e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:07/Issue:02/February-2025 Impact Factor- 8.187 www.irjmets.com

ASSESSING THE PERFORMANCING OF SELF CURING CONCRETE OF CONTAINING GRANITE WASTE

Megharaj B*[1], Kiran J*[2], Lavakumara AR*[3], Kumarijayalakshmi BR*[4], Prof. Shankar GS*[5]

*[1,2,3,4]Students, Civil Engineering, SJM Institute Of Technology, Chitradurga, Karnataka, India.

*[5]Assistant Professor, Civil Engineering, SJM Institute Of Technology, Chitradurga, Karnataka, India.

ABSTRACT

Concrete's widespread use in construction is accompanied by environmental concerns, including high carbon emissions from cement production and depletion of natural aggregates. This study explores self-curing concrete incorporating granite waste as a sustainable alternative. Self-curing concrete enhances hydration through internal curing agents like PEG 400, reducing external water curing needs. The research evaluates workability, mechanical properties, and durability by conducting compressive, split tensile, and flexural strength tests over 7, 14, and 28 days. Results indicate that replacing fine aggregates with granite waste improves strength characteristics. The addition of PEG 400 further enhances compressive strength, with a maximum of 39.5 N/mm^2 at 28 days for 100% granite replacement. Similarly, split tensile and flexural strengths show significant improvement, with PEG 400-modified mixes achieving the highest values. The findings demonstrate that self-curing concrete with granite waste meets modern construction standards, offering an eco-friendly, durable, and high-performance alternative to traditional concrete.

Keywords: Self-Curing Concrete, Granite Waste, Compressive Strength, Split Tensile Strength, Flexural Strength, Sustainable Construction.

I. INTRODUCTION

Concrete is one of the most essential construction materials globally, valued for its strength, durability, and adaptability. However, traditional concrete production poses significant environmental concerns, primarily due to the high carbon emissions from cement manufacturing and the extensive depletion of natural aggregates. Addressing these challenges is crucial for advancing sustainable construction practices. One promising innovation in this field is **Self-Curing Concrete (SCC)**, which enhances hydration and strength by retaining internal moisture, thereby reducing the need for external water curing.

Another sustainable approach involves the **utilization of granite waste** as a partial replacement for fine aggregates in concrete. The granite industry generates large quantities of waste, which, if not properly managed, contributes to environmental degradation. Incorporating this waste into concrete offers an eco-friendly solution, reducing landfill accumulation and conserving natural resources while improving the mechanical properties of the mix.

Recent research highlights the effectiveness of **self-curing agents like Polyethylene Glycol 400 (PEG 400)** in enhancing hydration, reducing shrinkage, and improving workability. Studies have also shown that using granite waste in concrete improves its compressive and flexural strength while lowering overall costs. By integrating self-curing techniques with sustainable materials, this study aims to assess the viability of **Self-Curing Concrete with Granite Waste** as a durable and eco-friendly alternative to conventional concrete. The findings will contribute to the development of innovative, high-performance, and environmentally responsible concrete technologies for modern construction.

II. METHODOLOGY

Collection of Materials

Granite waste is collected from stone-cutting and quarrying industries and processed for use as a partial replacement for coarse aggregates in concrete. The cement, fine aggregates, and PEG-400 (self-curing agent) are sourced as per IS specifications.

Characterization of Materials

The materials are analyzed for physical and chemical properties to ensure suitability in concrete mix design. The following tests are performed:

- Sieve Analysis (IS 2386:1963) – Determines particle size distribution of aggregates.

- Specific Gravity Test (IS 2720 Part 3:1980) – Assesses density variations in aggregates.
- Water Absorption Test (IS 2386 Part 3:1963) – Evaluates porosity and moisture retention.
- Cement Properties (IS 4031:1988) – Checks consistency, setting time, and compressive strength.

Mix Design as per IS 10262:2019

The M30 grade of concrete is designed following IS 10262:2019. Various mix proportions are prepared, incorporating 50% and 100% granite waste replacement for coarse aggregates. The mix includes Polyethylene Glycol (PEG-400) for self-curing.

Workability Assessment

Workability is assessed using:

- Slump Cone Test (IS 1199:1959) – Measures concrete's flowability.
- Compaction Factor Test (IS 5515:1983) – Determines compactibility of concrete mix.

Curing of Concrete Specimen

- Self-Curing: PEG-400 is added at 0.5% by weight of cement for internal curing.
- Conventional Water Curing: Specimens are submerged in water for comparison.

