

# Study on compressive strength of bacterial concrete

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**Abstract**— This paper says about the tests conducted to determine the compressive strength of concrete using a bacteria named bacillus subtilis. In this method of experiment, cement of OPC 43 grade, well graded aggregate and along with that 25Mm of CaCl<sub>2</sub>, 100 Mm of disodium oxalate and 50 Mm of sodium bicarbonate is added. And also a bacterial culture of bacillus subtilis is added for about 1.5 ml. Three different types of water is prepared for mixing and curing. They include distilled water, water with the above mentioned salts and the other with salts and bacteria. Individual cubes are casted by using different water and checked out for strength. The compressive strength is tested and the strength of concrete cube is tested for different type of mix proportions of water.

**Keywords**- bacillus subtilis, compressive strength

## I. INTRODUCTION

The per capita consumption of concrete is next water. it is mainly used in this infrastructure era of development. the carbon footprint of cement manufacturing industry is third in the world. Recent study showing that 40% cement manufactured are used for repair works. This is because of the degradation of concrete. In this paper we have studied the effect bacteria on the hardened properties of the concrete. the bacteria we have used here is bacillus subtilis which is a natural bacteria obtained from soil. a study on compressive strength is made because compressive strength is the direct representation of the various durability properties. In this research cubes are made with three types of water and cured in three types of water which is discussed below. S. Maheswaran et al (2014) compared the compressive strength of new type of wild strain Bacillus Cereus and Bacillus pasteurii. By his conclusion, Bacillus Cereus shows high performance than the Bacillus pasteurii. It is also good in marine environment. M Dhaarani et al (2014) had suggested that bacterial concrete is good in durability criteria. Srinivas Reddy et al (2012) has shown the results of durability properties of bacterial concrete.

He made investigation in Bacillus subtilis and also performed acid test for the bacterial concrete. The result shows that the bacterial concrete is an excellent resistance to acid attack. Keerthana (2016) in her study concluded that bacterial concrete is good acid resistant. Koustubh A. Joshi et al (2016) has concluded that bacteria has positive effect on the compressive strength of the concrete and compressive strength varies with the bacterial count changes.

## II. MATERIALS

### A. Bacillus subtilis

Bacillus subtilis, known also as the hay bacillus or grass bacillus, is a Gram-positive, catalase-positive bacterium, found in soil and the gastrointestinal tract of ruminants and humans. Its cells are typically rod-shaped, and are about 4-10 micrometers (µm) long and 0.25–1.0 µm in diameter, with a cell volume of about 4.6 fL at stationary phase. As with other members of the genus Bacillus, it can form an endospore, to survive extreme environmental conditions of temperature and desiccation.

### Reproduction of bacteria

Bacillus subtilis can divide symmetrically to make two daughter cells (binary fission), or asymmetrically, producing a single endospore that can remain viable for decades and is resistant to unfavourable environmental conditions such as drought, salinity, extreme pH, radiation, and solvents. The endospore is formed at times of nutritional stress, allowing the organism to persist in the environment until conditions become favourable. Prior to the process of sporulation the cells might become motile by producing flagella, take up DNA from the environment, or produce antibiotics. These responses are viewed as attempts to seek out nutrients by seeking a more favourable environment, enabling the cell to make use of new beneficial genetic material or simply by killing of competition. Under stressful conditions, such as nutrient deprivation, subtilis undergoes the process of sporulation to ensure the survival of the species.

This process has been very well studied and has served as a model organism for studying sporulation.

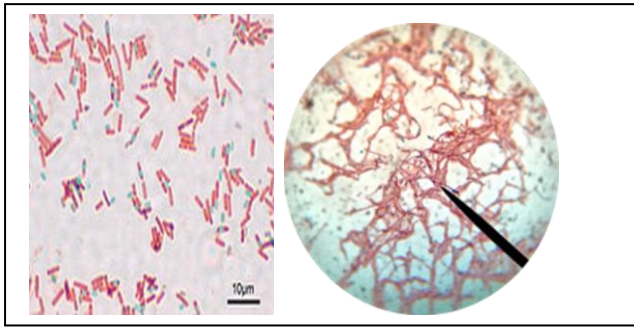


Figure 1 : Reproduction of Bacteria

**B. Cement**

Cement used in the mix design is of Ordinary Portland Cement (OPC) with 43 grade.

