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EXPERIMENTAL INVESTIGATIONS IN SELF RELIEVE CONCRETE FOR SUSTAINABLE CONSTRUCTION

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Abstract

Fractures in concrete structures, if not promptly treated, tend to spread, leading to expensive repairs. Despite modern technology's ability to reduce cracking severity, repairing concrete cracks has long been a research focus. Cracks and fractures are common in buildings, paved surfaces, and historical monuments. We've developed an innovative method for crack sealing using a continuously self-improving and environmentally beneficial biological process. Our investigation induced CaCO3 using Bacillus Sphaericus, a common soil bacterium, emphasizing the importance of understanding microbial involvement in crack restoration. To extend service life, we've recently created microorganisms based self-relieve concrete, consisting of a two-component relieve agent with microorganisms and a mineral precursor chemical. When cracks and water are present, active microorganisms transform absorbed organic chemicals into calcium(Ca) precipitates, effectively sealing and blocking cracks for self-relieve.

Keywords: Concrete Repair,Self-relieve Concrete,Biological Crack Sealing

Introduction

Concrete finds extensive use in diverse projects due to its commendable compressive strength, fireproofing attributes, durability, and ready availability for applications in water conservation, hydropower, traffic, and civil construction. Nonetheless, external elements can result in surface issues, compromising the concrete's ability to withstand permeability, chloride corrosion, and carbonization. Untreated cracks pose a significant threat to the structure's carrying capacity and overall durability, underscoring the importance of timely repairs.

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In response to these challenges, a self-relieve system named "Microorganismsl Concrete" has been innovatively developed, employing specially selected microorganisms, such as Bacillus subtilis, capable of inducing calcite precipitation to form a rejuvenated layer atop existing concrete. This self-relieve substance can remain dormant for an impressive duration of up to 200 years within the concrete matrix. The research delves into creating optimal conditions for these microorganisms, subjecting the material to mechanical assessments such as compressive and split tensile strength tests. Particularly advantageous for the restoration of historical monuments, microorganismsl concrete effectively addresses crack narrowing and structural reinforcement. The methodology, known as "Microbiologically Enhanced Crack Remediation," falls under the broader scientific theme of "Biomineralization." The microorganismsl deposition of calcite aids in reducing water absorption and gas permeability without significant alterations to the concrete's aesthetics. The precipitation process incorporates both passive and active nucleation, influenced by microorganismsl metabolism, pH elevation, and specific microorganismsl traits. Furthermore, the text provides insights into fine and coarse aggregates, chemical admixtures, mineral admixtures, and the properties of hardened concrete, underscoring the significance of mechanical strength, durability, and density in concrete construction.

Methodology

Producing high-quality concrete requires meticulous precision at every manufacturing stage. If careful attention is not given and proper regulations are not adhered to, the resulting concrete will be of inferior quality. Therefore, to ensure the production of top-notch concrete, it is crucial to be mindful of and follow the appropriate guidelines at each stage of the manufacturing process.

The primary five stages of the manufacturing process include batching, where the necessary ingredients are measured and gathered; mixing, where the ingredients are combined thoroughly; placing, involving the deposition of the mixed concrete in its designated location; compaction, which ensures the removal of air voids and enhances the material's density; and finally, curing, where the concrete undergoes a controlled environment to attain its desired strength and durability.

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Electrical portable Mixer

A concrete mixer is a specialized device utilized in the construction industry for blending various ingredients, primarily cement, water, and differently sized aggregates, to produce mortar and concrete. This equipment comprises two main components: a body and a rotating cylindrical container, powered by an electric motor that facilitates vigorous rotation.

Electric concrete mixers are equipped with controls operated by buttons or push buttons. During installation, it is crucial to exercise caution to prevent potential harm or damage. This precautionary measure aims to avoid unintended activation of startup switches and ensure the straightforward operation of stop buttons. Ideally, the push buttons should be situated outdoors, away from the engine area, to enhance safety and prevent accidental mishaps.

Aggregate Replacement

Exploring alternatives for cement and sourcing innovative aggregate materials in construction projects not only promotes environmental sustainability but also presents opportunities for cost-effectiveness. Integrating waste materials, promoting recycling initiatives, or reusing resources as partial substitutes for traditional aggregates contributes to minimizing the environmental impact of construction practices. Noteworthy alternatives for aggregate replacement include materials like concrete debris, paper or fiber, and recycled plastics. Considering that aggregate is a foundational component in producing concrete mixtures for crucial elements such as slabs, beams, and columns, the pursuit of eco-friendly alternatives becomes essential. With the continuous global demand for concrete, the search for sustainable substitutes for conventional construction materials becomes a key aspect of responsible building practices.

In terms of material measurement, the adoption of a weighing batch process emerges as a preferred method, offering benefits such as enhanced accuracy, adaptability to diverse project requirements, and overall procedural simplicity during concrete pouring. The endorsement of weigh batching underscores the significance of precision in the construction process. Additionally, the availability of various weigh batchers caters to the specific needs of individual projects. It is stressed that, in weigh batching, meticulous measurement of water using measuring jars is crucial. This detailed approach ensures precise control over water content, contributing to the overall quality and dependability of the concrete mixture.

