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Investigation of Bacterial Activity on Compressive Strength of Cement Concrete

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Abstract:
The application of concrete is rapidly increasing worldwide and therefore the development of sustainable concrete is urgently needed for environmental reasons. As present, about 7% of the total atmospheric carbon-dioxide (CO2) emission is due to cement production and its mechanisms that would contribute to a longer service life of concrete structures and it makes the material not only more durable but also sustainable. Cracks are common failures in concrete. Cracks may develop due to addition of excess of water during mixing of concrete, or may be due to shrinkage or creep. In this paper, the following notable points regarding development of a two component self-healing system, characterization studies done with different bacterial species, variation in compressive strength of concrete upon bacterial cell concentrations, physical properties of self-healing concrete, potential of bacteria to act as a self-healing agent etc., are observed and identified from the other research works. A specific group of alkali-resistant spore forming bacteria preferably of genus Bacillus are selected and added to concrete or mortar paste for development of self-healing capacity in structures.

Keywords: Crack remediation, Characterization Studies, Compressive strength, Spore formation

1. INTRODUCTION

Concrete is a strong and relatively cheap construction material and is therefore presently the most used construction material worldwide. Though concrete has a massive production, it exerts a negative effect on the environment. It is estimated that cement production alone contributes to about 7% of global anthropogenic CO2 emissions [2]. In the construction sector, concrete is considered as one of the most important building materials around the world. Advancement in concrete technology is in its strength improvement and its enhancement in durability, using pollution-free and natural methods. This needs to be taken care of at the design stage itself. Autogenous crack-healing capacity of concrete has been recognized in several recent studies. Mainly micro cracks with widths typically in the range of 0.05 to 0.1 mm have been observed to become completely sealed particularly under repetitive dry/wet cycles. The mechanism of this autogenous healing is chiefly due to secondary hydration of non- or partially reacted cement particles present in the concrete matrix. The development of a self-healing mechanism in concrete that is based on a potentially cheaper and more sustainable material then cement could thus be beneficial for both economy and environment. The main goal of the present research therefore was to develop a type of sustainable self-healing concrete using a sustainable self-healing agent. It was reported that the effect of bio-deposition improves the durability of cement mortar/concrete specimens. It was also observed that deposition of CaCO3 crystals decreased the water absorption of the sample depending on the inherent porosity of the specimen leading to a decrease in the carbonation rate by about 25–30%. Cracking of concrete is a common phenomenon. Without immediate and proper treatments, cracks in concrete structures tend to expand further and eventually require costly repair. Though it is possible to reduce the extent of cracking by available modern technology, crack remediation is still being under research. Use of bacteria in concrete remediation is an unorthodox concept in current concrete research. It is however, a new approach to an old idea that a microbial mineral deposit constantly occurs in natural environment. The long term goal is to understand the significance of micro-organisms in concrete structures. Therefore, bacterially induced calcium carbonate precipitation has been proposed as an alternative and environmental friendly crack repair technique. An integrated healing agent will save manual inspection and repair and moreover increases the structure’s durability. Addition of such an agent to the concrete mixture would save money and environment.

2. METHODOLOGY

2.1 Selection of Bacterial Species

Spore forming alkali-resistant bacteria can be isolated from its source. Bacterial strains such as *Bacillus sphaericus, Bacillus cereus* etc., are used for research works. Initially these bacteria are obtained from the source and first cultured in a solid media and then transferred to nutrient broth (liquid media) which is sterile and kept shaking in an incubator. Solid bacterial media found from NATIONAL CHEMICAL LABORATORY (NCL) PUNE.

Figure.1.Bacterial sample

2.2 Preparation of Bacterial Solution

Primarily 12.5g of Nutrient broth (media) is added to a 500ml conical flask containing distilled water. It is then covered with a thick cotton plug and is made air tight with paper and rubber band. It is then sterilized using a cooker for about 10-20 minutes. Now the solution is free from any contaminants and the solution is clear orange in colour before the addition of the bacteria.

Figure.2. Solution without bacteria

Later the flasks are opened up and an exactly 1ml of the bacterium is added to the sterilized flask and is kept in a shaker at a speed of 150-200 rpm overnight. After 24 hours the bacterial solution was found to be whitish yellow turbid solution.

