Effect of Various Polyethylene Glycol on the Compressive and Split-Tensile Strength of Self-Curing 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 project work, the individual effect of curing agents like PEG 400, PEG 4000 & PEG 6000 on strength properties by varying the percentage by 0.5% and 1% were studied. The study shows that PEG 6000 with 0.5% could help in gaining maximum strength of curing. The test results showed that self-curing concrete is best option in places where water scarcity occurs.

Key words: Self-Curing Concrete, Polyethylene Glycol, Freezing, Autogenous Shrinkage

I. INTRODUCTION

A. Concrete being the backbone of building materials is well known for its economic availability, durability and the ease by which it is manufactured at the site. Concrete is an artificial material consisting of ingredients such as cement, fine aggregates, coarse aggregates and water.

Cement reacts with water, which bond the other components together eventually creating a robust stone like material. Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. When concrete is exposed to the environment evaporation of water takes place and loss of moisture will reduce the initial water- cement ratio which will result in the incomplete hydration of the cement and lowering the quality of the concrete. Various factors such as wind velocity, relative humidity, atmospheric temperature, water-cement ratio and type of the cement used in the mix can also affect this. Continuous evaporation of moisture takes place from an exposed surface due to the difference in chemical potentials between the vapour and liquid phases.

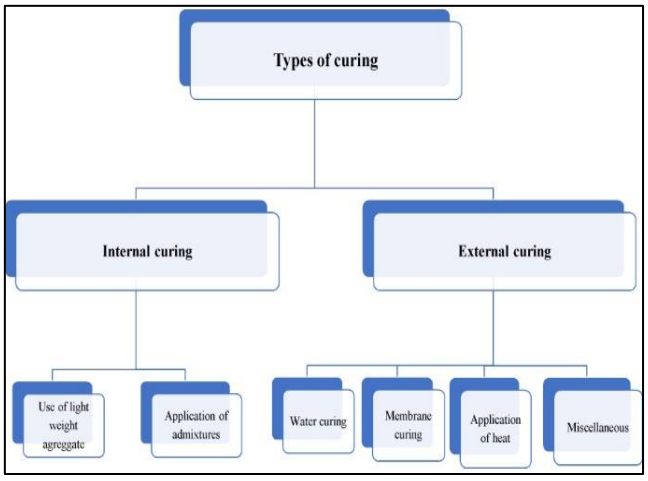

Fig. 1.1: Methods of Curing

A. *Polyethylene Glycol*

Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula H(OCH 2CH 2)nOH, where n is the average number of repeating ox ethylene groups typically from 4 to about 180.

Polyethylene glycol is a polyether compound with many applications from industrial manufacturing to medicine. PEG is also known as polyethylene oxide (PEO) or poly oxy ethylene (POE), depending on its molecular weight. Polyethylene glycol is soluble in water, acetone, alcohols, benzene, glycerol, glycol, and aromatic hydrocarbons, and is slightly soluble in aliphatic hydrocarbons. Increasing the molecular weight of PEG results in decreasing solubility in water and solvents. They are hygroscopic, it means that they attract and retain moisture from the atmosphere. PEG have low viscosity and are thermally stable for a limited period of time below 300 degree Celsius and without oxygen. One common feature of PEG appears to be the water-soluble nature. Polyethylene glycol is non-toxic, odorless, neutral, lubricating, non-volatile and non-irritating and is used in a variety of pharmaceuticals

B. *Objective*

- Study the effect of mixture of four different molecular mass Polyethylene Glycol PEG 400, PEG 800, PEG 4000& PEG 8000 in 2 different percentages such as 0.5% and 1% on Compressive and split tensile strength of M-40 grade concrete.
- To prepare cubes and cylinders of standard dimensions.
- To carry out Compressive strength& Split tensile strength for 7, 14 & 28 days and Water loss test on concrete cubes and cylinder.

II. METHODOLOGY

A. Materials Used & Tests on Materials

1) General

The chapter deals with the materials collection, which were used in the Investigation. It also explains the various the chapter deals with the materials collection, which were used in the experimental investigations carried out for Physical and chemical properties to understand the behaviour

Hand Sieving	1	2
weight of cement taken (w1) in gms	100	100
Weight of residue retained on 90µ sieve (w2) in gms	7.8	8.0
Percentage fineness of cement = (w2/w1)*100	7.8%	8.0%

Table 1: Fineness of Cement by Hand Sieving

Weigh accurately 100gms of cement and take it on a standard IS sieve 90µ.Break down the air set lumps with fingers. Place a pan at the bottom and cover the top of sieve by a lid. Fix the setup to a mechanical sieve shakes. Continuously sieve the sample for a period of 15 min

Mechanical sieving	1	2
weight of cement taken (w1) in gms	100	100
Weight of residue retained on 90µ sieve (w2) in gms	7.8	8.0
Percentage fineness of cement = (w2/w1)*100	7.8%	8.0%

Table 2: Fineness of Cement by Mechanical Sieving

Hand sieving = 7.9%

Mechanical sieving = 7.6%

Serial no	Time in min	Penetration, from the bottom in mm
1	5	0
2	10	2
3	15	3
4	20	5
5	25	6
6	30	7

Table 3: Setting Time Test for Cement Paste

Initial setting time= 30min

Final setting time = 285min

Trial no	Weight of cement taken(gms)	Percentage of water added	Quantity of water in (m)	Penetration in (mm)
1	400	25	100	33
2	400	25%+1%	4	27
3	400	26%+1%	4	16
4	400	27%+1%	4	9
5	400	28%+1%	4	6

