International Journal of Psychosocial Rehabilitation, Vol. 23, Issue 04, 2019
ISSN: 1475-7192

# A Comparative Study on Repairing of Binding Material Discontinuity Using Cultured Bacterial Compounds

M.K. Kamalakkannan, N. Atthikumaran, V. Aravind and
P.B. Narandiran

***Abstract---*** *The reality of the exploration work to define a special method of Binding Material in which included bacteria adopt Automatic-Repair of discontinuity. Modern Binding Material does commonly have few self-repairing ability which is due to more non-heated Adhesive material contents present in the binding matrix. These materials will undergo another hydration by discontinuity increases liquid resulting in made of new hydration materials which can cover or heal minor racks.. In this experiment we formed a bi-component auto-healing system which is made of bacterial spores which forms the metabolic conversion of natural spores to form calcium. This components stirred with the new Adhesive material Binding Material paste, that becomes an major part of the Binding Material. The research works shows the passing of water through freshly formed discontinuity activate present bacterial spores through diabolic activity of bacterial compounds make more amounts of calcium. The new biological -based bi-component material may shows a advanced class of Auto-healing process which can be used to binding material-based systems. The Auto-healing capacity of system is currently being qualified progress in a calculation of the raw products & durability of structure improves.*

***Keywords---*** *Self Healing, Bacterial Binding Material, Calcium, Bacillus Subtilus, Calcium Carbonate.*

## I. INTRODUCTION

Binding Material can be used as a kind of materials with the Characteristics same to that of rocks. The Binding Material as we know that is good in expansion but week in expansion. Many of the discontinuity which forms suddenly is due to tension. Discontinuity failure can form at any step of its stage cycle and almost start internally where they cannot be seen for more years until major rehabilitation revoke are needed. Destruction is caused by freeze/thaw cycles, corrosion, extreme loads, chemical attacks and other environmental conditions. Likewise, repair work to Binding Material structures is frequent and costly. Millions of amount is spent every year on construction. The production of Binding Material is an energy pensive process when mining, transportation and processing is considered. Its production level lies more than 2.35 billion metric tons per year and contributes an 10% of $CO_2$ emissions into the atmosphere. Here the self healing would enables the fewer repairs works or even failure of a structure through which the production level can even be decreased along with the reduced $CO_2$ emission.

*M.K. Kamalakkannan, Assistant Professor, Department of Civil Engineering, Nandha College of Technology, Erode, Anna University, Chennai, Tamil Nadu, India. E-mail: cdkk1991@gmail.com*

*N. Atthikumaran, Assistant Professor, Department of Civil Engineering, Nandha College of Technology, Erode, Anna University, Chennai, Tamil Nadu, India. E-mail: atthicivil@gmail.com*

*V. Aravind, Assistant Professor, Department of Civil Engineering, Nandha College of Technology, Erode, Anna University, Chennai, Tamil Nadu, India. E-mail: aravind.civil@ymail.com*

*P.B. Narandiran, Assistant Professor, Department of Civil Engineering, Nandha College of Technology, Erode, Anna University, Chennai, Tamil Nadu, India. E-mail: narandiran@gmail.com*

**Received: 16 Sept 2019 | Revised: 18 Oct 2019 | Accepted: 15 Nov 2019** 

## II. WORKING PROCESS OF SELF-HEALING USING BACTERIA

The microorganism used for manufacturing of microbial Binding Material should able to possess long-term effective discontinuity sealing during its lifetime serviceability. The principle behind bacterial discontinuity healing mechanism that the bacteria should able to transform soluble organic nutrients into insoluble inorganic calcium crystals which seals the discontinuity.

For effective discontinuity healing, both bacteria and nutrients incorporated into Binding Material should not di durb the integrity of Adhesive material sand matrix and also should not negatively affect other important fresh and hardened properties of Binding Material.

Only spore-forming gram positive strain bacteria can survive in high pH environment of Binding Material sustaining various stresses. It was reported that when bacteria is added directly to the Binding Material mix in suspension, their life-time limited due to two reasons; one Indian Adhesive material hydration resulting in reduction of Adhesive material sand matrix pore -diameter and other is due to insufficient nutrients to precipitate calcium crystals. However, a novel method of protecting the bacterial spores by immobilization before addition to the Binding Material mixture appeared to substantially prolong their life-time

## III. BACILLUS SUBTILUS

This strain isolated from soil has characteristics of high level urease activity, incessant precipitation of dense insoluble calcium crystals and has high negative zeta-potential. Potential applications of biological mineral precipitation are wide such as in sand consolidation and stabilization, remediation of discontinuity in Binding Material, preservation and restoration of historic heritage structures, areas where it is not possible to shut down the plant or hazardous for human beings to reach for repair work such as nuclear power plants, repair of waste water sewage pipes etc. These are the most bacteria to use for self healing purposes since these are alkalliphillic spore forming bacteria. The bacteria, from the genus Bacillus subtilus adopted for present study. The bacteria is cultured in the broth medium of artificial broth extract.

