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Review of the Durability of Bacterial Concrete in Marine Environments

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Abstract:

This review examines the durability of bacterial concrete in marine environments. Bacterial concrete (BC), also well-known as Self-Healing Concrete (SHC), utilizes bacteria that can precipitate Calcium Carbonate (CC) to repair cracks. Bacterial concrete's cost-effectiveness and sustainability in marine environments are crucial factors for its widespread adoption. The study focuses on recent research investigating the performance of bacterial concrete in marine settings, considering factors such as bacterial species, environmental conditions, and concrete composition. It discusses evaluation techniques for durability against chloride ingress, carbonation, and sulphate attack. Bacterial concrete relies on the metabolic activity of calcite-precipitating bacteria, typically belonging to the genera *Bacillus* and *Sporosarcina*. These bacteria facilitate the formation of calcium carbonate crystals within cracks, effectively sealing them and reducing the ingress of aggressive agents. The review delves into the biochemical processes involved in microbial-induced calcite precipitation, highlighting how bacterial activities contribute to crack healing and increased durability.The study also addresses long-term sustainability and challenges in implementing bacterial concrete in marine structures, offering insights for engineers and researchers. The findings contribute to understanding the viability and potential of bacterial concrete for durable and resilient marine applications.

Keywords: Marine Environments, Bacterial Concrete, self-healing concrete, *Bacillus* and Durability

1. Introduction

The marine environment is regarded as an aggressive and extreme environment for setting concrete structures. This is due to the presence of large amounts of chlorideand sulphate in seawater. These environments need special provisions and engineered processes for the reinforced concrete to survive, such as tidal effects, low temperature of seawater, biological life and pressure, and so on. Marine environments comprise high concentrations of chloride. When concrete structures are unveiled to saltwater environments, they form chemical and physical interactions which distress the stiffness and strength of concrete. The deterioration of concrete structures in marine systems is caused by factors like carbonation, chloride ingress, and physical abrasion, which stimulated interest in creating durable construction materials. This, in turn, leads to cracks, which affect the interior parts of the structure. Also, the gaps in concrete structures have a undesirableeffect on their durability, particularly in marine environments, because chlorides are able to penetrate speeder [1]. The potential resolution is the self-healing of cracks in concrete structures.

The autonomous self-healing concept of those risky cracks with minimal resources in below-par structures is a recent fascinating area for investigators. Hence, there is an immediate need to find a cost-effective, sustainable approach to healing cracks that do not need manual interference. Subsequently, a natural and autonomous self-healing technique can be comprehended through the addition of a specific kind of bacteria in concrete. Bacterial concrete, also called self-healing concrete, delivers a potential solution by employing bacteria to precipitate calcium carbonate and close cracks which form over time. Bacterial concrete can effectively remedy concrete cracks. The concentrations of bacteria have been enhanced for better-quality outcomes for the remediation of concrete pores [2]. Because of its benefits, microbial self-healing technology has been progressively smeared in tangible engineering constructions.On the other hand, the comprehensive application of microbial SHC still needs to be improved [3].

Considering the various existing scholarly works regarding the durability of Bacterial concrete, this literature review study intends to analyze the self-healing behaviour of bacterial concrete beneath marine environments. The present study provides an overview of the Bacterial concrete and its application. Also, the properties and behaviour of bacterial concrete are discoursed. Moreover, the durability of the bacteria concrete under marine conditions is discussed.

2. Bacterial Concrete

Bacterial concrete or MICP or Self-healing concrete forms $CaCO_3$ with the aid of Bacteria. It seals cracks which arise in concrete materials.

2.1 Composition of Bacterial concrete

Several Kinds of bacteria are utilized in concrete, and those are [4] as follows,

- *Bacillus cohnii*
- *Bacillus pseudofirmus*
- *Bacillus subtilis*
- *Bacillus sphaericus*
- *Bacillus halodurans*
- *Escherichia coli*
- *Bacillus pasteurii*
- *Bacillus balodurans*

The bacteria above can live in surroundings with high alkali contents. For instance, these bacteria employ metabolic procedures like urea hydrolysis, photosynthesis and reduction of sulphate. The consequence of these procedures is the formation of calcium carbonate as the by-product. Few reactions also surge the pH from neutral to alkaline conditions, thus forming carbonate and bicarbonate ions. These ions precipitate with calcium ions, which are present in the concrete, to produce CC reserves.

