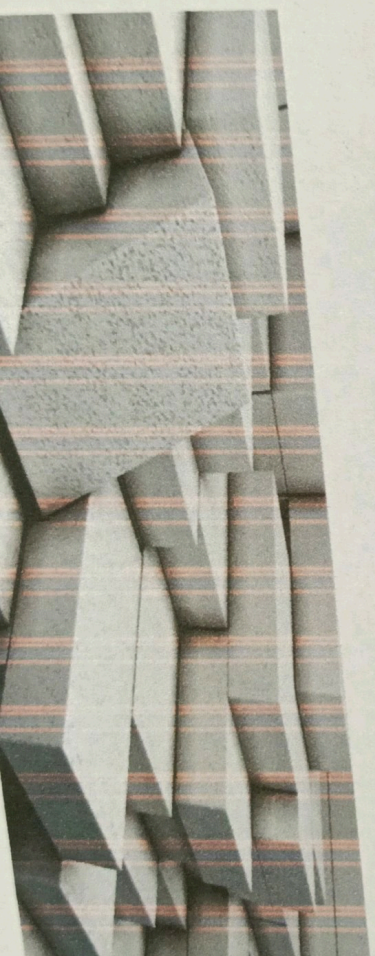


# **CRAACK FREEE FUTURRE · SELF HEALING BIO CONCRETE**



## ABSTRACT:

Concrete is the most widely used construction material, but it easily develops cracks over time due to environmental stress, temperature changes, and heavy loads. These cracks allow water and chemicals to enter, reducing the strength and lifespan of structures. This project explores a sustainable solution by using *Bacillus subtilis*, a naturally occurring, non-harmful bacteria, to create self-healing concrete. The bacteria are mixed with nutrients and added to the concrete mixture. When cracks form and water seeps inside, the bacteria become active and produce calcium carbonate, which fills and seals the cracks. The experiment compares normal concrete with bacteria-based concrete to observe crack-repair efficiency. Results show that the bacterial concrete exhibits faster and more effective crack healing, improving durability and reducing maintenance costs. This bio-based approach demonstrates an eco-friendly and innovative method to enhance the life of concrete structures.

## APPLICATION:

### 1. Bridges and Flyovers

These structures face constant vibration and heavy loads, causing micro-cracks.

Self-healing concrete increases durability and reduces maintenance costs.

### 2. Highways and Pavements

Traffic loads create frequent cracks.

Bacterial concrete repairs itself, extending the lifespan of roads.

## INTRODUCTION

Concrete is one of the most widely used building materials in the world, but it is prone to cracking due to environmental stress, shrinkage, or mechanical load. These cracks reduce the strength and durability of structures. This project aimed to develop self-healing concrete using *Bacillus subtilis* bacteria. The bacteria, when added to the concrete mix, produced calcium carbonate that filled the cracks automatically upon contact with moisture. The experiment compared normal concrete with bacterial concrete. Results showed that the bacterial concrete sealed cracks more effectively, demonstrating its potential for long-lasting, sustainable construction.

Concrete is strong in compression but weak in tension, making it susceptible to cracking. Once cracks appear, water and chemicals enter, accelerating corrosion of reinforcement and reducing lifespan. Repairing these cracks manually is

costly and time-consuming. Self-healing concrete, an innovative solution, uses specific bacterial species such as *Bacillus subtilis* that can survive in concrete's harsh conditions. When cracks form and water seeps in, these bacteria germinate and produce calcium carbonate ( $\text{CaCO}_3$ ), sealing the cracks naturally. This process increases the durability and sustainability of structures.

Traditional concrete structures often develop cracks that compromise their strength and longevity. Manual repair methods are expensive, labor-intensive, and not always effective in restoring durability. Therefore, there is a need to develop a self-healing mechanism that can repair cracks autonomously without human intervention.

If *Bacillus subtilis* bacteria are added to the concrete mixture, then the resulting concrete will be able to heal its cracks automatically by producing calcium carbonate, improving its strength and durability compared to normal concrete.

## **METHODS:**

### **Design of Study**

An experimental method was used to compare the crack healing ability of normal concrete and bacterial concrete.