## IV. MATERIALS USED

The materials used or the making of Binding Material is described below:

Adhesive material of ordinary Portland cement of 33 grades is used in the investigation. The Adhesive material is tested for different proportions as per the INDIAN STANDARD: 4031 – 1988 and found to be confirm to different properties of INDIAN STANDARD: 12269 – 1987 having specific gravity 4.0.

**Sand** locally available pure, more graded, manufactured sand having fines of 2.85 conforming INDIAN STANDARD: 383 – 1970 was used as the fine aggregate. **Coarse Aggregate** crushed angular aggregate of size 20 mm nominal size from the local source with specific gravity of 2.7 was used as coarse aggregate.

Locally available liqiud water confirmed to Indian standard456 Indian standard used.

**Microbes** Bacillus subtilus, a model.

**Received: 16 Sept 2019 | Revised: 18 Oct 2019 | Accepted: 15 Nov 2019** 

Available bacteria which is collected and matured at (Nandha Arts and Science College, Erode) Biotechnology Lab was pre owned at a total power of combination of $10^{7}$,10cells per ml by more dilution.

## V. RESULTS AND DINDIAN STANDARD CUSSION

The Responsive frame of the normal moulds are (15cm x 15cm x 15cm) of fill and un fill of Bacterial compounds were make and flexural members size of(120x150x180mm) were checked as per the Indian standard code of practice. Many Specimens were checked for the Extension Extension and the flexural members are waiting for the healing process i.e. the self repairing process by calcium precipitate formation. The normal finish of the Extension strength are shown in Table 1. The improved in the extension of strength in bacterial compound included specimen is close 20.3% as shown in table 2 than the normal specimens. For the discontinuity repair study the bacterial compound induced specimen is make to establish a first discontinuity by applying a loading and then the discontinuity process is analyzed by sending the Excess liquid and atmosphere air to flow by the developed discontinuity. This approach shows that the discontinuity is rebuild to some level by means of the calcium film formed, i.e. microbiologically induced calcium precipitation. The table 1& 2 show the Extension strengths of Binding Material specimen and percentage improve within the normal days. Fig shows the comparable real's of expansion strengths of Binding Material.

Table 1: Reflex of Bacillus subtilus bacteria

| Type of Specimen | Expansion Strength of specimens ($N/mm^2$) | | |
|---|---|---|---|
| | 7 days of curing | 14 days of curing | 28 days of curing |
| Normal Specimen | 16.12 | 23.94 | 29.25 |
| Bacterial specimen | 18.05 | 28.78 | 46.78 |

Figure 1: Correlation of durability

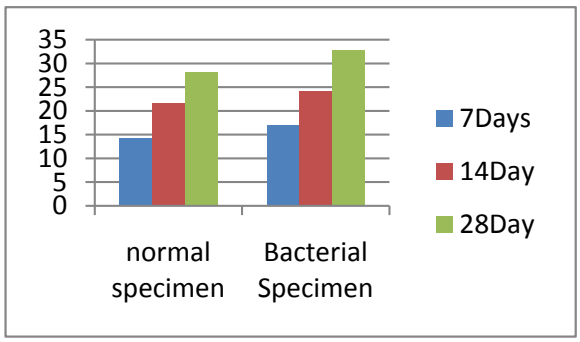


Figure 2: Reflex of Bacillus subtilus bacteria

Table 2: Reflex of Bacillus subtilus bacteria

| Expansion Strength of specimen ($N/mm^2$) | | |
|---|---|---|
| 7 days | 14 days | 28 days |
| 20.95 % | 15.57 % | 14.61 % |

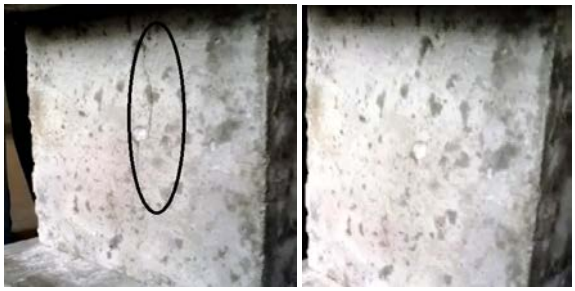

Figure 3: Discontinuity specimen

Discontinuity (left) & un continuity Specimen (right)

The discontinuity is framed by assign a load of $32N/mm^2$ and the initial discontinuity are creating and the specimen is allowed for curing. After 28 days of curing the discontinuity in the specimen was completely rebuild by the Micro organisms.

## VI. CONCLUSION

Healing of Binding Material by means of using bacteria is activated during the curing process. The Binding Material discontinuities are rebuilt by means of using Bacillus subtilus with improves in Extension strength of Binding Material. The bacillus subtilus bacteria show more Extension strength than the normal Binding Material.

## REFERENCES

[1] Alanthur. P.B. Narandiran, S. Radhamani,V. Mannikakumar, Sarany. M,G. Sridhar, Design of sewage treatment plant with experimental investigation and analyze of waste waterat).

[2] De Muynck W., Cox K., De Belie N. and Verstraete W. Bacterial carbonate precipitation as an alternative surface treatment for Binding Material, Constar Build Mater, 22, 875 -885 (2008)

[3] Jonkers H.M., Self healing Binding Material: A biological approach. In Self healing materials – An alternative approach to 20 centuries of materials science (ed. S. van der Zwaag), 195– 204 (2007) Springer, the Netherlands

[4] M.Dhaarani "Durability studies on Bacterial concrete.