2.2Working Principle of Bacterial Concrete

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The inbuilt-bacteria-based self-healing procedure was recognized to heal cracks up to a width of 0.5 mm. Upon the outward structure of the control concrete, $CaCO_3$ will be produced because of the reaction of CO_2exists with calcium hydroxide, which is available in concrete structure as per the subsequent equation:

$$CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O \quad \ldots\ldots (1)$$

From the above equation 1, it is revealed that the production of calcium carbonate is attained because of the existing restricted amount of CO_2. Since $Ca(OH)_2$is a soluble mineral, it simply dissolves in water and disperses aside from the crack. Because the active metabolic conversion of calcium nutrients through the bacteria exists in concrete, the self-healing procedure in Bacteria integrated concrete is very effective:

$$Ca(C_3H_5O_2)_2 + 7O_2 \rightarrow CaCO_3 + 5CO_2 + 5H_2O \ldots.. (2)$$

From the above equation 2, it is revealed that the calcium carbonate is not formed unswervingly because of the microbial process but also in an indirect manner because of the autogenously healing technique. This, in turn, leads to the practical crack-sealing approach, which is bio-based. The bacteria (*Bacteria Subtilis JC3*)that are employed for the research [5] unveils which catalyzes the hydrolysis of urea into carbonate and ammonium. Initially, the urea is hydrolyzed to ammonia and carbonate. Followed by it, carbonate hydrolyses to produce extra ammonia and carbonic acid. Subsequently, these products have hydroxide, ammonium and bicarbonate ions. The bicarbonate equilibrium is changed by ammonia, which leads to the production of calcium carbonate ions. As the bacteria's cell membrane is negatively charged, the bacteria pull cations from the surrounding, involving $Ca_2^+,$ to credit on one's cell surface. Consequently, the Ca_2^+ ions react with CO_3^{2-}ions, resulting in the $CaCO_3$precipitation on the cell surface, which acts as the nucleation site.

$$Ca_2^+ + Cell \rightarrow Cell - Ca_2 + Cell - Ca_2^+ + CO_3^{2-} Cell \text{-}\rightarrow CaCO_3 \ldots..(3)$$

2.3 Challenges and Limitations of Bacterial Concrete in Marine Environments:

Marine environments cause corrosion and cracks in concrete structures. Despite its potential, bacterial concrete faces challenges when applied in marine environments. The presence of high chloride concentrations, fluctuating pH levels, and exposure to seawater can influence bacterial activity and affect the efficacy of crack healing. Hence, this review paper explores these challenges, emphasizing the need for optimized bacterial strains and environmental conditions to ensure consistent performance in marine settings.

3. Need of the study

TheBacterial or self-healing concrete has the competence to recover repairs or cracks in concrete structures in the absence of any external intervention. Self-healing of damages can be accomplished by improving the automatic healing competence of concrete itself or toting repairing agents. In the midst of various self-healing technologies, utilizing Microbiologically-Induced Calcium Carbonate Precipitation (MICP) has been regarded as an environmentally friendly passageway.In marine environments, the concrete's durability is mainly reliant on its permeability, which surges because of cracking. Hence, the current investigation intends to analyze the significance of BC in increasing durability in concrete structures with respect to marine environments.

4. Review of the Previous Literatures

4.1 Strength Characteristics of bacterial concrete

In the past decade, it has been revealed that the cement-based materials were improved with the aid of bacteria and have been accredited to MICP. Even so, the competence of bacteria to endure, develop, and maintain one's metabolic activity in concrete is disputed. So, an analysis [6] reveals the mechanisms engaged in the strength improvement of cementation materials that are composed of bacteria. The accumulation of various concentrations of dead and live cells of $Bacillus\ cohnii$ in cement mortars results in a surge in compressive and flexural strength for mortars comprising both kinds of bacteria.

Similarly, another scholarly work[7]investigates the prospect of acquiring the concrete's strength through filler or microbiologically induced exceptional growth. The inquiry employs the bacteria *DzBacillus megateriumdz*. Also, the prisms and concrete cylinders were cast using and devoid of bacteria were released. Subsequently, the tensile strength and split's flexural strength are investigated. Moreover, there is an improvement in split flexural strength and tensile strength with the addition of bacteria. Through the analysis made by scanning electron Micrography, it is revealed that due to the accumulation of bacteria, the pores were partially occupied by material growth.

