COMPARATIVE STUDY ON BACTERIAL CONCRETE USING BACILLUS SPHAERICUS AND ESCHERICHIA COLI

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***Abstract*— Concrete is the most predominant building material in construction industries. Due to improper design, temperature effects like freezing, thawing and shrinkage which causes deformation and produce cracks in the structures. Cracks are one of the major weaknesses of concrete which leads to the structural failure. To remediate cracks in structures, bacterial concrete is new innovative technique in which Bacteria are used. During the mixing of concrete, bacteria produces calcium carbonate precipitate will cure the cracks automatically. The efforts has been made to study about the performance of Bacillus Sphaericus and Escherichia coli in concrete and also it deals with the comparison of bacterial concrete in strength aspects The bacterial strains produce calcite precipitation was examined by X-ray diffraction (XRD) analysis and visualized by Scanning Electron Microscope(SEM). The concrete mixture was prepared with each bacterial strains at 10^3, 10^6 & 10^9 concentrations of cells/ml of water. The mechanical properties of concrete such as compressive strength, Split tensile strength and flexural strength were evaluated. The concrete with Bacillus Sphaericus at 10^9 concentration gives higher strength than the concrete with Escherichia coli.**

***Index Terms*— Bacillus Sphaericus, calcite precipitation, Escherichia coli, Self healing bacterial concrete**

I. INTRODUCTION

Concrete is a vital building material that is an absolutely essential component of construction practice. It is also a very brittle material with low tolerance for strain, so it is commonly expected to crack with time. In order to rectify these cracks, self healing agents are used. The objective of this study to incorporation of Bacillus Sphaericus and Escherichia coli in the concrete mix which produces the calcium precipitate, it arrest the crack and can also reduce the amount of damage sustained by the concrete structure in place. The studies and results from various surveys have given an idea about bacterial concrete.

H.M.Jonkers (2011) gives an overview of durability of bacterial concrete. His paper deals with the self healing repair mechanism. He concludes that the bacterial concrete heals even millimeters of crack size .This concrete is very effective in wet environment and controls the corrosion of steel reinforcement. Jagadeesh Kumar et.al (2013) compared three species of bacillus such as Bacillus flexus, Bacillus Sphaericus and Bacillus pasteurize. From this he concluded that the bacillus flexus is a best option in MICP (Microbial Induced Calcite Precipitation). S.Maheswaran et.al (2014) compared the compressive strength of new type of wild strain Bacillus Cereus and Bacillus pasteuri. By his conclusion, Bacillus Cereus shows high performance than the Bacillus pasteuri. It is also good in marine environment.

II. MATERIAL USED

The materials investigated in this study are as follows

2.1 Cement

Ordinary Portland cement of 53 grade used in this investigation and it confirming specifications as per IS 12269-1987 having specific gravity of 3.15.

2.2 Fine Aggregate

The fine aggregate obtained from river is used in this experimental purpose with fineness modulus 2.47 (Sand confirming to zone II) as per IS 383-1970.

2.3 Coarse Aggregate

Angular coarse aggregate of maximum size 20mm with specific gravity 2.82 was used.

2.4 Water

Drinking water was used for casting all specimens for this investigation and the quality of water was found to satisfy the requirement of IS 456-2000.

2.5 Micro- organisms

Bacillus Sphaericus and Escherichia coli which is cultured and tested in Biotech Laboratory were used.

III. CONCRETE MIX PROPORTION

The mix proportions for ordinary grade concrete of M_{30} are designed using IS:10262-2009. In addition, Bacterial solutions are added at 250ml for 1 litre of water

IV. RESULTS AND DISCUSSION

3.1 Compressive strength test:

M_{30} grade of concrete are cast in the moulds of size 150mmx150mmx150mm and tested for compressive strength at 7,14 & 28 days. Bacillus Sphaericus strains and Escherichia coli strains are added to the concrete mix at 10^3,10^6&10^9 concentrations. The variation of compressive strength is shown in figure 1(a)&(b).

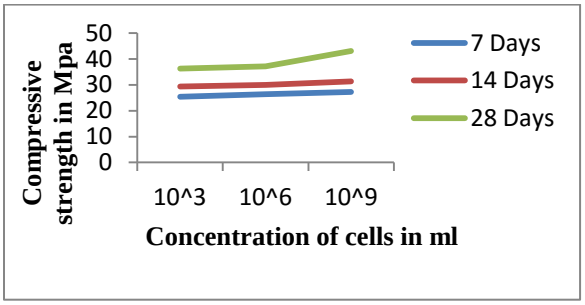

Figure 1(a): Average compressive strength of Bacillus Sphaericus at 7, 14, 28 days.

