Mechanical Properties of Bacterial Concrete with LECA

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***Abstract*- Reduction in unit weight of concrete with no compromise on the strength will lead to economy in the size of the structural members. Bacillus subtilis bacteria is cultured and used in this investigation for its calcite formation property. 20% of fine aggregate is replaced by Light weight clay aggregate (LECA)in this investigation. Compressive strength of bacterial concrete increased to 28%, 39.5% and 52.17% with 16ml, 32ml and 48ml of bacteria. 20% of replacement of fine aggregate by LECA lead to an increase in the compressive strength of light weight bacterial concrete 14.93%, 13.827% and 6% with the inclusion of 16ml, 32ml, 48ml of bacteria of bacterial solution.**

Index Terms- LECA, Bacillus subtilis, compressive strength, self-healing, flexural strength.

I. INTRODUCTION

Concrete is the most widely used material next only to water. Researchers strive to improve the properties of concrete to meet the various demands. Two significant properties are the self-weight and the crack formation in concrete which reduces the durability. Self-weight of concrete can be reduced by foaming the cement paste, entrapping air and using light weight aggregates. Light weight Expanded Clay aggregates are available in various sizes and densities the maximum density is 500 Kg/m^3 which is one fifth of the conventional aggregates. Bacillus subtilis produces calcite when cracks appear, CO_2 comes in contact and $CaCO_3$ is formed sealing the cracks.

II. MATERIALS

A. Cement

Ordinary Portland cement 53 grade with a specific gravity of 3.12 and confirming to IS 8112:1989 was used.

B. Fine Aggregate

River sand conforming to Zone II of IS 383-1970 with specific gravity of 2.5 was used. manuscripts

C. Coarse Aggregate

Coarse aggregate with 20mm as maximum size and conforming to IS 383-1970 is used in this investigation.

D.LECA

LECA is expanded light weight clay aggregate produced by heating the clay to1200ºC in rotary kiln. The expanding gases form clay bubbles which hardens due to high temperature. LECA is a versatile material, and is utilized in many applications. In the construction industry, it is used in the production of lightweight concrete, blocks and precast or in cast structural elements.

E. Bacillus Subtilis

Bacillus Subtilies is cultured in the laboratory using one gram of the bacterium. 28 gram of agar is mixed with one liter of water and autoclaved for 15 minutes at 121°C. Cool the sterilized Agar solution to 55 °C. Add one gram of the bacterium to the Agar solution and it is left overnight on the shaker with 150-200 rpm. After 24 hours the whitish yellow turbid solution is ready to use.

III. METHODOLOGY

Concrete mix was designed to have a characteristic compressive strength of 20 N/mm^2 at the end of 28 days. Twenty percentage of fine aggregate was substituted with LECA. Bacterial solutions are used in 16 ml, 32 ml,48 ml with LECA and without LECA.

14 days and 28 days cube compressive strength were determined on 150 mm side cube according to IS 516-1970. 63 cubes were cast for testing of

compressive strength at 7days 14 days and 28days of age. 16 beams of size 150 mm ×150mm ×1000mm were cast with two 10 mm diameter bars both at the top and at the bottom. 6 mm diameter bars are used for stirrups at 15cm spacing. Beams were tested for flexural strength at 28 days in two-point loading in accordance with IS 516-1959.Loading frame of 50 ton was used for testing of beams. Load cell of 25 ton was used to load the cell.

Data acquisition system is used to record the loads and deflection. Deflectometers are used to measure the deflection.

IV. RESULTS

Cubes are casted for 16 ml, 32 ml and 48 ml of bacterial solution with normal coarse aggregate The size of cube molds used in compression strength test was 150x150x150mm. After 14 and 28 days of curing period, cubes are tested in compressive testing machine in accordance with IS 516-1959.The results are tabulated in Table 1 and Fig.1

Table I Compressive Strength of Bacterial Concrete

s.no	ml of bacteria	Compressive strength MPa	
		14 days	28 days
1	16	27.76	29
2	32	29.98	32.11
3	48	30.78	35.22

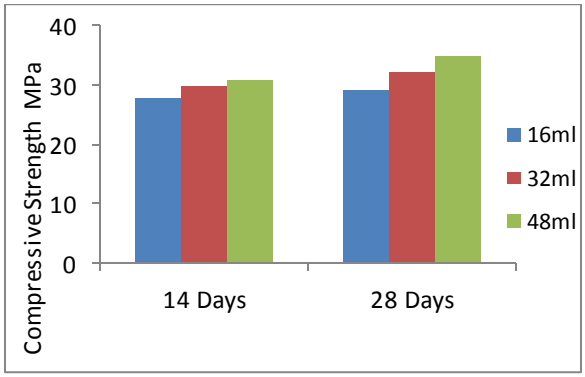

Fig.1. Compressive Strength of Concrete Cubes (Bacteria)

Table II Compressive Strength of Bacterial Concrete with LECA.

S. No	ml of bacteria	Compressive strength MPa	
		14 days	28 days
1	16	28.65	33.33
2	32	29.98	36.55
3	48	30.87	37

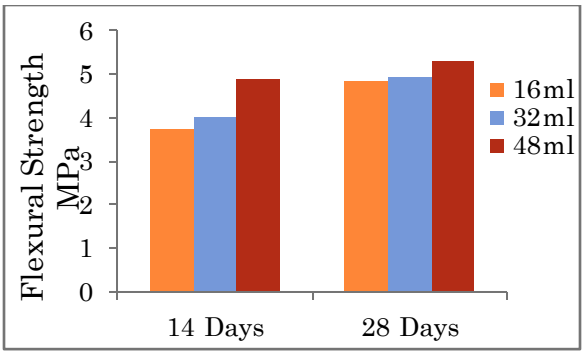

Fig.2. Flexural strength of Concrete Beams (Bacteria)

Compressive strength of bacterial concrete in comparison with conventional concrete increases in 28%, 39.5% and 52.17% with the addition of 16ml,32 ml, 48ml of bacterial solution.

Flexural strength is determined to improve the understanding on behavior of bacterial concrete with LECA.When 20 % of LECA is substituted for fine aggregate, the 28 days flexural strength increases by 33.7%, 26.47% and 32.6% respectively. It indicates the LECA's participation in the increase in flexural strength.

V. CONCLUSION

Bacterial solution contributes to the increase in compressive and flexural strength. 48 ml of bacterial solution increases the compressive strength at 28 days to 52.17% and flexural strength at 28 days to 26% Substitution of 20% of LECA for fine aggregate in 16 ml,32 ml and 48 ml bacterial solution concrete increases the compressive and tensile strength. The 48 ml of LECA bacterial concrete at 28 days found to have only 6% higher compressive strength than the normal bacterial concrete as against 16 ml and 32ml LECA bacterial concrete with 14.9 % and 13.8% higher compressive strength compared to bacterial concrete. Flexural strength of 20 % LECA substituted bacterial concrete increased to 33.7%, 26.47% and 32.6% respectively.

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