Experimental investigation of self curing concrete by using internal curing agent-PEG (polyethylein glycol 400)

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***Abstract* - The aim of this investigation is to study the strength and durability properties of concrete using water-soluble Polyethylene Glycol as self-curing agent. The function of self-curing agent is to reduce the water evaporation from concrete, and hence they increase the water retention capacity of concrete compared to the conventionally cured concrete. The experiments are designed by adding a shrinkage admixture (POLYETHYLENE GLYCOL-400) at different percentages such as 0, 0.1, 0.5, 1, and 1.5 of cement content. In this study, compressive strength of concrete containing self-curing agent is investigated and compared with those of conventionally cured concrete. It is found through this experimental study that concrete cast with Polyethylene Glycol as self-curing agent is stronger than that obtained by sprinkler curing as well as by immersion curing. The mechanical properties like compressive strength are studied. The test results were studied at inside the lab for air curing. The optimum dosage of PEG-400 for maximum strengths was found to be 1.5 percentages.**

***keywords* - Self-curing concrete; internal curing; Polyethylene-glycol; Compressive Strength**

I. INTRODUCTION

Concrete is a composite construction material composed of cement (commonly Portland cement) and other cementitious materials such as fly ash and slag cement, aggregate (generally a coarse aggregate made of gravels or crushed rocks such as limestone, or granite, plus a fine aggregate such as sand), water, and chemical admixtures. The word concrete comes from the Latin word "concretus" (meaning compact or condensed), the perfect passive participle of "concresco", from "com-" (together) and "Cresco" (to grow). Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a robust stone-like material. Concrete is used to make pavements, pipe, architectural structures, foundations, and motorways/roads, bridges/overpasses, parking structures, brick/block walls and footings for gates, fences and poles. Concrete is used more than any other man-made material in the world.

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. Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration. It may be either after it has been placed in position (or during the manufacture of concrete products), thereby providing time for the hydration of the cement to occur. Since the hydration of cement does take time – days, and even weeks rather than hours – curing must be undertaken for a reasonable period of time.

Curing has a strong influence on the properties of hardened concrete; proper curing will increase durability, strength, water tightness, abrasion resistance, volume stability, and resistance to freezing and thawing and deicers. In addition to the normal concrete mix some additional compounds like Polyetheline glycole(PEG) in proper dosage and materials such as fly ash is used to increase the durability and strength of the concrete mix.

Internal curing is an effective method for improving performance of low water –cement ratio and low permeability concrete because they require additional water to hydrate Cementation materials. In case of external curing (membrane curing) the impermeable coating of the compound is formed on the surface and water loss due to evaporation is controlled to maximum extent. These methods are useful in dry areas where water scarcity's more.

OBJECTIVE

1. To study in detail concept of self curing of concrete
2. To study the use of water soluble polyethylene glycol (PEG) in concrete for self curing.
3. To study the compressive strength, water retention by varying the percentage of PEG from 0% to 1.5% by weight of cement for self-compacting concrete and compare it with conventional concrete.
4. Result and recommendation based on above study

FUTURE SCOPE

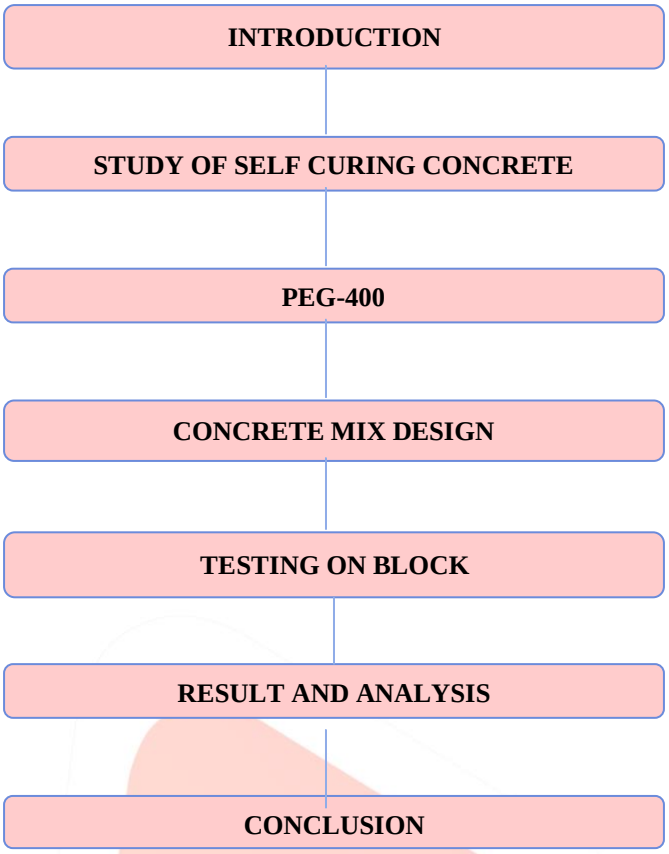
1. To increase durability of structure.
2. To avoid cracks in concrete.
3. To reduce curing & water demand cost.

