International Journal of Engineering

Journal Homepage: www.ije.ir

RESEARCH NOTE

Eco-friendly Self-curing Concrete Incorporated with Polyethylene Glycol as Self-curing Agent

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PAPER INFO

Paper history:
Received 05 December 2016
Received in revised form 08 January 2017
Accepted 09 February 2017

Keywords:
Self-curing Concrete
Immersion Curing
Polyethylene Glycol 400
Compressive Strength
Split Tensile Strength
Flexural Strength

ABSTRACT

Today concrete is most generally utilized development material in the world due to its strength and sturdiness properties. To attain good strength, curing of concrete is important so we introduce the concept of self-curing concrete rather than immersion or sprinkle curing to avoid water scarcity. It was observed that water solvent polymers can be utilized as a self-curing agent, i.e. polyethylene glycol (PEG-400). In the present study, to discover the effect of admixture polyethylene glycol (PEG-400) on compression strength, split tensile strength and flexural strength, adding the diverse rate of PEG-400 to the weight of cement from zero to two percentages as the measurement of the curing agent is done. The test results were studied for M30 concrete mix. The optimum percentage of PEG-400 was found to be 1% for compressive and Split Tensile Strength. If the dosage of PEG-400 increases to more than 1%, there is a decline in compressive and split tensile strength. However, the optimum percentage of PEG-400 for flexural strength was found at 0.5%. If we increase the dosage of PEG-400 more than 0.5%, there is reduction in strength of flexural strength.

doi: *10.5829/idosi.ije.2017.30.04a.03*

1. INTRODUCTION

Nowadays, concrete is one of the standout most projection material in the world. In order to accomplish good strength, good curing of concrete is imperative to meet the performance and strength requirements. In conventional curing, this is accomplished by external curing applied after blending, placing and setting. Self-curing is a technique that can be used to give extra dampness in cement to the more effective hydration of concrete and decreased self-desiccation. Therefore, a number of researchers [1-7] are involved in identifying the self-curing agent. Polyethylene glycol 400 was discovered that which diminishes the water evaporation minimizes and surface tension of water from concrete, consequently assembles the water maintenance limit of the concrete for the nonstop hydration reason [1, 5]. Based on the advantages an application of the current methods, a study has been taken up to assess the applicability of self-curing concrete for using the optimum percentage of polyethylene glycol (PEG-400) and to compare the strength parameters between conventional concrete and self-curing concrete. The optimum dosage of PEG-400 to get the maximum compressive strength, split tensile strength and flexural strength was found to be 1%. If the dosage of the PEG-400 exceeds 1% it tends to decrease in the strength. The strength of the self-curing concrete is more when compared to the conventional curing evaporation minimizes and surface tension of water from concrete, consequently assembles the water maintenance limit of the concrete for the nonstop hydration reason [1, 5]. Based on the advantages of an application of the current methods, a study has been taken up to assess the applicability of self-curing concrete for using the optimum percentage of polyethylene glycol (PEG-400) and to compare the strength parameters between conventional concrete and self-curing concrete. The optimum dosage of PEG-400 to get the maximum compressive strength, split tensile strength and flexural strength was found to be 1%. If the dosage of the PEG-400 exceeds 1% it tends to decrease in the strength. The

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Please cite this article as: G. Thrinath and P. Sundara Kuma, Eco-friendly Self-curing Concrete Incorporated with Polyethylene Glycol as Self-curing Agent, International Journal of Engineering (IJE), TRANSACTIONS A: Basics Vol. 30, No. 4, (April 2017) 473-478

strength of the self-curing concrete is more when compared to the conventional curing [2].

The rate of PEG-400 increases and it builds up the workability of the concrete. The optimum dosage of PEG-400 for maximum compressive strength was found to be 1% of M20 grade concrete and 1.5% of M30 grade concrete [3]. Using of self- curing agent, PEG-400 in concrete mix increases the mechanical properties of concrete. It is also said that PEG-400 is the best water retention agent on concrete for continuous hydration process to get fewer voids and pours in concrete leads to increase in concrete strength [4]. It is found that the self-cured concrete have less water absorption and water absorptivity values compared with concrete cured by different strategies [6]. The optimum dosage of PEG-400 for most prominent strengths was observed to be 1% for M20 and 0.5% for M40 grades of concrete. It is additionally suggested that as a percentage of PEG-400 augmented slump, it got augmented for together M20 and M40 grades of concrete [7].

2. MATERIALS AND METHODS

2. 1. Initial Investigation The Initial investigation involves of test consistent materials, determination of fresh and hardened properties of OPC.

