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Experimental Study on Bio Brick using Bacillus Pasteurii

Asst. Prof. K.Priyanka | **UG student S.Mohamed Uvais** | **UG student A.Salman Khan** | **UG student CK. Ali Murthaza** | **UG student S.Muhamed Ashir**
Department of Civil Engineering
Dhaanish Ahmed Institute of Technology, Coimbatore
Email: priyankabharathi7@gmail.com

***Abstract* – This article mainly is focus on manufacturing of eco-friendly bricks using bacteria without undergoing natural process such as heating. It is necessary to induce calcium precipitate to convert clay into solid bricks .The bacteria that have been used in this process is a bacillus type of bacteria (Bacillus Pasteurii). Moreover, it supports the idea in this technology can lead to self-healing materials. Hence there was an increase in 4.29% of the bricks made of with cement and bacteria compared to the bricks made by using without cement and bacteria.**

***Keywords* – Calcium precipitate, Bacillus Pasteurii, self-healing.**

I. INTRODUCTION

The emerging economies have an imperative of rapidly building their infrastructure while controlling the energy consumption and emission.

Thus, they must select building materials that satisfy the performance needs of the user as well as the development needs of the society, without causing any adverse impact on environment. Manufactured by compacting a mixture of locally available soil, sand and a small quantity of cement, these bricks have a very low embodied energy and CO2 emission. Moreover, it uses local materials and inexpensive equipment.

The observations clearly indicated that bacterial calcite precipitation proceeds as long as nutrients for microbial growth and ingredients for calcite precipitation are available and seals the pores.

II. REVIEW OF LITERATURE

1. Study on Soil

Sand bio-consolidation through the precipitation of calcium carbonate by two Ureolytic bacteria Márcia Aiko Shirakawa , Katia Kaori Kaminishikawahara, Vanderley Moacyr John,Henrique Kahn, Marcos Massao Futai Volume 65, Issue 11,pages 1519-1744

Two ureolytic strains, B. sphaericus and Bacillus sp, were tested for their ability to consolidate sand by submitting them to two days' treatment using 107 viable cell concentrations of inoculated and medium precipitation with calcium ions. The results showed that B. sphaericus induced greater calcium carbonate formation.

Both strains produced calcite and were able to consolidate sand.Tensile strength of consolidated sand was not a function of the amount of precipitated CaCO3 but a linear function of the ratio bio-consolidation index (BC) defined as the ratio of CaCO3 volume to initial sand porosity

2. Study on Brick

Bacterial Calcification for Enhancing Performance of Low Embodied Energy Soil- Cement Bricks Abhjit Mukherjeel, Navdeep Kaur Dhami, B.V.V. Reddy, and M. Sudhakara Reddy

Soil–cement bricks are vastly more energy efficient than fired clay bricks. Although they have adequate strength, they absorb high levels of moisture and in humid conditions they become soft and non-uniform expansion leads to excessive deformation and cracking.

In this research a barrier layer on their surface that impedes moisture ingress is developed by depositing calcite using bacteria. Soil-cement bricks (230 mm x 110 mm x 60-75 mm) were prepared by mixing bacteria (Bacillus megaterium) and cured by spraying a nutrient media for 28 days.

The specimens were tested for water absorption, porosity and compressive strength and compared with control specimens. The results suggest that the barrier layer created by bacterial activity greatly alleviates the weaknesses of energy efficient soil-cement bricks enabling their large scale use.

III. MATERIALS AND METHODS

1. Clay soil

In this study, the soil sample is collected from an area Red hills, Chennai. The soil taken for test is disturbed sample. The physical characteristic of soil sample is classified as per IS codes shown in table I. The soil is classified as Silty Clay (Gs = 2.62 with 88.6% fines) with expansive behaviour.

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Table -I: Physical Characterisation of Soil Sample

S.No.	Properties	Values
1.	Specific gravity	2.83
2.	Atterberg's Limit • Liquid limit(%) • Plastic limit • Shrinkage limit(%)	 27.48 18.18 24.66
3.	Compaction characteristics • Maximum dry density(KN/m3) • Optimum moisture content(%)	 2.21 19.6

2. Bacteria

The termite mound samples were collected from four different places at Madipakkam in Chennai, Tamil Nadu, India. The collected samples were placed inside sterile ethyl polythene bags and transferred to the lab aseptically in ice boxes.

3. Urea

Urea or carbamide is an organic compound with the chemical formula CO(NH2)2. The molecule has two -NH2 groups joined by a carbonyl (C=O) functional group. Urea serves an important role in the metabolism of nitrogen- containing compounds by animals and is the main nitrogen-containing substance in the urine of mammals. It is a colourless, odourless solid, highly soluble in water and practically non-toxic.

Dissolved in water, it is neither acidic nor alkaline. The body uses it in many processes, the most notable one being nitrogen excretion. Urea is widely used in fertilizers as a convenient source of nitrogen.

4. Water

The water is reasonably free from such impurities as suspended solids, organic matter and dissolved salts which adversely effect the properties of brick.

5. Methodology

The experiment consists of casting and testing of bricks of size 190 x 90 x 90 mm is obtained by mixing the constituent materials.