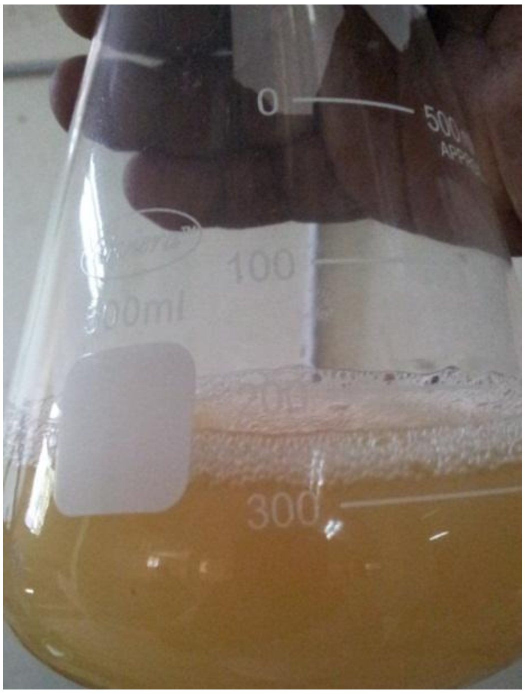

Figure.3. Solution with bacteria

The Sequence of procedure adopted in mixing of mortar and additive rate for bacteria are provided as follows:

1. Materials (cement and sand) are dry mixed for first 30 seconds at very slow speed to ensure homogeneous mixing of cement and sand.
2. Then, 80% of the total bacterial culture required to get adequate consistency is added and mixed thoroughly for 60 seconds at medium speed.
3. After that, mixer is stopped and sides of mixer basin are scrapped and again mixed or 30 seconds.
4. Then, remaining 20% of bacterial culture is added and mixing is continued for another 60 seconds and finally, the paste is mixed for 30 seconds at higher speed before poured in the respective moulds.

Three numbers of cubes each for 7, 14 and 28 days of curing are cast towards compressive strength studies.

3. RESULTS

The test results showed a significant difference in the specimens tested, with and without bacteria. Here are the following tables and charts which will give clear information about the compression strength test results of Bacillus spharicus and Bacillus cereus.

Table.1. For Bacillus spharicus

Sr.No.	Days	Normal concrete(N/mm2)	Bacterial concrete(N/mm2)
1	7	20.90	27.09
2	14	27.36	35.13
3	28	29.84	38.94

Table.2. For Bacillus cereus

Sr.No.	Days	Normal concrete(N/mm2)	Bacterial concrete(N/mm2)
1	7	20.90	26.83
2	14	27.36	34.32
3	28	29.84	38.02

4. CONCLUSIONS

The bacterial activity in the presence of two different types of nutrients have been studied with two different concentrations of bacterial cells.

The following conclusions are made.

1. 1.Supply of nutrients play a significant role in the bacterial activity in cement mortar

2. .It is understood that waste water rich in organic sources supply sufficient nutrients for the survival of bacteria. From the results obtained with and without bacterial concentrations in cement mortar cured in water, it is revealed

that the incorporated bacteria is playing a major role in strength improvement

3. The non uniformity of the strength gain over the period indicates that bacterial activity is highly dependent on the period of curing.

5. REFERENCES

[1]. Abo-El-Enein, S., A.H.Ali, Talkhan, F. N. and Abdel-Gawwad, H. (2013). “Application of microbial bio-cementation to improve the physico-mechanical properties of cement mortar.” Housing and Building National Research Center, 9, 36-40.

[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]. Achal, V., Mukherjee, A., Basu, P. C., and Reddy, M. S. (2009). “Strain improvement of sporosarcina pasteurii for enhanced urease and calcite production.” Journal of industrial Microbiology and Biotechnology, 36, 981-988.

[4].V. Achal; A. Mukherjee; and M. S. Reddy. 2010. Microbial Concrete: A way to enhance the Durability of Building Structures. J. Materials for Civil Engg.

[5]. Bureau of Indian Standards, (1959). “Indian standard code of practice methods of test for strength of concrete.” IS 516-1959, New Delhi, India.

[6]. Ramachandran, S. K., Ramakrishnan, V., and Bang, S. S. (2001). “Remediation of concrete using microorganisms” American Concrete Institute Materials J., 98, 3-9.