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Bacterial Stabilization of Soil Bricks or Bacterial Bricks

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Abstract:
This paper discuses about the manufacturing of eco-friendly bricks using bacteria by undergoing natural process without undergoing any artificial process such as heating. It is necessary to induce calcium precipitate to convert clay into solid bricks. The bacterium that is used in this process are Bacillus type of bacteria, because this type of bacteria are capable of generating Urease enzyme in greater quantity. On inoculating this urease enzyme in a mixture of sand and limestone, a chemical reaction takes place in converting a clay particle into a Solid brick without undergoing any heating or any other artificial process. The manufacturing cost of bacterial brick is low as compared to normal brick, also the strength produced by this brick is similar to that of normal bricks. Thus this bacterial brick is completely manufactured without affecting the surrounding environment. Thus this brick is generally referred to as eco-friendly bricks.

Keyterms: Calcium precipitate, Bacillus Bacteria, Urease enzyme, chemical reaction.

1. INTRODUCTION:

The preparation of soil bricks using the bacteria which will give effective way to settle down the natural phenomena [1]. A review of different researches in the recent years on the use of bacterial concrete bricks and the chemical process takes place in the concrete [2]. The notable points regarding classification of bacteria, self healing concrete bricks, chemical process of crack remidiation self healing mechanism of bacteria, advantages and disadvantages of bacterial concrete[3].It is an attempt to define bacterial concrete, types and classification of micro organisms working of bio concrete as a repair material, advantages and disadvantages of bacterial concrete and application by literature review are discussed[4].The study of both physical and mechanical properties of brick specimen containing combination of limestone dust and small amount of portland cement binder for producing brick material[5]. The representation of information regarding slag bricks and plant properties and their users in a most concise, and to the point manner[6].

2. METHODOLOGY:

The raw materials which are necessary for the manufacture are collected depending upon the amount of quantity needed. The raw materials used in this project are sand, lime powder and bacteria.The collected raw materials are tested based on the nature. For sand; Specific gravity test and grain size distribution test. For lime; Fineness test, initial setting time test, final setting time test and specific gravity test. The material which passes all the above test are thus taken to the further process.

Tests on sand:

Specific Gravity test:

Specific gravity is the ratio of the density of a substance to the density of the reference substance equivalently. it is the ratio of the mass of a substance to the mass of a reference substance for the same given volume. Specific gravity test is carried out using pycnometer.

Procedure:

The 200gm of sand sample is taken for this test.The empty weight of a pycnometer is taken and it is denoted as (W_1). The sand is added 1/3 of its volume into the pycnometer and weighed; it is denoted as (W_2). Remaining 2/3 of water is added along with the sand and weighed; it is denoted as (W_3). The empty pycnometer along with water is weighed and denoted as (W_4).

Formula to calculate specific gravity:

(W_2-W_1) / $(W_4-W_1)(W_3-W_2)$

Specific Gravity = 2.3

Figure.1. Specific gravity test for sand

Grain size distribution:

The Grain size distribution test is carried out by using Sieve analysis. The sieve is arranged in a descending order. The 500

gm of sand sample is taken for this test. The sand passing through 4.75mm sieve and retaining grains in 2.75 mm sieve are thus taken for the manufacture of bricks.

Table.1. Size distribution of sand

Size of sieve (mm)	Wt. of soil retained (gm)	% retained	Cumulative % retained	% fineness
4.75	.045	4.5	4.5	95.5
2.36	.051	5.1	9.6	90.4
1.18	.272	27.2	36.8	63.2
.6	.345	34.5	71.83	28.7
.3	.121	12.1	83.4	16.6
.15	.036	3.6	87	13
.075	.015	1.5	88.5	11.5
Pan	.011	1.1	89.6	10.6

Figure. 2. Grain Size distribution test

Tests on lime:

Fineness test:

The 100gm of lime powder is taken for fineness test. The fineness test is carried out with the help of 90 micron sieve and a pan. The fineness of lime powder can be calculated by using a formula;

(Weight of retained sample / Total weight of sample) x 100

% retained =3.34%

Figure.3. Fineness test on lime

Setting time test:

The setting time test is generally carried out for both. They are;

- Initial setting time
- Final setting time

500 gm of lime powder is mixed with a same quantity of water and properly mixed to form a proper mix of lime powder and water. The setting time test is generally carried out in Vicat's apparatus.

Initial setting time:

The lime mortar is placed in a mould and placed in a non porous plate of a Vicat's apparatus. The needle is attached to the rod and it is allowed to fall from a certain height. The penetration of 5mm from bottom is allowed to know its initial setting time. The initial setting time of lime is calculated as 120 min.

