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A REVIEW OF CONCRETE PREPARE WITH BECTERIA ANALYSIS OF ITS PHYSICAL PROPERTIES

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Abstract -Bacterial concrete is self-healing concrete that has the ability to "heal itself" if cracks develop in the concrete structure over the course of its lifespan. In recent years, it has become clear that adding bacteria to concrete can significantly increase its lifespan. Concrete that has been combined with bacteria significantly improves the durability and strength of concrete buildings. Worldwide adoption of the idea of bacterially mixed concrete is still in its infancy. However, numerous studies in the literature show that the concrete's bacterial mixing process is quite successful in extending the structure's useful life as a whole. Additionally, several microorganisms were added to examine their impact on various types of change-causing variables. Researchers have used Bacillus subtilis and calcium lactate as self-healing agents in recently published studies to lessen difficulties.

I. INTRODUCTION

One of the most crucial building materials is concrete. Changes in temperature and water content can cause cracks to appear and concrete to contract or expand. The effectiveness of concrete is influenced by a wide range of other elements. Poor building materials, chemicals, and design, for instance, can result in a brief lifespan. The unavoidable outcome of reinforced concrete building cracking is due to these and other reasons. A number of strange events take place inside a concrete structure when it breaks. These cracks lessen the structure's strength and service life, in addition to reducing its ability to perform its intended function. Therefore, the self-healing properties of bacterial hybrid concrete are highly helpful for enhancing the performance of concrete structures in order to prevent problems like these.

Bacteria Mixed Concrete:

Concrete that has self-healing components that enable the concrete structure to "self-heal" if it cracks over time is known as bacterial concrete. Self-healing substances may be delivered as organic components, reinforced hollow fibres, or solid microcapsules. Self-healing concrete or organic concrete are other names for bacterial concrete or bacterial mixed concrete. Concrete with bacteria added to it is stronger and has the capacity to repair long-term damage from mechanical stress. An example of a self-healing substance is bacterial concrete. A group of intelligent materials known as self-healing materials have the capacity to gradually repair structural harm brought on by mechanical stress.

Biological systems with the capacity to repair damage are stimulated. The propagation of microcracks and other imperfections is known to alter the material's thermal, electrical, and acoustic properties, eventually leading to failure. Initially, it can be challenging to find cracks, but human assistance can be used to make any necessary repairs. Self-healing materials offer the potential to lower costs in many industrial processes by increasing component life and lowering ageing-related inefficiencies. The process of self-repair must take place without human interference in order for matter to be defined as having the capacity to function autonomously. For instance, in order for healing polymers to begin the healing process, external modifications must occur. While some Roman mortars are self-healing, the development of these materials really took off starting in the late 1990s. Although self-healing is effective on all materials, including metals, ceramics, and cementitious materials, polymers and elastomers make up the majority of materials. From adherence to the substance through the entry of the repair material into a microscopic vessel, the repair procedure varies.

II. PROBLEM FORMULATION

Cracking is one of the most important issues regarding concrete structures. Cracks in concrete tend to start at the surface and work their way to the bottom of the slab over the course of several months. If cracks are allowed to reach through to the sub grade, it is required to fully replace the concrete structure to restore its strength and appearance. So, it is important to find the solution for this issue and bacteria mixed concrete is found to be one of the most prominent materials to solve this issue.

III. NEED FOR BACTERIA MIXED CONCRETE

Concrete is the most important building material but most of the concrete members are subject to cracks. Even little cracks on the concrete surface make the whole building unsafe. Cracks allow water to seeps and it will deteriorate the concrete and corrode the steel reinforcement. The lifespan of the building will automatically get deteriorated with the time. Bacteria mixed concrete is that kind of product which will biologically produce limestone to heal the cracks.