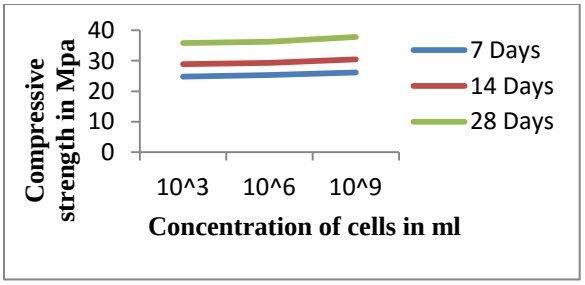

Figure 1(b): Average compressive strength of Escherichia coli at 7, 14, and 28 days.

3.2 Split tensile strength test:

Bacillus Sphaericus and Escherichia coli strains are mixed with M_{30} grade of concrete and are cast in the cylinder specimen of diameter 150mm & height 300mm and tested for tensile strength at 7,14 & 28 days. The tensile behavior of bacterial concrete is shown in figure 2(a)&(b)

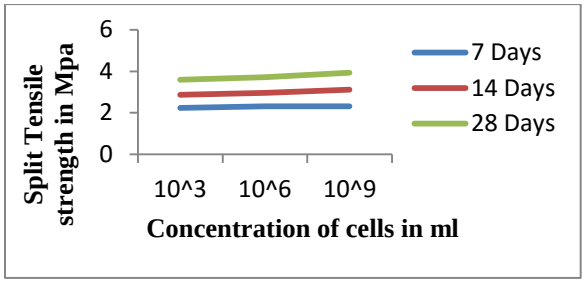

Figure 2(a): Average Split tensile strength for Bacillus Sphaericus at 7, 14, and 28 days.

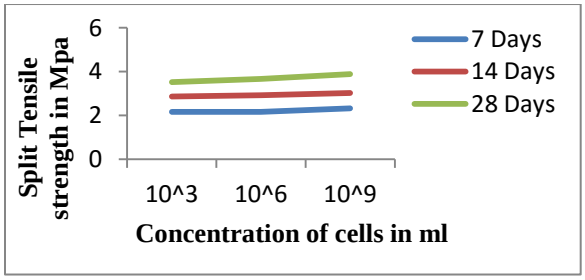

Figure 2(b): Average Split tensile strength for Escherichia coli at 7, 14, and 28 days

4.3 Flexural strength test:

This test is carried to study the effect of flexural behavior on concrete.M_{30} grade of concrete are casted in the prism of size 750mmx150mmx150mm and tested for flexural strength at 7,14 & 28 days. The strains of Bacillus Sphaericus and Escherichia coli are added to the concrete mix at 10^3,10^6&10^9 concentrations. The variations of flexural strength are shown in figure 3(a)&(b).

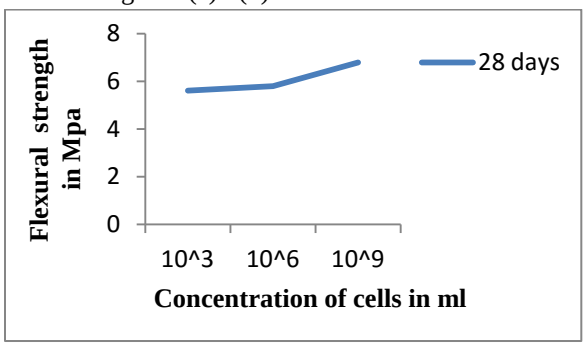

Figure 3(a): Average flexural strength of Bacillus Sphaericus at 7, 14, and 28 days

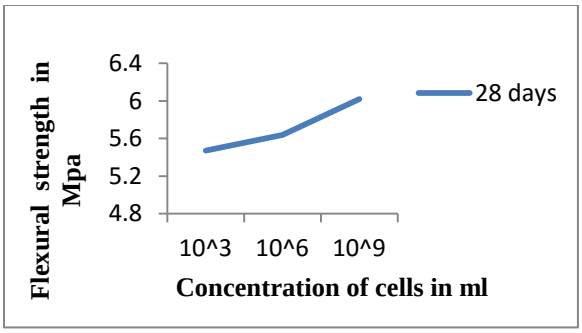

Figure 3(b): Average flexural strength of Escherichia coli at 7, 14, and 28 days

V. CONCLUSION

The experimental investigation of bacterial concrete made the following conclusion

- The compressive, split tensile and flexure strength of bacterial concrete is more than the conventional concrete.
- It is observed that the mechanical properties of Bacillus Sphaericus are higher than the Escherichia coli.
- The results revealed that at higher concentration (10^9cells/ml) give more strength in both Bacillus Sphaericus and Escherichia coli bacterial concrete.

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