

The Self Healing Concrete By Using Bacillus Megaterium de Bary (ATCC 14581)

¹Faisal Khan, ²Juhi Chavan, ³Sayali Nalawade, ⁴Omkar Kumbhar, ⁵Prof. Rachana Vaidya

^{1,2,3,4} UG Student, Department Of Civil Engineering, Alard College Of Engineering And Management, SPPU, Pune, India

⁵ Assistant Professor, Department Of Civil Engineering, Alard College Of Engineering And Management, SPPU, Pune, India

ABSTRACT:- Formation of cracks in concrete structure is a common occurrence during which the water percolates in concrete through the cracks which reduces the strength of the structure and also affects the reinforcement once it comes into reality with water. These cracks also make concrete liable for adverse environmental impact. The self-healing concrete is the addition of bacteria like Bacillus Megaterium de Bary (ATCC 14581) which seals the cracks formed in concrete. The activated bacteria start to go after salt which is converted to insoluble limestone. This paper represents that Bacillus Megaterium de Bary (ATCC 14581) utilized in different concentrations like 10^{-1} and 10^{-3} accustomed cast the concrete blocks later cured for 3, 7 and 28 days have been tested to get the results.^[2] It is revealed that the strength of the bacterial concrete is over the standard concrete. The bacteria named Bacillus Megaterium de Bary (ATCC 14581) is employed within the mixture of concrete to extend the strength. This study concludes the effect of the utilization of Bacillus Megaterium de Bary (ATCC 14581) utilized in concrete has increased the compressive strength of concrete.

Keywords : Bacillus Megaterium de Bary (ATCC 14581), Concrete, Cracks, Bacteria, Self- Healing Concrete, Strength, Bacterial concrete

1. INTRODUCTION:-

The utilization of concrete is increased worldwide because it is durable, sustainable, economic, and versatile. Concrete possesses high compressive strength and it's weak in tension. Due to this formation of cracks in concrete structures takes place. It ends up in damage the structure. The techniques which are available to repair cracks are highly expensive and time community posses. Hence the self-healing concrete is introduced during which the bacteria which is added to the concrete can seal the cracks after it's activated. Self-healing concrete is the bacteria (Bacillus Megaterium de Bary (ATCC 14581) included with concrete. The bacterial remediation technique is bio-based, eco-friendly, cost-effective.^[2]

Professor Hendrik Jonkers of Delft technical university in the Netherlands has developed self-healing concrete which has made a remarkable impact on the housing industry. The addition of bacteria helps to provide carbonate. The conversion of calcium carbonate to insoluble limestone seals the cracks.

1.1. Self Healing Process:

It is essential to understand the bacteria types which will survive within the concrete, how they work to boost the lifespan of the structure, what style of catalyst will initiate the method of chemical change within the bacteria and what would happen to those particular species of specialized bacteria once they are exposed to the catalyst and they work together for not only healing the cracks but also strengthens the structure into which they're incorporated. When the bacteria is given exposure to the weather like oxygen and food, they are going through an action that causes them to inter-wine, thus filling up the crack formed, and strengthening the concrete structure. In this way, it helps to increase the structure's lifespan and fix the damage caused. The method of healing a crack can take a pair of days.^[5]

1.2. Effect of Bacteria on Strength :

The assorted tests are applied to concrete within which compressive strength is one of the important tests administered on concrete to work out its characteristics and to test if the concrete is produced properly. Determining the compressive strength with the effect of bacteria is predicated on the planning mixture of concrete.

1.3. Selection of Bacteria :

The Bacillus Megaterium de Bary (ATCC 14581) incorporates a positive gram aerobic bacteria which has growth under 30°C temperature the time required for forming a colony is 24 hours. the bulk of this bacteria is found in soil, seawater, sediments, rice paddies, dried food, and honey. These bacteria are

commonly utilized in the agricultural industry as a fertilizer which helps to grow plant nutrition.^[5]

selected sorts of the genus Bacillus, together with a calcium-based nutrient salt, and nitrogen and phosphorus, are added to the ingredients of the concrete when it's being mixed. This bacteria can survive within the concrete for up to 200 years.^[5]

Table 1: Characteristics of bacteria

Characteristics	Bacillus Megaterium (de Bary 14581)
Shape	Long rods
Size	0.6 to 0.8 micro metre
Gram Stain	Gram positive
Colony Morphology	Irregular,dry,white
Lactose	No acid,No gas
Dextrose	No acid,No gas
Sucrose	Acid and gas

1.4. How Does Bacteria Remediate Cracks?

The bacteria is mixed with concrete, when it comes in contact with moisture it gets activated. When it's exposed to the environment (air), then all its functions are stimulated. The cracks formed in concrete get healed by limestone. By consuming oxygen, corrosion of steel decreases and also the durability of RCC structures. The method of chemical carbonate reaction from dissolved caustic lime occurs in line with the subsequent reaction.^[1]

