CRACK FREE FUTURE - SELF HEALING BIO CONCRETE

NATIONAL SCIENCE FAIR RESEARCH PLAN

LEVEL : MIDDLE LEVEL

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SUBMITTED BY

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PROJECT TITLE : CRACK FREE FUTURE -

SELF HEALING BIO CONCRETE

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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 ($CaCO_3$), 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.

Procedure :

1. The bacterial culture of Bacillus subtilis was prepared in a nutrient medium and incubated for 24 hours.
2. Two concrete mixtures were prepared: one control sample (without bacteria) and one bacterial sample (with Bacillus subtilis culture).
3. The concrete was cast into molds and allowed to cure for 7 days.
4. After curing, controlled cracks of about 1 mm width were created on each sample.
5. The samples were sprayed with water daily to activate bacterial growth and healing.
6. Crack healing was observed and recorded after 7 and 14 days.
7. Photographs and measurements were taken to compare healing levels between control and bacterial concrete.

RESULT

Data TableTABLE

1: Experiment Overview

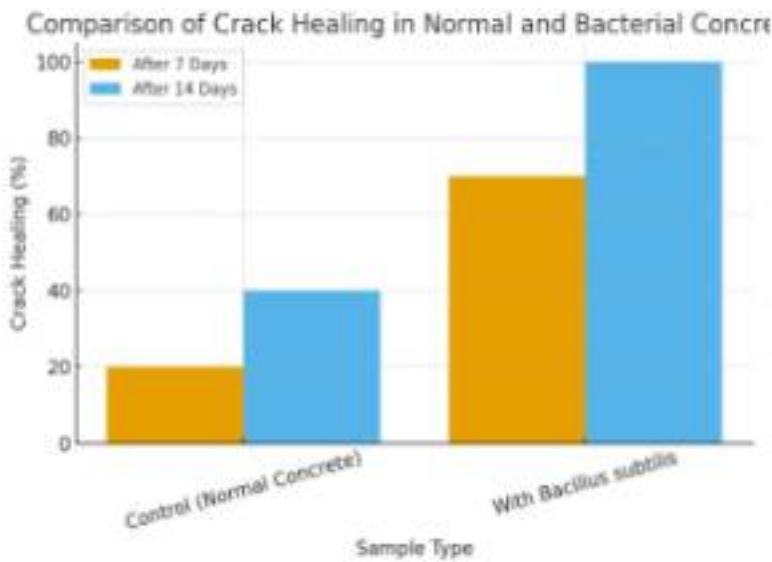
Group	Sample Type	Bacteria Added
A	Regular concrete	No
B	Bio-concrete	Yes (Bacillus subtilis + Ca-lactate)

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 inside crack
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 $CaCO_3$ layer visible
12	Same width	Almost full healing observed
14	No healing	Crack completely sealed with $CaCO_3$




DAY
4


Day
8


Day
14

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 $CaCO_3$, 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.

Future Enhancement

- Testing with different bacterial species that can survive longer or produce more $CaCO_3$.
- Evaluating long-term strength, water permeability, and load resistance.
- Developing commercial self-healing concrete mixtures for industrial use.
- Using encapsulated bacterial spores for better control and durability.

References:

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