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REVIEW ARTICLE

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A REVIEW ON BACTERIAL CONCRETE AS A APPLICATION IN CONSTRUCTION

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ABSTRACT

Crack widths in concrete structures should be limited, mainly for durability reasons. If cracks widths are too large the cracks need to be repaired or extra reinforcement is needed already in the design. If a method could be developed to automatically repair cracks in concrete this would save an enormous amount of money, both on the costs of injection fluids for cracks and also on the extra steel that is put in structures only to limit crack widths. Recently, it is found that microbial mineral precipitation resulting from metabolic activities of favorable bacteria in concrete improved the overall behavior of concrete. It is expected that further development of this new type of self-healing concrete will result in a more durable and moreover sustainable concrete which will be particularly suited for applications in wet atmospheres where reinforcement corrosion tends to impede durability of traditional concrete constructions. Hence this paper defines the bacterial concrete, its classification and types of bacteria, advantages and dis-advantages and possibilities of application of Bacterial Concrete.

Key Words: Bacterial Concrete, Type of Bacteria, Advantages and Disadvantages, Application

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1. INTRODUCTION

We can also define bacterial concrete as self-healing concrete. Now, as the name suggests a Self-healing Concrete is one that can sense its crack formation and can react to cure itself without any kind of human intervention. It is a type of concrete that can biologically produce limestone to heal the cracks that appear on the surface of any concrete structure. The process of self-healing can be carried out by adding specially selected types of bacteria which are added to the ingredients of the concrete when it is being mixed. These self-healing agents can lie dormant within the concrete for up to 200 years. The "Bacterial Concrete" can be made by embedding bacteria in the concrete that are able to constantly precipitate calcite. Bacillus Sphaericus is a type of soil bacterium which can continuously precipitate a new highly impermeable calcite layer over the surface of an already existing concrete layer.Under favourable conditions Bacillus Pasteurii

when used in concrete can continuously precipitate a new highly impermeable calcite layer over the surface of the already existing concrete layer. Calcite has a coarse crystalline structure that readily adheres to surfaces in the form of scales. In addition to the ability to continuously grow upon itself it is highly insoluble in water. Due to its inherent ability to precipitate calcite continuously bacterial concrete can be called as a "Smart Bio Material". Cracks in concrete significantly influence the durability characteristics of the structure. 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 favourable conditions do not directly exist in a concrete but have to be created. Tests are conducted to study the mechanical properties of the above concrete with various percentages of Bacteria. The tests carried out are Compressive strength test, Split Tensile strength test, Permeability test, two point load test, etc. Some possible mechanisms of a Self-healing concrete are:

- Material formation like calcite.
- The path is block due to sedimentation particles.
- Cement particles under goes continued hydration.

2. LITERATURE REVIEW

Dr. Nele De Belie[1], has published a paper on Healing and Self-Healing of Concrete, has shown during their presentation how repair and consolidation of mineral phases of building materials and the healing and self- healing of concrete with the help of bacteria is possible. Micro-organisms play a crucial role in pedogenesis, transformation of minerals and exchange of elements in structures. In the bacterial treatment, the solution medium used was of equimolar concentration of urea (20g/l) and CaCl2 or Ca(NO3)2 for 3 days and thereafter dried for 3 days at 28oC. The treatments were applied by placing the samples on plastic rods in the treatment solution, where the liquid level was 10 mm above their lower side. Remediation of cracks could be possible by formation of biocers.

Kantha D.Arunachalam et al[2], has published a article on Biosealant properties of Bacillus sphaericus in which they say Bacillus spharecius was yet another partially characterized species with similar entity, having the capability of precipitating calcium carbonate. Bacillus spharecius was sub cultured and temperature, pH were optimized at 7.4 and 37°C. Growth curve for Bacillus spharecius showed that the log phase was between 4-11 hours and after 21 hours the bacterial growth was inhibited. EDTA titration was performed to find out the amount of CaCO3 precipitate and it was highest at pH 8. The broth culture was subjected to Atomic Force Microscope studies. The analysis confirmed the presence of calcite in both the bacterial solution and dry scrapes.

