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BEHAVIOUR OF BACTERIAL CONCRETE BY VARYING TYPES OF BACTERIA

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ABSTRACT: Concrete is one of the most commonly used construction material suffers from micro cracks that cut down the load carrying capacity resulting in shortening of life. Now a day biologically modifications of construction materials become more popular for strength improvement and long term sustainability. An investigation has been conducted to study the compressive strength of concrete by using bacteria named bacillus subtilis with the concentration of 10^6cells/ml. The cubes of conventional and bacterial concrete of size 150 mm X 150 mm X 150 mm were casted for the experimental study. Further these various cubes are tested under laboratory method i.e. UTM. It has been found that there was an increase in compressive strength at both 7 days and 28 days.

Keywords: Bacillus Subtilis, UTM, compressive strength.

1. INTRODUCTION

Concrete is one of the most widely used construction material but developments of micro cracks are an almost unavoidable feature of ordinary concrete. The micro cracks form a continuous network, which may substantially increase the permeability of concrete, thereby reducing the resistance of concrete against ingress of aggressive substances, which affects the durability of the structures. Hence occurrences of cracks are a prevalent form of damage in concrete structures. There are many techniques used for crack repairing but bacterial concrete can be alternative and environment friendly technique to improve the strength of concrete. The "Bacterial Concrete" is a concrete which can be made by embedding bacteria in the concrete that are able to constantly precipitate calcite. This phenomenon is called microbiologically induced calcite precipitation. However, over the last few decades, microorganisms have also been investigated for the positive effects they can exert on mineral construction materials. These research efforts mainly rely on microbial induced calcium carbonate precipitation (MICP) and focus on its application for the consolidation of natural stone and concrete, soil consolidation and sand cementation, as an additive for strength improvement of concrete, for manual crack repair, and self-healing of cracks in concrete. A number of studies reported that small cracks in concrete could heal by using bacteria. The Calcite ($caco_3$) precipitation by the bacterium occupies the voids between cement matrixes, which lead to a denser concrete. This approach does not deplete any natural resources, as the bacterium can be easily produced by cultivation process. The potential of bacteria as a self-healing agent in concrete has evinced to be a promising solution. Most of the bacteria's belongs to genus bacillus families which are fulfilling the required criteria that is resist the alkalinity and precipitate the calcium carbonate. Some types of bacteria used in self-healing concrete are as follows-

1. Bacillus Spaericus
2. Bacillus Subtilis
3. Bacillus Cereus
4. Bacillus Cohnii

In this investigation, Bacillus Subtilis bacteria were studied to improve the compressive strength of concrete with respect to conventional concrete (M20).

2. METHODOLOGY

2.1Selection of bacteria

There are various types of Bacteria's that can be used in the concrete such as B. Subtilis, B. Pasteurii, B. Cohnii, B.

Licheniformis etc. We have selected Bacillus Subtilis since this bacteria produces Calcium Carbonate and due to ease of availability from Vidya Pratishthan's School of Biotechnology. Bacillus subtilis is a Gram-positive, catalane- positive bacterium, found in soil and the gastrointestinal tract of ruminants and humans. A member of the genus Bacillus, B. Subtilis is rod-shaped, and can form a tough, protective endo-spore, allowing it to tolerate extreme environmental conditions.

2.2Materials

2.2.1Cement

Ordinary Portland cement of 53 Grade available in local market is used in the investigation. The cement used has been tested for various properties as per IS: 4031-1988 and found to be confirming to various specifications of IS: 12269-1987 having specific gravity of 3.0, consistency-31%, initial setting time 123 minutes and final setting time 162 minutes.

2.2.2Sand

In our investigation we had used the crushed sand of size 4mm according to IS 383.Specificgravity of sand was found out to be 2.60.

2.2.3Coarse Aggregates

The coarse aggregate is strongest and porous component of concrete. Presence of coarse aggregate reduces the drying shrinkage and other dimensional changes occurring on account of movement of moisture. In our investigation we had used the aggregate passing through 20mm IS-Sieve and retaining on 12.5mm sieve. The specific gravity of aggregate was found out to be 2.50.

2.2.4Water

Locally available tap water (used for drinking purpose) confirming to IS 456 was used.