II. LITERATURE REVIEW

Table 1: Literature Review

SR.NO	TITLE OF PAPER	AUTHOR	VOLUME NUMBER	DELIVERABLE
1	Strength characteristics of self-curing concrete	1)M.V.Jagannadha Kumar 2)M. Srikanth	ISSN: 2319-1163	In this paper author study self curing concreteusing Polyethylene-glycol-400 at various percentage such as 0%,,0.5%,1%,2% of cement content.
2	Experimental study on self- curing concrete	1)K.Nithya 2)K.Ranjitha	ISSN: 2395-0072	The author study involves the use of shrinkage reducing admixtures in concrete which helps in self-curing and helps in better hydration and hence strength.
3	An Experimental Study on Mechanical Proper-ties of Self Curing Concrete	1)Akshara O.S 2)Divyasasi	ISSN: 2229-5518	In this paper author study, the mechanical properties of concrete containing self-curing agent is investigated and compared with those of conventionally cured concrete. And he conclude the optimum dosage of PEG-400 for maximum strengths be 1%.
4	Experimental study of self Compacting self curing concrete	1)Dr.N.P. Rajamane 2)R. Udhayan	IJCIET	In this paper self-compacting self-curing concrete is done by using polyethylene glycol at a rate of 0%, 1%, and 2%.And author found that the optimum dosage of 1% of PEG gives higher strength.
5	An experimental study on selfCuring concrete	1)Tatineniyeswanth Sail	ISSN: 2278-621X	In this paper author study self curing concrete using Polyethylene-glycol-400 at various percentage such as 0%,,0.5%,1%,1.5%,2% of cement content.
6	The Preliminary Test of Ingredients of Concrete Pavement Block	1)Deshpande B. C. 2)Darade M. M.	ISSN: 2348-7968	The author examines the effect of fly ash, as partial replacement to cement and dust as partial replacement to fine aggregate on the various properties of pavement block.
7	Quality of Water for Making Concrete: A Review of Literature	1)Mr. K. J.Kucche 2)Dr. S. S. Jamkar 3)Dr. P. A. Sadgir	ISSN: 2250-3153	This paper reviews the literature related to quality of water for making concrete.
8	Self-Curing Concrete	1)Muddassir Bora 2)PMausam Vohra 3)Mohammed Sakil Patel 4)Dhruv Vyas	ISSN: 2321-9939	In this paper Shrinkage reducing agents and lightweight aggregates such as Polyethylene-glycol and Leca, Silica fume and stone chips are used respectively to achieve effective curing results.

III.PROPOSED METHODOLOGY AND DISCUSSION



Flow chart of Methodology

We decide the topic self-curing concrete. For this we made the mix design for concrete of grade M25. After that we made some concrete blocks by using the self-curing agent PEG (400) and some blocks are made without using the self-curing agent. After that we conduct compressive strength test on the blocks by using the compression testing machine and determine the strength of them and compare it currently the method uses polyethylene glycol (PEG) which reduces the evaporation of water from the surface of concrete and also help in water retention

IV.CONCRETE MIX DESIGN

Mix design for "M25"Grade

(a) Stipulations for Proportioning:

1. Grade designation	M25
2. Type of cement	OPC53grade
3. Type of admixture	Polyethylene glycol-400
4. Maximum nominal size of aggregate	20mm
5. Minimum cement content	300kg/m3
6. Maximum water-cement ratio	0.5
7. Workability	100 mm (slump)
8. Exposure condition	Severe (For plain Concrete)
9. Method of concrete placing	Hand placing
10. Degree of supervision	Good
11. Type of aggregate	Sub angular aggregate
12. Maximum cement (OPC) content	394 kg/m3

(b) Test Data for Materials:

1. Cement used	OPC 53 grade
2. Specific gravity of cement	3.15
3. Specific gravity of coarse aggregate	2.51
4. Specific gravity of fine aggregate	2.63
5. Specific gravity of fly ash	2.12
5. Water absorption	
Coarse aggregate	Nil
Fine aggregate	Nil
6. Free (surface) moisture	
Coarse aggregate	Nil
Fine aggregate	Nil

7. Sieve analysis

Coarse aggregate Nominal max Size of aggregate 20mm as per IS 383Confirming to grading Zone III of

Fine aggregate table 4 of IS-383

(c) Target Strength for Mix Proportioning

Fck=fck + t.5

t=1.65

Fck=fck + (1.65 x 5)

Fck= Target average compressive strength at 28 days,

Fck = Characteristics compressive strength at 28 days,

And S = Standard deviation.