2. 2. Materials Test to be conducted on the material is also plays an important role to get an accurate mix design. Here, it was found the material properties of cement, fine aggregate, coarse aggregate and the properties are such as initial setting time, final setting time, the specific gravity of cement, fine aggregate, and coarse aggregate. Properties found on the cement, fine aggregate, coarse aggregate is within permissible limits. 43 grade of cement used in this trial test where ordinary Portland cement conforming to IS: 8112-2013 [8]. The cement test resulted is obtained from the laboratory are specific gravity is 3.15, initial setting time is 30 min and final setting time is 600 min. The fine aggregate utilized was taken from a close by waterway source which fitting in zone III as per IS: 383-1970 [9] and testing of fine aggregate was done as per IS 2386 Part III-1963, methods of test for aggregates Part3-Specific gravity, Density, Voids, Absorption and Bulking [10]. Its specific gravity is 2.605. The coarse aggregate used in this paper was as per IS: 383-1970 [9] and testing of course aggregate was done as per IS:2386 Part III-1963, Methods of Test for Aggregates Part 3 – Specific gravity, Density, Voids, Absorption and Bulking [10]. Its specific gravity is 2.74. Consumable water accessible at KL University was utilized for both curing and mixing of concrete. The pH value of water is 7 and curing of plain concrete is done as per IS 456-2000 code of Practice for Reinforced Concrete and Plain [11]. Polyethylene glycol (PEG) is a polymer compound. PEG is otherwise called polyethylene oxide or polyoxyethylene relying upon its molecular weight. PGE 400 is a low- molecular weight grade of polyethylene glycol. It is a colorless, clear, viscous liquid. The structure of PEG is usually communicated as:

$H-(O-CH_2-CH_2)n-OH$

The polyethylene glycol is added to the weight of cement. The dosage of the PEG-400 of a cement weight percentage varies from 0-2. The properties of polyethylene glycol are shown in Table 1.

3. EXPERIMENTAL PROGRAM

The experimental program has done at the KL University for finding the compressive strength, split tensile strength, the flexural strength of concrete for M30 mix proportion. Totally, 135 specimens were cast for the testing out of 135, which of them, 45 cubes have cast, 45 cylinders have cast and 45 prisms have cast. The details of specimens were also tabulated in Table 2. The cubes were tested for finding the compressive strength, cylinders were tested for finding split tensile strength and prisms were tested for finding flexural strength.

3. 1. Compressive Strength To find the compressive strength of the concrete 150 X 150 X 150mm was cast and it was tested for 3, 7 and 28 days. The equipment used for finding the compressive strength is a compression testing machine. By using Equation (1), we can determine the compressive strength [12].

$$\text{Compressive Strength} = \frac{p}{A} \quad (1)$$

where, P is the applied load A is the cross-sectional area (150 X150 X 150mm).

TABLE 1. Properties of polyethylene glycol (miss placed in paper which u have send)

Mol. Wt.	380-420
Appearance	Clear liquid
pH	5-7
Specific Gravity	1.12-1.13

Figure 1. Polyethylene glycol 400

3. 2. Split Tensile Strength To find the split tensile strength of concrete 150 X 300 mm Cylinders was cast and it was tested in 3, 7 and 28 days. By using Equation (2), we can determine the split tensile strength of the concrete [13].

$$\text{Split Tensile Strength} = \frac{2p}{\pi DL} \quad (2)$$

where, P is the applied load, D is the diameter of the cylinder (150mm) and L is the height of cylinder (300mm).

3. 3. Flexural Strength To find the concrete Flexural strength of 500 X 100 X 100mm prisms was cast and it was tested for 3, 7 and 28 days. Equation (3) can be used for finding the Flexural strength of the concrete [12].

$$\text{Flexural Strength} = \frac{Lp}{BD_2} \quad (3)$$

where, P is the Failure of Load, L is the Prism Length (500 mm), B is the Breadth of Prism (100 mm), D is the Width of Prism (100 mm).

3. 4. Mix Design The mix design has been adapted from IS 10262:2009 [14] to design grade ratio of 1:1.8:3.3 of concrete.

3. 5. Quantity of Material for Single Specimen The quantity of material for cast single cube, cylinder and prism are shown in Table 3.