Testing of Concrete Specimens

- Concrete specimens are tested at 7, 14, and 28 days for strength and durability:
- Compressive Strength Test (IS 516:1959) – Evaluates load-bearing capacity.
- Flexural Strength Test (IS 516:1959) – Determines bending resistance.
- Split Tensile Strength Test (IS 5816:1999) – Measures tensile strength.
- Permeability Test (IS 3085:1965) – Assesses concrete's resistance to water penetration.

Results and Discussion

The results are analyzed to compare the mechanical properties and permeability of self-curing concrete with granite waste replacement against conventional concrete. The impact of PEG-400 and granite waste on strength, durability, and workability is discussed.

III. MODELING AND ANALYSIS

TESTS ON HARDENED CONCRETE

a) Compressive Strength Test:

- Concrete cube specimens were tested at **7, 14 and 28 days** of curing.
- Specimens were positioned correctly and secured in the compression testing machine.
- The loading rate was set based on cube size:
  - **5 KN/sec** for **150 mm** cube
  - **2.5 KN/sec** for **100 mm** cube
- The test commenced by applying load gradually until cracks appeared.
- Results were recorded, and average compressive strength was computed.

Formula: Compressive Strength= P/A

Where,

P = Maximum applied load

A = Area of the cube

Table 1: Compressive Strength Test Parameters

Cube Size	Loading Rate (KN/sec)
150 mm	5
100 mm	2.5

b) Split-Tensile Strength Test:

- Three cylindrical specimens (**100 mm diameter, 200 mm height**) were tested at **7, 14, and 28 days**.
- A **Universal Testing Machine (1000 kN capacity)** was used.
- The load was applied at a controlled rate of **1.2–2.4 N/mm²/min**.
- Specimens were carefully aligned on a steel plate before testing.
- Load was applied until cracks formed along the specimen's length.
- The maximum force recorded was used to calculate split-tensile strength.

Formula: $FS = 2P / \pi d L$

Where,

P = Maximum applied load

d = Diameter of the cylinder

L = Measured depth of the specimen

Table 2: Split-Tensile Strength Test Parameters

Cylinder Diameter	Cylinder Height	Load Rate (N/mm²/min)
150 mm	300 mm	1.2 - 2.4

c) Flexural Strength Test:

- Beam specimens (**100 mm x 100 mm x 500 mm**) were tested at **7, 14, and 28 days**.
- Specimens were positioned so that stress was applied along two lines **200 mm (or 130 mm) apart**.
- Proper alignment ensured uniform stress distribution.
- The load was applied continuously at **0.7 N/mm²/min** until failure.
- The flexural strength was calculated using:

Formula: $MR = PL/bd^2$

Where:

P = Maximum applied load

b = Measured width of the specimen

d = Measured depth of the specimen

L = Measured length of the specimen

Table 3: Flexural Strength Test Parameters

Beam Width	Beam Depth	Beam Length	Stress Rate (N/mm²/min)
100 mm	100 mm	500 mm	0.7

Figure 1: Testing the specimens

Mix Design:

The concrete is designed for M30 grade by using the procedure as per Indian standard (IS10262:2009). This proportion is used to prepare the samples. The mix proportions are shown in table.

Table 4:

MIX PROPORTIONS		
1	Cement	= 344 kg/m^3
2	Water	= 165kg/m^3
3	Fine aggregate	= 818 kg/m^3
4	Coarse aggregate	= 542 kg/m^3
5	Granite pieces	= 516 kg/m^3
6	Chemical admixture	= 1.72 kg/m^3
7	Water-Cement ratio	= 0.43

Table 5:

For 50% replacement			
Cement	**C.A**	**Granite**	**F.A**
1	**1.58**	**1.5**	**2.38**

Table 6:

For 100% replacement		
Cement	**C.A**	**F.A**
1	**3.08**	**2.38**

IV. RESULTS AND DISCUSSION

1. Compressive Strength

The compressive strength test was conducted on six samples for each mix proportion, and the obtained values are shown in Table 1. The comparison of strength at 7, 14, and 28 days is illustrated in Chart 1.

