OBSERVATION OF MECHANICAL BEHAVIOUR OF SELF CURING HIGH STRENGTH CONCRETE

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ABSTRACT:

Concrete requires curing to continue with the hydration process. 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. The present study involves the use of polyethylene glycol which acts as a self curing compound. The most important aspect is that this compound is expected to maintain maximum water retention there by contributing to full hydration. The parameters in the study include grade of concrete, type and dosage of polyethylene glycol, curing conditions and age of curing. The present involves the two types of self curing compounds PEG 4000, PEG 200 with dosage of 0.1%, 0.5%, 1% for M70 grade of concrete. Weight loss and compressive strength, flexural strength and durability tests were determined as a performance benchmark for the investigated curing compounds. It was reported from the study that higher dosage (1%), higher molecular weight (4000) based PEG compounds act as better curing compounds in higher grade concretes compared to other self curing compound.

Keywords: Fly ash, stress, concrete aggregate.

1. 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. The development of concrete has brought several challenges to the engineers to improve the performance characteristics: strength and durability. One of major considerations in achieving this is gaining control on water. The water supplied during mixing in concrete is needed to hydrate the cement to achieve the

required rheological properties in mixing, transportation, placing and compacting. One of the most important aspects in hydration is the need to maintain relative humidity of around 100%. Decrease in relative humidity will cause self desiccation or chemical shrinkage at micro level. To prevent this problem, it is recommended to make available, embedded water for curing. 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. Internal curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing water.

Need for 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 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 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. This situation is intensified in HPC (compared to conventional concrete) due to its generally higher cement content, reduced water-cement(w/c) ratio and the pozzolonic mineral admixtures (fly-ash, silica fume).

2. Related Study

M.V.Jagannadha Kumar, M.Srikanth, Dr.K.Jagannadha Rao [1]

Studied that self curing concrete is provided to absorb water from moisture from air to achieve better hydration of cement in concrete. In this shrinkage reducing admixture polyethylene glycol (PEG 400) is a self curing compound. Two types of grades are taken i.e., M20 and M40 grades of concrete. In this study the self curing agent is added to concrete with 0.5%, 1%, 1.5%, 2% by weight of cement. The experimental programme involves the compressive, tensile and modulus of rupture for M20 and M40 grades of concrete. For M20 grade of concrete totally 15 cubes, 15 cylinders, 15 beams are casted. Similarly for M40 grade of concrete totally 15 cubes, 15 cylinders, 15 beams are casted to evaluate the strength properties.

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Prof. Vinayak Vijapur1, Manjunath .G. Tontanal2 [3]

Investigated behaviour of self cured steel fibre reinforced concrete. Fibres are use din concrete to control cracking due to both plastic and drying shrinkage which reduces the permeability of concrete and bleeding of water. In this study steel fibres are used as an admixture and pumice aggregates as an self curing agent. The grade of concrete was found to be M30. The steel fibres are added to concrete with 2% by volume fraction and self curing agent i.e., pumice aggregates are replaced by natural aggregates by different percentages i.e., 0%, 10%, 20%, 30%, 40%, 50%. The experimental programme involves the sorptivity, water absorption test and strength properties of concrete.

Scope and objective:

The objectives of the work are stated below:

i) To develop mix design methodology for mix 70MPa

ii) To study the effect of self-curing compound and its dosage on fresh properties concrete.

iii) To determine the water retention capacity of all mixes by measuring weight loss of cubes at 3, 7,10, 14, 21, 28 days.

iv) To determine the compressive strength of cubes at 7, 14, 28 days.

3. METHODOLOGY

Materials Used

The different materials used in the investigation are:

Cement

Cement used in the investigation was found to be Ordinary Portland Cement(53 grade) confirming to IS : 12269 – 1987.

Fine Aggregate

The fine aggregate used was obtained from a near by river course. The fine aggregate confirming to zone – II according to Is 383-1970 was used.