4.2. Crack management and Self-healing properties of bacterial concrete

Also, a paper [8]performs an investigation to arrest the cracks formed in concrete using calcium lactate and *Bacillus subtilis* bacteria. The research employs the *Bacillus subtilis* bacteria with calcite lactate and is engaged in various percentages like five per cent, ten per cent and fifteen per cent of cement weight for $M40$ grade concrete.Subsequently, the abrasion resistance was determined with respect to cantabro loss for all mixes. The outcomes reveal that the Cantabria loss declines while simultaneously flexural strength surges.

An advanced technology permitting repairing open micro-cracks in concrete through $CaCO_3$ precipitation is known as bacterial self-healing. This bio-technology enhances the durability of the concrete's structure. Accordingly, a study [9] employs the $Bacillus\ subtilis$, yeast extract and peptone in concrete mix design. This results in the reduction in porosity and increase in dynamic modulus and strength, as well as decreases the water uptake, chloride permeation, and gas permeability. Also, the outcomes display that the microbial precipitations in the crack were$CaCO_3$.

Likewise, research [10]intended to examine the micro-crack management issue and whether the particular microbes will surge the concrete's tensile strength and compressive strength. The ingredients of the concrete mix were the mixture of the microbe's pure culture along with the nutrients in the required amount mixed with water. Consequently, the blocks were cast and examined for compressibility, and tensile strength was investigated. The outcomes revealed that the split tensile strength and compressive strength of species *bacillus megaterium and bacillus subtilis* and groupings of both these species were witnessed to be greater than the well-established concrete.

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The main motive of the exploration [11] is to produce a type of self-healing concrete through engaging mineral-producing bacteria *bacillus pasteurii* to identify the rift in the most preferable conditions for accomplishing autogenous healing. Self-healing concrete comprising bacteria has been produced for this investigation by means of the application of bacterial self-healing elements as nutrients and spores with various percentages of bacteria as the substitute for mixing water. The effect of bacteria was witnessed. The durability and mechanical properties of the 35 mixture were investigated.

Several investigators have presented bio-carriers to develop the microbial viability of concrete in aggressive environments. Also, to manage the self-healing efficiency of concrete. Accordingly, a paper [12] uses the bio-carrier (bottom ash immobilized with Bacteria P) to investigate the self-healing competence of concrete. Additionally, the outcomes of the healing ratio measurement specify that the bio-carrier will be utilized as the self-healing agent for sustainable self-healing and long-term durability performance of concrete structures.

The most promising self-healing alternative for sealing concrete's crack widths is bacterial concrete by means of MICP. Hence, an inquiry [13] employs two bacterial strains that are entrenched at fluctuating dosages in concrete. Beam specimens quantify the maximal crack-sealing efficacy. Meanwhile, the cylinder samples were used to measure their impacts on the concrete's intrinsic mechanical properties and the stiffness recovery at the time of persuading damage. The outcomes reveal that the specimens group with the leading calcium alginate concentrations leads to enhancement in stiffness recovery.

The corrosion of reinforcement occurs due to the cracks, which increases the concrete's permeability. Subsequently, the Compressive Strength (CS) and Tensile Strength (TS) of the building decreased significantly, producing the breakdown of structures. With the employment of bacterial concrete, the cracks can be evaded. Likewise, an exploration [14] employs the gram-positive cell bacterium – *Bacillus subtilis*. This bacteria surges the TS and CS of reinforced concrete elements in buildings for the comparable grade of well-established concrete. Hence, it does not permit cracks to happen.

Primarily, because of load or environmental conditions, concrete structures are susceptible to forming cracks. Several advanced examinations are being conducted to manage the gaps in concrete construction. One of those investigations is integrating microorganisms that are proficient in precipitating $CaCO_3$ and can self-heal the trials. Consequently, research [15] recognizes multiple venues utilizing mineralizing bacteria to surge the concrete's structural strength. There is an impact on the concrete's flexural strength due to the addition of laboratory-cultured Bacillus subtilis.

4.3 Durability of bacterial concrete

A conventional study [16]examines the durability properties of microbial-treated concrete structures subsequent to exposure to physical and chemical salt solutions. The study observes that sulphate attack destroys the untreated concrete specimens, producing ultimate failure because of the expansion beneath exposure regimes. Severe surface scaling and thick salt efflorescence were detected in the untreated mortar at the time of the physical sulphate attack. On the other hand, the specimens treated with bacteria enhanced the resistance against sulphate ingress.

