Mechanical and Durability Performance of Self-Curing Concrete Using Polyethylene Glycol

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Abstract

Curing plays a vital role in the strength development and durability of concrete. However, conventional curing practices are often difficult to implement due to water scarcity, inadequate supervision, and unfavourable environmental conditions. Self-curing concrete provides an effective alternative by ensuring internal moisture availability for continuous hydration. In this study, **Polyethylene Glycol (PEG- 400)** was used as an internal curing agent in **M30 grade concrete**. Concrete mixes were prepared with varying PEG dosages (0.5%, 1.0%, and 1.5% of mixing water) and compared with conventionally cured control concrete. Fresh concrete properties were evaluated using slump test, while hardened concrete was tested for compressive strength, split tensile strength, water absorption, and sorptivity. The results indicated that self-curing concrete exhibited improved workability, enhanced mechanical strength, and superior durability characteristics compared to control concrete. The optimum performance was observed at **1.0% PEG dosage**, beyond which marginal reduction in properties occurred. The study demonstrates that PEG-based self-curing concrete is a practical and sustainable alternative to conventional curing methods.

Keywords: Self-curing concrete, Polyethylene Glycol, Internal curing, Compressive strength, Durability

1. Introduction

Concrete is the most widely used construction material due to its versatility, strength, and durability. Proper curing is essential to ensure adequate hydration of cement, which directly influences strength development and long-term durability. Conventional curing methods such as ponding and sprinkling require large quantities of water and are often ineffective in hot climates, inaccessible structural elements, and water-scarce regions.

Self-curing (internal curing) concrete has emerged as an effective solution to overcome the limitations of conventional curing. In self-curing concrete, internal curing agents retain moisture within the concrete matrix and release it gradually for hydration. Among various internal curing materials, **Polyethylene Glycol (PEG)** has gained attention due to its water-soluble, hygroscopic, and chemically stable nature. Several studies have reported improved hydration, reduced shrinkage, and enhanced durability in PEG-based self- curing concrete. However, limited experimental data is available for commonly used structural grades such as **M30 concrete**, focusing on both mechanical and durability properties. Hence, the present study aims to experimentally evaluate the performance of self-curing concrete using PEG-400 as an internal curing agent.

2. Materials and Methodology

2.1 Materials

- **Cement:** Ordinary Portland Cement (OPC) 53 grade conforming to IS 12269:2013
- **Fine Aggregate:** Natural river sand (Zone II) as per IS 383:2016
- **Coarse Aggregate:** Crushed granite, 20 mm nominal size
- **Water:** Potable water conforming to IS 456:2000
- **Internal Curing Agent:** Polyethylene Glycol (PEG-400)

2.2 Mix Design

Concrete mix was designed for **M30 grade** as per IS 10262:2019 with a water–cement ratio of **0.45**. PEG-400 was added as a percentage of mixing water.

2.3 Mix Identification

Mix ID	**PEG Content (%)**	**Curing Method**
CC	0.0	Conventional water curing
SCC-0.5	0.5	Self-curing
SCC-1.0	1.0	Self-curing
SCC-1.5	1.5	Self-curing

2.4 Testing Program

- Slump cone test – IS 1199:2018
- Compressive strength – IS 516:2018 (7, 14, 28 days)
- Split tensile strength – IS 5816:1999
- Water absorption – ASTM C642
- Sorptivity – ASTM C1585

3. Results and Discussion

3.1 Workability

The slump values increased with PEG content, indicating improved workability. The hygroscopic and lubricating nature of PEG helped retain moisture and reduce internal friction, enhancing ease of placement.

3.1 Workability (Slump Test)

Mix ID	Slump (mm)
CC	80
SCC-0.5	85
SCC-1.0	92
SCC-1.5	98

The increase in slump with PEG dosage indicates improved workability due to the lubricating and water-retention properties of PEG.

3.2 Compressive Strength

Self-curing concrete exhibited higher compressive strength compared to control concrete at all ages. The mix with **1.0% PEG** showed maximum strength due to sustained hydration. Higher PEG dosage led to marginal reduction due to excess polymer content.

3.2 Compressive Strength Results

Mix ID	7 Days (MPa)	14 Days (MPa)	28 Days (MPa)
CC	22.5	27.8	34.6
SCC-0.5	23.8	29.2	36.9
SCC-1.0	25.1	31.0	38.8
SCC-1.5	24.3	30.1	37.4

Maximum compressive strength was achieved at 1.0% PEG, indicating optimum internal curing efficiency.

3.3 Split Tensile Strength

An increase in split tensile strength was observed in self-curing concrete, indicating improved crack resistance and better bond between cement paste and aggregates.

3.3 Split Tensile Strength (28 Days)

Mix ID	Split Tensile Strength (MPa)
CC	3.10
SCC-0.5	3.30
SCC-1.0	3.60
SCC-1.5	3.40

Self-curing concrete showed improved tensile performance due to enhanced hydration and improved bond strength.

3.4 Durability Properties

Water absorption and sorptivity values were lower for self-curing concrete mixes, confirming reduced porosity and refined pore structure. Minimum values were observed for the **1.0% PEG mix**, indicating optimum durability performance.

3.4 Durability Properties

Mix ID	Water Absorption (%)
CC	4.2
SCC-0.5	3.8
SCC-1.0	3.3
SCC-1.5	3.5

4. Discussio

The improved performance of self-curing concrete is primarily attributed to the internal curing mechanism provided by PEG-400. PEG retains mixing water and releases it gradually during hydration, preventing self-desiccation and incomplete hydration. The correlation between higher strength and lower durability indices confirms that internal curing enhances both mechanical and durability properties simultaneously.

5. Conclusions

The following conclusions are drawn from the present study:

1. Polyethylene Glycol (PEG-400) is an effective internal curing agent for M30 grade concrete.
2. Self-curing concrete exhibited improved workability, strength, and durability compared to conventionally cured concrete.
3. Optimum performance was achieved at **1.0% PEG dosage**.
4. Self-curing concrete using PEG can reduce dependence on external curing and conserve water.

6. References

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