



EXPERIMENTAL STUDY ON SELF-HEALING CONCRETE USING CRYSTALLINE AD MIXTURES, FLY ASH, AND NYLON FIBERS

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Abstract

In recent years, there has been an increasing interest in self-healing materials due to their ability to regain mechanical properties after damage. This study investigates the use of crystalline admixtures (CA) as self-healing agents in concrete, combined with fly ash and nylon fibers to enhance mechanical performance. Artificial cracks were induced, and healing efficiency was evaluated through compressive, split tensile, and ultrasonic pulse velocity (UPV) tests at 28 days. The inclusion of 1.1% CA, 15% fly ash, and 1% nylon fibers showed notable improvements in strength and healing capability.

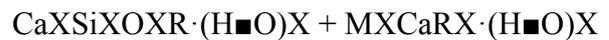
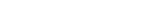
Keywords: Fly Ash, Nylon Fibers, Crystalline Ad mixture, Compressive Strength, Split Tensile Strength, Self-Healing Concrete.

I. INTRODUCTION

Concrete is inherently brittle and prone to cracking due to its low tensile strength. These cracks reduce the service life of structures by allowing ingress of moisture and harmful substances. Self-healing concrete refers to concrete capable of autonomously repairing cracks, enhancing both durability and sustainability. Crystalline admixtures are effective self-healing agents as they form insoluble crystals that block microcracks and prevent permeability.

II. MECHANISM OF ACTION OF CRYSTALLINE ADMIXTURES

Crystalline admixtures react with unhydrated cement particles in the presence of water, forming additional calcium-silicate-hydrate (C-S-H) and crystalline pore-blocking products, as shown in the reaction below:



These products create a dense matrix that reduces permeability, enhances durability, and improves water resistance.

III. OBJECTIVES

- To evaluate the percentage of crack healing at 28 days.
- To compare strength variations of concrete with and without crystalline admixture, fly ash, and nylon fibers.
- To determine the optimum nylon fiber dosage.

IV. MATERIALS AND MIX PROPORTIONS

The materials used include OPC (53 Grade) cement, fine aggregate (Zone II), coarse aggregate (20 mm), crystalline admixture, flyash (ClassF), and nylon fibers. The mix was designed as per IS10262:2019 for M25 grade concrete.

| Material | Quantity (kg/m ³) | Proportion |
|------------------|-------------------------------|------------|
| Cement | 383.16 | 1 |
| Fine Aggregate | 685.87 | 1.79 |
| Coarse Aggregate | 1102.29 | 2.87 |
| Water | 191.58 | 0.5 |

Mix Variations:

| Mix ID | CA (%) | Fly Ash (%) | Nylon Fibers (%) |
|--------|--------|-------------|------------------|
| MIX 1 | 0 | 0 | 0 |
| MIX 2 | 1.1 | 15 | 0.5 |
| MIX 3 | 1.1 | 15 | 1.0 |
| MIX 4 | 1.1 | 15 | 1.5 |

V. RESULTS AND DISCUSSION

UPV and strength tests revealed significant healing effects. MIX3 (1% nylon fiber) achieved the highest recovery and strength gain, confirming the synergy between CA, fly ash, and fibers.

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VI. CONCLUSION

- Addition of 1.1% CA, 15% fly ash, and 1% nylon fibers enhances compressive and tensile strengths.
- The optimal nylon fiber dosage is 1%; higher values reduce workability.
- Crystalline admixture effectively heals microcracks as confirmed by UPV results.
- The combination offers a sustainable and durable self-healing concrete formulation.

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