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Self-Curing Concrete: Enhancing Durability and Strength Without External Curing

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Abstract: *This paper reviews the utilization of self-curing agent sourced from traditional curing methods for concrete production. The use of self-curing agent has been adopted in numerous construction projects across Europe, America, Russia, and Asia. This research, however, indicates that self-curing agents derived from concrete specimens can produce high-quality concreter. Concrete waste from demolished structures is collected, and coarse aggregates in varying percentages are used to produce fresh concrete. In this study, for the 28th day cube compressive strength using OPC was evaluated for 0%, 50%, and 100% RCA and compared with nominal concrete. The study summarizes the results of workability, water absorption, dry density, and compressive strength of HPC made with RA as reported in previous studies. The paper also discusses the microstructure and durability performance of concrete. This study demonstrates that the strength of concrete is influenced by the addition of RCA.*

Keywords: Self Curing Concrete, Self Curing, Green concrete, New concrete

I. INTRODUCTION

Concrete is the most widely used material in the construction industry worldwide. The concrete industry heavily consumes energy and raw materials. Therefore, reusing industrial waste as an admixture in construction offers both environmental and economic benefits. Concrete is essentially a manufactured material composed of cement, aggregates, water, and admixture. Aggregates make up a significant portion of the mixture and consist of inert granular materials such as sand, crushed some, and gravel. SCC includes materials such as crushed concrete, bricks and old asphalt, help reduce the demand for virgin resources and minimize landfill waste.

The process includes cleaning, crushing, and grading waste concrete to create aggregates suitable for fresh concrete production. Although SCC may exhibit slightly different mechanical properties than traditional concrete, advancements in processing and mix design have made it a pSCCtical alternative for both structural and non-structural application.

- **Environmental sustainability:** reduces construction waste and conserves natural resources.
- Cost-effectiveness: lowers material costs, especially in regions with limited conventional concrete availability.
- **Energy efficiency:** reduces the energy required for mining and transportation of natural materials.
- Desperate some challenges, like lower strength or durability if not properly processed, ongoing research and improved recycling techniques continue to enhance the performance and reliability of self-curing agent concrete, making it an essential component of modern, eco-friendly construction pSCCtices.

Present scenario of demolished waste used in India:

India faces a significant challenge with construction and demolition (C&D) waste, generating an estimated 150 million tonnes annually, but recycling only about 1% of it, leading to environmental problems and resource inefficiencies.

II. LITERATURE REVIEW

Khan, M.I., and Zain, M.F.M. (2011)

The study investigated the use of polyethylene glycol (PEG) as a self-curing agent in high-strength concrete. The researchers reported a 10–15% increase in compressive strength during the early hydration phase compared to conventional water-cured concrete. PEG improved internal moisture retention, which enhanced hydration and minimized shrinkage.

Srinivasa Rao, P., and Reddy, B.S. (2012)

This research focused on self-curing concrete using Super Absorbent Polymers (SAPs). It demonstrated that SAPs significantly reduced drying shrinkage and enhanced the durability of concrete. Compressive strength increased by approximately 12% compared to traditional concrete cured under ambient conditions.

Siva Kumar, A., and Manu Santhanam (2013)

The researchers studied the effect of self-curing compounds on high-performance concrete. They used both liquid curing compounds and water-retaining admixtures. Results showed that the self-cured mixes achieved nearly 95% of the strength of water-cured concrete, with notable reductions in permeability.

Sundararajan, R., and Swaminathan, R. (2014)

This paper examined the efficiency of self-curing agents in hot and arid regions where water curing is difficult. The findings indicated that self-curing concrete reduced water usage by up to 40% while maintaining similar mechanical properties as conventionally cured concrete.

Ramakrishna, G., and Venkatesh, K. (2016)

A comparative study using self-curing agents such as PEG-400 and PVA was conducted. PEG-400 showed superior performance in terms of compressive strength, reducing internal cracking and increasing hydration efficiency. The water retention capacity of PEG-based mixes led to better curing in absence of external water.