From Table I, Standard Deviations = 4N/mm 2.

(d) Selection of Water-Cement Ratio:

From Table 5 of IS 456, maximum water-cement ratio 0.5

Based on experience, adopt water-cement ratio as 0.45.

Hence, Ok.

(e) Selection of Water Content:

From Table 2, maximum water content

For 20 mm aggregate =186 liter (for 100 mm slump range)

Estimated water content for 75 mm slump = 186 x 6/100 + 186

= 197 liter

(f) Calculation of Cement:

Water-cement ratio =0.5

Cement content = 394kg/m3

0.5 From Table 5 of IS 456, minimum cement content for 'Severe' exposure conditions = 300kg/m3

394kg/m3 > 300 kg/m3

Hence, ok.

(g) Proportion of volume of coarse aggregate fine aggregate content:

From Table 3, volume of coarse aggregate corresponding to20mm size aggregate and fine aggregate (Zone I)

For water-cement ratio of 0.5 = 0.60

Volume of fine aggregate content = 1 − 0.6= 0.4

(h) Mix Calculations:

The mix calculations per unit volume of concrete shall be as follows:

a) Volume of concrete = 1m3

As cement is partially replaced by fly ash, initially we will go for 20% replacement

In above step so we get cement content of 394 kg/m3,20% of its replaced by fly ash i.e 79kg and cement content of 315 kg/m3.

b) Volume of cement t = mass of cement / Specific gravity of cement X 1/1000

= 0.1m3

c) Volume of fly ash = mass of fly ash / Specific gravity of cement X 1/1000

= 0.0373m3

d) Volume of water = mass of water / Specific gravity of water X 1/1000

= 0.197m3

e) Volume of all in aggregate = a-(b+c+d)

= 1-(0.1+0.037 + 0.197)

= 0.666m3

f) Mass of coarse aggregate = e X Volume of coarse aggregate X Specific gravity of coarse aggregate X 1000

= 0.666X 0.6 X 2.63 X 1000

= 1051 Kg

g) Mass of fine aggregate = e X Volume of coarse aggregate X Specific gravity of coarse aggregate X 1000

= 0.666X0.4X2.51X1000

= 668.664 Kg

Material required for M25 grade concrete per one cubic meter quantity:

Mix Proportion for Mix A.

Table 2: Mix Proportion for Mix A

		Cement	Fine aggregates	Coarse aggregates	Water	Fly ash
MIX A	**Quantity Of matrial**	315	669	1051	197	79
	Mix proportion	1.00	2.12	3.33	0.63	0.25

Quantities of Each Mould in kg:
***Mix proportions of M25 grade:* 1: 2.12: 3.33:0.6**
Water cement ratio = 0.5
Specific gravity of cement sc = 3.15
Specific gravity of fine aggregate = 2.51
Specific gravity of coarse aggregate = 2.63
V = volume of each cube = 0.15 × 0.15 × 0.15 = 3.375 ×10-3m3
For cubes:
Cement=1.06kg
Fly ash=2.26kg
coarse aggregate =3.55kg
fine aggregate=2.26kg
Water=0.66liter
Quantities of addition of PEG-400 to the concrete mix:
PEG -400 is the shrinkage admixture which gives more strength when those are added to the concrete than normal concrete mix .PEG-400 is added to the concrete mix in the proportion of 0, 0.1, 0.5, 1, 1.5 percentage of the weight of concrete.
Addition of PEG-400 in proportion to the concrete mix

Table 4: PEG-400 proportion

Percentage of PEG-400 (in cement concrete)	Dry Weight of cement concrete (gram)	Weight of PEG-400 (gram)	PEG-400 (ml)
0.1	12757.5	14.99	11.31
0.5	12757.5	74.98	56.55
1	12757.5	149.96	113.098
1.5	12757.5	224.95	169.65

V. RESULT AND DISCUSSIONS

COMPRESSIVE STRENGTH VALUES FOR SELF CURIGNG CONCRETE BY USING PEG-400
Cubes:
3- **Days compressive strength results**

Table 5: 3 Days compressive strength results

DESIGNATION	BLOCK1 (KN/mm)	BLOCK2 (KN/mm)	BLOCK3 (KN/mm)	AVERAGE(KN/mm)
AW 0 %	8.32	6.78	8.19	7.76
AI 0 %	7.30	7.01	6.85	7.05
AL 0.1 %	7.92	8.61	8.27	8.27
AL 0.5 %	4.94	4.68	4.81	4.81
AL 1 %	6.54	6.71	6.62	6.62
AL 1.5 %	9.63	9.81	9.72	9.72