Coarse aggregate

The coarse aggregate used is from a local crushing unit having 20mm nominal size. The coarse aggregate confirming to 20mm well-graded according to IS:383-1970 is used in this investigation.

Polyethylene glycol (PEG)

Polyethylene glycol of low molecular (200) and high molecular weight (4000) were used in the study. The chemicals were mixed with water thoroughly prior to mixing of water in concrete.

BASF glenium B233

BASF glenium B233 is a super plasticizing admixture. Glenium B233 is an admixture of a new generation based on modified polycarboxylic ether. The product has been primarily developed for applications in high performance concrete where the highest durability and performance is required.

Sieve sizes (mm)	Weight retained (gm)	% weight retained	Cumulative % weight retained	% passing
80	0	0	0	100
40	0	0	0	100
20	490	9.8	9.8	90.2
10	4411	88.22	98.02	1.98
4.75	99	1.98	100	0

Fig.2. Proportions of different size fractions to obtain 20mm aggregate.

Sieve sizes (mm)	Weight retained (gm)	% weight retained	Cumulative % weight retained	% passing
16	0	0	0	100
12.5	875	17.5	17.5	82.5
9.5	2080	41.6	59.1	40.9
4.75	1980	39.6	98.7	1.3
2.36	65	1.3	100	0

Fig.3. Proportions of different size fractions to obtain 12.5mm aggregate.

Slump Test

The slump test is performed to know about workability. The plot of the slump test values for different dosages of PEG is shown in Table 5.1 & Fig 5.1. The following are the observations on slump test.

i) It is been observed that in case of specimens with PEG 4000 of 1% is

less compared to other dosages (0.1%, 0.5%).

ii) It is been observed that in case of specimens with PEG 200 of 0.1% is less compared to other dosages (0.5%, 1%).

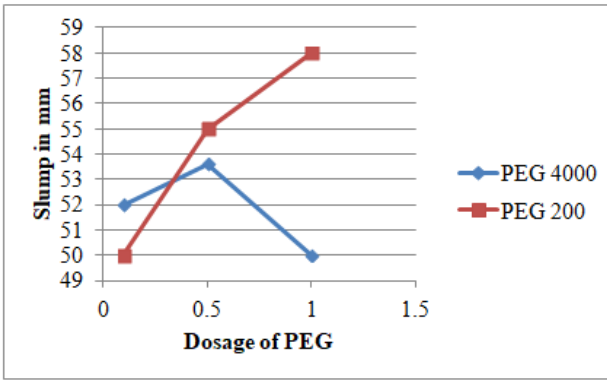

Fig.4. Variation of PEG with slump.

Concrete with high molecular weight polyethylene glycol subjected to indoor curing was studied by weighing the samples at regular intervals of 3 days, with digital weighing of accuracy 5 gm up to 28 days. The results were recorded in Table 5.2. The plot of weight loss and average weight loss with different percentage of polyethylene glycol is shown in Fig.5.2. The following are the observations of water retentivity of concrete.

i) it is clearly observed that the specimen without self curing agent i.e., in air curing losing more weight when compared to specimens with dosage of 0.1%, 0.5%, 1% of self curing agent.

ii) It is also been observed that in case of specimens with self curing agent of PEG 4000-0.5% dosage the weight loss is more when compared to other dosages
(0.1%, 1%) of self curing agent.

It is also been observed that in case of specimens with self curing agent of PEG 4000-1% dosage the weight loss is less when compared to other dosages (0.1%, 0.5%) of self curing agent.

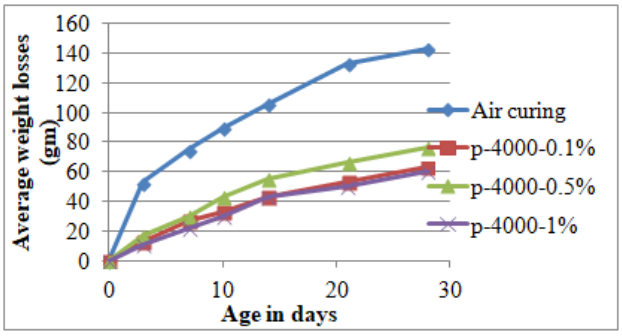

Fig.5. Variation of average weight losses with age.