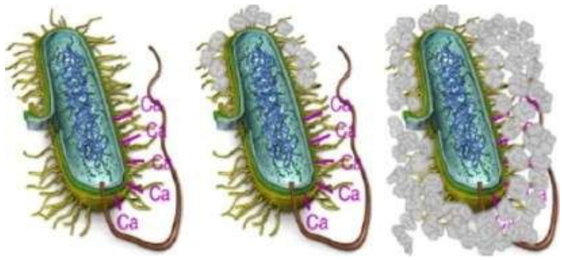

Fig 1 Self-healing concrete bacteria

IV. FINDINGS

- This study aimed to develop novel bacteria-based self-healing concrete by microbial induced calcium carbonate precipitation mechanism. [1]
- One of the important concerns is how to improve the crack-healing effect based on microbial mineralization while preserving adequate mechanical characteristics and durability of concrete. This involves increasing the concentration of bacteria and nutrients in the fracture location. [2]
- To increase the impermeable properties of concrete and to show the pace of crack healing utilising biological agents. [3]
- An industrialization study of microbial self-healing concrete was conducted to increase awareness of the material. [4]
- The numerous characteristics of bacterial concrete are briefly explained in this essay. [5]
- In contrast to the typical incubation environment (water), the impact of soil incubation was explored to see if the self-healing mechanism might be initiated. [6]
- The carrier of the core-shell structure based on low-alkali cement material is designed to ensure the long-term survival of spores in concrete under demanding conditions. Studies have been done on properties such as protection, distribution and density. Then, the effect on workability, mechanical properties and self-healing ability of concrete was

investigated. After comparing and validating the treatment products, an analysis of the mechanisms driving the protective effects and self-healing behavior was carried out. [7]

- Immobilization procedures can increase the effectiveness of bacteria-based self-healing concrete by protecting the bacteria from being crushed during mixing so they can remain latent until concrete fractures occur and then mend uniformly. [8]
- A thorough analysis of the development of urea hydrolysis and the role of bacterial growth was carried out to improve the precipitation of calcium carbonate in concrete. [9]
- In this study, spores are protected from highly alkaline environments in cement-based products using low-alkalinity sulfo-alumina cement (SC) as a carrier. [10]
- The focus of this work is on synthetic methods of strengthening concrete by filling cracks, such as the use of crystalline admixtures, polymers, and fibers. This paper also discusses the methods and tests used to determine the self-healing ability of concrete. [11]
- One of the main goals of the research is to produce an antimicrobial agent without using yeast extract. [12]
- The purpose of this study was to evaluate the use of Sporosarcinapasteurii in the production of self-healing plasters and to investigate the effect of bacterial concentration and air-permeable plaster content on the effect of fracture. X-ray diffraction and electron microscopy studies were performed to determine calcium carbonate in the vaterite phase for S. pasteuri bio mineralization precipitates used to fabricate self-healing mortar samples. [13]
- This study investigates the possibility of using micro-cellulose fibers treated with gastric juice as a carrier of new self-healing bacteria to create a more beneficial carrier of bacteria. Using cellulose fiber as a bacterial carrier, two different types of bacterial myoma were created. [14]
- In this study, the effect of bacteria on self-healing of cement weathering was investigated quantitatively using urea-producing Bacillus pasteurii. [15]

V. STRENGTHS

Biomimetic mineralization was deduced from calcium carbonate by microbially induced calcium carbonate precipitation studies and XRD testing. Fine crystals of calcite produced by microorganisms are often more compact than chemically produced calcium carbonate. Using B. subtilis M9, a self-healing concrete with a flexural strength of 4.2 MPa as measured by the 3-point bending test was developed. After 28 days of self-healing, the flexural strength of the sealed beams subjected to secondary bending increased by 0.34 MPa or 14% of the original strength. Trauma sealing and fiber-matrix interface repair leads to restoration of flexural strength. The refracted surface of the curved beam shows the contour of the fluorescent edge corresponding to the site of bacterial growth. This phenomenon is caused by low pH due to carbonation on the concrete surface, high pH of the inner matrix and a dry environment that is too difficult for bacteria to grow. Consequently, as the fracture depth increases, the healing rate decreases. This drawback makes the research and application of self-healing microbial technology in engineering very difficult. SEM studies were carried out on sedimentary minerals considered from self-healing concrete. When calcium carbonate is precipitated, calcite appears to be the most common mineral phase. Rough hexagonal crystals were found to have antibacterial effects. Friction sheared by scratching and sliding PVA fiber during SEM test. In addition, calcium carbonate precipitation was found on the fiber surface, indicating the improvement of the fiber-matrix interface bond. Self-healing concrete already has fiber removal properties. [1]

