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STRENGTHENING OF BACTERIAL CONCRETE

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Abstract: The purpose of this experiment was to examine the capabilities of bacterial concrete for building. To make concrete stronger than regular concrete and to increase the qualities of concrete, a bacterial called BACILLUS SUBTILIS (together with its nutrition) is injected. The project is designed to investigate evaluate cube specimens compressive strength, know the optimal number of bacteria to use, and research the characteristics of cracks in the specimens by adding the urease, gram-positive Bacillus Subtilis (spore forming bacteria), as well as facultative aerobic.
Mechanism: When there is oxidation and moist present, bacteria transfer the calcium found in concrete into lime. We deduced from the abovementioned method that adding bacillus species to concrete boosts its strength and gives it the ability to self-heal cracks.
Keywords: Compressive strength; Bacillus, Self-heal, Oxidation, Split tensile strength.

1. INTRODUCTION

A vital ingredient of any building is concrete. Because its tensile strength without reinforcement is significantly lower than its compressive strength, it is best effective when reinforced with steel bar. Over the periods of its expected service life, cracks occur and experiences significant wear - and - tear because it's such a fragile, high maintenance material. In order to achieve the required level of quality and durability, emerging technologies are being used to transform ordinary concrete into various types of concrete, such as high strength (HS), high performance concrete (HPC), ultra-high performance concrete (UHPC), self-compacting concrete (SSC), and fibre reinforced concrete (FRC). Through the use of diverse materials and technologies, a great deal of effort has been done over the last few decades to increase performance. Due to its benefits, including self-healing capability, higher durability, increased strength, etc., bacterial concrete has recently become more and more popular. Numerous elements are anticipated to affect the activity of live creatures when they are added to cementitious materials. The survival and intended activity of bacteria in concrete require a conducive environment, including factors like temperature, nutrition, pH, and others. The study takes into account nutrients for bacterial survival in cement mortar along with all the other important parameters.

2. OBJECTIVES

1. Create bacterial concrete by incorporating bacteria from the bacillus family.
2. To calculate the ideal amount of bacteria needed for bacterial concrete.
3. To make concrete more compressively strong.
4. To repair concrete that has developed cracks.

3. PROPERTIES OF MATERIALS

Cement: Ordinary Portland Cement of 53 Grade referring to 8112-1989

Fine Aggregate: Natural river sand conforming to Zone 2 grading as per IS: 383-1987 Coarse Aggregate: 20 mm Maximum size conforming to IS: 383-1970

Water: Free from physical impurities, with respect to IS: 10500-1963.

Selection of Bacteria: Since Bacillus Subtilis makes calcium carbonate and is widely available, we chose it. It is a gram-positive, Catalane-positive bacteria that is sometimes referred to as Hay Bacillus or Grass Bacillus. It may be found in soil, the gastrointestinal system of ruminants, and in people. B.Subtilis, a Bacillus member with a rod-like morphology, can produce a hard, protective endo-spore that gives it the ability to withstand harsh climatic conditions. This bacterium is regarded as the most researched Gram-positive bacterium and a model organism for research on bacterial cell development and chromosomal replication.

Experimental Procedure for Cultural Growth of Bacteria: On proper medium combined with a calcium supply, the suitable soil bacteria Bacillus subtilis may form calcium precipitates. In accordance with the supplier's guidelines, the bacteria were cultured in liquid media. In order to create a solid medium for the stock culture, 1.5 percent agar was added to the bacteria-growing media, which was composed of 5.0 g peptone and 3.0 g meat (beef) extract per litre of distilled water.MnSO4 in the amount of 0.01 g was added to the medium. Using 1 N HCl, the pH was brought down to 7.0 in order to promote sporulation. The combination was initially sterilised for 20 minutes at 121 degrees Celsius in an autoclave before being allowed to cool to room temperature (25oC). B. Subtilis cultures were made by reactivating lyophilized bacteria, whereas cultures for all subsequent tests were made via sub culturing. Be aware that the entire culturing procedure was carried out under sterile conditions. Then, for 72 hours, cultures were cultured at 30 °C and 130 rpm in a shaker incubator. The 72-hour-old growing culture was then centrifuged to extract the bacteria.