Water Retention Test Results of PEG 200 :

Concrete with low molecular weight polyethylene glycol subjected to indoor curing was studied by weighing the samples at regular intervals of 3 days, with digital weighing of accuracy 5 gm up to 28 days. The results were recorded in **Table 5.3.** The plot of

weight loss and average weight loss with different percentage of polyethylene glycol is shown in **Fig.5.3.** The following are the observations of water retentivity of concrete.

i) it is clearly observed that the specimen without self curing agent i.e., in air curing losing more weight when compared to specimens with dosage of 0.1%, 0.5%, 1% of self curing agent.

ii) It is also been observed that in case of specimens with self curing agent of PEG 200-1% dosage the weight loss is more when compared to other dosages (0.1%, 0.5%) of self curing agent.

iii) It is also been observed that in case of specimens with self curing agent of PEG 4000-0.1% dosage the weight loss is less when compared to other dosages (0.5%, 1%) of self curing agent.

AVERAGE WEIGHT LOSS OF CUBES AT DIFFERENT AGES (gms)							
Nomenclature of mix	0 days	3 days	7 days	10 days	14 days	21 days	28 days
Air curing	0	53	75	90	106	133	143
PEG-200-0.1%	0	13	26	35	46	56	66
PEG-200-0.5%	0	16	28	41	55	70	80
PEG-200-1%	0	45	56	58	66	83	93

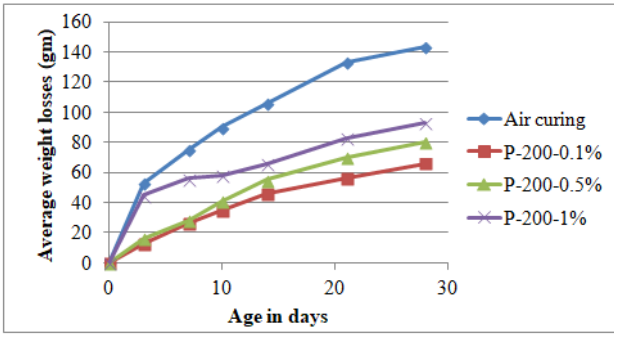

Fig.6. Variation of average weight losses with age.

Nomenclature of mix	AVERAGE ACID DURABILITY FACTOR VALUES								
	7 days			14 days			28 days		
	% loss of strength	S_d(%)	ADF	% loss of strength	S_d(%)	ADF	% loss of strength	S_d(%)	ADF
Air curing	23.497	76.50	19.12	34.89	65.1	32.55	41.4	58.59	58.59
Water curing	9.9	90.09	22.52	14.77	85.22	42.61	18.42	81.57	81.57
PEG-200-0.1%	8.92	91.07	22.76	14.28	85.71	42.85	19.64	80.35	80.35
PEG-200-0.5%	16.2	83.79	20.94	23.42	76.57	38.28	29.2	70.79	70.79
PEG-200-1%	20.19	79.8	19.95	26.1	73.86	36.94	33.49	66.5	66.5

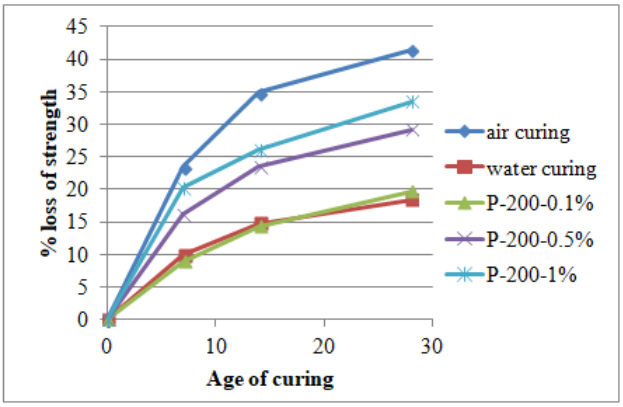

Fig.7. Variation of % loss of strength with age.

