine aggregate used was M sand. The fine aggregate conforming to zone-II according to IS: 383-1970 and Specific gravity 2.76 was used.
3. ***Coarse aggregate*****:** The coarse aggregate according to IS: 383-1970 was used. Crushed granite stone available from local quarry of size 20 mm and specific gravity of 2.54 was used.
4. ***Conplast SP 430:*** 1% of super plasticizing agent was used for the casting inorder to get the required slump and workability.
5. ***Polyethylene Glycol-4000 (PEG4000):*** Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula $H(OCH2CH2)_n$ OH, where n is the average number of repeating oxy-ethylene groups typically from 4 to about 180.The anumeric suffix written in combination with PEG denotes the average molecular weight
6. ***Poly vinyl Alcohol (PVA):*** Polyvinyl alcohol is produced commercially from polyvinyl acetate, usually by a continuous process. Polyvinyl alcohol is an odorless and tasteless, translucent, white or cream colored granular powder. They help to retain water.

B. Mix Proportion

The mix was designed using IS 10262: 2009. The self curing agents such as PEG4000 and PVA were mixed with water at various proportions like 1%, 2% and 3% by weight of cement. The self curing properties of M30 concrete were studied in this experimental study.

C. Casting and curing

Concrete specimens like cubes (150mm size), cylinders (150mm diameter and 300mm height) and beams (700mm X150mm X 150mm) were casted as per mix design. These specimens were air cured at room temperature.

TABLE 1: Mix proportions in kg/m^3

SI.No	Cement	FA	CA	Water	SP	PEG	PVA
Mix1	395	686	1214	158	7.9	-	-
Mix2	395	686	1214	158	7.9	7.9	-
Mix3	395	686	1214	158	7.9	15.8	-
Mix4	395	686	1214	158	7.9	23.7	-
Mix5	395	686	1214	158	7.9	-	7.9
Mix6	395	686	1214	158	7.9	-	15.8
Mix7	395	686	1214	158	7.9	-	23.7

IV. TESTING

A. Slump Test

Slump test is the best method to check the consistency of concrete. It can be tested on site and off site. It is conducted using slump cone. However, it is used conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch.

TABLE 2: Slump Test Results

Mix	Slump (mm)
Mix 1	100
Mix 2	100
Mix 3	110
Mix 4	121
Mix 5	95
Mix 6	90
Mix 7	85

The workability of self curing concrete with polyvinyl alcohol is less than that of conventional water cured concrete and self curing concrete with polyethylene glycol as self curing agent. Decrease in workability is due to higher water absorption of aggregates. Hence admixture is necessary for self cured concrete for improving the workability.

B. Compressive Strength

The compressive strength tests were done on concrete cube specimens of size 150mm X 150mm X 150mm. The cubes were tested after a curing period of 28 days. Three cubes were tested for each percentage of PEG and PVA. Reasonable good control has been exercised in the laboratory during the casting, curing and testing of the specimens. The strength variation of individual cubes in each of the mixes is given in table 2.

TABLE 2: Compressive strength in N/mm^2

Mix	Compressive strength (N/mm^2)
Mix 1	34.4
Mix 2	34.5
Mix 3	33.29
Mix 4	31.18
Mix 5	35.25
Mix 6	27.76
Mix 7	27.4

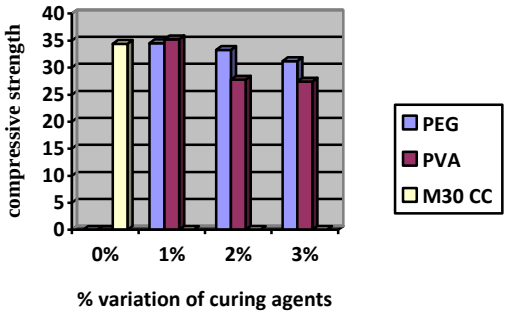

Fig. 1: Compressive strength chart

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From the results it is clear that the compressive strength of the conventional water cured concrete is slightly less than the self cured concrete, but as the percentage of PEG increases the strength of concrete decreases. However lower amount of PEG gives high strength. Also, it is clear that in the concrete specimen with poly vinyl alcohol (PVA) as the self curing agent, the compressive strength is higher in lower percentages of PVA especially at 1% of weight of cement when compared to conventionally water cured concrete.