Final setting time:

The starting steps are same as that of initial setting time. In this method a needle is replaced with plunger and attached to a rod. The annular needle does not penetrate into the mould and should remain only in the surface of the mould. The final setting time of lime powder is 1000min.

Specific Gravity Test:

The specific gravity test for lime is similar that of sand test. This test is carried out with the help of pycnometer. The observed reading are as follows:

The specific gravity is calculated using formula;

$$\frac{W2-W1}{(W4-W1)(W3-W2)}$$

Specific Gravity =2.53

Figure. 4. Specific gravity test for lime

3. BACTERIA SPECIFICATION:

The bacteria selected for generating calcium precipitate should satisfy the following criteria;

1. Concentration of calcium.
2. The pH value.
3. The availability of nucleation.
4. Dissolve in organic carbon.

The bacteria which satisfies all the above criteria is selected for this project and the project is carried out by using the bacteria. Generally, bacillus type of bacteria satisfies all the above condition. Genus Bacillus type of bacteria has a self-healing capacity, which is used to fill cracks in the surface of concrete. The main purpose of the bacteria is to generate calcium crystals

to create more stability to bricks and to manufacture eco-friendly bricks without involving the process of heating.

CHEMICAL REACTION:

On hydrolyzing urease enzyme with water it generally forms two components. They are:

1. Carbon dioxide
2. Ammonia.

$(NH_2)_2CO + H2O \longrightarrow CO_2 + 2NH_3$

$CaO + Co_2 \longrightarrow CaCo_3$

The presence of ammonia will increase the pH in the brick which helps to form the crystalline structure in the brick. The carbon dioxide then reacts with calcium oxide (Cao) to form calcium carbonate. At last the calcium precipitate helps in converting soft clay into crystalline form and then converted into hard bricks. Within 3-5 days from the inoculation of bacteria eco-friendly brick is obtained.

PROCESS:

The raw materials which are needed for this project are thus collected and stored. The raw materials are sand, limestone and water. The sand and limestone are generally taken under the proper ratio based on trial and error. The normal brick mould size of 21x10x10 cm whereas the brick is of size 19x9x9 cm.

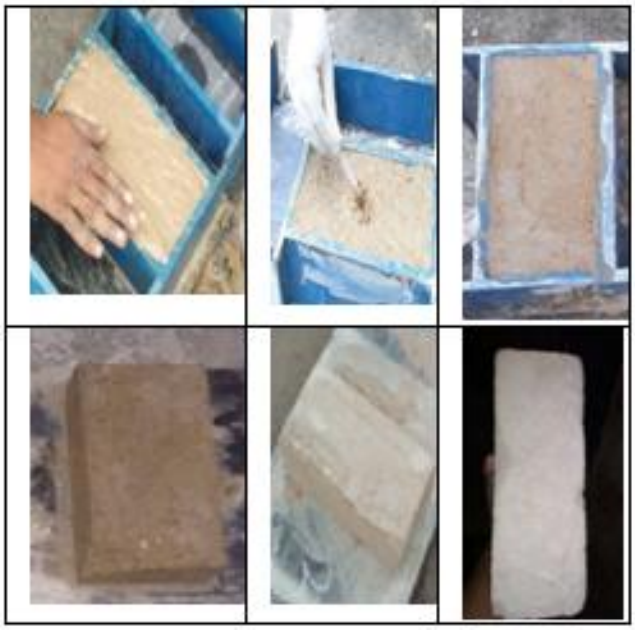

Figure. 5.Process involved in the manufacturing of bricks

The general processes which are commonly involved in the manufacture of bricks are generally followed, mixing, weeing and placing in mould are carried out. After placing in mould, the bacteria is just inoculated into the mixture of sand and limestone in drops. Once the bacteria is inoculated the demoulding process is carried out and the brick is kept under normal temperature to form the crystal like structure in its surface. At the end the calcium carbonate precipitate tends to form and thus it forms the bacterial bricks. Within 3-5 days from the inoculation of bacteria in the surface of the bricks, the perfect bacterial bricks are thus obtained. At the end the bacterial brick is out of utilizing the bacteria without affecting the surrounding natural environment.

4. TESTS ON BACTERIAL BRICKS.:

The below tests are carried on bacterial bricks to make sure whether the brick is suitable for construction purpose. The various test conducted on bacterial bricks are as follows;

Absorption test
Crushing strength test
Hardness test
Shape and size test
Color test
Soundness test
Structure of bricks

Our bacterial brick satisfies the entire above test and it is further used for a construction purpose.