4. RESULTS AND DISCUSSION

4. 1. Compressive Strength (Missing Flow in Reading in Paper Which u Have Send) For this study, M30 grade mix proportion is used and the mix ratio is 1:1.8:3.3. To find out compressive strength, 45 cubes were cast. The average compressive strength was calculated at 150 x 150 x 150 size cubes by taking the average of 3 specimens for 3,7 and 28 days. The compressive strength of plain concrete and self-curing concrete is 39.89 and 42.72N/mm^2 for 28 days. Thus, the compressive strength of the self-curing concrete is much greater than the plain concrete. The optimum dosage of PEG-400 was found to be 1% for compressive strength. As the percentage of PEG-400 increase to more than 1%, the strength of concrete tends to decrease. We also found that at 1.5% dosage of PEG-400, 39.67 N/mm^2 reaches the target strength of 38.25 N/mm^2, whereas by adding 2% of PEG-400, 35.31 N/mm^2 does not reach the target strength of 38.25 N/mm^2 of concrete. The results are tabulated in Table 4 and pictorially represented in Figure 3.

4. 2. Split Tensile Strength (Missing Flow in Reading in Paper Which u Have Send) For finding split tensile strength, totally 45 cylinders were cast. The average split tensile strength was calculated on 300 X 150mm size cylinder by taking the average of three specimens for 3,7 and 28 days.

TABLE 2. Details of specimens case(miss placed)

Sl.No	Mix	No of Specimens Cast		
		Cubes	Cylinders	Prisms
1	Plain	9	9	9
2	0.5%	9	9	9
3	1.0%	9	9	9
4	1.5%	9	9	9
5	2.0%	9	9	9

TABLE 3. Mix proportion values for single cube, cylinder, and prism(miss placed)

		Cement (Kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Water (Lt)	PEG-400 (ml)
Cubes	**Plain**	1.53	2.89	5.19	0.65	0
	0.5%	1.53	2.89	5.19	0.65	7.69
	1%	1.53	2.89	5.19	0.65	15.39
	1.5%	1.53	2.89	5.19	0.65	23.08
	2%	1.53	2.879	5.19	0.65	30.78
Cylinders	**Plain**	2.41	4.52	8.16	1.01	0
	0.5%	2.41	4.52	8.16	1.01	12.08
	1%	2.41	4.52	8.16	1.01	24.17
	1.5%	2.41	4.52	8.16	1.01	36.25
	2%	2.41	4.52	8.16	1.01	48.34
Prisms	**Plain**	2.28	4.26	7.69	0.96	0
	0.5%	2.28	4.26	7.69	0.96	11.4
	1%	2.28	4.26	7.69	0.96	22.8
	1.5%	2.28	4.26	7.69	0.96	34.2
	2%	2.28	4.26	7.69	0.96	45.6

Figure 2. Testing on cubes for finding compressive strength

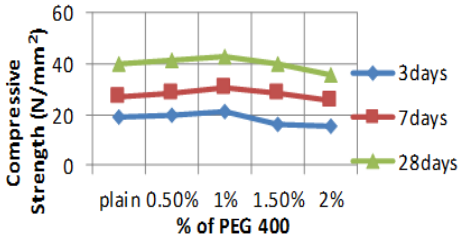

Figure 3. Compression between % PEG-400 and compressive strength

The split tensile strength of the plain concrete for 28 days is 2.2 N/mm^2 whereas the split tensile strength of the self-curing concrete for 28 days is 2.45 N/mm^2 which much greater than the plain concrete. The optimum dosage for the occurring maximum split tensile strength was found to be 1%. If the PEG-400 adding more than 1%, the concrete tends to a reduction in strength and also we found that at PEG-400 1.5% and PEG-400 2% the split tensile strength is 2.4 N/mm^2 and 2.21 N/mm^2 which greater than the plain concrete 2.2 N/mm^2.The results were tabulated as shown in Table 4 and it also represented in pictorially in Figure 5.

4. 3. Flexural Strength (Missing Flow in Reading in Paper Which u Have Send) For finding flexural strength, totally 45 prisms were cast. The average flexural strength was calculated on 500 X 100 X 100mm size prisms by taking the average of 3 specimens for 3,7 and 28 days. The flexural strength of the plain concrete for 28 days 6.21 N/mm^2 whereas the flexural strength of the self-curing concrete for 28 days is 6.54 N/mm^2 which much greater than the plain concrete [15]. The optimum dosage for the occurring maximum flexural strength was found to be 0.5%. If the percentage of PEG-400 increases, the flexural strength of the concrete decreases. By adding PEG-400 1%, PEG-400 1.5% and PEG-400 2% flexural strength values are 5.88 N/mm^2, 5.39 N/mm^2 and 5.23 N/mm^2 which much lower than the plain concrete 6.21 N/mm^2. The test results were tabulated as shown in Table 4 and it also represented in pictorially in Figure 7.