C. Spiltting Tensile Strength

Concrete cylinders were used to conduct splitting tensile test on hardened concrete. The splitting tensile strength test was conducted on the compression testing machine using cylinders of 300mm height and 150mm diameter.

TABLE 3: Values of splitting tensile strength (in N/mm^2)

Mix	Splitting tensile strength (N/mm^2)
Mix 1	2.35
Mix 2	2.4
Mix 3	2.096
Mix 4	0.966
Mix 5	3.063
Mix 6	2.42
Mix 7	2.073

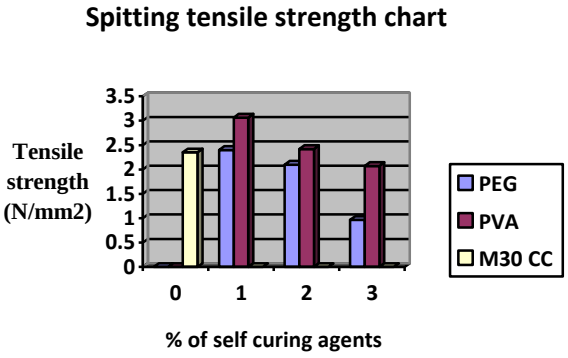

Fig. 2: Splitting Tensile strength chart

From the table it is clear that the splitting tensile strength of the conventional water cured concrete is slightly less than the self cured concrete, but as the percentage of PEG increases the splitting tensile strength of concrete decreases. However lower amount of PEG gives high tensile strength. Also, it is clear that in the concrete specimen with poly vinyl alcohol (PVA) as the self curing agent, the splitting tensile strength is higher in lower percentages of PVA especially at 1% of weight of cement when compared to conventionally water cured concrete as well as at 1% PEG.

D. Flexural Strength

The flexural strength test was conducted on a flexure testing machine. Standard specimen of size 100mm X 100mm X 500mm has been cast for this test. The specimens were tested after 28 days of curing. The results obtained for the test are given in table4.

TABLE 4: FLEXURAL STRENGTH

Mix	Flexural strength (N/mm^2)
Mix 1	6.66
Mix 2	6.67
Mix 3	4.23
Mix 4	3.38
Mix 5	4.56
Mix 6	4.126
Mix 7	3.93

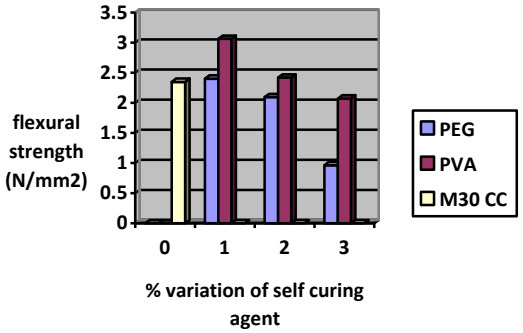

Fig.3: Flexural strength chart

From the results it is clear that the flexural strength of concrete with self curing agent is attained in similar to that of water cured concrete at 1%of weight of cement as amount of PEG. But expected strength is not attained in case of concrete with PVA as self curing agent.

V. CONCLUSION

1. The self curing agent PVA was found to be effective than PEG. From the strength test, all the strength properties were found to be higher for PVA.
2. As the percentage of PEG4000 increases the slump value also increases. But in case of PVA the increase in percentage caused decrease in slump value.
3. From compressive strength, splitting tensile strength and flexural strength test results, it was found that self curing concrete has more strength results than that was found in water cured concrete.
4. Self cured concrete showed better hydration even under drying condition compared to conventional concrete.
5. Increase in percentage of self curing agent resulted in decrease in strength properties of concrete.
6. Cement content and w/c ratio affects the performance of self curing agent to a large extent.
7. 1% by weight of cement was found to be the optimum dosage of self curing agents.

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VI. LIMITATIONS

1. Variation in temperature from 41°C to 24°C during the experimental study resulted in variation of strength results than that was expected.
2. As the percentage of PEG increased, mix showed tendency of bleeding and in case of PVA the increase in percentage resulted in stiff and hard mixture.

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