Mayur Shantilal Vekariyet al[3], In this paper the authors have stated about the bacteria's and the usage of the bacteria's according to the compatibility with the concrete. One such an alternative repair mechanism is based on the application of bio mineralization of bacteria in concrete. The applicability of specifically calcite mineral precipitating bacteria for concrete repair and plugging of pores and cracks in concrete has been recently investigated and studies on the possibility of using specific bacteria as a sustainable and concrete -embedded self-healing agent was studied and results from ongoing studies are discussed. And thus have concluded that, Microbial concrete technology has proved to be better than many conventional technologies because of its eco-friendly nature, self-healing abilities and increase in durability of various building materials.

Henk Jonkers[5], has published a paper on Bacteria-based self-healing concrete. In this paper the author has described about the action of bacteria after the insertion into the concrete. Viable bacteria as self-healing agent and the autonomous crack healing system of self healing agent are the two main points that have been focused in this paper. As regular manual maintenance and repair of concrete constructions is costly and in some cases not at all

possible, inclusion of an autonomous self-healing repair mechanism would be highly beneficial as it could both reduce maintenance and increase material durability.

Srinivasa Reddyet al[6], has published a paper on Bacterial Concrete. In this stated paper the bacteria used is bacteria Subtilis and the physical and chemical transformation of the concrete at high temperatures have been shown. The behaviour of concrete subjected to high temperatures depends on many factors such as member size, heating rate, peak temperatures, dehydration of C–S–H gel, phase transformations, and thermal incompatibility between aggregates and cement paste. This paper investigates the effect of sustained elevated temperature on residual compressive strength and percentage weight loss of Controlled Concrete and Bacterial Concrete mixes of ordinary grade (M20), standard grade(M40) and high strength grade (M60 and M80) after exposing to 200ºC, 400ºC and 600ºC for 2 hrs, 4hrs and 6 hrs.

.**3. CLASSIFICATION OF BACTERIA:**Bacteria are classified as on the basis of

Table no.1: Classification of bacteria,[3]

Gram Size	Gram positive and Gram negative
Oxygen Demand	Aerobic and Anaerobic
Shape	Cocci, Bacilli, Spirilla

4. ADVANTAGES OF BACTERIAL CONCRETE:

I. Compressive strength of concrete is enhanced.
II. Freezing and thawing action is reduced and can be resisted.
III. Permeability of concrete is reduced.
IV. Corrosion of reinforced concrete is reduced.
V. Eco friendly.

5. DIS-ADVANTAGES OF BACTERIAL CONCRETE:

I. Cost is high as compare to regular concrete.
II. Atmosphere is the factor which affect the growth of bacteria.
III. IS code of design of bacterial concrete is not prepared yet.
IV. Studying precipitation of calcite layer is quite difficult.
V. Very limited research work is done across the globe.

6. APPILCATION OF BACTERIAL CONCRETE:

I. In cement mortar
II. In precast concrete member
III. In production of brick
IV. Used as a crack filling material.
V. To give a cover to pervious member

7. CONCLUSION

- Due to microbial precipitation, concrete having low and moderate chloride permeability can be upgraded to high chloride permeable concrete.
- Corrosion from sample from microbial media is less as compared to conventional concrete media
- Mass loss of steel is reduced as concentration of microbial cell increases
- As shallow cracks can be healed fast as compared to deeper crack, microbial remediation is more effective for shallow cracks.
- Microbial concrete technology has proved to be better than many conventional technologies because of its eco- friendly nature, self-healing abilities and increase in durability of various building materials.
- Enhancement of compressive strength, reduction in permeability, water absorption, and reinforced corrosion has been seen in various cementituous and stone materials.
- Bacterial concrete is a potential self-healing remediation technique for cracks in concrete due to its high impermeable nature.

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