- The brick mould is made of three samples
- Without cement and with bacteria
- Without cement and bacteria
- With cement and bacteria

To study the properties of bio brick, the following tests are conducted

- Compression test
- Water absorption
- Efflorescence test

IV. RESULTS AND DISCUSSION

1. Compression strength

This figure 1 shows the comparison of compressive strength of bricks without cement with bacteria, bricks without cement and bacteria and with cement and bacteria.

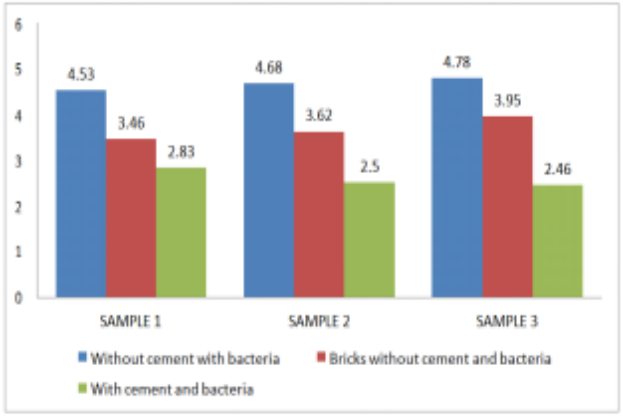

Fig.1.Comparison of compressive strength of bricks

Table- II: Comparison of compressive strength of bricks

Category	Sample 1	Sample 2	Sample 3
Without cement With bacteria (blue)	4.53	4.68	4.78
Bricks without cement and bacteria (red)	3.46	3.62	3.95
With cement and bacteria (green)	2.83	2.5	2.46

2. Water absorption

The figure 2 shows the comparison of water absorption of bricks without cement with bacteria, bricks without cement and bacteria and with cement and bacteria.

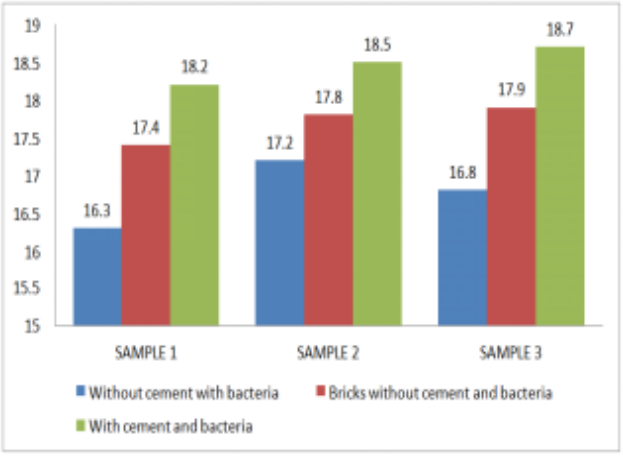

Fig. 2. Comparison of Water absorption of bricks.

Table -III: Comparison of Water absorption of bricks.

Category	Sample 1	Sample 2	Sample 3
Without cement With bacteria (blue)	16.3	17.2	16.8
Bricks without cement and bacteria (red)	17.4	17.8	17.9
With cement and bacteria (green)	18.2	18.5	18.7

3. Efflorescence

Results of efflorescence test shall be reported as Nil,slight,moderate,heavy or serious. The value should be Nil, If there is no noticable deposit of efflorescence, it should be marked as slight when less than 10% of exposed area of brick is covered by a thin layer of salt and it should be moderate for 10-25% of the brick surface.

Table IV: Comparison of Efflorescence of bricks

S.No.	Type of brick	Observation
1	Without cement with bacteria (blue)	Nill
2	Bricks without Cement and bacteria (red)	Slight
3.	With cement and bacteria (green)	Moderate

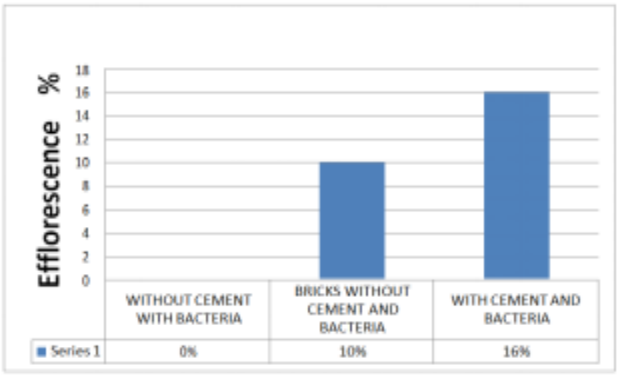

Fig.3.Comparison of Efflorescence of bricks.

V. CONCLUSION

In this experiment it was found that the bricks made by using without cement and with bacteria having high compressive strength when compared to the other bricks. The average compressive strength of bricks having without cement and with bacteria attain 26.86% higher value than the bricks produced using without cement and bacteria. And there is a decreasing of 29.37% of average compressive strength in the bricks made by using cement & bacteria when compared to the bricks made of without cement and bacteria.And from the results it was observed that the value of water absorption is decreased by 5.64% for the bricks made of using without cement and with bacteria when compared to the bricks of without using cement and bacteria and there was a increase in 4.29% of the bricks made of with cement and bacteria compared to the bricks made by using without cement and bacteria.

So it was concluded that the bricks made by using without cement and with bacteria having good compressive strength.it was observed that the bricks made by using without cement and with bacteria having low water absorption and producing Nil efflorescence among the all in this experiment.

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