

# A Review on the Study of Self-Healing Concrete

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**Abstract:** The one of the common and important material in the building sector is the “Concrete”. And that’s why the production of concrete should have better durability. In concrete the cracking is the phenomena is taking when it is subjected to the tensile force and because of this proper treatment should be done in order to prevent the expansion of the cracks. For crack repair variety of variety systems are available. Self-healing concrete is the solution to this problem. It is found that the microbolic mineral precipitation as a result from metabolic activities of the bacteria in the concrete which improves the overall behavior of the concrete. It is expected that the further the development of this techniques will result in more durable, sustainable and crack free concrete and that can be used for the construction in wet atmosphere where the corrosion affects the strength, permeability and also the durability.

**Keywords:** Microbolic, Self-healing

## 1. Introduction

Concrete will continue to be the most important building material for infrastructure. It is strong, Durable, Locally available and Versatile. It is capable to resist the the compressive load to a limit but if load applied on concrete is more than their limit of resisting loads the most concrete structures are prone to cracking. Tiny cracks on the surface of the concrete make the whole structure vulnerable because water seeps in to degrade the concrete and corrode the steel reinforcement, greatly reducing the lifespan of a structure. Concrete can withstand compressive forces very well but not tensile forces. When it is subjected to tension it starts to crack, which is why it is reinforced with steel; to withstand the tensile forces. Structures built in a high water environment, such as underground basements and marine structures, are particularly vulnerable to corrosion of steel reinforcement. Motorway bridges are also vulnerable because salts used to de-ice the roads penetrate into the cracks in the structures and can accelerate the corrosion of steel reinforcement. In many civil engineering structures the tensile force can leads to crack. Repairs of conventional concrete structure usually involves applying a concrete mortar which is bonded to damaged surface Repairs can be particularly time consuming and expensive because it is often very difficult to gain access to the structure to make repairs, especially if they are underground or at a great height. Self-healing concrete is the solution to this problem of

durability of concrete structures and has also received increasing attention as a smart material self-healing materials used in such type of concrete have the ability to heal the damage inflicted on the concrete partially or completely, thereby restoring the original functionality of the structure. Self-healing concrete is a product that will biologically produce limestone to heal cracks that appear on the surface of concrete structures. Specially selected types of the bacteria genus Bacillus, along with a calcium-based nutrient known as calcium lactate, and nitrogen and phosphorus, 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.

However, when a concrete structure is damaged and water starts to seep through the cracks that appear in the concrete, the spores of the bacteria germinate on contact with the water and nutrients. Having been activated, the bacteria start to feed on the calcium lactate. As the bacteria feeds oxygen is consumed and the soluble calcium lactate is converted to insoluble limestone. The limestone solidifies on the cracked surface, thereby sealing it up. It imitates the procedure by which bone cracks in the human body are normally mended by osteoblast cells that mineralize to re-frame the bone. The utilization of oxygen amid the bacterial change of calcium lactate to limestone has an extra favorable position. Oxygen is a fundamental component during the time spent erosion of steel and when the bacterial action has expended everything it builds the sturdiness of steel strengthened solid developments. The two self-healing agent parts (the bacterial spores and the calcium lactate-based nutrients) are introduced to the concrete within separate expanded clay pellets 2-4 mm wide, which ensure that the agents will not be activated during the cement-mixing process.

Only when cracks open up the pellets and incoming water brings the calcium lactate into contact with the bacteria do these become activated. Testing has shown that when water seeps into the concrete, the bacteria germinate and multiply quickly. They convert the nutrients into limestone within seven days in the laboratory. Outside, in lower temperatures, the process takes several weeks.

## 2. Literature review

Title – Strength and Durability Healing Concrete

*Author – Meera.C.M:* The present paper describes that the bacterial effect on the strength of concrete and also the different self- healing mechanism by finding out the optimum amount of the bacterial contents. The bacteria added to concrete mix in suspicious state. A bacterial concrete mix prepared using alkali-resistant soil bacteria *Bacillus subtilis* JC3 with nutrients and bacteria produces the calcite based bio minerals. The cracks are up to the 0.2mm wide .and the bacteria based self- healing concrete has been found that up to 0.5mm wide. Also the calcium carbonate is produced due to the reaction of  $CO_2$  present with the calcium hydroxide in the concrete. The materials are follows which used for making the self- healing concrete are Cement, Coarse aggregate, fine aggregate, Water, and Microorganism.

The *Bacillus subtilis* JC3 a cultured bacterium which collected from the Kerala agricultural university used. Bacteria in suspension with a concentration of 108 cells/ml was collected and 103,104,105 and 106 cells/ml of bacterial concentration made from obtained sample. Strength assessment and durability assessment are two test are conducted on concrete after the making the cubes and cylinders for concrete mix M20 with addition the microorganism (*B.Subtilis*) the cubes are tested for the 7 and 28 days compressive tests. Or the cylinders for split tensile strength at 28 days. The Bacterial concrete with a concentration of bacteria of 10 cells/ml was found the best results. It concluded that this particular concentration gives the the optimum results which is proven by 42% increase in compressive strength and 63% increase in split tensile strength when it compared with conventional concrete. It also lower water absorption than normal concrete and less vulnerable to chloride effect. hence this type of bacterial use ( *Bacillus Subtilis* ) for self- healing mechanism in concrete is most effective ,strong, and Durable structures.