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The utilization of carbonate-producing bacteria is an advanced procedure for enhancing the characteristics of concrete. The concrete's durability in harsh surroundings like sulphate exposure has always been a concern. Accordingly, the study [17] assesses the durability enhancement of concrete encompassing bacteria wide-open to sulphate surroundings. The outcomes revealed that the integration of bacteria in concrete decreases water absorption, volume variation, and mass variation, simultaneously surging the specimen's compressive strength. Furthermore, the bacterial concrete has poorer chloride penetration when compared with the control specimens.

The requirement of extreme durability for structures exposed to harsh environments such as sewage pipes, sea-floor, tunnels, radioactive elements and structures for liquid, solid waste composed of venomous chemical composites cannot be accomplished utilizing ordinary Portland cement in recent times. Accordingly, research [18] creates a specialism of increasing the energy and entire durability of the concrete employed in standard concrete through integrating *Bacillus subtilis*. It is revealed that the process of bacterial precipitation has surged the strength and durability properties of concrete.

Subsequently, an inquiry [19] employs the four various mixes as: bacterial concrete, fibre-reinforced concrete, and bacterial concrete, along with the incorporation of fibres in standard concrete. The repairing and healing efficacy of concrete is determined with respect to the compressive strength and electrical resistivity of concrete on healed and pre-cracked samples. Moreover, the outcomes are interrelated with the analysis of the spectrometer and microscope. The findings of the inquiry reveal that there is a considerable improvement in the strength and durability of concrete because of the incorporation of bacterial concrete along with fibres.

Another study [20] analyzes the durability of concrete, water absorption, water penetration depth and carbonation depth in specimens encompassing fine limestone powder and slag in one's concrete mixes, which is exposed to bacterial usage. These specimens were successively treated for twenty-eight days in seawater, curing media of tap water and the solution of urea and calcium lactate. Lastly, the specimen's surface was cured for two weeks in one of the above media. The outcomes revealed enhanced durability in both bacteria-combined concrete specimens.

One more investigation [21]analyzes the durability and mechanical performance of bacterial concrete with respect to water absorption capacity, split tensile strength, compressive strength and density. The investigational outcomes of normal bacteria (in the absence of bacteria) were correlated with the specimens that consisted of bacteria. The results reveal that the optimal bacterium level was recognized as 3.5 per cent, and it displayed the highest values with respect to density, split TS and CS. Hence, bacterial concrete improves its durability.

4.4 Impact of various bacteria

Bacteria secluded from the manufactured sand ($Bacillus\ megaterium$) were integrated into concrete mixtures, and their respective impacts on durability and mechanical properties were examined [22]. The impact of the bacteria concentration was evaluated with respect to water permeability, chloride ion penetration, acid resistance, flexural strength, split TS and CS. Moreover, the microstructural examinations were performed, and the results of the review uncover that the flexural strength, split rigidity and compressive strength of cement produced with $10^5\ cells/ml$ of bacteria is 10.7 per cent, 97.5 per cent and 11.3 per cent, correspondingly.

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An imperative engineering property of concrete, particularly to extend its lifespan, is its durability. The exposure of concrete to an aggressive environment will harm the concrete's durability. Existing investigations on bio-concrete utilizing various kinds of bacteria involving sulphate reduction bacteria had displayed progress enhancement. The outcomes of the research [23] reveal that the addition of sulphate reduction bacteria in concrete specimens enhances the water permeability and compressive strength. This context especially opts for applications in seawater situations in which reinforcement corrosion inclines to obstruct the durability of concrete constructions.

Another paper [24] analyzed the impacts of a particular strain of *Bacillus subtilis* presented into natural lightweight aggregate concrete as an advanced technique on its compressive strength, electrical resistance, carbonation depth, chloride ion penetration, water absorption, water penetration depth in sulphate surroundings. In order to fulfil this aim, two groups of specimens were created with and devoid of bacteria. The investigational outcomes reveal that while correlated with the standard models, those specimens consisted of bacteria in their mixed water and cured in the calcium lactate surrounding, documented a reduction in chloride penetration, water penetration depth, carbonation depth and water absorption of about 20.5 per cent, 44.3 per cent, 27.2 per cent and 13.1 per cent.