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Compressive Strength Test

The decrease in compressive strength observed at higher concentrations of calcium(Ca) lactate indicates that an excessive formation of calcium(Ca) carbonate has a detrimental effect on concrete strength. This observation aligns with the findings of researchers Faiz and Steve, who similarly concluded that a moderate increase in calcium(Ca) carbonate content leads to the most significant enhancement in strength. Additional research corroborates the idea that specific concentrations of microorganisms contribute to increased compressive strength compared to control samples. Faiz and Steve's observations on the positive impact of a limited amount of calcium(Ca) carbonate on strength are consistent with these findings.It is essential to highlight that diverse concentrations of microorganisms have demonstrated the ability to improve compressive strength compared to control samples. However, the concentration of microorganisms plays a pivotal role, influenced by the inherent characteristics of the microorganisms themselves. The selection of microorganisms from various ancestries introduces a nuanced dimension to this research, emphasizing the intricate relationship between microorganismsl concentration and its consequential impact on the compressive strength of concrete. This underscores the intricate nature of microbial involvement in concrete properties and underscores the necessity for a comprehensive understanding of the specific contributions of microorganisms to concrete strength.

Type of concrete	Compressive strength after seven days		
	Sample 1	Sample 2	Sample 3
Conventional Concrete	22.70	23.03	23.51
Concrete with 5% Bacillus Sp	24.04	24.51	24.83
Concrete with 5% B.sp+ 0.005 CL Mol/L	25.70	26.32	26.55
Concrete with 5% B.sp+ 0.005 CL + Urea Cacl2	28.12	28.54	29.52

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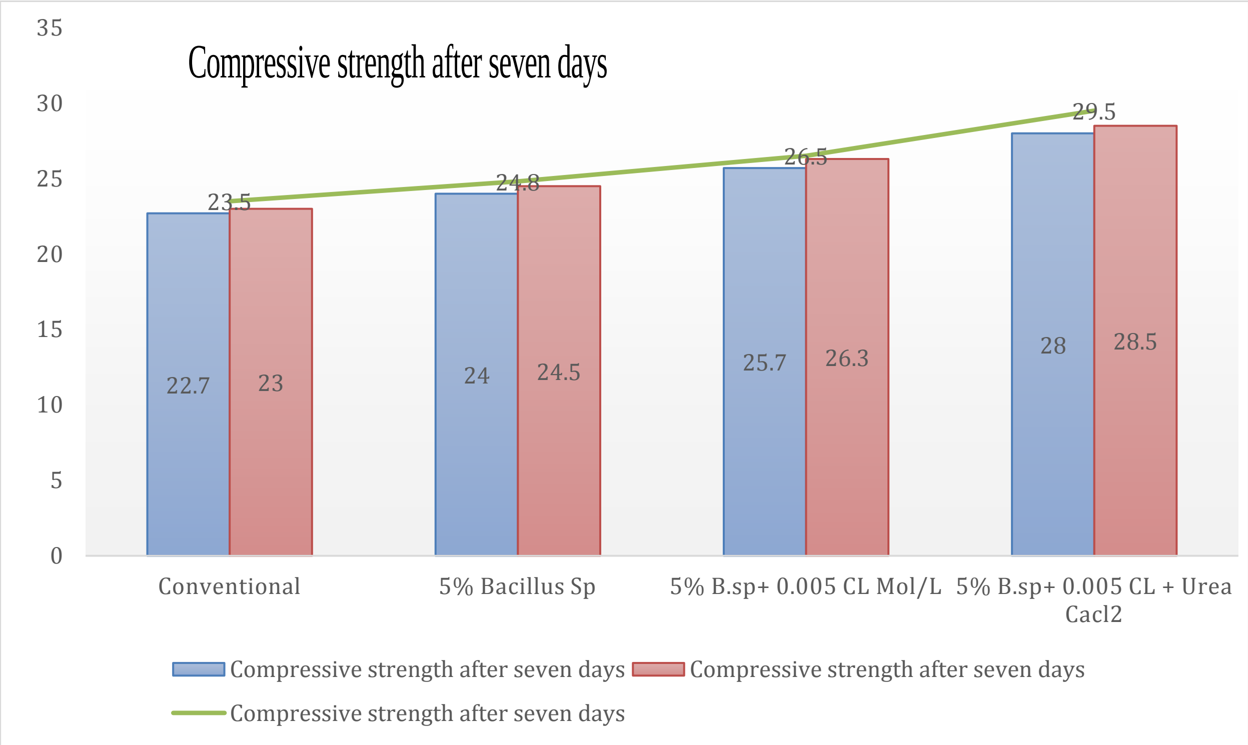