Table 4: Standard Consistency of a Cement Paste

Percentage of water required to make cement paste = 29%

The normal consistency of cement = 6mm

Trials	1	2	3
Empty weight of pycnometer (w1)	640	640	640
Weight of pycnometer + 1/3 of fine aggregates (w2)	1000	950	960
Weight of pycnometer + 1/3 of fine aggregates + water (w3)	1734	1688	1700
Weight of pycnometer + water (w4)	1510	1494	1500
Specific gravity	2.64	2.67	2.66

Table 5: Specific Gravity of Fine Aggregate

The specific gravity of fine aggregates = 2.65

Fig. 1: Specific gravity test for fine Aggregate

Sl no	Trial	1
1	Weight of saturation surface dried sample in gms (A)	1004
2	Weight of oven dried sample in grms (B)	996
3	Water absorption = ((A-B)/B)*100	0.8

Table 6: Water Absorption of Coarse Aggregates

– Fine aggregates

Sl no	Trial	1
1	Weight of saturation surface dried sample in gms (A)	1007
2	Weight of oven dried sample in grms (B)	994
3	Water absorption = ((A-B)/B)*100	1.3

Table 7: Water Absorption of Fine Aggregates

W/C Ratio	Initial reading (mm)	Final Reading (mm)	Type of slump	Slump value
0.50	300	270	True collapse	30

Table 8: Slump Test on Fresh Concrete

Sl no	Particular	Obtained value
1	Specific gravity	3.2
2	Fineness of cement by IS sieve method By hand sieve By mechanical sieve	 7.9% 7.6%
3	setting time of cement initial setting time final setting time	 30min 285mim

Table 9: Physical Properties of Cement

Sl no	Particulars	Obtained value
1	Fineness modulus	2.55
2	Maximum size	2.36
3	Specific gravity	2.65
4	Water absorption	1.3%

Table 10: Property of Fine Aggregates

Sl no	Particular	Obtained value
1	Fineness modulus	2.26
2	Maximum size	20
3	Specific gravity	2.7
4	Water absorption	0.8%

Table 11: Property of Coarse Aggregates

III. RESULT & DISCUSSION

1) Compressive strength test for adding 0.5% of PEG – 400, 4000, 6000 for 7 and 28 days

Mix Proportion	Age (days)	Load at Failure (KN) Compression	Comp. Strength (Mpa)
0.5% of PEG 400	7	635.5	28.24
	14	854.1	37.96
	28	1031.1	45.82
0.5% of PEG 4000	7	691.9	30.75
	14	874.3	38.85
	28	1041.4	46.27
0.5% of PEG 6000	7	721.2	32.05
	14	897.4	39.88
	28	1061.7	47.18

Table 12: Test Results of M40 Grade Concrete for 3, 7and 28 Days

2) Compressive strength test for adding 1% of PEG – 400, 4000, 6000 for 7 and 28 days

Mix Proportion	Age (days)	Load at Failure (KN) Compression	Comp. Strength (Mpa)
1% of PEG 400	7	532.5	23.66
	14	811.2	36.05
	28	1029.2	45.74
1% of PEG 4000	7	552.2	24.55
	14	839.8	37.32
	28	1049.8	46.65
1% of PEG 6000	7	604.2	26.85
	14	866.8	38.52
	28	1061.1	47.16

Table 13: Test Results of M_{40} Grade Concrete for 3, 7and 28 Days

3) Tensile strength test for adding 0.5% of PEG – 400, 4000, 6000 for 7 and 28 days

Mix Proportion	Age (days)	Load at Failure (KN) tension	Tensile Strength (Mpa)
0.5% of PEG 400	7	250.8	5.57
	14	301.6	6.4
	28	360.9	8.02
0.5% of PEG 4000	7	263.4	5.84
	14	311.1	6.6
	28	371.2	8.24
0.5% of PEG 6000	7	278.2	6.17
	14	338.7	7.18
	28	381.2	8.46

Table 14: Test Results of M_{40} Grade Concrete for 3, 7and 28 Days

4) Tensile strength test for adding 1% of PEG – 400, 4000, 6000 for 7 and 28 days

Mix Proportion	Age (days)	Load at Failure (KN) Compression	Comp. Strength (Mpa)
1% of PEG 400	7	234.8	5.21
	14	298.7	6.33
	28	332.7	7.39
1% of PEG 4000	7	246.2	5.46
	14	310.4	6.58
	28	347.3	7.71
1% of PEG 6000	7	253.2	5.62
	14	320.7	6.80
	28	378.3	8.4

Table 15: Test Results of M_{40} Grade Concrete for 3, 7and 28 Days

IV. CONCLUSION & SCOPE FOR FURTHER WORK

1) Self-cured concrete showed better hydration even under dried condition when compared to conventional concrete.
2) By adding polyethylene glycol as an admixture from 0.5% to 1% the hydration process of concrete has been improved because of that the compressive strength and tensile strength of concrete increases over conventional concrete.
3) The self-cured concrete have revealed that With the addition of 0.5% of polyethylene glycol shows better hydration process over 1% of polyethylene glycol.
4) The hydration process of concrete improves as the molecular mass of polyethylene glycol increases.
5) The amount of water requirement also reduces because of the addition of polyethylene glycol over conventional concrete.
6) The emission of carbon-dioxide also decreases.

V. SCOPE OF FUTURE WORK

1) In this experimental study only compressive strength and split tensile strength has been checked for 3,7,28 days. In further work, we are going to calculate the 56 days compressive strength to analyze the strength variations for M_{40} grade of concrete.
2) We are going to checking for higher molecules we may get better more

A. GAP Acceptance

SL.NO	LOCATION	AVG GAP(S)	MIN GAP(S)	MAX GAP(S)
1.	HUNSUR	1.603	0.5	3.08
2.	NANJANGUD	1.58	0.58	2.82

Table 5.31 Gap Acceptance Values

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