The outcomes showed that the numerical tube pressure increased and the water absorption decreased after EP particles were coated. When combining EP with concrete, wrapping materials can successfully lower the EP particle breakage rate and fend off water intrusion. [2]

According to studies, compared to conventional concrete, the bio concrete mixture increased compressive strength by 22%, tensile strength by 16%, and flexural strength by 11% after 28 days of curing. Ultrasonic pulse velocity readings are used to analyze concrete density. Water absorption and absorption tests are used to evaluate the durability properties of concrete samples made from conventional and bacterial materials. The addition of bacteria improves the durability properties of bacteria-based concrete samples. [3]

The spray-dry fermentation bacterial method offers many possibilities for formulating capsule-based microbial concrete powders and conditioners. It is better than liquid-based therapeutic drugs in terms of manufacturing, transportation, storage and use. [4]

According to research, the recruitment of bacteria will increase the strength and hardness of concrete, which shows that the encapsulation method can give better results than direct application. The addition of urea-stimulating bacteria and calcium sources causes calcite to precipitate in concrete. The supply of calcium is combined with ureolytic bacteria such as Bacillus Pasteurii and Bacillus Subtilis to prevent the precipitation of calcium carbonate (CaCO3) from the newly formed microcrates. [5]

This experimental data explores the possibility of using self-healing bio-concrete in soil. The data allows comparison of the healing ratio between samples incubated in naturally saturated soil and samples incubated in a normal environment (eg water). The data can be used to determine whether soil bacteria can naturally heal concrete cracks without adding self-healing agents to the concrete mix. The information is useful for scientists and engineers working to develop durable construction materials for underground structures. [6]

There is no detrimental effect on the performance of the concrete base, and the ability to self-heal from subsequent cracks is significantly improved. Carbonization and chloride ion resistance can be improved up to a certain time. The fly ash will eat away the harmful alkaline chemicals and the by-products will act as a catalyst for the development of secondary and protective powers, filling the pores of the carrier. The carrier ensures that the spores can effectively contribute to the subsequent cracking of the concrete by providing a stable physical and chemical habitat. This study provides a practical option for low-cost carrier preparation and is expected to encourage the use of microbial self-healing concrete in engineering applications. [7]

The best immobilization of all grafts resulted in subsequent healing of cracks up to 1.2 mm wide and 85% recovery of pre-rupture compressive strength. Immobilization and direct induction of BNMPs with widths of 0.15 mm and 0.45 mm showed strength recovery up to 45% and 65%, respectively. [8]

A recent study showed that the compressive strength of concrete containing spores, vegetative cells, and urea-vegetative cells increased by 9%, 10%, and 15%, respectively, compared to the control sample. [9]

Studies on self-healing cement-based materials have not revealed an average depth of 2895 m. [10]

In addition, the effects of admixtures on the mechanical properties of self-healing concrete are presented. [11]

A 0.3 mm enamel fracture was treated in 7 days with a mixture of L. boronitolerans YS11 spore powder, cement, paste, sand, yeast extract, calcium lactate and water. In addition, precipitation of calcium carbonate was observed on the crack surface. Therefore, we were able to demonstrate that YS11 spore powder coated mortar was successful in filling small cracks in concrete. [12]

The main purpose of this study is to test the best microbial admixture for S. pasteurii. The effect of bacterial concentration and AEA content on the flexural strength of air samples was investigated. During the 3-point bending test, a crack with a width of about 0.4 mm was produced at the bottom of the beam. The filler precipitation in the fracture was determined by SEM. [13]

The compressive strength decreased with the addition of cellulose fibers in the investigated dosage. Cellulose fibers have been shown to act as a bridge across wounds, increasing the presence of bacteria at the wound site. Compared to alternative bacteria carriers, cellulose fibers offer the cheapest and simplest method of removing bacteria. [14]