Figure 4. Split tensile strength

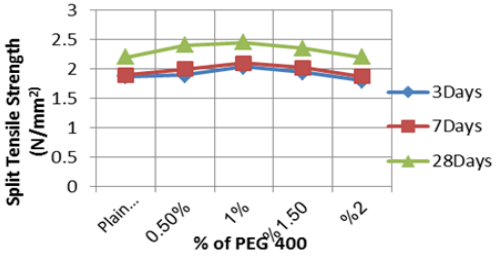

Figure 5. Compression between % PEG-400 and split tensile strength

Figure 6. Flexural strength.

TABLE 4. Average compressive, split tensile and flexural strength of concrete(miss placed)

Mix	Compressive Strength (N/mm^2) Days			Split Tensile Strength (N/mm^2) Days			Flexural Strength (N/mm^2) Days		
	3	7	28	3	7	28	3	7	28
Plain Concrete	18.96	27.25	39.89	1.87	1.9	2.2	4.9	5.39	6.21
PEG-400, 0.5%	19.83	28.56	41.63	1.9	2	2.4	5.72	6.04	6.54
1%	21.14	30.21	42.72	2.04	2.1	2.45	5.23	5.55	5.88
1.5%	16.13	28.12	39.67	1.94	2.02	2.35	4.74	5.06	5.39
2%	15.69	25.45	35.31	1.8	1.87	2.21	4.41	4.74	5.23

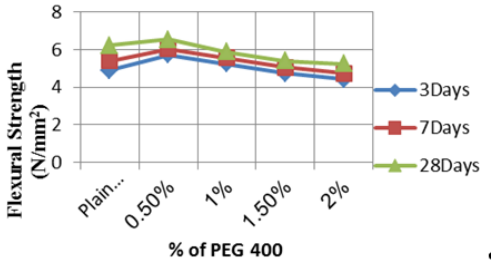

Figure 7. Compression between % PEG-400 and flexural strength

5. CONCLUSION

From the above experimental program and results obtained at KL University, the following conclusions are made

• The compressive strength value gets increased by adding 1% of PEG-400 and strength decreases by adding more than 1% of PEG-400.

• The split tensile strength value gets increased by adding 1% of PEG-400 and strength decreases by adding the more than 1% of PEG-400.

• The Flexural strength value gets increased by adding 0.5% of PEG-400 and strength decreases by adding more than 0.5% of PEG**.**

• It was observed 1% of the PEG-400 optimum ideal dosage of maximum compressive strength and split tensile strength **.**

• As the percentage of PEG-400 increase, the workability of concrete also increases and it was found by workability test**.**

• Self-curing concrete is the answer to where the scarcity of water is more**.**

• In the study cast cubes, cylinders and prisms were kept for curing at room temperature.

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چکیده

امروز بتن، به علت خواص قدرتی و ستبری آن، عمومی ترین ماده توسعه یافته استفاده شده در جهان است. برای رسیدن به قدرت خوب، پخت بتن مهم است، لذا ما مفهوم بتن خود درمان کننده را به جای غوطه وری یا نم نم درمان کننده برای جلوگیری از کمبود آب معرفی می کنیم. مشاهده شده است که پلیمرهای حلال آب می توانند به عنوان یک عامل خود درمان کننده یعنی پلی اتیلن گلیکول (PEG-400) استفاده شوند. در مطالعه حاضر، برای کشف اثر پلی اتیلن گلیکول (PEG-400)مخلوط روی قدرت فشرده سازی، مقاومت کششی و استحکام خمشی، اضافه کردن نرخ متنوعی از PEG-400 به وزن سیمان از صفر تا دو ٪ به عنوان اندازه گیری عامل پخت انجام شد. نتایج آزمون برای M30 مخلوط بتن مورد مطالعه قرار گرفت. درصد بهینه PEG-400، ۱٪ برای فشرده سازی و استحکام کششی تقسیم پیدا شد. اگر دوز مصرفی PEG-400 به بیش از ۱٪ افزایش یابد، در استحکام کششی فشاری و تقسیم کاهش وجود خواهد داشت. با این حال، درصد بهینه PEG-400 برای استحکام خمشی ۰/۵ درصد بود. اگر ما دوز PEG-400 را بیش از ۰/۵٪ افزایش دهیم، کاهش در قدرت استحکام خمشی وجود خواهد داشت.

***doi**: 10.5829/idosi.ije.2017.30.04a.03*