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Bacterial Concrete

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Abstract: ***Cement mortar durability is the function of its internal pore structure and distribution, porosity and its permeation properties. Research has shown that some specific bacterial species isolatedfrom soil can tolerate harsh and challenging alkaline environment and can be used in remediating cracks in cement mortar structures. This state-of-the-art microbial based crack healing mechanism is one such phenomenon on which studies were carried out to investigate the role of calcite mineral precipitation in improvement of durability in bacteria integrated cement mortar.***
Keywords: Bacteria, Bacillus Subtilis, Self-Healing

I. INTRODUCTION

Cement mortar is a quasi brittle material which is susceptible to cracking. Maintenance of cement mortar structures is costly and labor intensive. Furthermore, delay between the initiation of damage and repair often increases the severity of damage. Thus research has been undertaken worldwide to develop a smart sustainable infrastructure material in which cracks are healed at their occurrence. Recent developments related to this self healing phenomenon include application of adhesive filled glass fibers in cement mortar, use of fly ash in cement mortar that can healshrInkage cracks, rewetting of cement mortar to recover freeze-thaw damage etc.

II. GENERAL CHARACTERISTICS OF BACILLUS SUBTILIS

Bacillus subtitles is a spore forming, motile, rod-shaped, Gram-positive, facultative aerobe. It is mostly found in soil and vegetation with an optimal growth temperature from 25-35 degrees Celsius. B. subtilis has the ability to produce and secrete antibiotics.
The genomic structure of this microorganism contains five signal peptidase genes that are important for the secretion of these antibiotics. B.subtilis has shown to be capable of secreting polymyxin difficindin, subtilin ,and, mycobacillin.

A. Bacterial Concrete

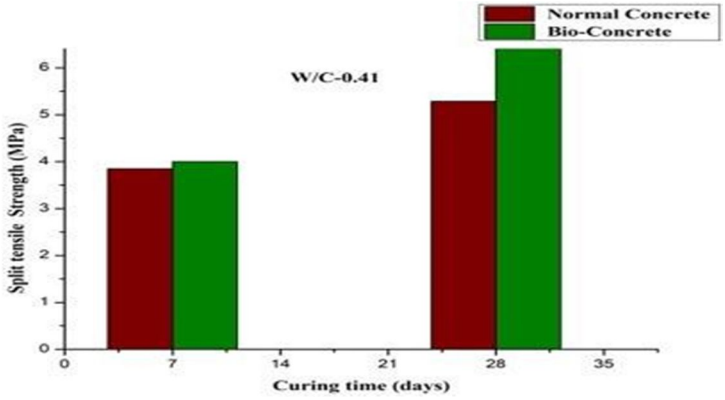
The effect of bacteria suspended in different mediums on the alkali aggregate reactivity of concrete beams In this study bacteria were first suspended separately in three different mediums (water, phosphate-buffer and urea-CaCl2) to obtain a final concentration of 1 x 108cells/ml.

B. What Bacteria is Used

Most of the bacterial belongs to genus bacillus are fulfilled the required criteriadiscussed above, some of the list of bateria are B. Pseudofirmus , B. cohnii, B. Fila…subtilis. etc The suitable chemical precursor found to be the most suitable



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C. Advantages of Bio-Concrete

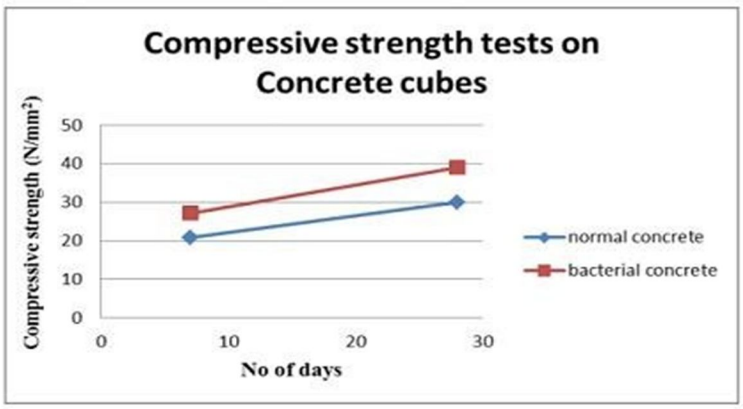
1) Reduction in permeability of concrete.
2) Reduction in corrosion of reinforced concrete.
3) Better resistance towards freeze that attack reduction.
4) Increase in durability of concrete