The percentage of self-healing of the area and the ratio of inviability served as indicators of the treatment effect. [15]

VI. WEAKNESS

It is important to take important healing steps to keep hair moisturized and provide bacteria and nutrients to provide self-healing benefits.An effective way to quantitatively characterize the effectiveness of self-healing at the construction site is to monitor changes in the speed of ultrasound waves and waves. This will allow you to measure the level of self-healing. Manufacturing and construction experience has been a useful guide to the commercialization of microbial self-healing concrete. [4]

It is recommended that future studies thoroughly investigate the number of microbial cells entrapped and released by the immobilizer during the bio-remediation process. [8]

More research should be focused on developing and exploring suitable and adequate carrier protection methods to effectively accommodate bacteria for a long time and encourage them to carry out metabolic activities in the concrete matrix. [9]

Insufficient research has been done on the width and depth of treated reinforcement. Insufficient research on fracture healing and speed. Lack of information about the durability of fully repaired fractures. Insufficient information on how to repair structural defects. Sufficient information is available on the strength of fractures cured at different temperatures. [11]

Self-healing has been shown, but more research is needed to accurately calculate the amount of nutrients and spores needed to produce the best material and strength for use in construction projects. As a result, L. boronitolerans YS11, which can live in mortar by sporulation, is determined to be a good choice for self-healing concrete. [12]

The authors recommend that future studies consider high-risk samples.Further studies may consider treatment periods longer than 21 days.

After absorbing the bacterial solution, the cellulose fiber can be coated with cement or other coating material to improve its performance (retention of bacteria). In addition to the UPV test, other damage tests can be considered to assess strength recovery. The self-healing ability of the bacterial plaster can be confirmed by SEM and XRD tests. Carbonation levels and porosity tests are recommended to understand the production and tolerance of calcium hydroxide in the air of bacteria. [14]

This study may contribute to a deeper understanding of the role of bacteria in the self-healing of myoma fractures. [15]

VII. OUTCOMES

After 28 days of recovery, the diameter was 1.24 mm when fully healed. Permeability tests revealed that the self-healing technique of bacterial spores immobilized on EP coated with a low alkaline material can increase the permeability of samples in fractures. Although EP-coated samples with alkaline materials showed no permeability, S-B, H-B, and K B samples were able to withstand water pressure of 0.35, 0.65, and 1.1 cm after 14 days of curing. Calcite was identified as a mineral precipitated on the fracture surface by X-ray diffraction. Microstructural studies revealed that a significant proportion of bacterial spores were immobilized by EP particles; consequently, EP proved to be a higher carrier of bacteria. [2]

According to the results of the sorptivity test, bio-concrete shows a greater resistance to the penetration of water into the concrete, which reduces the porosity of the concrete. [3]

The results of the current review suggest "microbial concrete" as an alternative to conventional concrete in fracture healing. Cost-effective and environmentally friendly while increasing the longevity of building materials. Finally, Bacillus Pasteuri and Bacillus Subtilis were shown to be the most beneficial bacteria for filling concrete cracks. [5]

Fractures were examined by light microscopy before and after incubation to assess the healing ratio. Energy dispersive X-ray spectrometry (EDX) and scanning electron microscopy (SEM) were used to analyze mineral precipitation in the beads. The data shows how bio-concrete performs in specific applications, such as tunnels and deep foundations, where concrete components are exposed to the environment. [6]

The application of the carrier does not adversely affect the self-healing of the cracks, and the self-healing capacity of the subsequent cracks is significantly increased. The high surface area improvement and water infiltration improvement rate remained after 122 days. This enhancement effect will be easier to see in CT scans by adding some Eu^{3+} during curing to create a more solid repair product. [7]

Investigations using SEM, EDX, XRD and TGA on chemical and visually identified samples show that bacteria introduced through all media can produce sufficient amount of carbon minerals capable of sealing cracks. [8]

