

HEALTH IMPROVEMENT TECHNIQUES OF MONUMENTAL BUILDINGS USING SELF HEALING BACTERIAL CONCRETE

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Abstract

Temples, dams, monumental building, are the pride of our nation. These structures should be protected and maintained regularly as they speak our culture and heritage. As these structure stands for decades to decades they may get weakened due to ageing which induce creep effect in structure. The crack developed should be repaired permanently. To get a permanent solution the self healing technique is used with the help of bacteria which produce calcium carbonate in their metabolic activity. Since curing is difficult in repair work self curing is also adopted.

In our work, we are using BACILLUS MEGATARIUM as self healing agent by adding it into freshly made concrete. Cracks in concrete are unpreventable, and it is intrinsic weakness of concrete. Through these cracks, water and others salts can seep. It initiates corrosion, further reducing the life of the concrete. So there was a requirement to develop an intrinsic bio-material, a self-repairing technique which can rectify the cracks and fissures developed in concrete. Bio-concrete is a material which can successfully rectify cracks in concrete. This technique is highly desirable because the activity of crack remediation is eco-friendly and natural. This research work discusses the effect of Bacillus megaterium in concrete. It was found that the use of Bacillus megaterium improves the compressive strength and stiffness of concrete. It also shows that there is reduction in water absorption and water permeability when compared to conventional concrete.

Key Words: *Self Healing, Bacillus megaterium, compressive strength, water permeability, water absorption.*

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I. INTRODUCTION

Concrete technology has been going through quick improvement now a day. To improve the performance and durability of concrete proper curing must be done. A favourable environment should be provided for continuous hydration of concrete. Self-curing concrete is one of special concrete which function to reduce the water evaporation from concrete.

We all know that structures are susceptible to cracking which makes the water to enter and degrade the strength of concrete and needs expensive and highly health-risk maintenance in sealing of cracks.

There are many ways to deals with cracks in concrete structures. epoxy resin reinforcing grouting is a method that is widely used at present. It has strong bonding force, small shrinkage after curing, high mechanical strength, heat

resistance and stability. however, these repair methods are mostly used in the case of wide cracks, and the autonomy is poor. It is difficult to repair very small cracks are micro cracks inside the structures.

In this context, along with the development of modern science and technology, people began to have interested in the new technology of concrete self-healing to repair cracks. after the concrete has cracked it has self-repaired called self-healing of concrete.

The aim of the self-healing of concrete cracks is to improve and densify the concrete skin, thus extending the life span of concrete structures and simultaneously reducing the maintenance cost expended on cement-based structural deterioration.

Natural processes, such as weathering, faults, land subsidence, earthquakes, and human activities create fractures and fissures in concrete structures and historical stone monuments. These fractures and fissures are detrimental since they can reduce the service life of the structure. In the case of monuments and buildings of historic importance, these cracks tend to disfigure and destroy the structure. Use of synthetic agents such as epoxies for remediating these structures will reduce the aesthetic appearance of the structure.

II. SELF HEALING MATERIAL

A. Bacterial Cement

Cement mortar is the major material used in construction works which is recyclable. It is strong, locally available, durable and versatile. It is a composite material with combined fine aggregates, coarse aggregates, water, cement that hardens over time.

Bacterial Cement is the new imaginative procedure in which the microscopic microorganism is added to blend with cement, fine aggregates, coarse aggregates, water and some selected material.

B. Self Curing

Self curing technology is the process which hydrate the cement internally in concrete, no external source needed for curing such as water curing. Mostly concrete goes under extensive self- desiccation, autogenous shrinkage and other properties of concrete can be affected due to improper curing. The ACI-308 Code states that “internal curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing Water.” Conventionally, curing concrete means creating conditions such that water is not lost from the surface i.e., curing is taken to happen ‘from the outside to inside’. In contrast, ‘internal curing’ is allowing for curing ‘from the inside to outside’ through the internal reservoirs (in the form of saturated lightweight fine aggregates, superabsorbent polymers, or saturated wood fibers) Created. ‘Internal curing’ is often also referred as ‘Self-curing.’

C. Saw Dust

In this project we take “SAW DUST” as a self-curing material. The main concern related to the survival of such microorganisms in cementitious environment has been successfully addressed by devising proficient



immobilization scheme coherently. Pre-saturated sawdust is used as a source of internal curing by partially replacing sand.

III. OBJECTIVE

The aim of the project are repair and renovate the ruined monuments to enhance look reduced the voids and cracks and to improve the life time. So, By use of bacteria (*bacillus megaterium*) induced in cement and pored to fill the crack by use of grouting method. The principal approach will be microbially – induced calcium carbonate precipitation.

The main objective of the self healing concrete is,

- To increase the service time and durability of concrete works.
- To reduce the material loss.
- To build the environmental friendly civil works.

IV. LITERATURE REVIEW

Novel technique for remediating damaged structural formations has been developed by employing a selective microbial plugging process, in which microbial metabolic activities promote calcium carbonate (calcite) precipitation. Due to its inherent ability to precipitate calcite continuously bacterial concrete can be called as a “Smart Bio Material”[].

The bacterial remediation technique can be used for repairing structures of historical importance to preserve the aesthetics value, as conventional technique, such as epoxy injection cannot be used to remediate cracks in those structures [].

