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Comparative Study of Self – Healing Concrete & Normal Concrete

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Abstract – *Bacterial concrete or self healing concrete fills up the cracks developed in structure with the help of bacterial reaction in the concrete after hardening. Types of bacteria, its mechanism and preparation of bacterial concrete is discussed. In modern days, the use of technology has taken the standard of construction to a new high level. Different types of procedure, methods and materials are used to attain a very good, sustainable and economical concrete construction. But due to human mistakes, incorrect handling and unskilled labors. An efficient building is hard to sustain its designed life of structure. Many problems like weathering, cracks, leak and bending etc., arises after the construction. Overcome this type of problem, much remedial procedures are undertaken before and after construction.*

Key words: Bacterial concrete, cracks, leaks.

1. INTRODUCTION

Self - healing concrete could solve the problem of concrete structures deteriorating wall before the end of their service life. Concrete is still one of the main materials used in the construction industry, from the foundation of building to the structure of bridges and underground parking lots. Traditional concrete has a flow it tends cracks when subjected to tension. A healing agent that works when bacteria embedded in the concrete convert nutrients into limestone.

This common problem of cracking in building has many remedies before and after the crack. One of the remedial processes is bacterial concrete or self healing concrete. The process of self healing cracks or self filling of cracks with the help of bacterial reaction in the concrete after hardening is known as self-healing concrete. It can be observed that small cracks that occur in a structure of width in the range of 0.05 to 0.1 mm, gets completely sealed in repetitive dry and wet cycles. The mechanism of this autogenously healing is the width of range 0.05 - 0.1 mm act as capillary and the water particles seep through the cracks. These water particles hydrate the non or partial reacted cement and the cement expands, which in turn fills the crack. But when the cracks are of greater width, need of other remedial work is required. One possible technique is currently being investigated and developed was based on application of mineral producing bacteria in concrete. The bacteria used for self healing of cracks are acid producing bacteria. These types of bacteria can be in a dormant cell and be viable for over 200 years under dry conditions. The bacteria act as a catalyst in the cracks healing process.

2. VARIOUS TYPES OF BACTERIA USED IN CONCRETE

Bacterial concrete is a material, which can successfully remediate cracks in concrete. This technique is highly desirable because the mineral precipitation as a result of microbial activities is pollution free and natural. Bacterial concrete or self healing concrete fills up the cracks developed in structures with the help of bacterial reactions in the concrete after hardening. Types of bacteria, its mechanism and perception of bacterial concrete is discussed.

1. Bacillus pasteurize
2. Bacillus sphaericus
3. Bacillus subtilizes
4. Bacillus cohnii
5. Bacillus psedofirms

3. MECHANISM AND PREPRATION OF BACTERIAL CONCRETE

Self healing concrete needs special named bacillus pasteurize that are able to produce limestone on a biological basis. The positive side effects of this property the bacteria consume oxygen, which in turn prevents the internal corrosion of reinforced concrete. However, the bacteria do not pose a risk to human health, they can only survive under the alkaline conditions inside the concrete. Special types of bacteria known as bacillus are along with calcium nutrient known as calcium lactate. While preparation of concrete, this is are added in the wet concrete when the mixing is done. The consumption of oxygen during the bacterial conversion of calcium lactate to limestone has an additional advantage. Oxygen is the essential element in the process of corrosion of steel and when the bacterial activity has consumed it all it increases the durability of steel reinforced concrete structure. The two self healing agent parts the bacterial spores and the calcium lactate – based nutrients are introduce the concrete within separate expand 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 bring the calcium lactate into contact with the bacteria

do this 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. Outside, in lower temperature, the process takes several weeks.