7- Days compressive strength results

Table 6: 7 Days compressive strength results

DESIGNATION	BLOCK1 (KN/mm)	BLOCK2 (KN/mm)	BLOCK3 (KN/mm)	AVERAGE(KN/mm)
AW 0 %	10.98	11.34	11.16	11.16
AI 0 %	9.99	9.29	9.64	9.64
AL 0.1 %	11.68	10.87	11.27	11.27
AL 0.5 %	8.29	8.35	8.32	8.32
AL 1 %	11.32	12.05	11.68	11.68
AL 1.5 %	15.73	15.83	15.78	15.78

14 Days compressive strength results

Table 7: 14 Days compressive strength results

DESIGNATION	BLOCK1 (KN/mm)	BLOCK2 (KN/mm)	BLOCK3 (KN/mm)	AVERAGE(KN/mm)
AW 0 %	14.25	12.69	13.47	13.47
AI 0 %	10.20	12.12	11.16	11.16
AL 0.1 %	14.98	14.86	14.92	14.92
AL 0.5 %	11.90	12.23	12.06	12.06
AL 1 %	15.56	16.93	16.24	16.24
AL 1.5 %	22.22	21.94	22.08	22.08

28- Days compressive strength results

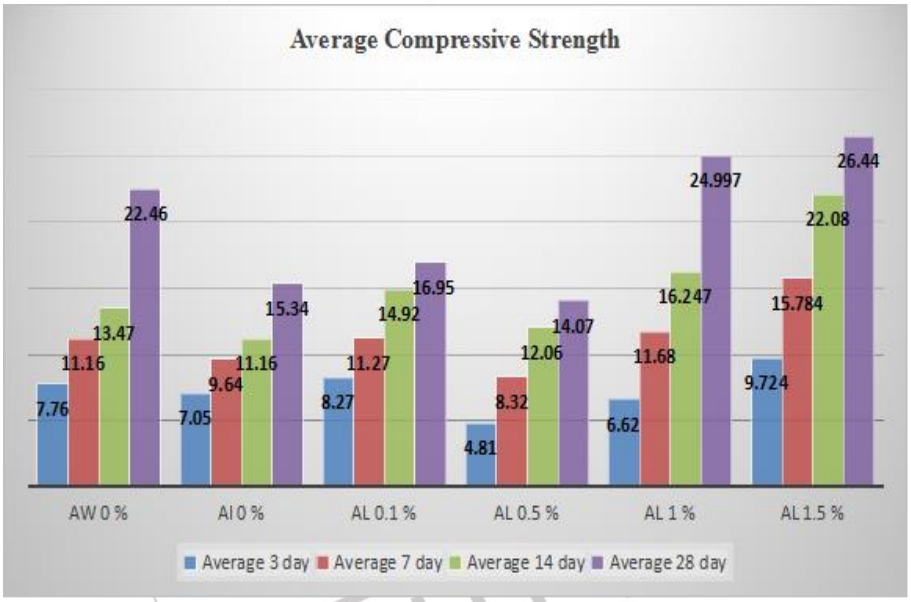
Table 8: 28 Days compressive strength results

DESIGNATION	BLOCK1 (KN/mm)	BLOCK2 (KN/mm)	BLOCK3 (KN/mm)	AVERAGE(KN/mm)
AW 0 %	21.66	23.07	22.46	22.46
AI 0 %	15.56	15.13	15.34	15.34
AL 0.1 %	17.28	16.84	16.73	16.95
AL 0.5 %	13.60	13.85	14.76	14.07
AL 1 %	20.03	20.27	20.88	24.99
AL 1.5 %	27.94	26.16	25.21	26.44

Average compressive strength of cubes

Table 9: Average compressive strength of cubes

DESIGNATION	AVERAGE(KN/mm) 3days	AVERAGE(KN/mm) 7days	AVERAGE(KN/mm) 14days	AVERAGE(KN/mm) 28days
AW 0 %	7.76	11.16	13.47	22.46
AI 0 %	7.05	9.64	11.16	15.34
AL 0.1 %	8.27	11.27	14.92	16.95
AL 0.5 %	4.81	8.32	12.06	14.07
AL 1 %	6.62	11.68	16.24	24.99
AL 1.5 %	9.72	15.78	22.08	26.44



VI.CONCLUSION

PEG-400 is added to the concrete the Workability of the concrete is increases. It is observed that the Workability increases as the dosages of PEG 400 are increased. It is observed that the Workability results for 1.5% of PEG 400 are higher compared to other dosages. The compressive strength of self curing concrete wit 1.5% of PEG-400 has more compressive strength than other mixes as compared to conventional concrete.PEG-400 is useful to reduce and save the water on site which required for curing . It is also reduces permeability of concrete ,protects reinforcing steel ,increases mortar strength, increases early age strength of concrete, provides greater durability to concrete, greater utilization of cement, lower maintenance and cost effective.

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