Fig: 1

Table: 1 Properties of cement

S. No	Description	Result
1	Fineness of Cement	94%
2	Normal Consistency	30%
3	Initial Setting Time	30 minutes
4	Final Setting Time	10 hours
5	Specific gravity	3.15

Table: 2 Properties of Fine Aggregate

S. No	Description	Result
1.	Sand zone	Zone-II
2.	Specific gravity	2.64
3.	Water absorption	1.2%
4.	Bulk density	1560
5.	Fineness modulus	3.2
6.	Moisture content	2.0%

Table:3 Properties of Coarse Aggregate

S. No	Description	Results
1.	Specific Gravity	2.78
2.	Impact Value	5.7%
3.	Water Absorption	1.0%
4.	Crushing Value	18.72%
5.	Bulk Density	1935.3kg/m3

4. EXPERIMENTAL METHODS AND TESTS

Compressive strength of cubes: In our investigation we have made M30 grade of concrete as per IS 10262. Further, we have poured the concrete in the cube moulds and five different samples were made which are as follows.

1. Conventional concrete of gradeM30
2. Concrete with 15 ml bacterial solution
3. Concrete with 30 ml bacterial solution
4. Concrete with 45 ml bacterial solution
5. Concrete with 60 ml bacterial solution

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

a. Direct mixing
b. Indirect mixing
c. Injection method

In our investigation we have adopted the direct method mixing. The compressive strength is determined using compressive testing machine.

5. RESULTS

Compressive strength for M30 grade of bacterial concrete. Bacteria is mixed in concrete as 0%, 0.3%, 0.6%, 0.9% and 1.2% i.e., as 0 ml, 15 ml, 30 ml, 45 ml and 60 ml.

Effect of bacterial concrete is shown in the graph below. With increase in ml of bacteria in concrete, compressive strength of cubes increases and maintains constant value from the optimum value. Hence the optimum value is considered as 45 ml of bacteria in concrete.

Table: 4Compressive strength values: Various mix proportions at 28,56 and 90 days

MIX	28 days (N/mm^2)	56 days (N/mm^2)	90 days (N/mm^2)
0 ml	38.82	42.29	45.37
15 ml	42.40	46.20	49.59
30 ml	45.07	49.10	52.71
45 ml	49.55	53.97	57.95
60 ml	50.20	54.68	58.62

Table:5 Split tensile strength values: Various mix proportions at 28,56 and 90 days

MIX	28 days (N/mm^2)	56 days (N/mm^2)	90 days (N/mm^2)
0 ml	3.83	4.16	4.48
15 ml	4.12	4.48	4.81
30 ml	4.38	4.76	5.12
45 ml	4.77	5.19	5.57
60 ml	4.94	5.38	5.76

6. CONCLUSIONS

1. The conventional concrete compressive strength for 28, 56 and 90days is 38.82 N/mm^2, 42.29 N/mm^2 and 45.37 N/mm^2.
2. The conventional concrete split tensile strength for 28, 56 and 90days is 3.83 N/mm^2, 4.16 N/mm^2 and 4.48 N/mm^2.
3. The compressive strength increases by45ml bacterial concrete using B. Subtilis for 28, 56 and 90 days 49.55 N/mm^2, 53.97 N/mm^2 and 57.95 N/mm^2.
4. The compressive strength increases by60ml bacterial concrete using B. Subtilis for 28, 56 and 90 days 50.20 N/mm^2, 54.68 N/mm^2 and 58.62 N/mm^2.
5. The split tensile strength increases by45ml bacterial concrete using B. Subtilis for 28, 56 and 90 days 4.77 N/mm^2, 5.19 N/mm^2 and 5.57 N/mm^2.
6. The split tensile strength increases by60ml bacterial concrete using B. Subtilis for 28, 56 and 90 days 4.94 N/mm^2, 5.38 N/mm^2 and 5.76 N/mm^2.

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