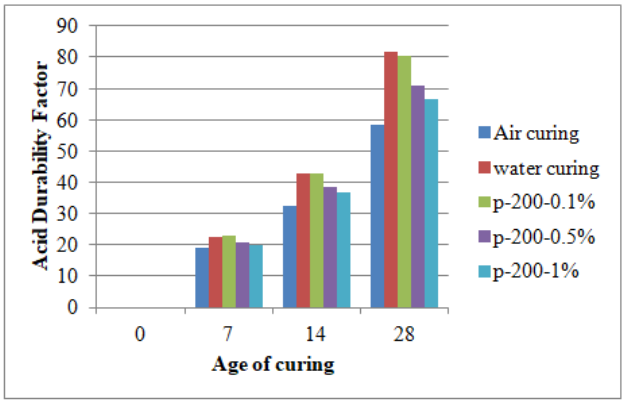

Fig.8. Variation of ADF with age.

CONCLUSION

After the analysis of the result of the experimental programme the following conclusions were arrived.

1. High grade concrete containing Ordinary Portland Cement with Polyethylene Glycol in indoor curing with 0% dosage (by weight of cement) has maximum weight loss when compared to the 0.1%, 0.5%, 1% dosages.
2. High grade concrete containing Ordinary Portland Cement with Polyethylene Glycol (PEG 4000) in indoor curing with 1% dosage (by weight of cement) has minimum weight loss when compared to the 0%, 0.1%, 0.5% dosages of PEG 4000.
3. High grade concrete containing Ordinary Portland Cement with Polyethylene Glycol (PEG 200) in indoor curing with 0.1% dosage (by weight of cement) has minimum weight loss when compared to the 0%, 0.5%, 1% dosages of PEG 200.
4. In this investigation, it is noticed that High grade concrete containing Ordinary Portland Cement with 1% dosage (by cement weight) of PEG 4000 gives better results when compared to the 0.1% dosage of PEG 200.
5. Compressive strength of High grade concrete with 0% dosage of Polyethylene Glycol in wet curing is higher compared to the 0% dosage in indoor curing.
6. Compressive strength of High grade concrete with 1% dosage of PEG 4000 in indoor curing is higher when compared to the 0%, 0.1%, 0.5%.
7. Compressive strength of High grade concrete with 0.1% dosage of PEG 200 in indoor curing is higher when compared to the 0%, 0.5%, 1%.
8. In this investigation, it is noticed that High grade concrete containing Ordinary Portland Cement with 1% dosage (by cement weight) of PEG 4000 gives better results when compared to the 0.1% dosage of PEG 200.
9. In case of Acid attack test of High grade concrete with 1% dosage of PEG 4000 in indoor curing gives the better results compared to other dosages.
10. In case of Acid attack test of High grade concrete with 0.1% dosage of PEG 200 in indoor curing gives the better results compared to other dosages.

11. In this investigation, it is noticed that High grade concrete containing Ordinary Portland Cement with 1% dosage (by cement weight) of PEG 4000 gives better results when compared to the 0.1% dosage of PEG 200.
12. In case of Acid durability factor test of High grade concrete with 1% dosage of PEG 4000 in indoor curing gives the better results compared to other dosages.
13. In case of Acid durability factor test of High grade concrete with 0.1% dosage of PEG 200 in indoor curing gives the better results compared to other dosages.
14. In this investigation, it is noticed that High grade concrete containing Ordinary Portland Cement with 1% dosage (by cement weight) of PEG 4000 gives better results when compared to the 0.1% dosage of PEG 200.
15. In this investigation, it is noticed that High grade concrete containing Ordinary Portland Cement with 1% dosage (by cement weight) of PEG 4000 gives better results when compared to the 0.1% dosage of PEG 200.
16. In general it was concluded from the investigation that specimens with higher strength were also exhibiting superior performance from Acid Attack point of view.

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