ABSORPTION TEST:

Table.2. Absorption test value of bacterial bricks

Weight of dry brick(W1)	*Weight of wet brick(W2)*	*Difference in weight(W2-W1)*
3.200 kg	*3.770 kg*	*0.570 kg*

CRUSHING STRENGTH TEST:

Table .3. Crushing strength value of bricks

Crushing strength value of normal brick(N/mm2)	*Crushing strength value of bacterial brick(N/mm2)*
3.5	*3.92*

Hardness test on bacterial bricks:

A good brick should resist scratches against sharp things. So, for this test a sharp tool or finger nail is used to make scratch on brick. If there is no scratch impression on brick then it is said to be hard brick. The bacterial brick is free from any scratches or impression, so it is fit for construction.

Soundness test on bacterial bricks:

Soundness test of bricks show the nature of brick against sudden impact. In this test, two bricks are chosen randomly and struck with one another. Then sound produced should be clear bell ringing sound and brick should not break. The bacterial brick satisfies the above condition and it does not break, therefore it can be used for construction purpose.

Color test of bacterial bricks:

A good brick should possess bright and uniform color throughout its body. The bacterial brick possesses bright and uniform color in its entire structure; hence it is fit for construction.

Structure of bacterial bricks:

A bacterial brick is picked randomly from a group of bricks and broken into two pieces. The inner portion of the brick is observed, if it is free from lumps and it remains homogeneous then it is said to be a good brick.

Figure .6. Well shaped bacterial brick

Shape and size test:
The standard normal size of the bacterial bricks is 19cm x 9cm x9cm. If all the bricks are of similar size then it is qualified for construction work.

ADVANTAGES OF BACTERIAL BRICKS:

- Color and texture of these bricks are uniform.
- These bricks are well suitable for multi storied buildings.
- On constructing in clay soils this bricks are more preferable.
- Bacterial brick provides more comfort and accessibility for architectural and aesthetic view of buildings.
- This brick have accurate size and shape with sharp edges.
- Solar heat effect is minimized on exposed walls made up of bacterial bricks.
- Colored bacterial bricks do not need any finish to the wall, so cost is reduced.
- These bricks have great water resistant and fire resistance properties.
- These bricks reduces noise from outside.
- Cost of construction is reduced.
- It does not affect the surrounding environment at any cause.

DISADVANTAGES OF BACTERIAL BRICKS:

- If clay is available in plenty in nature , then clay bricks are more economical than bacterial bricks.
- These bricks are not suitable for laying foundation, because they cannot act as a water repellent for a longer period.
- They are not suitable for building furnaces because they cannot bear fire for a longer period.
- The abrasion properties of this brick is very less and hence they cannot be used as a paving materials.

5. CONCLUSION:

This paper provides the way for manufacturing bricks using bacteria. Even though the bacteria can be used for many other purposes, now it is proved that it can be used in the field of civil engineering also for the manufacture of bricks. On making bacterial brick in large quantity we can eliminate the liberation of carbon dioxide content and thus prevent surrounding environment. This process also helps in controlling pollution from the environment.

6. REFERENCE:

[1]. K. D. Arunachalam, K. S. Sathyanarayanan, B. S. Darshan, and R. B. Raja, "Studies on the Characterization of Bio sealant properties of Bacillus sphaericus," International Journal of Engineering Science and Technology, vol.2, no.3, 2010, pp. 270– 277.

[2]. Annie Peter.J, Lakshmanan.N, Devadas Manoharan.P, Rajamane.N.P& Gopalakrishnan. S ―Flexural Behaviour of RC Beams Using Self Compacting Concrete. The Indian Concrete Journal, June 2004, PP 66- 72.

[3]. Benini S, Rypniewski W, Wilson KS, Miletti S, Ciurli S, Mangani S., "A new proposal for urease mechanism based on the crystal structures of the native and inhibited enzyme from Bacillus pasteurii: why urea hydrolysis costs two nickels." Structure7, 1999, pp.205-216.

[4]. Ghosh P, Mandal S, Chattopadhyay BD, Pal S.,"Use of microorganism to improve the strength ofcement mortar." Cement and Concrete Research 35, 2005, pp.1980-1983.

[5]. P. Tiano, L. Biagiotti, G. Mastromei, "Bacterial biomediated calcite precipitation for monumental stones conservation: methods of evaluation", Journal of Microbiological Methods, Vol.36, Issues 1–2,1999, pp.139 145. Seshagiri Rao M.V., Ch Sasikala V. and Srinivasa Reddy, "A Biological Approach To Enhance Strength

[6]. And Durability In Concrete" Structures, International Journal of Advances in Engineering and Technology (IJAET), Sept 2012 4(2), 392 -399 (2012).