D. Disadvantages

1) Cost of bacterial concrete is double than that of conventional Concrete.
2) For design of mix concrete with bacteria there is no available any is Code or other code.
3) Investigation of calcite precipitation is costly studied



E. Test On Bio-Concrete



III. METHODOLOGY

Self-healing concrete is a product that will biologically produce limestone to Heal cracks that appear on the surface of concrete structures.

Ca(c3h5o2)2 + 7o2 caco3 + 5co2 + 5h2o(calcium lactate) (lime)

specially selected types of the bacteria genus bacillus, along with a calciumbased nutrientknown as calcium lactate, and nitrogen and phosphorus, are

Added to the ingredients of the concrete when it is being mixed.

Cracks less than .2mm can be auto fill by concrete. But it cracks are more than .2mm than concrete itself thus opening passage to chemicals and other materials.

In bio concrete if water is the contact with the concrete with the concrete the cracks the bacteria get activated from its stage of dormance formed which further in calcium carbonate which act as a healing material.

When the cracks are filled completely by the bacteria it again went to the stage of dormancyagain.

Again if in future if cracks gets widen and the forein particles tends to enter through the cracksthe bacteria gets activated and thus heal the cracks, thus acting as a long lasting healing agent.

IV. RESULT AND DISCUSSION

The effects of the following parameters on the durability of concrete were investigated:Bacteria suspended in water (BW). Bacteria suspended in urea-CaCl2 (BU). Bacteria suspended in phosphate buffer (BP) andDifferent concentrations of bacteria.

All the test results were compared with that of the control concrete. It was found that all the beams made with bacteria performed better when compared to the control concrete with oneexception (BW).

The beams made with bacteria suspended in water (BW) performed as bad as the control concrete. Because of a difference in osmotic pressure, bacteria cannot survive inwater and they will eventually lyse.

The following major reasons are attributed to the better performance of the bacterial concrete:Formation of a new additional layer on the surface of the already existing concrete layer. This new additional calcite layer formed by bacteria is highly insoluble and increases the impermeability of the specimen. Thus it resists the penetration of harmful solutions into the concrete (alkali, sulfate etc….) thereby decreasing the deleterious effects they may cause.

The compressive strength of concretes made with BW, BU and BP were determined. It was found that concretes made with BU and BP had marginal (5 to 10%) increase in the strength whereas the concrete made with BW had marginal decrease in strength (10%) when comparedto control concrete. This increase in the matrix strength (for concrete made with BU & BP) would have resulted in lesser mean expansion and would have eventually increased the overalldurability performance of the concrete.

V. CONCLUSION

The presence of bacteria in different mediums (water, phosphate-buffer and urea-CaCl2)increased the resistance of concrete towards alkali, sulfate, freeze-thaw attack and dryingshrinkage.

Phosphate-buffer proved to be an effective medium for bacteria than the other two mediums (water and urea-CaCl2). Concrete made with bacteria suspended in water did not perform well as expected, because bacteria cannot survive in water. The durability of bacterial concrete increased with the increase in the concentration of bacteria.

VI. FUTURE SCOPE

The concept of self healing concrete is still thing of the future for commercial and residential buildingsdue to the production cost .