[5] Nandagopal S., Arunachalam V.P., Karthik S."A novel approach for inter-transaction association rule mining, *Journal of Applied Sciences Research* VOL, 8, Issue 7, 2012.

[6] Kannan R., Selvambikai M., Jeena Rajathy I., Ananthi S. Rasayan, A study on structural analysis of electroplated Nano crystalline nickel based thin films, *Journal of Chemistry*, Vol 10, issue 4, 2017.

[7] Arunvivek G.K., Maheswaran G., Senthil Kumar S., Senthilkumar M., Bragadeeswaran T. Experimental study on influence of recycled fresh concrete waste coarse aggregate on properties of concrete. *International Journal of Applied Engineering Research*, Vol 10, issue 11, 2015

[8] Krishna S.K., Sathya M. Usage of nanoparticle as adsorbent in adsorption process. *A review International Journal of Applied Chemistry*, vol 11, Issue 2, 2015.

[9] Sudha S., Manimegalai B., Thirumoorthy P. A study on routing approach for in-network aggregation in wireless sensor networks, *International Conference on Computer Communication and Informatics: Ushering in Technologies of Tomorrow, Today, ICCCI* 2014.

[10] Satheesh A., Jeyageetha V. Improving power system stability with facts controller using certain intelligent techniques, *International Journal of Applied Engineering Research*, Vol 9, no 23, 2014.

[11] Ashok V., Kumar N, Determination of blood glucose concentration by using wavelet transform and neural networks, *Iranian Journal of Medical Sciences*, Vol 38, Issue 1, 2013.

[12] Somasundaram K., Saritha S., Ramesh K, Enhancement of network lifetime by improving the leach protocol for large scale WSN, *Indian Journal of Science and Technology*, Vol 9, Issue 16, 2016.

[13] Jayavel S., Arumugam S., Singh B., Pandey P., Giri A., Sharma A. Use of Artificial Intelligence in automation of sequential steps of software development / production, *Journal of Theoretical and Applied Information Technology*, Vol 57, Issue 3, 2013.

[14] Ramesh Kumar K.A., Balamurugan K., Gnanaraj D., Ilangovan S, Investigations on the effect of flyash on the SiC reinforced aluminium metal matrix composites, *Advanced Composites Letters*, Vol 23, Issue 3, 2014.

[15] Suresh V.M., Karthikeswaran D., Sudha V.M., Murali Chandraseker D, Web server load balancing using SSL back-end forwarding method. *IEEE-International Conference on Advances in Engineering, Science and Management, ICAESM-2012*, 2012.

[16] Karthikeswaran D., Sudha V.M., Suresh V.M., Javed Sultan A, A pattern based framework for privacy preservation through association rule mining, *IEEE-International Conference on Advances in Engineering, Science and Management, ICAESM-2012*, 2012.

[17] Senthil J., Arumugam S., Shah P, Real time automatic code generation using generative programming paradigm, *European Journal of Scientific Research*, vol. 78, issue 4, 2012.

[18] Vijayakumar J., Arumugam S, Certain investigations on foot rot disease for betelvine plants using digital imaging technique, *Proceedings - 2013 International Conference on Emerging Trends in Communication, Control, Signal Processing and Computing Applications, IEEE-C2SPCA*", 2013.

[19] Vijayakumar J., Arumugam S. Odium piperis fungus identification for piper betel plants using digital image processing, *Journal of Theoretical and Applied Information Technology*, vol 60, issue 2, 2014.

[20] Manchula A., Arumugam S, Face and fingerprint biometric fusion: Multimodal feature template matching algorithm, *International Journal of Applied Engineering Research*, vol 9, issue 22, 2014.

[21] Ramesh Kumar K.A., Balamurugan K., Arungalai Vendan S., Bensam Raj J, Investigations on thermal properties, stress and deformation of Al/SiC metal matrix composite based on finite element method. Carbon - Science and Technology, Vol 6, Issue 3, 2014.

[22] Kanchana A., Arumugam S, Palm print texture recognition using connected-section morphological segmentation, *Asian Journal of Information Technology* Vol 6, Issue 3, 2014.

[23] Padmapriya R., Thangavelu P, Characterization of nearly open sets using fuzzy sets, *Global Journal of Pure and Applied Mathematics*, vol 11, issue 1, 2015.

[24] P.B. Narandiran, T. Bragadeeswaran, M. Kamalakannan, V. Aravind, Manufacture of Flyash Brick Using Steel Slag and Tapioca Powder. *Jour of Adv Research in Dynamical & Control Systems*, Vol. 10, No. 12, 2018, 527-532

[25] R. Girimurugan*, N. Senniangiri, K. Adithya, B. Velliyangiri, Mechanical Behaviour of Coconut Shell Powder Granule Reinforced Epoxy Resin Matrix Bio Composites, J*our of Adv Research in Dynamical & Control Systems*, Vol. 10, No. 12, 2018, 533-541.