Type of concrete	Compressive strength after Fourteen days		
	Sample 1	Sample 2	Sample 3
Conventional concrete	28.32	29.05	29.56
Concrete with 5% Bacillus Sp	29.10	29.85	30.43
Concrete with 5% B.sp+ 0.005 CL Mol/L	31.52	30.81	31.94
Concrete with 5% B.sp+ 0.005 CL + Urea Cacl2	32.54	32.03	33.45

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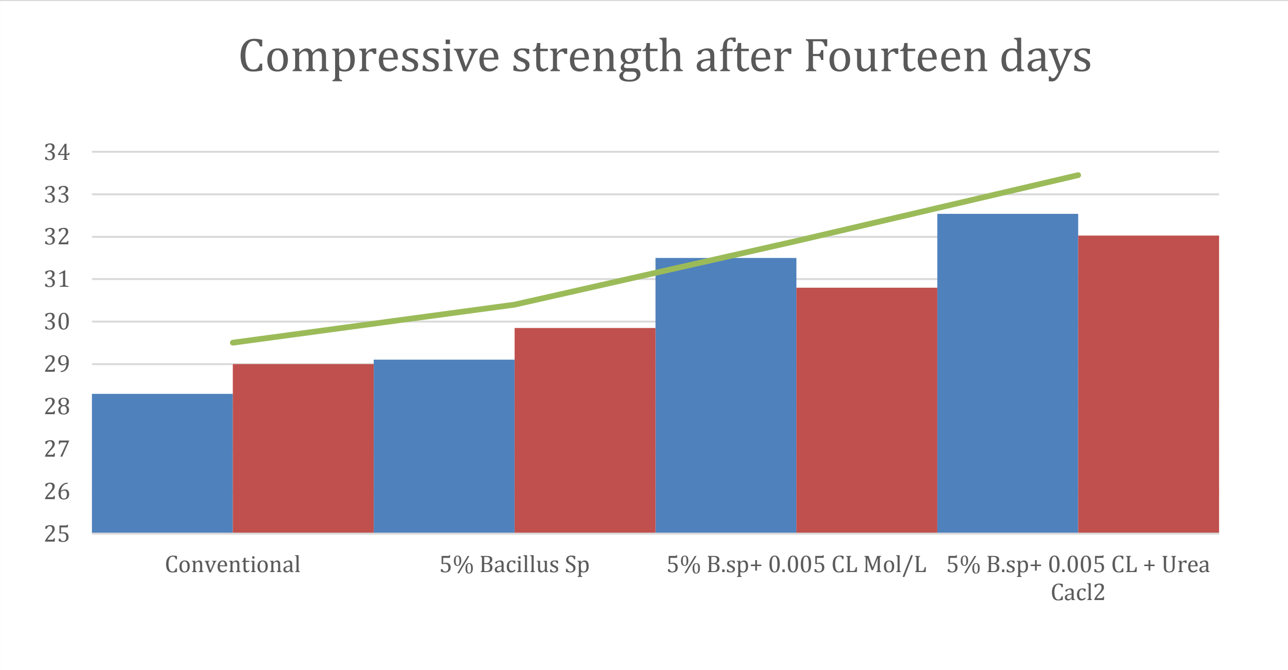

Results and Discussion

Concrete plays a crucial role in the construction industry, demanding high-quality standards for creating enduring structures. In the realm of innovative progress, an article titled "A Self-Relieve Concrete for the Future" introduces a pioneering method involving a common soil bacterium to trigger calcite precipitation. This natural and unpolluted mineral formation through microbial activities was demonstrated in the workability test, showcasing a favorable slump value of 90mm for its consistency and user-friendliness. Highlighting the bacterium's ineffectiveness in water, the research underscores the effectiveness of combining the microorganismsl concrete with a buffer solution instead. The stability of the mixture's pH value, even when exposed to acid or alkali, illustrates the robustness of this microorganismsl concrete. The study explores various ratios of microorganisms incorporation into concrete specimens for comprehensive testing and research purposes.An important aspect highlighted in the article is the cost-effectiveness of microorganismsl concrete, comparable to traditional concrete. Additionally, its self-relieve properties eliminate the need for costly rehabilitation work, typically required for addressing cracks in conventional concrete after 15 years. This self-repair mechanism, requiring no human intervention, presents a promising solution for the prolonged durability and maintenance of concrete structures.

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Conclusion:

The significance of top-notch concrete in construction is underscored, presenting an inventive method involving a common soil bacterium for self-relieve concrete. A workability test validates its positive performance, evidenced by a slump value of 90mm. Despite the bacterium's inability to thrive in water, its combination with a buffer solution ensures the self-relieve concrete maintains a steady pH value, highlighting its robustness. The article accentuates the cost-effectiveness of microorganismsl concrete compared to conventional alternatives, emphasizing its capacity to obviate the need for costly rehabilitation work typically required after 15 years. With self-repair mechanisms addressing cracks autonomously, this concrete presents a promising avenue for fortifying the long-term durability of concrete structures without human intervention.

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