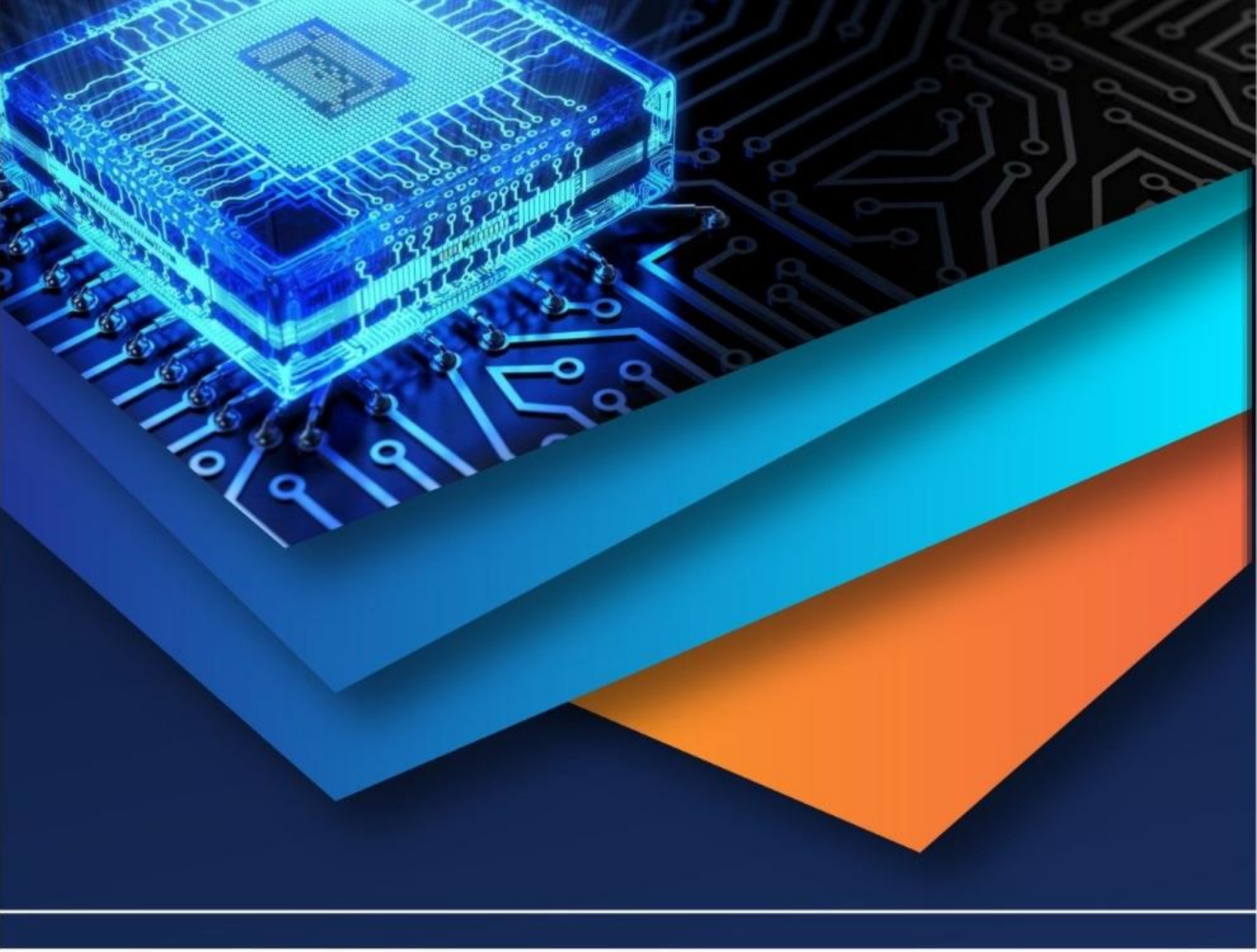
However this concrete is currently being looked at for use in building underground containers forhazardous waste.

As this technology continue to develop in the future , the self healingconcrete could make a huge Impact on the construction industry, as well as the environment.

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