Review Article Impact Factor: 4.226 ISSN: 2319-507X
Dharampalsingh Jhala, IJPRET, 2018; Volume 6 (7): 221-225 IJPRET

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

A PATH FOR HORIZING YOUR INNOVATIVE WORK

SPECIAL ISSUE FOR
NATIONAL LEVEL CONFERENCE
"Recent Trends and Development in Civil Engineering"

REVIEW ON EFFECT OF BACILLUS PASTUERII STRENGTHENING OF CRACKED CONCRETE

DHARAMPALSINGH JHALA[1], DHANRAJSINH VAGHELA[1], DARSHIL GONDALIYA[1], KAUSHAL RAVAL[2], ABHIJITSINH PARMAR[2]

1. U.G. Student, Department of Civil Engineering, SVBIT, Gandhinagar – 382650
2. Assistant Professor, Department of Civil Engg., S.V.B.I.T., Gandhinagar - 382650

Accepted Date: 27/01/2018; Published Date: 01/03/2018

Abstract: Cracks are the common type of failure in concrete which are irreversible in process [1, 2] Bacillus Pastuerii, Bacillus Cohni, Bacillus Sphearicus are common soil bacterium induce the precipitation of calcite exhibited its positive potential in selectively consolidating simulated fractures in the consolidation of sand. [1, 3, 4, 5] In this study we tried to find the effect of Bacillus Pastuerii on strengthening of cracked concrete. It was found that all the increase in depth of crack reduce the strength of cubes and beams.

Keywords: Bacterial Concrete, Self-Healing, Cracks, Concrete, Repair

Corresponding Author: DHARAMPALSINGH JHALA

PAPER-QR CODE

Access Online On:

www.ijpret.com

How to Cite This Article:

Dharampalsingh Jhala, IJPRET, 2018; Volume 6 (7): 221-225

INTRODUCTION

In concrete, cracking is a regular observable fact due to the comparatively low tensile strength. Many factors are affecting the durability and strength of concrete. High tensile stresses can result from external loads which lead to failure of concrete. Many methods and material are available in market to repair concrete cracks. But most of materials are not eco-friendly and cause environment pollution and due to these many are banned in many countries. Bacterial induced calcium precipitation type repairing technique is eco-friendly and has been proposed as an alternative and environmental friendly crack repair technique. B. Pastuerii produces urease, which catalyzes urea to produce CO_2 and ammonia, resulting in an increase of pH in the surroundings where ions Ca_2^+ and CO_3^{2-} precipitate as $CaCO_3$. Possible biochemical reactions in medium to precipitate $CaCO_3$ at the cell surface that provides a nucleation site. The microbial urease catalyzes the hydrolysis of urea into ammonium and carbonate.[9] One mole of urea is hydrolyzed intracellularly to 1 mol of ammonia and 1 mole of Carbamic acid (1), which spontaneously hydrolyzes to form an additional 1 mole of ammonia and carbonic acid (2).[3, 4, 5, 6, 7, 8, 9, 10]

$CO(NH_2)^2 + H_2O$ ---> $NH_2COOH + NH_3$ (1)
$NH_2COOH + H_2O$ ---> $NH_3 + H_2CO_3$ (2)

Ammonium and carbonic acid form bicarbonate and 2 moles of ammonium and hydroxide ions in water (3 &4).

$2NH_3 + 2H_2O$ <---> $2NH^{+4} + 2OH^-$ (3)
H_2CO_3 <---> $HCO^{-3} + H^+$ (4)

The production of hydroxide ions results in the increase of pH, which in turn can shift the bicarbonate equilibrium, resulting in the formation of carbonate ions (5)

$HCO^{-3} + H^+ + 2NH^{+4} + 2OH^-$ <---> $CO_3^{-2} + 2NH^{+4} + 2H_2O$ (5)

The produced carbonate ions precipitate in the presence of calcium ions as calcium carbonate crystals (6).

$Ca^{+2} + CO_3^{-2}$ <---> $CaCO_3$ (6)

The formation of a monolayer of calcite further increases the affinity of the bacteria to the soil surface, resulting in the production of multiple layers of calcite.