### **Variables**

#### **Independent Variable:**

Presence of *Bacillus subtilis* bacteria in the concrete mix.

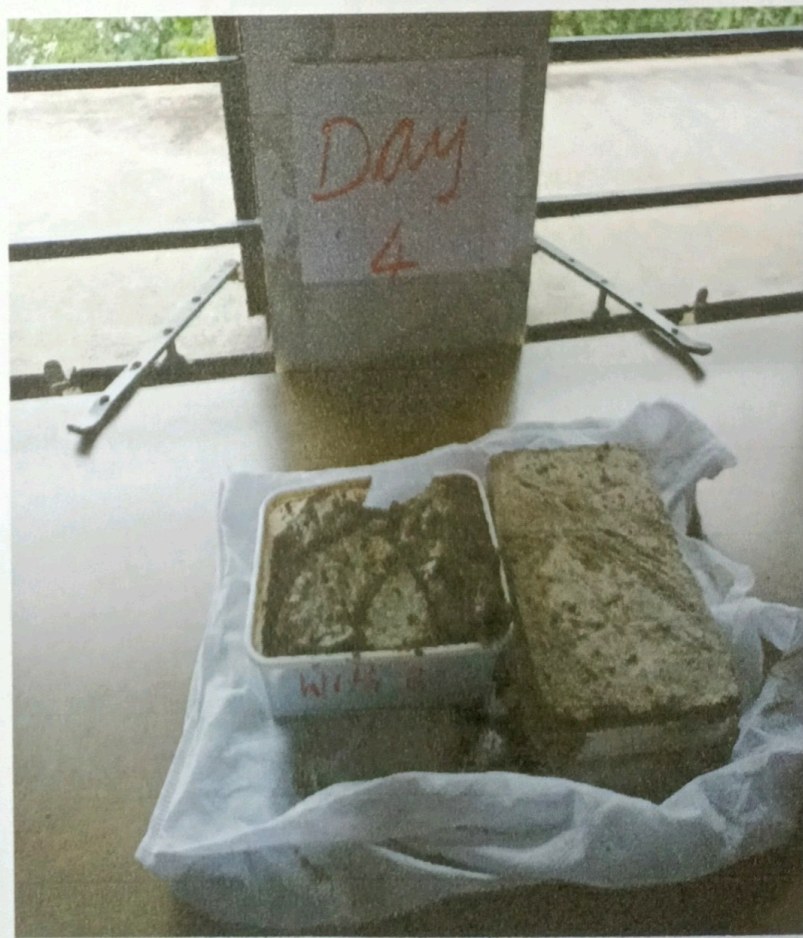
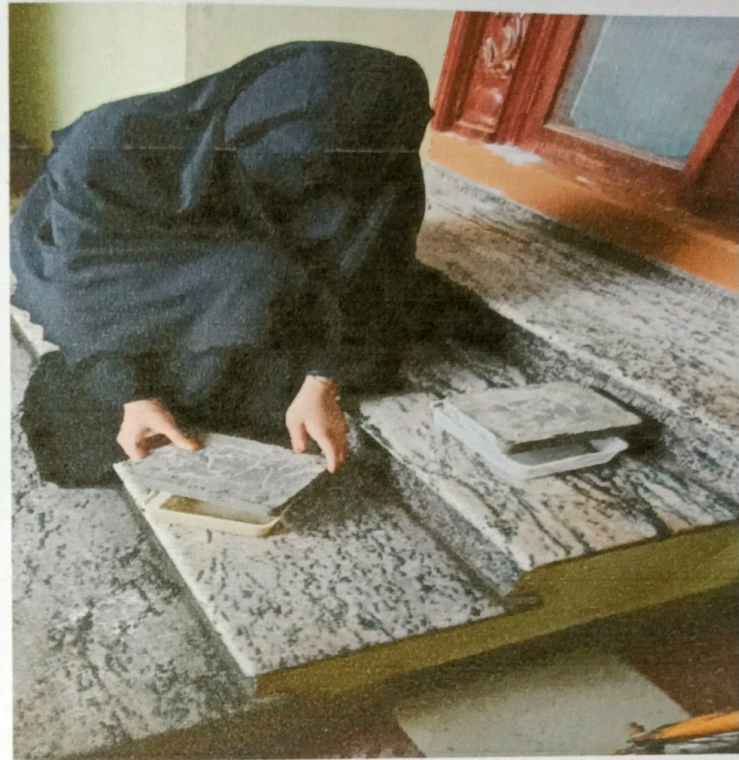
#### **Dependent Variable:**