Similarly, an inquiry[25] examined the usage of $Bacillus\ subtilis$ microorganisms as a break recuperating specialist in concrete underneath destructive environmental factors. The assessment uses the microorganisms with a cell centralization of 10^6 cells/ml. The durability properties of bacterial concrete are assessed by chloride attack assessment, sulphate attack assessment, and rapid chloride penetration assessment. The concrete's mechanical properties are examined by split tensile strength and compressive strength tests. Scanning electron microscopy is utilized to investigate microstructural behaviour. The outcomes of the study revealed that $Bacillus\ subtilis$ bacteria can rectify micro-cracks in concrete beneath corrosive surroundings. The durability and mechanical properties of BC were suggestively developed, succeeding in self-healing. However, the rate of self-healing in seawater decreases by twenty to thirty per cent.

Also, research [26] employs calcite formation through $Bacillus\ subtilis - a\ gram - positive\ bacteria$- a model research centre microbes that was used to frame calcite hasten on proper media went with a calcium source. Substantial blocks with 3 different cell convergences of microorganisms and control examples were likewise projected. The consequences of the exploration reveal that there was an enhancement in the concrete cubes' compressive strength with the incorporation of bacteria. The outcomes disclosed that bacterial calcite enhances the concrete's power when compared to traditional concretes.

Consequently, a study [27]intends to concentrate on the laboratory analysis of Bacterial concrete. This concrete is introduced on the application of mineral-forming microbes such as *Bacillus subtilis* that have bio-calcification properties and the competence to precipitate calcium carbonate efficiently inside concrete structures. The calcium carbonate precipitation has the capability to seal the cracks and pores internally and consequently make this structure turn out to be more condensed. The integration of Bacillus subtilis bacteria in concrete surged the concrete's compressive strength when compared with the control specimen.

An additional paper [28] displays the impact of *Bacillus megaterium* on the high-strength silica fume produced with M-sand. Several tests, such as ultrasonic pulse velocity test, CS test, split tensile strength and ultrasonic pulse velocity test, have been performed. The bacterial concentration was optimized, and eight concrete mixes were formulated. The durability tests of specimens utilizing NaCl and H_2SO_4 display the bacterial concrete efficacy utilizing M-Sand and silica fume in marine surroundings. Regression analysis quantitatively correlates the modelling of strength properties of various mixes.

4.5 Other specific Properties

Correspondingly, an inquiry[29] investigates the usage of bacterial-incited self-fixing substantial that affects its mechanical properties and furthermore the break recuperating skill of deep rooted concrete. Dualistic sorts of types of the variety Bacillus are incorporated into the substantial to fix the break. It not only heals the cracks but also improves concrete's mechanical properties. The micro-cracks present in the transition zone are healed. The groupings of microscopic organisms are adjusted and joined with the substantial blend to see the modification in the mechanical properties, and the outcomes display a significant surge in the capability of the BC.

Moreover, research [30] emphasized the use of bacteria to enhance performance by decreasing the voids in concrete. The existence of voids in concrete will result in a decline in its performance while treated to high shrinkage and settlement. One of the excellent healers for concrete voids is the *Bacillus* family bacteria. The inquiry utilizes the bacillus megaterium bacteria of the bacillus family. A count of around forty-eight specimens was cast and examined for their water absorption and mechanical strength after seven and twenty-eight days of curing. The outcomes of the test reveal that the flexural strength, split tensile strength and compressive strength surged to 9.02 per cent, 10. Twenty-eight per cent and 12.91 per cent correspondingly after twenty-eight days of curing while correlated with the standard M30 grade concrete mix.

The creation and design of MICP items for break mending, especially in seawater, stays questionable, subsequently confining the utilization of MICP in oneself recuperating of marine conditions.Through thermodynamic and exploratory procedures, the work[31] examinations the movement of fluid species and furthermore the microstructures and stage arrays of bio-minerals in compound arrangements reproducing substantial breaks in marine water. The MICP results of substantial self-recuperating in seawater and freshwater are being explored. The discoveries of relative examination on recuperating items isolated from genuine substantial breaks in marine water showed a speeder abiotic precipitation of brucite, which was prevailed by the MICP methodology.

There is a lack of outdoor application instances appeals for investigations evaluating the efficacy of the self-healing approaches beneath the actual environmental conditions like sustained load conditions, freeze-thaw cycles and marine environment. The durability of biological self-healing concrete has to be assessed in industrialized projects. The paper[32] defines the apparatus, mechanical performance of concrete and assessment techniques of the durability. Finally, the paper recommends an advanced set-up for executing the tests in outdoor conditions and laboratory set-up.