**C. Coarse Aggragete**

Coarse Aggregates used must be well graded with same size throughout and maximum size is 20 mm and minimum size is 10mm

**D. Fine aggregate**

Fine Aggregate conforming to Zone III.

**E. Salt solutions**

Solution is prepared by mixing sodium bicarbonate(25%), Disodium oxalate(10%) and calcium chloride(65%) with water to make the concrete which will act as medium during mixing and curing to prevent bacteria from severe environment.

**F. Water**

Drinking water is used for casting of all specimens

II. W1-Water containing calcium chloride, sodium bicarbonate and disodium oxalate

III. W2-Water containing calcium chloride, sodium bicarbonate and disodium oxalate and bacillus subtilis

IV. IV. RESULTS AND DISCUSSION

A. Specimen dimensions

Cube : 150mmx150mmx150mm

No of Cubes casted : 27

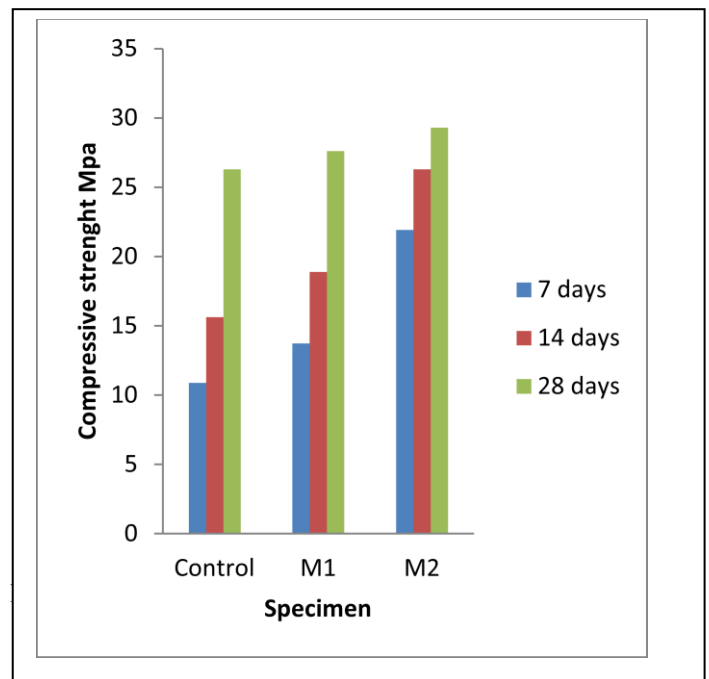
B. Specimen details

S/n	Specimen Code	Mixing	Curing	Average Compressive strength (N/mm <sup>2</sup> )		
				7days	14 days	28 days
1	CM	Distilled water	Distilled water	10.8	15.6	26.3
2	M1	W1	W1	13.7	18.8	27.6
3	M2	W2	W2	21.6	26.3	29.3

\*W1-Water containing calcium chloride, sodium bicarbonate and disodium oxalate

\*W2-Water containing calcium chloride, sodium bicarbonate and disodium oxalate and bacillus subtilis

Table 2 : Compressive strength results



III. MIX DESIGN

The mix proportion for ordinary concrete is M25 grade was prepared using IS: 10262 2009. In addition bacterial solution added at 5.9 liters/m<sup>3</sup>.

Cement	Fine aggregate	Coarse aggregate	Water content
320 kg/m <sup>3</sup>	751 kg/m <sup>3</sup>	1356 kg/m <sup>3</sup>	138 liters/m <sup>3</sup>

## VI.

## VII. V. CONCLUSION

The compression strength obtained from the above results are

1. Conventional concrete - 26.3 N/mm<sup>2</sup>
2. Concrete with salts - 27.6 N/mm<sup>2</sup>
3. Concrete with bacteria - 29.3 N/mm<sup>2</sup>

From this study it is proved that the bacterial concrete gives a positive result in determining the compressive strength. It also helps in crack healing and corrosion of steel. Thus permeability of concrete is also reduced.

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