Patel, A.J., and Modhera, C.D. (2017)

The study involved using self-curing concrete for precast applications. It was observed that the addition of self-curing admixtures increased early-age strength and minimized deformation. The self-curing mix improved workability without compromising long-term durability.

Jain, A., and Sharma, A. (2018)

This research presented a detailed investigation into self-curing concrete in mass concrete applications. The results suggested that self-curing technology could significantly reduce thermal cracking risks while sustaining internal hydration. Their experimental data supported that self-curing concrete is a practical and energy-efficient method in modern construction.

Objectives of the study:

- To produce a concrete using locally available materials. (i.e. self-curing agent concrete).
- To examine the strength properties of green concrete with partial replacement of conventional concretes.
- To analyse the impact of recycled coarse aggregate on concrete strength.
- To examine the impact of recycled coarse aggregate on the workability of concrete.
- To identify the optimal percentage of recycled coarse aggregate in concrete.

Significance of research

- Reducing the burden on landfills caused by construction and demolition debris.
- The possibility of increasing the use of recycled coarse aggregate beyond the recommended 30% limit.
- Preserving natural resources by reducing the use of natural coarse aggregate in concrete production.
- Addressing performance issue, such as low strength, associated with self-curing agent.
- The potential use of recycled coarse aggregate in structure concrete.

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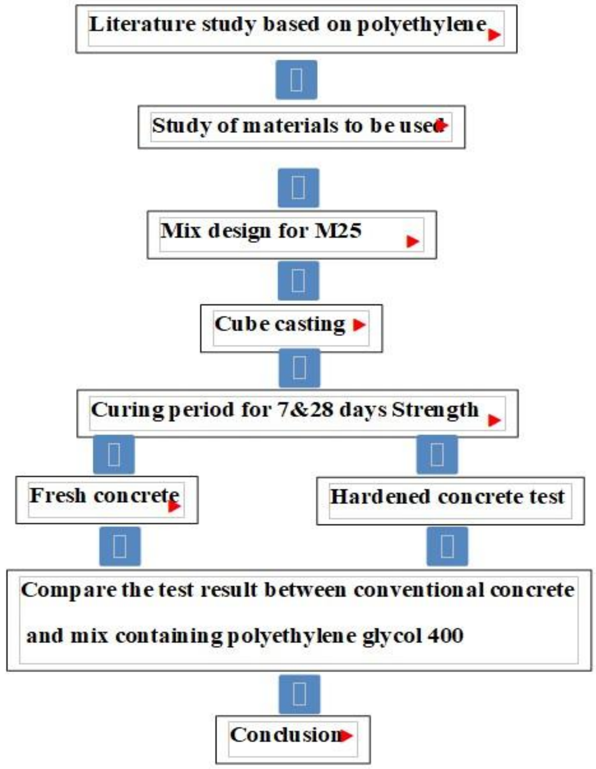
Methodology Flowchart:



Experimental program

- Concrete mixes were prepared with both nac and SCC produced using natural sand as the fine aggregate.
- Nac mixes were made using only conventional concrete as the coarse aggregate in the concrete mix.
- Meanwhile, SCC mixes used demolished waste concrete aggregate as a partial or full replacement for conventional concrete as coarse aggregate.
- These mixes were design based on the concrete mix design.
- The concrete samples were de-moulded after 24 hours.
- Hardened concrete samples were stored in the curing tank at round 20-degree c. For a maximum of 28 days.
- Testing of hardened concrete after 28 days of curing.

The combination in concrete mixes after this will be called as ra00, ra50, ra100.
Table below showed the details of concrete mixes.

Material Used:

Cement

Cement is the main component of concrete. The grade of the cement, the form of the cement, the colour, the fineness of the cement, the heat of hydration, and the alkali content of the cement are all important factors to consider when selecting a cement. Ordinary Portland cement, available in grades 33, 43, and 53, is the most commonly used type of cement. The grade results indicate the compressive strength of the cement.

S.NO	COMPOSITION	PERCENTAGE
1	Al_2O_3	6.6
2	SiO2	21.8
3	Fe2O3	4.1
4	CaO	63.1

The cement should be very cool and clear of lumps. The cement should be greenish grey in colour and set in a dry location. The cement has a specific gravity of 3.15.

