Research On Self-Curing Concrete Using Polyethylene 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. The use of self-curing admixtures is very important from the point of view that water resources are getting valuable every day. Polyethylene glycol in 0.3%, 0.6%, 0.9% and 1.2% place using concrete (i.e.; each 1m3 of concrete required about 3m3 of water for construction. Most of which is for curing Concrete are made up of M30 grade mix and tested for its compressive strength test, split tensile test and flexural test up to 7, 14 & 28 days of age and compared with conventional concrete.

Keywords: Self-curing concrete, Self-curing agent, Polyethylene Glycol (PEG-400), Water retention, Compressive strength, Workability, Saving of water.

Introduction – In the building business, concrete has shown to be the most versatile material. Due to its great compressive strength and longevity, it is the world's second most widely used material. It is a mixture of cement, fine aggregate, coarse aggregate, and water that requires curing to reach the requisite strength. When cement is mixed with water, it undergoes a hydration reaction, which is required for concrete to harden. Curing is the process of preventing concrete from becoming too dry during the hydration process. The curing effect has a significant impact on the qualities of hardened concrete, including increased durability, strength, volume stability, abrasion resistance, impermeability, and resistance to freezing. If water is not available, concrete shrinks, resulting in cracking. Unexpected shrinkage and temperature fissures can also compromise the concrete's strength, durability, and serviceability. In the realm of construction, concrete stands as a cornerstone material renowned for its versatility and durability. As the world's second most utilized substance, concrete's inherent strength and longevity make it indispensable for various infrastructure projects. Central to the process of many circumstances, practical concrete curing is not possible owing to a lack of sufficient water quality and a variety of other practical issues. Concrete technology has advanced rapidly during the last two decades. It is possible to construct a reasonably good fast track concrete mixture utilizing ordinary materials and admixtures. Self-Curing Agents can be used to achieve internally cured concrete. However, the traditional curing process often poses challenges, particularly in regions with limited water resources or where environmental conditions inhibit effective moisture retention. In such scenarios, the effectiveness of concrete can be compromised, leading to issues like reduced durability, increased permeability, and even structural defects due to inadequate hydration to address these challenges, advancements in concrete technology have paved the way for innovative solutions, such as self-curing agents. These agents, including water-soluble polyethylene glycol (PEG-400) studied in this research, offer a promising alternative by reducing water evaporation and enhancing moisture retention within the concrete matrix. This study focuses on evaluating the feasibility and effectiveness of incorporating polyethylene glycol as a self-curing agent in concrete mixtures. By varying the concentration of PEG-400

Literature review- Several studies on self-curing concrete using polyethylene glycol 400 have been undertaken in recent years. The work of various researchers have been studied and discussed below

Review of literature-

Roland Tak Yong Liang and Robert Keith Sun (2002) developed a glycol and wax-based concrete internal curing mixture. For the first time, the innovation provides an internal curing composition that meets the curing criteria of Australian Standard AS 3799 when applied to concrete or other cementitious mixtures.

Wen-Chen Jau (2011) developed self-curing concrete that collects water from the air and improves cement hydration. It uses a self-curing ingredient like poly-acrylic acid, which has a strong ability to absorb moisture from the air and provide the water required for concrete curing, to tackle the problem of low cement hydration due to lack of or improper curing

John Roberts et al. (2013) internal curing of pervious concrete was found to improve flexural and compressive strength . Except for internal curing, the internally cured regions received no poly protection or additional curing. The use of LWAS increased compressive and flexural strength by 150 and 200 percent, respectively. The preconditioned LWAS used meets ASTM C330 and C33 standards (except for gradation). Only the control slab underwent standard curing for 14 days with a 6 mm poly coating, and the replacements were 50, 100, and 150 pounds of LWAS per cubic yard. Material selection, technique execution, and adequate concrete preparation and curing all contribute to the attributes needed in Pervious Concrete used in infiltration systems PatelManish kumar Dahyabhai, Prof. Jayesh kumar Pitroda (2014) studied on "Introduction of self-curing concrete in the construction industry" was the subject of research. Selfcuring admixtures increase the compressive strength of self-curing concrete. In comparison to standard concrete, adding 1.0 percent PEG600 and 33.9 percent PEG1500 raised the compressive strength of the mix by 37 percent and 33.9 percent, respectively. For M25 concrete, the optimum dosage of PEG600 for maximal compressive strength was found to be 1% of cement weight. The optimum PEG1500 dosage for maximal compressive strength in M25 grade concrete was found to be 1% of cement weight. In the desert, self-curing concrete is the most effective solution to the problem of poor curing.

