ECOFRIENDLY SELF CURING CONCRETE USING POLYETHYLENE GLYCOL 600 AND GGBS

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Introduction: Curing is a critical process in concrete construction that ensures proper hydration of cement, leading to the development of desired mechanical properties such as strength, durability, and impermeability. It involves maintaining adequate moisture content and temperature in the concrete immediately after placing and finishing. Proper curing enhances resistance to abrasion, freezing and thawing, and improves volume stability. Traditional curing methods consume large quantities of water, raising sustainability concerns. As an alternative, self-curing (internal curing) utilizes water-retentive agents like water-soluble polymers to retain moisture within the concrete matrix, promoting continuous hydration even in arid conditions. Factors such as ambient temperature, humidity, wind velocity, water-cement ratio, and cement type influence the curing effectiveness. While high temperatures accelerate early strength gain, they may compromise long-term strength. Therefore, controlled curing conditions are essential to ensure the longevity and performance of concrete structures.

Objectives:

1. To compare and study of fresh concrete properties of Self-Curing concrete over conventional concrete by varying % of self-curing agent.
2. To evaluate mechanical properties of concrete (i.e. compressive, tensile, and flexural strength) by varying percentages of PEG 600(0.5%,1%,1.5%) and GGBS

(10%,20%,30%).

3. To design the mix for M30 grade concrete for the percentage replacement of cement by GGBS and PEG600.

Methodology: The methodology worked out to achieve the objectives is followed as shown in the flow chart below

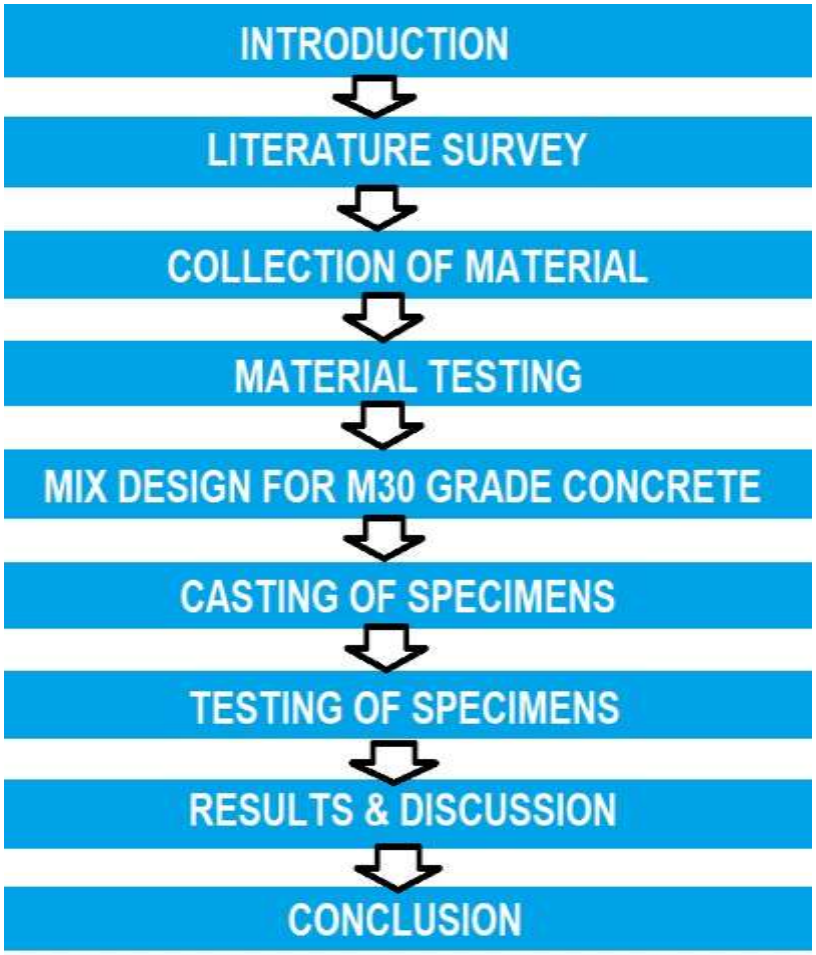

Fig 1: flowchart of methodology

In this project, Polyethylene glycol 600 is purchased from Bengaluru and ggbs from ballari and M30 grade concrete was designed as per IS 10262:2019. Cement was partially replaced with GGBS at 10%, 20%, and 30% levels, and Polyethylene Glycol 600 (PEG 600) was added at 0.5%, 1.0%, and 1.5% dosages by weight of cementitious material. Dry materials were mixed first, followed by water mixed with PEG 600 to ensure uniform distribution. Concrete specimens were cast and the control mix was conventionally water-cured, while PEG 600 mixes were self-cured under

ambient conditions. Workability (slump test) and mechanical properties (compressive, split tensile, and flexural strength) were evaluated at 7, and 28days. Results compared with conventional concrete to identify the optimum GGBS and PEG 600 combination for strength, and self-curing performance.