The presence of bacteria increased the resistance of concrete towards alkali, sulfate, freeze-thaw attack and drying shrinkage. Phosphate-buffer proved to be an effective medium for bacteria. Concrete made with bacteria suspended in water did not perform well, because bacteria cannot survive in water. The durability of bacterial concrete increased with the increase in the concentration of bacteria[].

The author concludes fully grown calcite crystal with distinct and sharp edges all over the surface of the crack acts as an agent for an eventual plugging and remediation. Microbial mixture with sand filled in the cracks was found to remain intact after five days treatment proving the microbial calcite precipitation. Studies showed that the bacterial treatment of the drilled cube has increased the strength to about 34%, when compared to the drilled, non remediated cube (control).

V. MATERIAL PROPERTIES

A. Saw Dust

Sawdust (or wood shavings) is a by-product or waste product of woodworking operations such as sawing, milling, planing, routing, drilling and sanding. It is composed of fine particles of wood.



Figure:1 Saw dust

Pre-saturated sawdust is used as a source of internal curing by partially replacing sand. Pre-saturated sawdust is used to re-place fine aggregate at replacement levels of 3% by mass respectively.

TABLE 1 - Chemical and Physical properties of Saw Dust

Chemical properties	Value	Physical properties	Value
Extractives	3.3	Moisture content	10.8
Lignin	29.3	Apparent specific gravity	0.14
Hollocellulose	83.8	Porosity (%)	84
Carbon (C) (%)	61.58	Water retention (%)	50
Hydrogen (H) (%)	5.32	Water drainage (mls-1)	282.0
Oxygen (O) (%)	33.04		
Nitrogen (N)	0		

B. Bacteria

Self-healing material is "Bacillus Megatarium" Bacteria. It is solid, locally accessible, tough and adaptable.



Figure:2 Bacillus Megatarium

VI. MIX PROPORTION

Normally rich cement mortars of mix proportions of (1:1.5) to (1:4) by volume are used ,1:3 mix ratio of mortar is chosen for testing. The final mix proportion is determined based on trial test by varying the percentage of bacteria and curing agent saw dust.

The mortar specimen was prepared by having the following ingredients such as 53 grade cement , fine aggregate , saw dust and microorganism of bacillus subtillis in the ratio of 1:2 with 1%percentage of bacteria and 0.25%,0.5%.0.75%,1% of woodpowder were replaced with sand .

Trial Mix -1:

C + F.A + 0.25% of Wood Powder + 1% Bacteria

Trial Mix -2:

C + F.A + 0.5% of Wood Powder + 1%Bacteria

Trial Mix -3:

C + F.A + 0.75% of Wood Powder + 1%Bacteria

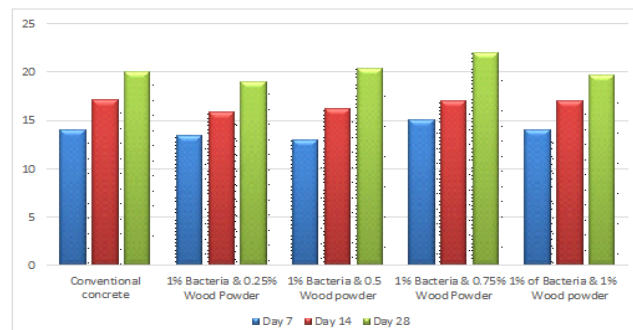
Trial Mix -4:

C + F.A + 1% of Wood Powder + 1%Bacteria

VII. TEST RESULTS

A. Compressive strength Test

Compressive strength test, mechanical test measuring the maximum amount of compressive load a material can bear before fracturing.



B. Scanning Electron Microscope Test

Scanning Electron Microscopy (SEM) is a test process that scans a sample with an electron beam to produce a magnified image for analysis. The method is also known as SEM analysis and SEM microscopy, and is used very effectively in microanalysis and failure analysis of solid inorganic materials. Electron microscopy is performed at high magnifications, generates high-resolution images and precisely measures very small features and objects.

In this project SEM test is to be done to see the pore structure and pore space of the concrete

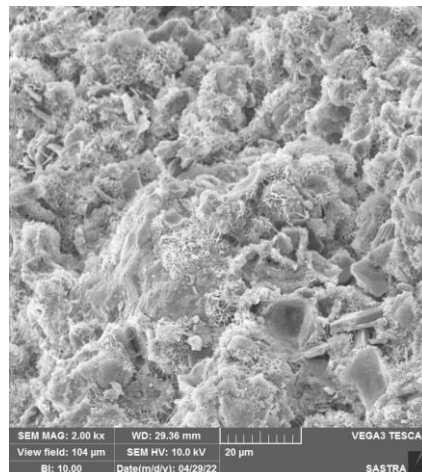


Figure:3 SEM Analysis

VIII.CONCLUSION

In this project we discussed about the self-healing concrete. Self healing concrete has very good performance compared to conventional concrete. In present the concrete are used in India and abroad for economical purpose, increasing strength and performing of bacterial growth. Self curing concrete is an effective means of eliminating autogenous shrinkage. Self curing concrete is an alternate to conventional concrete in desert region where there is scarcity of water, hence 0.75% of saw dust were optimum percentage to attain a high strength .

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