M. Manoj Kumar and D. Maruthachalam (2013) by self-curing. For this study, a fantastic permeable polymer was used as the self-curing M40 grade of concrete. This new study was cleared for release. The following conclusion was reached. In comparison to conservative concrete mixes, water preservation for selfcuring concrete mixes is higher. As determined by mass reduction over time. The best amount is 0.3 percent SAP lead to a significant increase in mechanical strength. There was a gradual increase in strength from 0.2 to 0.3 percent, followed by a gradual decrease. Self-cured concrete made with SAP was also less expensive than conventionally cured concrete. In the laboratory, cubes were cast and kept at room temperature for curative purposes.

L. Kalaivani, I. Santhiyaraj, A. Robin, S. Lochana Suganthi, T. Siva Santhi (2020) the purpose of this study is to look at the strength and durability of concrete made with water soluble polyethylene glycol as a self-curing agent. The purpose of a self-curing agent is to keep concrete from evaporating.Self-curing admixtures are essential, especially as water resources become increasingly important.

RESULT-

7-Days compressive strength results:

Sample 1

Sr. No.	Percentage of PEG-400	Weight	Compressive Strength [KN]
1	Conventional concrete (0%)	8.438	395.5
2	0.5%	8.586	368.5
3	1.0%	8.624	392.8
4	1.5%	8.410	399.6

Sample 2

Sr. No.	Percentage of PEG-400	Weight	Compressive Strength [KN]
1	Conventional concrete (0%)	8.203	436.1
2	0.5%	8.471	440.8
3	1.0%	8.332	394.7
4	1.5%	8.084	341.7

Sample 3

Sr. No.	Percentage of PEG-400	Weight	Compressive Strength [KN]
1	Conventional concrete (0%)	8.579	378.6
2	0.5%	8.358	349.7
3	1.0%	8.172	453.8
4	1.5%	8.434	379.8

28-Days compressive strength results :

Sample 1

Sr. No.	Percentage of PEG-400	Weight	Compressive Strength [KN]
1	Conventional concrete (0%)	8.438	621.4
2	0.5%	8.586	604.4
3	1.0%	8.624	659.9
4	1.5%	8.410	550.0

Sample 2

Sr. No.	Percentage of PEG-400	Weight	Compressive Strength [KN]
1	Conventional concrete (0%)	8.203	651.1
2	0.5%	8.471	625.4
3	1.0%	8.332	651.2
4	1.5%	8.084	598.7

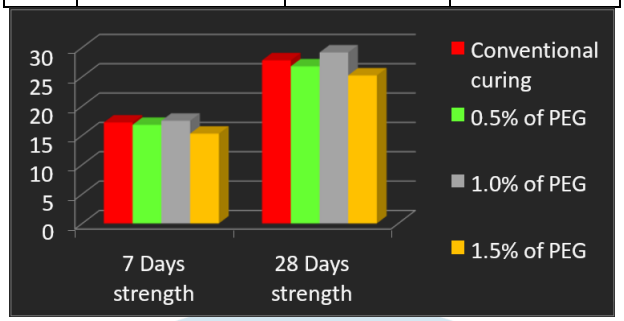
Sample 3

Sr. No.	Percentage of PEG-400	Weight	Compressive Strength [KN]
1	Conventional concrete (0%)	8.579	605.3
2	0.5%	8.358	631.5
3	1.0%	8.172	656.6
4	1.5%	8.434	555.2

Average Compressive strength results for self-curing concrete by using PEG-400

Sr. No.	Percentage of PEG-400	7 Days	28 Days
1	Conventional concrete (0%)	17.93	27.82
2	0.5%	17.17	27.57

3	1.0%	18.39	29.15
4	1.5%	16.61	25.23



OBJECTIVES-

Evaluate Self-Curing Agent Efficacy: Assess the effectiveness of water-soluble polyethylene glycol (PEG-400) as a self-curing agent in concrete by varying concentrations (0.3%, 0.6%, 0.9%, and 1.2%) within M30 grade concrete mixtures.

Measure Compressive Strength: Investigate the impact of PEG-400 on concrete's compressive strength at different curing ages (7, 14, and 28 days) compared to conventional concrete.

Compare Performance with Conventional Concrete: Conduct a comprehensive comparison between self-curing concrete and conventional concrete in terms of strength and durability properties to ascertain the viability of PEG-400 as a self-curing agent.

METHODOLOGY-

The study on self-curing concrete using polyethynol glycol. The function of self-curing concrete agent is used to reduce the water evaporation in the concrete. Self-curing admixtures are crucial since water resources are becoming

increasingly valuable every day. By using Poly ethylene Glycol improve the water content of mix concrete. We must determine the compressive and tensile strength of concrete by adding polyethylene glycol at various percentages.