Also, research [33] correlated the growth and mineralization characteristics of the $bacterium\ Sporosarcina\ pasteurii$ underneath two outrageous saltiness conditions, for example, seawater and new water and oneself recuperating conduct of breaks succeeding the blend of the bacterium with mortars. According to the findings, the salinity of the seawater affected the bacterium's morphological structure, inhibited its mineralization behavior, slowed its growth, and marginally reduced its self-healing capacity of cracks in mortars with the diatomite loaded with the bacterium. The outcomes of the study aid in learning the bacterium's mineralization and possess significant engineering significance for developing the service life and durability of sea-side concrete structures.

The mechanisms and performance of stimulated autogenous self-healing in cement-based composites with the addition of seawater, NaCl solutions and crystalline admixtures uncovered to water were analyzed [34]. The healing products, water absorption, chloride penetration, and crack closure were considered for cracked mortars that were visible in dry/wet cycles. The correlation between durability recovery and crack closure for cracked specimens indicates the requirement for a performance-recovery-based technique for evaluating self-healing competence.

Besides, a paper [35]utilizes the microbial-induced carbonate precipitation technique to strengthenthe calcareous sand. The disintegration component and toughness highlights of MICP-supported calcareous sand underneath a few natural elements were broke down artificially based on minuscule morphology, mass misfortune rate and unconfined compressive strength in field and lab studies. MICP-supported calcareous sand shows the most elevated protection from temperature cycles, which is prevailed by the dry-wet cycle, salt-splashing with drying cycles, and coupling effect of temperature.Also, it shows the poorest resistance to field marine situations yet; the sample's veracity will be managed after thirty days of field examinations.

4.6 Summary of Literature Review

The concrete's durability is mostly impacted by its volume change, formation of cracks and permeability. The cracks in concrete are produced because of several factors involving contraction, thermal expansion, corrosion, shrinkage, reinforcement and tensile failure. Harsh environments like seawater damage the durability of concrete. Self-healing concrete is a potential solution to this issue since it repairs micro-cracks in an automatic manner. After analyzing various scholarly papers, it is revealed that bacterial concrete possesses self-healing properties and remedies the cracks in concrete structures. The most commonly employed bacteria in the formation of self-healing concrete are gram-positive bacteria such as *Bacillus subtilis* and *Bacillus megaterium*, and it is not harmful to living beings. The self-healing property of bacterial concrete is reduced by around 20 to 30 per cent in marine environments. Through this healing ratio, long-term durability can be accessed.On the other hand, it has been found that the durability of the concrete is enhanced by bacterial concrete when compared to normal concrete in marine environments.

5. Futuristic recommendations

The review discusses recent research endeavours aimed at enhancing the durability of bacterial concrete in marine surroundings. Strategies such as the development of specialized bacteria strains, incorporation of supplementary cementation materials, and improved curing techniques have been explored to address the challenges posed by harsh marine conditions. These advancements contribute to a deeper understanding of how bacterial concrete can be tailored for marine infrastructure applications. A study[36] also provides a substantial opportunity to develop an understanding of SHC in realistic surroundings such as marine atmospheres. The outcomes of the research reveal that the healing agents employed in concrete compositions can enhance

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durability by decreasing chloride ingress and degradation. Still, more investigations are required to develop the healing efficacy of the bacterial or self-healing concrete in marine environments. Furthermore, the environmental benefits, including reduced carbon emissions and material waste, need to be highlighted.

6. Conclusion

Bacterial concrete holds substantial promise as a durable construction material for marine environments. While challenges remain, recent advancements in microbial-induced calcite precipitation, coupled with economic and environmental benefits, underscore its potential to revolutionize the field of marine infrastructure. As research progresses and implementation practices improve, bacterial concrete could play a crucial role in extending service life of coastal and offshore structures, ensuring sustainability and resilience in the face of harsh marine conditions.The outcomes of the review paper show that *Bacillus subtilis* is the most commonly utilized bacteria to increase the durability of concrete structures when compared to other bacteria. Also, it is revealed that *Bacillus subtilis* has significantly surged the durability properties of the concrete. The review paper concludes by discussing potential future directions for the utilization of bacterial concrete in marine environments. As research continues to address challenges and refine strategies, bacterial concrete could become a standard construction material for coastal and offshore structures. The integration of advanced monitoring and maintenance techniques, along with ongoing developments in bacteria-assisted construction materials, opens doors to innovative approaches for enhancing the durability of marine infrastructure.

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