Bacteria such as Bacillus Pastuerii, Bacillus pseudofirmus, Bacillus cohnii, Sporosarcina Pastuerii, and Arthrobacter crystallopoietes increase the compression strength of concrete through their

biomass. Not all bacteria increase the strength of concrete significantly with their biomass [11]. Bacillus sp. CT-5. can reduce corrosion of reinforcement in reinforced concrete by up to four times. Sporosarcina Pastuerii reduces water and chloride permeability. B. Pastuerii increases resistance to acid [11].146 Bacillus Pastuerii and B. sphaericuscan induce calcium carbonate precipitation in the surface of cracks, adding compression strength.[11]

Literature Review

Abhijitsinh Parmar et. al. 2013, in this study a comparative study on effect of crack repair by different bacteria on compression, flexural and durability tested on mortar cubes and concrete beams. The effect of different depth of crack on the compression, flexural and durability of concrete was studied. It was found that all the increase in depth of crack reduce the strength of cubes and beams. And concluded that Cracked repaired by Bacillus Pastuerii gives more strength in compressive, flexural and durability test than repaired by Bacillus Sphericus [12].

Abhijitsinh Parmar et. al. 2013, a compression, flexural and durability tested on mortar cubes and concrete beams treated with bacteria were studied. The effect of different depth of crack on the compression, flexural and durability of concrete was studied. It was found that all the increase in depth of crack reduce the strength of cubes and beams. The experimental study on concrete beams shows that not much considerable improvement in flexural strength because of following reason:

- o At time of developing cracks due to continuous vibration of machine micro cracks has been developed in beams and just because of that reason at time of testing it may not have shown much improvement in flexural strength results.
- o The other reason is bond between calcite and concrete is not developed well in 56 days. It might take more than 6 month to create good bond between them [13].

Medapati Abhinav Reddy, 2016; This paper deals with the study of the different kinds of bacteria which are used in the bio-concrete and their effect on the strength parameters of the concrete like compressive strength and water absorption under the influence of the factors like bacterial cell concentration at different temperatures is explicitly studied. The most optium pH for the bacteria growth is 7.4. The maximum compressive strength attained by the cube containing bacillus sphaericus is 38.7 kN/mm2 at 105 cells/ml at 30ºC and bacillus cereus achieved 39.5 kN/mm2 at 106 cells/ml at 200ºC. The most resistance offered to the water absorption is bacillus sphaericus as its water absorption is only 1.2 Kg/m2 at 30ºC(105 cells/ml) and water absorption by bacillus sphaericus is least at 3.8 (106 cells/ml). Therefore it can be concluded that bacillus sphaericus can be used as in bacterial concrete at lower temperature and bacillus cereus can be used in bacterial concrete subjected to high temperature [14]
Vijeth N Kashyap & Radhakrishna, 2013; in this paper improvement of physical properties of cement paste, mortar and concrete are studied. It is done by the addition of bacterial strains namely Bacillus Sphaericus and Sporosarcina Pastuerii. It is found that these bacteria when

added at 10^6 concentration of cells/ml of water to cement composites increased by about 39.8% and 33.07% in paste. There is an increment of 50% and 28.2% in mortar for two bacterial strains. The strength increment is found to be 18.3% and 12.2% for Bacillus Sphaericus and Sporosarcina Pastuerii respectively for concrete. Ultrasonic pulse velocity of the bacterial concrete was in line with conventional concrete. SEM and XRD images revealed presence of CaCO3 produced microbially. There is overall improvement in the bacterial composites compared to conventional composites. The SEM and XRD analysis shows that the presence of calcite inside the cement composite specimens which are produced microbially. These microbes also increase the strength and durability of cement composites [15].