Table 6: Compressive Strength of Conventional vs. Self-Curing Concrete

Sl no	Cementitious material	Compression strength N/mm^2		
		7days	14days	28days
1	50% (CA+Granite)	25.42	27.7	38.3
2	50%(CA + Granite)+PEG400	28.49	35.84	39.3
3	100% (CA + Granite)	27.65	30.67	38.6
4	100% (CA+Granite)+PEG400	34.66	39.2	39.5

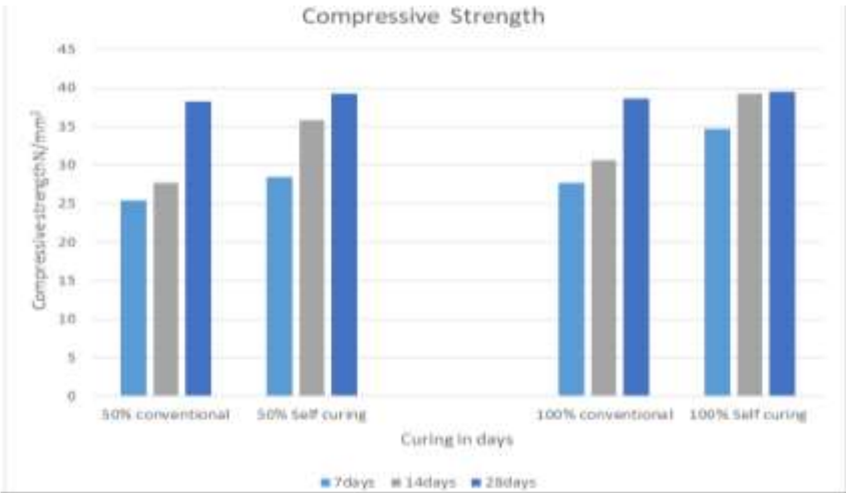

Chart 1: Compressive Strength of Concrete Cubes

2. Split Tensile Strength

The split tensile strength test results for various mix proportions at 7, 14, and 28 days are presented in Table 2. A comparison of split tensile strength values is shown in Chart 2.

Table 7: Split Tensile Strength of Conventional vs. Self-Curing Concrete

Sl no	Cementitious material	Split tensile strength N/mm²		
		7days	14days	28days
1	50% (CA+Granite)	1.38	2.6	3.76
2	50%(CA + Granite)+PEG400	2.86	3.38	3.8
3	100% (CA+Granite)	1.3	2.56	3.74
4	100% (CA+Granite)+PEG400	2.14	2.67	3.82

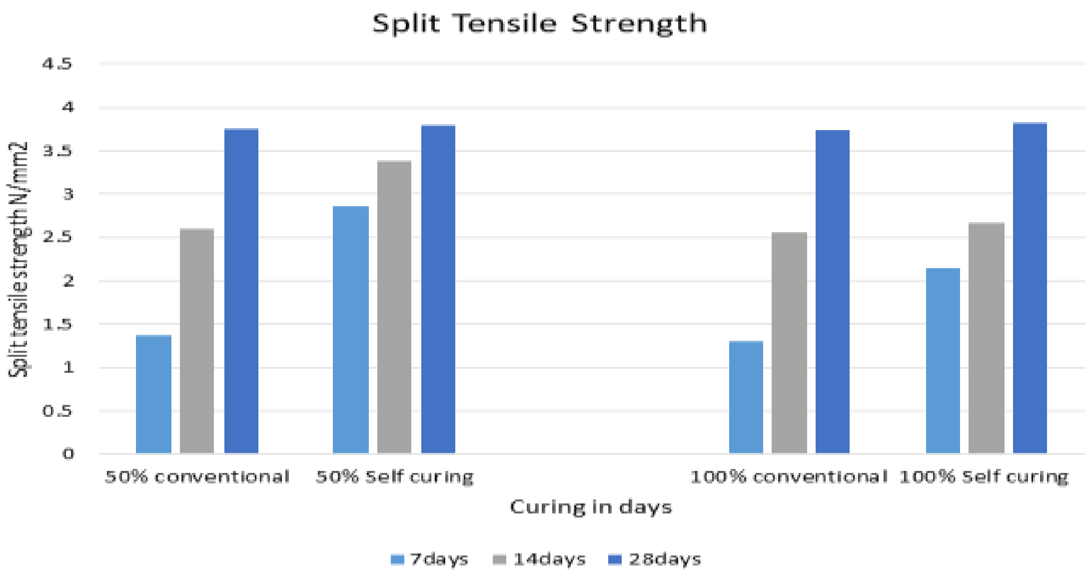

Chart 2: Split Tensile Strength Comparison

3. Flexural Strength Test for Beams

In the second phase, flexural tests were conducted on beams based on the optimum results obtained from the compressive strength test. A comparative study between the optimal replacements and conventional concrete was performed.

The aim of this test is to evaluate the flexural behaviour and splitting tensile strength of the beams. Tests were conducted using a loading frame with an 800 KN capacity. The beams were simply supported, and two-point loading was applied. Mountable mechanical strain gauges measured strains, while LVDTs recorded deflection. Load cells were used for load calculations. The load was applied in increments of 5 KN, and deflection readings were recorded until failure.