In contrast to pH 9, the pH range of 12 to 13 not only inhibits the growth of bacteria, but also reduces the efficiency of urea hydrolysis by 75-80%. In the same case, at 28 days, concrete with the addition of urea-vegetative cell solution increased the compressive strength by about 15% compared to concrete without bacteria. [9]

In all these studies, the use of microscopy, digital photography, SEM, and EDS analysis are popular methods for evaluating the width and depth of repaired fractures. Most of the authors focus on the speed of healing cracks, and only a few tests have been done to investigate water penetration. [11]

In this study, bio mineralizing bacteria were injected directly into the tower to produce an environmentally friendly structure and improve the long-term durability of the concrete. Research has been done to develop a cheaper, more environmentally friendly environment compared to synthetic microbial agents for calcium carbonate-precipitating bacteria. Cereal products are chosen as a green and convenient option. Creating a microbiological environment without using yeast extract is one of the main goals of this work. In the first screening procedure, PBD is used to select key parameters. The test procedure selects favorable conditions for bacterial growth and eliminates unfavorable conditions. In addition to having carbohydrates, protein and fat components necessary for the growth of bacteria, rice bran and malt are rich suppliers of calcium, iron, zinc and other inorganic materials. [12]

It was found that the MICP technique left some impressions of bacteria on the surface of the crystal when the cracks were closed. [13]

This study investigated the self-healing of myoma fractures caused by microorganisms. It shows that there is a relationship between the amount of bacterial fluid and the amount of substrate needed. It examines how bacteria aggregate. [15]

REFERENCES

1. Feng, Jun, et al. "Microbial induced calcium carbonate precipitation study using Bacillus subtilis with application to Self-Healing Concrete preparation and characterization." Construction and Building Materials 280 (2021): 122460.
2. Qian, Chunxiang, et al. "Application of microbial Self-Healing Concrete: Case study." Construction and Building Materials 290 (2021): 123226.
3. Zhang, Xuan, et al. "Effects of carrier on the performance of bacteria-based Self-Healing Concrete." Construction and Building Materials 305 (2021): 124771.
4. Chen, Bingcheng, et al. "Crack sealing evaluation of self-healing mortar with Sporosarcinapasteurii: Influence of bacterial concentration and air-entraining agent." Process Biochemistry 107 (2021): 100-111.
5. Jiang, Lu, et al. "Sugar-coated expanded perlite as a bacterial carrier for crack-healing concrete applications." Construction and Building Materials 232 (2020): 117222.
6. Jogi, Pavan Kumar, and TVS Vara Lakshmi. “Self-Healing Concrete based on different bacteria: a review." Materials Today: Proceedings 43 (2021): 1246-1252.
7. Algaifi, Hassan Amer, et al. "Insight into the role of microbial calcium carbonate and the factors involved in SHC." Construction and Building Materials 254 (2020): 119258.
8. Zheng, Tianwen, et al. "Low alkali sulpho-aluminate cement encapsulated microbial spores for self-healing cement-based materials." Biochemical Engineering Journal 163 (2020): 107756.
9. Ryu, Youngung, et al. "Optimization of bacterial sporulation using economic nutrient for Self-Healing Concrete." Journal of Microbiology 58 (2020): 288-296.
10. Singh, Harshbab, and Rishi Gupta. "Cellulose fiber as bacteria-carrier in mortar: Self-healing quantification using UPV." Journal of Building Engineering 28 (2020): 101090.
11. Rong, Hui, et al. "Influence of bacterial concentration on crack self-healing of cement-based materials." Construction and Building Materials 244 (2020): 118372.
12. Effect of crystalline admixtures, polymers and fibers on SHC - a review
13. Durga, ChereddySonali Sri, et al. "Performance studies on rate of self-healing in bio concrete." Materials Today: Proceedings 27 (2020): 158-162.
14. Souid, Adam, et al. "Experimental data of bio Self-Healing Concrete incubated in saturated natural soil." Data in brief 26 (2019): 104394.
15. Shaheen, Nafeesa, et al. "Synthesis and characterization of bio-immobilized nano/micro inert and reactive additives for feasibility investigation in Self-Healing Concrete." Construction and Building Materials 226 (2019): 49