2. FORMATION OF BACTERIAL CONCRETE

2.1. Culture And Growth Of Bacteria: -

Freeze-dried cultures are supplied in vacuum-sealed glass ampoule. To revive the culture followed the procedure

1. Prepare the desired liquid growth medium (nutrient broth)
2. Score the center of the ampoule with an ampoule cutter
3. Disinfect the ampoule with alcohol-dampened gauze
4. Wrap sterile gauze round the ampoule and break it carefully

5. Add about 0.2 ml of a liquid medium with a sterile Pasteur pipette .mix well and transfer the cell suspension to the expansion medium (nutrient broth)
6. Open the contents of the vial in approximately 2-5 ml respective medium and incubate the cells under specified conditions as mentioned within the letter. since some cells may exhibit a chronic lag period before growth, incubation should be continued for a minimum of 2 weeks at approximate temperature before discarding the cells as nonviable
7. The ampoule should be kept during a refrigerator if it'll not be opened soon after receipt.
8. The ampoule should be kept in a refrigerator if it'll not be opened soon after receipt.

2.2. Colonial Characteristics:-

Colonies of strain were round in shape, convex, smooth, and appeared to be translucent on a nutrient agar plate. The colony size reached up to a diameter of 2-3 mm within 24 hours of the incubation period in aerobic conditions at 30°C temperature.



Fig 1 cultural growth of bacteria in a petri dish

2.3. Casting And Curing :

We have cast three set of cubes of size (150x150x150 mm), grade of concrete (M25), with different concentrations of bacteria (10^{-1} , 10^{-3} cell concentration/ml) of bacteria in nutrient broth medium.prepared by adding 30 ml of bacteria in each cube of dimension 150 mm x 150 mm x 150 mm as per standard procedure.

Materials Used: Ordinary Portland Cement 43 grade, Coarse aggregates (10 mm and 20 mm in equal proportion), Fine aggregates (crushed sand), Potable Water, and Chemical Admixture (Bacillus Megaterium de Bary (ATCC 14581)



Fig 2 casting and addition of bacteria

Curing : The concrete cubes has been cured for 3 days, 7 days and 28 days.

3. Compressive Test On Cubes:

The size of molds used in the compression strength test was 150mm x 150mm 150mm. Cubes are cast by adding 30 ml bacterial solution ($10^{-1}, 10^{-3}$). Cubes are tested in a compressive testing machine shown in fig.3 after 3, 7, and 28 days curing period. After curing cubes are placed in compression strength results are shown below. From the experimental results, it has been observed that the addition of bacteria in concrete increases the strength of the concrete more than conventional concrete.



Fig.3 compressive test on concrete cube of bacillus megaterium de Bary (ATCC 14581)

RESULT :

The compressive strength after addition of bacteria (Bacillus Megaterium (de Bary 14581) :

- Bacterial solution of 10^{-1} of curing compressive strength is 30% greater than conventional concrete.
- Bacterial solution of 10^{-3} of curing compressive strength is 23% greater than conventional concrete.

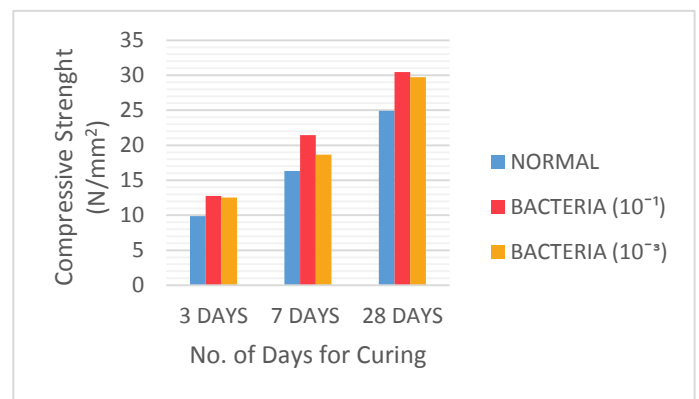


Table 2 of compressive strength of M25 grade concrete with bacterial concentration

Healed Concrete :

After the development of cracks the bacteria (Bacillus Megaterium de Bary (ATCC 14581)) started feeding the calcium carbonate and converts it into limestone.



Fig 4 (a) crack formation

Fig 4(b) 75% healed crack

CONCLUSION :

From this paper we have observed that bacteria repair the cracks in concrete. It increase its strength and durability. The work on bacterial concrete using Bacillus Megaterium de Bary (ATCC 14581) improves the strength than conventional concrete. The cracks formed in concrete has been healed within 10 days. From above graph it is observed that the compressive strength of cubes formed

by dilution of bacteria 10^{-1} increases strength as compared to concentration of 10^{-3} and conventional concrete.

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