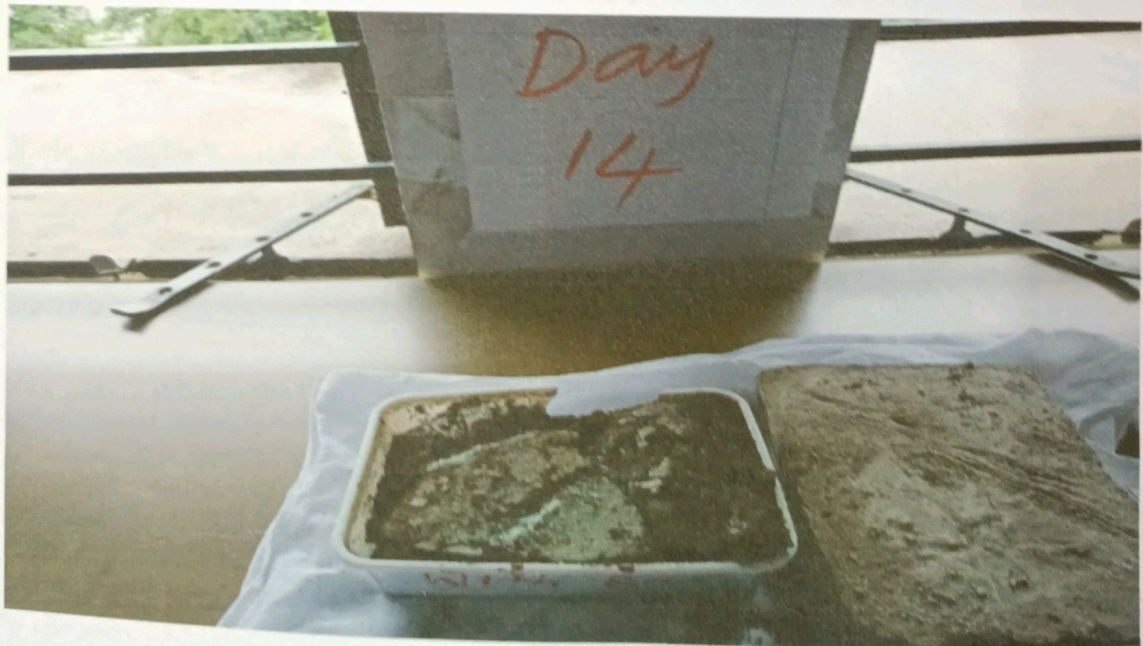
Amount and rate of crack healing observed over time.

#### **Controlled Variables:**

Type and grade of cement, curing time, temperature, water-cement ratio, and size of concrete samples.