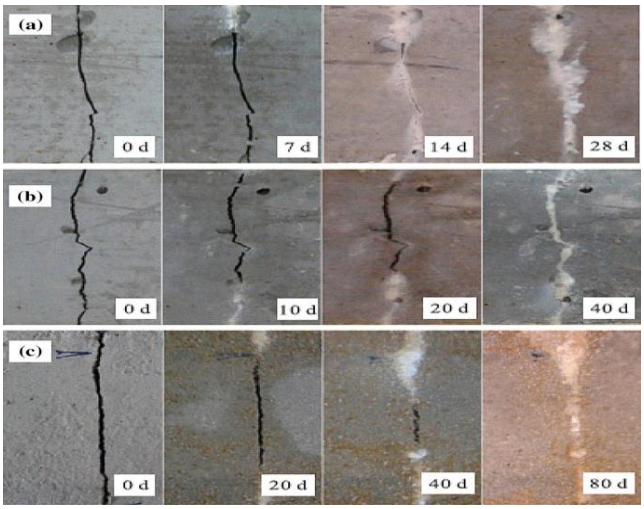

fig. 1 process of fixing of self healing concrete.

4. CHEMICAL PROCESS OF SELF-HEALING CONCRETE

Self - healing concrete in that type of concrete which repairs its cracks by the deposition of limestone ($CaCO_3$) in them. This is because of a process called carbonation which takes place when the calcium bring phases present in concrete are attacked by carbon dioxide of the atmosphere in the presence of moisture, and are converted to calcium carbonate.

The equation involved his thus:

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

The calcium carbonate so formed precipitates out and gets deposited in the pores and cracks of concrete, thus making it stronger.
According to recent research in some self healing concrete strains of bacteria, mainly the bacillus pasteurize, which are found in naturally in highly alkaline lakes near volcanoes, and are able to survive for up to a staggering 200 years without oxygen or food is activated when they come into contact with water and then use the calcium lactate as a food source, producing limestone close up the cracks. The limestone then hardens itself and seals the cracks in the concrete.

5. ENVIRONMENTAL IMPACT

Cement industry is one of the mains two producers of carbon dioxide (CO_2) emission, which is directly harming our planet. Therefore, by using self healing concrete or bacterial concrete the carbon dioxide emission are reduced significantly.

6. ADVANTAGES & DISADVANTAGES OF SELF-HEALING CONCRETE

6.1 Advantages self-healing concrete

1. The cement has bacteria or other elements that produce new calcium to fill in crack so that water is less able to enter a structure.
2. It is increase structural integrity for many more years.
3. Self repairing of cracks without any external aide.
4. Significant increase in compressive strength and flexural strength when compared to normal concrete.

6.2 Disadvantages of self-healing concrete

1. It is not suitable where higher compressive strength is needed, such as in tall building.
2. The cost of self-healing concrete is two times the ordinary concrete.
3. Growth of bacteria is not good in any atmosphere and media.

7. TEST & RESULT OF SELF HEALING AND NORMAL CONCRETE

Standard tests were conducted on normal concrete and self healing concrete or bacterial concrete. Tests conduct were compressive and flexural strength tests on a concrete cube for 7 and 28 days.

Compressive strength (N/mm^2) :

Sr. no.	Self-healing concrete			Normal concrete	
	Compressive strength (N/mm^2)			Compressive strength (N/mm^2)	
	Name of bacteria	7 days	28 days	7 days	28 days
1	Bacillus pesteurii	26.79	37.82	20.10	28.56

Flexural strength (N/mm^2) :

Sr. no.	Self-healing concrete			Normal concrete	
	flexural strength (N/mm^2)			flexural strength (N/mm^2)	
	Name of bacteria	7 days	28 days	7 days	28 days
1	Bacillus pesteurii	4.8	7.93	3.49	28.56

From the result we can see that both the compression strength and the flexural strength of the bacterial concrete is greater than that of normal concrete.

8. CONCLUSION

In this study, we conclude that self-healing concrete is the best solution for the demand of sustainable concrete due to its ability of self-repair and durability. In the future, self-healing concrete is going to play the most important role in concrete technology. Concrete is the most important building material but most of the concrete members are subject to crack. Even is very small cracks of a concrete surface make the whole building unsafe. Cracks allow to seep and it will deteriorate the concrete and corrode the steel reinforcement. It will finally reduce the lifespan of the building. Self healing concrete is a concrete that will produce biologically limestone with the help of bacteria and heal the cracks.

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