Table 8: Flexural Strength of Conventional vs. Self-Curing Concrete

Sl no	Cementitious material	Flexural strength N/mm²		
		7days	14days	28days
1	50% (CA+Granite)	3.52	3.69	4.34
2	50%(CA + Granite)+PEG400	3.74	4.19	4.39
3	100% (CA+Granite)	3.69	3.88	4.35
4	100% (CA+Granite)+PEG400	4.14	4.38	4.4

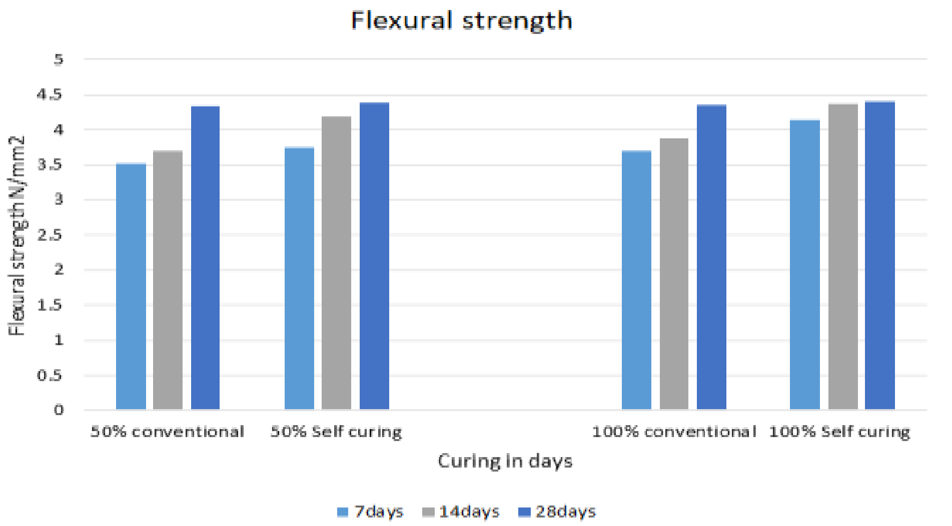

Chart 3: Flexural Strength Comparison

V. CONCLUSION

This study evaluated the performance of self-curing concrete with the partial replacement of coarse aggregates by granite waste. The research findings indicate that incorporating granite waste in concrete provides a sustainable solution by reducing environmental impact and improving mechanical properties. The use of self-curing agents, particularly polyethylene glycol (PEG 400), enhanced the hydration process, leading to better strength and durability characteristics.

Key observations from the study include:

- The inclusion of PEG 400 significantly improved the compressive, split tensile, and flexural strengths compared to conventional curing methods.
- The optimal replacement percentage of coarse aggregates with granite waste was found to be 50%, beyond which the strength properties began to decline.
- Self-curing concrete exhibited improved workability, reduced shrinkage, and enhanced durability, making it suitable for applications where conventional water curing is challenging.
- The sustainability benefits of utilizing granite waste contribute to eco-friendly construction by minimizing landfill waste and conserving natural resources.

The findings align with previous research, reinforcing that self-curing techniques using PEG 400 effectively retain internal moisture, improving long-term performance. Future studies can explore additional admixtures, extended durability assessments, and large-scale practical applications to further validate the feasibility of self-curing concrete with granite waste in the construction industry.

VI. REFERENCES

[1] Pooja Ahire, et al. (2024) “Partially Replacement of Aggregate in Concrete with Granite” IJSSSR, Vol. 4

[2] Prof. K. A. Salunke, et al. (2023) Conducted study on “Use of Granite Waste for the Application as Coarse Aggregate in Concrete”., IJTSRD, Vol 7

[3] P. Pallavi, et al. (2023) Has worked on “Self curing Concrete”, IRJET, Vol 10

[4] Varakala Harish. (2021) Has worked on “Experimental Investigation On Self Curing of Concrete with Polyethylene Glycol”, www.sathyabama.ac.in,

[5] Rayees Ali Khan et al. (2020) Has worked on “Strength and durability of self-curing concrete developed using calcium lignosulfonate” Science direct.

[6] A. Ananthi et al. (2017) Has worked as “Experimental Study on the Properties of Self-Curing Concrete”, Journals Pub, Vol. 3 (3)

[7] R. Siva Kumar et al. (2016) Conducted on study “An Experimental study on partial replacement for coarse aggregate by Granite Waste”, IJIRSET, Vol. 3(3)