MATERIALS AND METHODS

1. Cement In concrete, cement is a binding substance that holds the other materials together to produce a compact mass. OPC is commonly utilised for all engineering construction projects. All grades of OPC have a specific gravity of 3.15. OPC comes in three different grades. The cement utilised in this investigation is OPC 53 grade. The starting setting time for regular Portland cement is 32 minutes, while the final setting time is 600 minutes.

2. Aggregate Fine aggregate is sand, crushed stones, or crushed gravel with a size of less than 4.75 mm. The fine aggregate in this investigation is M sand. Fine aggregate has a specific gravity of 2.64. Fine aggregate has a fineness modulus of 2.85 and a unit weight of 1600kg/m3. The percentage of water absorbed is 3.5 percent. Zone III limits the grading of fine aggregate according to IS: 383-1970. Coarse aggregate is defined as material with a maximum size of 4.75 mm. The most common size of aggregate is 20 mm. The aggregate size used in this investigation is 20 mm. Coarse aggregate has a specific gravity of 2.66. The fineness modulus is 6.5, and the coarse aggregate unit weight is 1600kg/m3. 0.5 percent of water is absorbed.

3. Polyethylene Glycol 400 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 oxyethylene groups typically from 4 to about 180. The abbreviation (PEG) is termed in combination with a numeric suffix which indicates the average molecular weights. 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.

4. Mix Proportion M30 grade of design mix according to IS 10262 was utilized in this research. The cement, fine aggregate, and coarse aggregate proportions in the concrete mix are 1: 1.50: 2.55 by volume, with a water cement ratio of 0.45

Table-1: Mix proportion

W/C Ratio	Cement	Fine Aggregate	Coarse Aggregate
0.45	1	1.50	2.55

5. Casting and Curing Casting and Curing Detail: Polyethylene Glycol were added in concrete in step of 0.3 % (0%, 0.3%, 0.6%, 0.9% ,1.2%).For each percent of polyethylene glycol by replacing water, 3 cubes, 3 cylinders and 3 prism were casted for 7 days and 28 days and additionally 1 beam were casted. Final strength of cube, cylinder and beam were tested after 7& 28 days self-curing.

TEST PROCEDURE-

Compression Test The cube specimens were put through their paces on a 3000KN compression testing equipment. The machine's bearing surface was cleaned, and sand or other debris was removed from the specimen's surface. The specimen was put in the machine so that the load was applied to the cubes' opposite sides as casted, rather than top and bottom. The specimen's axis was precisely positioned at the loading frame's centre. The load was increased at a consistent rate until the specimen's resistance to the growing load broke down and it could no longer be sustained. On the specimen, the maximum load was recorded. Compressive stress was calculated as follows Compressive strength = P/A x 1000 Where, P = Load in KN A = Area of cube

Future Scope –

Optimization of Self-Curing Agent Concentrations: Further research can focus on optimizing the concentration of polyethylene glycol (PEG-400) to achieve the ideal balance between water retention and concrete strength. Exploring a wider range of concentrations and their impact on concrete properties can provide valuable insights for practical implementation.

Long-Term Durability Studies: Conduct long-term durability studies to assess the performance of self-curing concrete containing PEG-400 under various environmental conditions, including exposure to freeze-thaw cycles, chemical attack, and aging. Understanding the material's durability over extended periods is essential for its widespread adoption.

Compatibility with Different Cement Types: Investigate the compatibility of PEG-400 with different types of cement (e.g., Portland cement, blended cement) and supplementary cementitious materials (e.g., fly ash, slag) to assess its applicability across diverse concrete formulations.

CONCLUSION-

In conclusion, the investigation into self-curing concrete utilizing water-soluble polyethylene glycol (PEG-400) as a curing agent presents promising advancements in concrete technology aimed at addressing challenges associated with traditional curing methods, particularly in regions with water scarcity or environmental constraints.

Through a comprehensive evaluation of concrete properties, including compressive strength, split tensile strength, and flexural strength over various curing periods (7, 14, and 28 days), this study has demonstrated the potential benefits of incorporating PEG-400 to enhance water retention and mitigate water evaporation during concrete curing processes.

The findings from this research indicate that varying concentrations of PEG-400 (0.3%, 0.6%, 0.9%, and 1.2%) in M30 grade concrete formulations contribute to improved durability and strength characteristics compared to conventional concrete. Notably, self-curing concrete formulations exhibit enhanced performance attributes such as increased compressive strength and reduced permeability, which are crucial for achieving durable and sustainable construction materials.

The literature review highlights previous studies that have explored self-curing concrete technologies, showcasing innovations in internal curing compositions and materials that collect water from the air to facilitate cement hydration. These advancements underscore the growing interest

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