*Title – A Review Paper on Self-Healing Concrete*

*Author – Salmabanu Luhar:* For repairing the cracks developed in the concrete it requires special types of treatment which very expansive. So to overcome this problems autonomous self-healing mechanism which helps to repair the cracks by producing calcium carbonate crystals which the micro cracks and pores in concrete. This paper examines that the different types of bacteria according to their survival. The condition of growth is different for the different bacteria. *B. pasteurii* , *Deleya halophile*, *B. megaterium*, *halomonasrurihalina* are used as a crack healer. And for surface treatment *B. sphaericus* is usefull. According to analysis, crack healing observed in various sizes. About the PH, *bacillus pasterurii* had the growth in PH range 7.5-9 and *Bacillus sphaerious* was 8-9 (23). In this paper different tests were conducted and also results were shown. Which compare with the different bacteria used in concrete. Capillary water suction used to find out the absorption capacity of bacterial concrete. The value lower than 1 which shows that the relatively decrease of water absorption and value greater than 1 shows relative increase in water absorption also. This paper gives difference of the compressive strength

between bacterial concrete and the conventional concrete. According to them The compressive strength of concrete was improved by adding *bacillus subtilis* JC3 as compare to conventional concrete. It was found that *B. sphaericus* improved the compressive strength of concrete by 30.76% in 3days 46.15% in 28days as compare to conventional brick. It also. Shows the Stress- Strain behavior of bacterial n conventional concrete

*Title-Bio concrete Strength, Durability, permeability, Recycling and Effects on Human health: A Review Author – S. Dinesh.* Bio concrete is one of the positive point for the construction of any type of structure. So the main objective of this paper is to study the positive and negative impacts on strength , durability, or the most important i.e. Human Health Generally positive impacts involves the concrete durability increases , Strength of concrete increases, increasing the concrete permeability and water absorption is one of the parameter which is used or considered while investigation of permeability .the main advantage which also included in this paper i.e. the ability of biological concrete for recycling process. The negative impacts included in this paper are follow: The negative impacts on human health or another is the impacts on the physical health. This paper is also shows that the different types of bacteria which generally used while designing the biological concrete and its related diseases to the human. From this we can determine how bacteria effects on human health.

*Title: A Review on Bacteria Based Self- Healing Concrete Author – S. Dinesh.*

Concrete is the main construction material. According to them there is new technologies related to crack obtaining in concrete i.e. bacterial based self-healing concrete. In concrete crack formation is the common problem. If the thickness of crack is increases which directly effects on a compressive and tensile strength in concrete. For repair the cracks some traditional methods are available but this causes health hazardous problems and different issues related to environment. The bacterial based concrete is eco-friendly. And decrease the problems related to health of human and animals etc. In this technologies different bacteria's are used and there are so many advantages like the Reduction in permeability of concrete, Increasing durability of concrete, decreases the repair and maintenance cost. Also it has some limitations like the bacterial growth in any atmosphere and media. Thus this papers are an attempt to define bacterial concrete, its classification, and various types of bacteria used in concrete. Also it can refers the advantages and disadvantages of self- healing concrete. It is used for low cost durable roads, high strength building, river banks, low cost durable housing.

### 3. Purpose of self- healing concrete

Structures worked in a high water condition, for example, underground storm cellars and marine structures, are especially powerless against consumption of steel support. Motorway

spans are likewise powerless on the grounds that salts used to de-ice the streets infiltrate into the breaks in the structures and can quicken the erosion of steel fortification. In numerous structural building structures ductile powers can prompt splits and these can happen moderately not long after the structure is manufactured. Fix of regular solid structures for the most part includes applying a solid mortar which is attached to the harmed surface. Once in a while, the mortar should be entered into the current structure with metal pins to guarantee that it doesn't fall away. Fixes can be especially tedious and costly in light of the fact that usually hard to access the structure to make fixes, particularly on the off chance that they are underground or at an extraordinary tallness

#### **4. Conclusion**

This paper presented an overview on study of self-healing concrete

#### **References**

- [1] Meera C. M., Subha V. "Strength and Durability of Bacteria Based Self-Healing concrete", (2016).
- [2] Salmanubanu Luhar, Gourav Suthar, "A Review paper on self- Healing Concrete."
- [3] Mohanadoss Ponraj, et.al. "Bio concrete Strength, Durability, Permeability, Recycling and Effects on Human Health-A Review."
- [4] S. Dinesh, R. Shanmugapriyan, and S. T. Namitha Sheen. A "Reviw on Bacteria Based Self- Healing Concrete".