Fig 2: Casting of specimen

Fig 3: Curing of specimen

Result and discussion:

Sl. No.	Percentage of GGBS replaced to the cement	Percentage of PEG- 600 replaced to the cement	Compressive Strength (N/mm²) at 7 days		Compressive Strength (N/mm²) At 28 days	
			Water Curing	Self-curing	Water Curing	Self-curing
1	10%	0.5%		19.6		32.2

2	20%	1%	18.2	16.2	30.28	27.4
3	30%	1.5%		14.3		22.8

Sl. No.	Percentage of GGBS replaced to the cement	Percentage of PEG- 600 replaced to the cement	Tensile Strength (N/mm²) at 7 days		Tensile Strength (N/mm²) At 28 days	
			Water Curing	Self-curing	Water Curing	Self-curing
1	10%	0.5%		2.7		2.91
2	20%	1%	2.21	2.5	2.4	2.68
3	30%	1.5%		2.2		2.46

1.Compressive strength

2.Split tensile strength

3.Modulus of rupture

Sl. No.	Percentage of GGBS replaced to the cement	Percentage of PEG- 600 replaced to the cement	Flexural Strength (N/mm²) at 7 days		Flexural Strength (N/mm²) At 28 days	
			Water Curing	Self-curing	Water Curing	Self-curing
1	10%	0.5%		7.12		7.56

2	**20%**	**1%**	**2.56**	**5.3**	**3.83**	**7.2**
3	**30%**	**1.5%**		**4.24**		**7.03**

In conclusion,

1.With use of 0.5% of self-curing agent polyethylene glycol 600 show higher compressive strength for replacement of cement with 10% GGBS for M30 grade of concrete.

2.The optimum dosage of PEG 600 for maximum tensile and flexural strength was found to be 0.5% of weight of cement for M30 grade of concrete.

3.When compared with water curing of concrete, self-curing concrete showed increased flexural and tensile strength at 7 and 28 days of testing of concrete for M30 grade of concrete.

4.For M30 grade concrete with 0.5% of polyethylene glycol 600 an increase of 1.4% for 7 days curing and 1.92% for 28 days curing of compressive strength and for 1.0% and 1.5% of self-curing agent used to decrease of 3.9% for 7days curing, 2.88% for 28 days of curing and 2% for 7days curing, 7.48% for 28 days curing respectively of compressive strength is observed when compared with water cured concrete.

5.Self-curing concrete is a sustainable and sufficient solution for concrete construction, offering numerous benefits over traditional methods. Its ability to self-cure without external water makes it a valuable tool for reducing water consumption and improving the overall quality of concrete structures.

Project Outcome & Industry Relevance

Eco-friendly self-curing concrete using PEG-600 and GGBS results in improved hydration, reduced water demand, lower shrinkage, and enhanced durability. The use of GGBS decreases the carbon footprint and increases long-term strength, while PEG-600 ensures continuous internal curing, leading to better microstructural density and extended service life of structures.

This concrete is highly applicable in water-scarce regions, large infrastructure projects, and sustainable construction initiatives. It supports green building certifications and environmentally responsible construction.

Working Model vs. Simulation/Study:

This project involved the development of a physical working model. Self-cured concrete blocks and conventional concrete blocks were manually prepared, self-cured in normal room temperature and conventional concrete in water tank and tested in the laboratory for compressive strength, split tensile strength and modulus of rupture and durability making it an experimental study based on real working model.

Project Outcomes and Learnings:

1. Cost-effectiveness: Using GGBS (which is cheaper than cement) and reducing curing water and labour costs led to overall economic benefits**.**

2. Enhanced Strength and Durability: Concrete mixes with PEG 600 and GGBS showed comparable or improved compressive and tensile strength compared to conventional concrete after 7and 28 days.

3. Reduced Water Usage: Significant reduction in water consumption was achieved, promoting eco-friendly construction practices especially in water-scarce regions.

4. Improved Workability: The addition of PEG 600 slightly improved the workability of concrete mixes, making placement and finishing easier.

5. Lower Carbon Footprint: Partial replacement of cement with GGBS (a waste by-product) reduced overall CO_2 emissions associated with cement production.

Future Scope:

The future scope of this project includes:

1. Self- Curing concrete is an alternative to conventional concrete in desert regions where scarcity of water is a major problem. It should be necessary to check the temperature effect in desert regions.

2. Further investigation is to be done on different hydrophilic polymers for selecting self-curing agents w.r.t strength and durability of concrete.

3. The effect of self-curing agent on the microstructure and pore size distribution of the self-curing concrete requires additional study.

4. Structural properties, shrinkage characteristics, creep characteristics of self-curing concrete need to be investigated.

5. Performance of the self-curing agent is affected by the mix proportions, mainly the cement content and the w/c ratio.

6. Further in-depth investigation is to done for choosing optimum dosage of self-curing agent in strength and durability point of view.