CONCLUSIONS

• From the study of various papers on Bacillus Pastuerii, concluded that Compression test and Flexural test on repaired cracked concrete with Bacillus type bacteria can be re-strengthen up to almost its original strength in case of smaller depth cracks. But in case of larger depth than 15 mm improvement in compressive strength reduces as the depth of crack increases. Because for calcite precipitation process Bacillus type bacteria needs more oxygen. Due to larger depth Bacteria didn't get enough amount of Oxygen from atmosphere.

• The use of this biological repair technique is highly desirable because the mineral precipitation induced as a result of microbial activities is pollution free and natural.

• Regain in compressive strength filled with bacteria and Fly Ash is comparatively less than results with cracked fill with bacteria and Ennore sand.

REFERENCES

1. Abhijitsinh Parmar, Ankit Patel, Priyank Shah, "IMPROVEMENT OF THE CONCRETE CRACKS BY USING BACILLUS SPHAERICUS", International Journal of Engineering Development and Research (IJEDR), ISSN:2321-9939, Volume.1, Issue 2, pp.82 - 84, Sept 2014

2. Abhijitsinh Parmar, Ankit Patel, Vismay Shah , Sandeep Khorasiya, Dipan Patel. (2013). "Improvement on the concrete cracks by using Bacillus pastuerii." International Journal for Scientific Research & Development (IJSRD) | Vol. 1, Issue 1, 2013

3. H.M.Jonkers, "Bacteria-Based Self Healing Concrete",vol .56, 2011, pp.1-12.

4. Henk Jonkers, "Development And Application Of Bacteria-Based Self-Healing Materials",2012

5. Srinivasa Reddy. V, Achyutha Satya.K, Seshagiri Rao .M. V, Azmatunnisa. M, "A Biological Approach To Enhance Strength And Durability In Concrete Structures", vol. 4, 2012, pp. 392-399.

6. Ramakrishnan, V., Bang, S.S., Ramesh, K.P., and Mulukutla, S., "Performance of Bacterial Cement", Proceedings of 24th International Conference of Cement Microscopy, San Diego, California, April 2002, pp. 336-354.

7. Ramakrishnan, V., Bang, S.S., Srinivasan Neelamegam., and Ramesh, K.P., "Durability of Cement Mortar Made With Different Concentrations of Bacteria", Proceedings of 25th International Conference of Cement Microscopy, Richmond, Virginia, April 2003.

8. Ramachandran, S.K., Ramakrishnan, V., and Bang, S.S., "Remediation of Concrete using Microorganisms", ACI Materials Journal, v.98, Jan-Feb 2001, No.1, pp. 3-9.
9. DeJong, J.T.; Fritzges, M.B.; Nüsslein, K. (2006). "Microbial Induced Cementation to Control Sand Response to Undrained Shear". Journal of Geotechnical and Geoenvironmental Engineering. 132 (11): 1381–1392
10. DeJong, J.T.; Morenson, B.M.; Martinez, B.C.; Nelson, D.C. (2010). "Bio-mediated soil improvement". Ecol. Eng. 36 (2): 197–210.
11. Navdeep Kaur Dhami; Sudhakara M. Reddy; Abhijit Mukherjee (2012). "Biofilm and Microbial Applications in Biomineralized Concrete". Archived from the original on 19 December 2013.
12. Abhijitsinh Parmar, Ankit Patel, Parin Patel, Harshad Patel, Harsh Patel, "Comparitive study on Improvement on the Concrete Cracks by using Bacillus Pastuerii and Bacillus Sphaericus", IJSRD - International Journal for Scientific Research & Development, Vol. 1, Issue 8, 2013.
13. Abhijitsinh Parmar, Ankit Patel, Vismay Shah, Sandeep Khorasiya, Dipan Patel, "Improvement on the concrete cracks by using Bacillus pastueri", International Journal for Scientific Research & Development (IJSRD), Vol. 1, Issue 1, 2013.
14. Medapati Abhinav Reddy, "Temperature Effect on Various Bacteria Used in Microbial Concrete", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 4, April 2016.
15. Vijeth N Kashyap, Radhakrishna," A STUDY ON EFFECT OF BACTERIA ON CEMENT COMPOSITES", International Journal of Research in Engineering and Technology, November – 2013.