## RESULT

### Data Table

#### 1: Experiment Overview

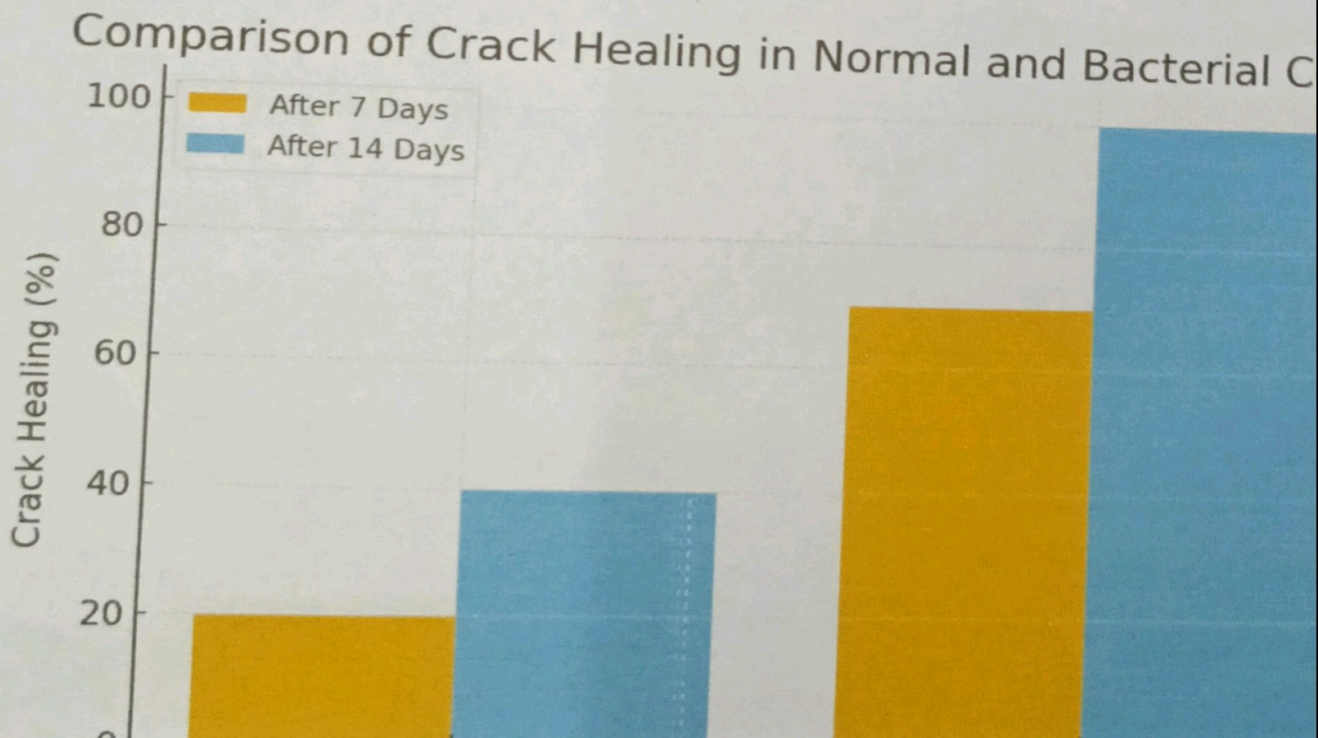
Group	Sample Type	Bacteria Added
A	Regular concrete	No
B	Bio-concrete	Yes (Bacillus subtilis + Ca-lactate)

TABLE 2: Crack Width Measurement

Days	Group A – Regular (mm)	Group B – Bio-Concrete (mm)
0	2	2
2	1.95	1.6
4	1.9	1.2
6	1.88	0.9
8	1.85	0.6
10	1.83	0.3
12	1.8	0.2
14	1.78	0.1

TABLE 3. VISUAL OBSERVATION

Day	Group A – Regular Concrete	Group B – Bio-Concrete
0	Visible surface crack (~2 mm)	Visible surface crack (~2 mm)
2	No change	Small white deposits appear
4	Slight crack reduction	White mineral growth continues
6	Minor water absorption	Crack partially sealed (~50%)
8	Crack stable, no healing	Crack nearly filled, less water penetration
10	No visible deposits	Crack mostly sealed, white layer visible
12	Same width	Almost full healing observed
14	No healing	Crack completely sealed with $\text{CaCO}_3$



## DISCUSSION:

After 7 days, bacterial concrete samples showed visible white deposits along the cracks, indicating calcium carbonate formation. By the 14th day, cracks in the bacterial concrete were almost fully sealed, while the control samples remained partially open. The bacteria had precipitated  $\text{CaCO}_3$ , filling the cracks and restoring structural integrity. This confirmed that *Bacillus subtilis* could survive the alkaline environment of concrete and effectively heal cracks upon exposure to moisture. The results support the hypothesis that bacterial concrete performs better in self-healing than conventional concrete, thus increasing durability and reducing maintenance costs.

## **Conclusion and Application:**

The experiment proved that *Bacillus subtilis* bacteria can successfully heal cracks in concrete by producing calcium carbonate. Bacterial concrete offers an eco-friendly, cost-effective solution for extending the lifespan of structures.

## **Applications include:**

- Bridges, tunnels, and dams where cracks are difficult to access.
- Long-lasting pavements and high-rise buildings.
- Reducing maintenance and repair costs in large infrastructure projects.

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