2.2.5Cube Moulds

The cube Moulds (150x150 mm) was placed in position on an even surface. All the interior faces and sides were coated with mud oil to prevent the sticking of concrete to the Moulds

2.2.6Bacterial Culture

Bacillus subtilis were used in this investigation with concentration 10^6 cells/ml.

2.3Experimental Testing

2.3.1Preparation of concrete mix

In our investigation we have made M 20 grade of concrete. The mix ratio obtained after the mix design as per IS 456:2000 was M20. (1:1.5:3)

We have poured the concrete in the cube Moulds and six different samples were made which are as follows

1. Conventional Concrete of grade M 20.
2. Concrete with 20 ml bacterial solution.

2.3.2Methods of mixing

There are different methods of mixing the bacterial solution in the concrete which are

1. Direct Mixing
2. Encapsulation method

Direct mixing

In our investigation we have adopted the direct method in which, firstly the measuring jars were sterilized in oven for at temperature of about $1000C$ for 5 min. The bacterial solution is poured in the measuring jar and measured solution directly added to water. Once the bacterial solution is mixed in the water, the water is properly stirred and then it is used for immersion in the concrete.

2.3.3Casting and curing

Once the concrete is completely mixed the concrete is poured in the cube, compaction is been done by the vibration machine. Concrete cubes were removed from the Moulds after 24 hrs. And they were put into the curing tank. Curing was done for 7 and 28 days for all samples.

2.3.4Experimental test on specimen

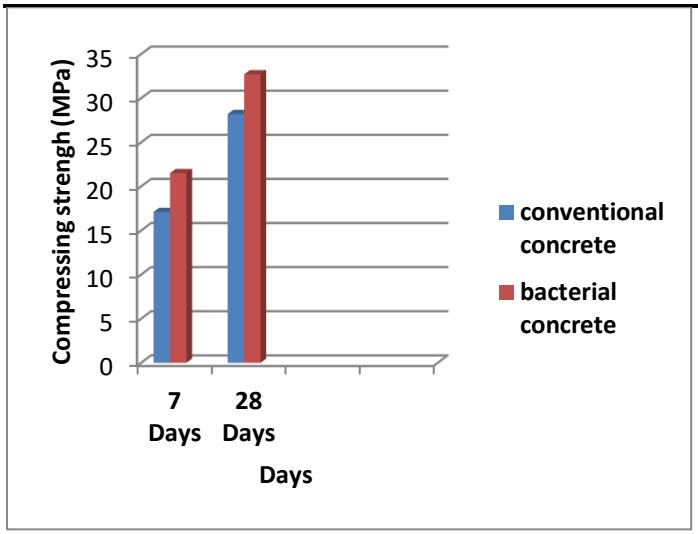
Compressive strength test was performed on conventional and bacterial concrete. The concrete cubes were removed from the tank after their respective days of curing. The cubes were allowed to dry under the Laboratory condition. Cleaning out the bearing surface of the testing machine Once the cube were completely dried, placed under the compressive testing machine one after another in such a manner that the load shall be applied to the opposite sides of the cube cast. The specimen centrally aligned on the base plate of the machine. The load gradually applied without shock and continuously till the specimen fails. The maximum load recorded and noted down. Concrete cubes placed in the CTM machine. Readings of conventional and bacterial concrete were taken each time after curing interval of 7days and 28 days.

3. RESULTS AND DISCUSSION

Table-1: Results

Type of concrete	7 Days		28 Days	
	Load (N)	Compressive strength (N/mm^2)	Load	Compressive strength(N/mm^2)
Conventional concrete	384.7×10^3	17.1	634.5×10^3	28.2
Bacterial concrete	483.7×10^3	21.5	735.7×10^3	32.7

Compressive strength test of concrete cube was carried out after curing period of 7 and 28 days. The results so obtained are tabulated above in table no.1 with their respective graph



Graph 1- Compressive strength of conventional and bacterial concrete blocl at 7 &28 days.

4. CONCLUSION

In this experimental work behavior of bacterial concrete were studied .the following conclusions can be drawn based on the experimental study-

- The compressive strength of bacterial concrete is greater than conventional concrete.
- Durability characteristics are improved with addition of bacteria.

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