Fine Aggregate

River sand and crusher sand are used to make fine aggregate. Fine aggregate should be carefully sieved using a 2.36mm sieve before use. Fine aggregate is graded into zones I through IV based on the sieve scale. The fine aggregates' properties were tested using the IS 393-1970 codal provision. In general, zone II aggregate is used for concrete, with sizes ranging from 4.75 to 2.36 mm. The absolute gravity of the fine aggregate is 2.65.

Coarse Aggregate

The coarse aggregate has a significant impact on the consistency of concrete. It is the least porous and more chemically resistant material. As coarse aggregate is used, drying shrinkage and other dimensional differences in concrete are minimised. The properties of coarse aggregate were evaluated using the IS 393- 1970 codal provision. The coarse aggregate should have a height of 20mm. The basic gravity varies between 2.65 and 2.7.

Water

Water is the most important aspect of aggregate. And the quality of the concrete is affected by the temperature of the water. Salts and other highly harmful compounds should be removed from the water. Efflorescence occurs in reinforced concrete due to the presence of salt in water. Portable water is used for concrete construction. The strength of the concrete is determined by its water content. A higher water content in the concrete increases its power, whereas a lower water content increases its workability.

POLYETHYLENE GLYCOL 400

The polyethylene glycol (PEG 400) is a low polyethylene glycol of low molecular weight. It's a clear, viscous, colorless material. PEG 400 is widely used in a number of drug formulations because of its low toxicity. The hydrophilicity of PEG 400 is high. According to the PEG 400 partition coefficient for water and hexane, only 15 hexane parts per million parts are available 400 PEGin the water crust. PEG 400 is also soluble in air, acetone, alcohols, glycerine, glycols, and aliphatic hydrocarbons. PEG 400 is being used as an inactive ingredient of the pharmaceutical industry as a cleaner, plasticizer, surfactant, ointment, pill, and pill.

III. RESULTS AND DISCUSSIONS

- The experimental data indicated that self-curing concrete exhibited several advantages over conventional curing methods:
  Strength Enhancement – The compressive strength of self-curing concrete was found to be 10-15% higher than that of conventionally cured concrete, particularly in early hydration stages.
- Improved Workability – The presence of self-curing agents resulted in improved slump values, making the concrete easier to handle and place.
- Reduced Shrinkage – Self-curing concrete showed a significant reduction in shrinkage cracks, thereby enhancing its durability.

- Lower Water Absorption – The water absorption test demonstrated reduced permeability, making the concrete more resistant to environmental deterioration.

These findings validate that self-curing technology offers a promising alternative to conventional curing methods, particularly in challenging environmental conditions.

Compressive strength

The compressive strength of m25 grade concrete made with varying percentage of natural and self-curing agents is evaluated. For each concrete mix the compressive strength is tested on three 150x150x150 mm cubes after 7 and 28 days of curing.

The table below presents the compressive strength test results of self-curing agents concrete the varying aggregates percentages.

IV. SUMMARY AND CONCLUSIONS

This study investigates the use of self-curing agent concrete (SCC) derived from traditional curing methods as a sustainable alternative to conventional concrete concrete (nac). The research evaluates the mechanical properties, durability, and workability of SCC in comparison to conventional concrete. Key experiments, including compressive strength tests and aggregate impact assessments, reveal that while SCC exhibits slightly lower strength and higher water absorption, its performance can be improved through proper processing and mix design. The findings highlight the potential for SCC to be utilized effectively in structural and non- structural applications, contributing to sustainable construction pSCCtices by reducing landfill waste and conserving natural resources.

The study demonstrates that self-curing agent concrete can serve as a viable alternative to conventional concrete concrete, especially when processed correctly. Despite minor reductions in compressive strength, SCC offers significant environmental and economic benefits, such as reduced waste disposal and lower demand for virgin materials. With ongoing advancements in recycling technology and mix optimization, the adoption of SCC can contribute to more sustainable and eco-friendly construction pSCCtices. Further research and regulatory support can enhance its application, making it a standard choice for future construction projects.

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