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REVIEW ON SELF-HEALING CONCRETE BY ADDING PSEUDOMONAS FLUORESCENS BACTERIA

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ABSTRACT— concrete is most commonly used building material. Cracks in concrete are the main reason to structural failure. Cracks are occurred due to various activities such as shrinkage, mechanical compressive and tensile forces etc. The present study is to obtain performance of concrete by microbial activities. It is the development of very special concrete which is known as bacterial concrete where bacteria is introduce in concrete to heal the cracks developed in it.

The present study is about the pseudomonas fluorescens bacteria which is capable of healing up the cracks developed in concrete. The optimal temperature and optimal dosage required to growth of bacteria are studied in this study.

Keyword- Pseudomonas fluorescens, Microbial concrete, Self-healing concrete, concrete, bacteria used in concrete

I. INTRODUCTION

1.1 General

Now-a-days concrete is very essential material which is used for construction work. The positive impact of using concrete in construction is its ability to resist the compression load or stress of structure up to 50-100 years but it has negative impact too. Concrete is weak in resisting the tensile stress of structure. So when this tensile stress exceeds its limit, cracks are developed in concrete structure. Due to these cracks, strength of concrete reduces and it results in failure of structure.

To counteract this phenomenon, various methods were adopted by the researchers in whole world. From that, some methods are very useful for the future development in concrete i.e. self-healing of concrete, the concrete which heals automatically by its own. To make this self-healing concrete different materials are used which were never used before.

Recently it has been found that, to make self-healing concrete the various types of bacteria can be used. Our study is about bio concrete in which the pseudomonas fluorescens is mixed in concrete to heal the cracks developed in concrete.

Self-healing is the phenomenon in which the cracks heals due to the precipitation of calcium carbonate which is spread by bacteria. When crack develops, the bacteria come in contact with air and water and it activated due to surrounding atmospheric condition. Bacteria spread on the surface of crack and fill the crack by calcium carbonate which is excrete by bacteria.

1.2 Introduction of bacteria

To made this concrete self-heal we need to add the bacteria such as Pseudomonas fluorescens, bacillus subtilis and E-coli which are non-pathogenic bacteria. This bacteria are non-host based bacteria and they are capable of multiplying and recharged to be refilled within concrete.

Pseudomonas fluorescens are rod shaped bacilli and gram negative bacteria. The temperature required for their growth is 30-37oC. For this bacterium growth, the strains of bacteria should keep in agar solution for 72 hours.

Group	Species
Pseudomonas Group	Pseudomonas azotoformance
	Pseudomonas brenneri
	Pseudomonas cedrina
	Pseudomonas fluorescens
	Pseudomonas fragi
	Pseudomonas poae
	Pseudomonas gesardii

The bacteria are available in solid as well as liquid state too. For making solid bacteria, organic matter should mix with liquid bacteria and make small balls of them and add it in concrete during casting.

Fig. 1 Pseudomonas Fluorescens

1.3 Objectives

1. To increase the service time and durability of concrete.
2. To reduce the crack width widening in concrete
3. structure.
4. To reduce maintenance cost of structure.
5. To determine the optimal dosage of bacteria requires to heal the crack.
6. To increase the strength parameters such as
7. compressive strength, flexural strength.

II. MATERIALS AND METHODOLOGY

2.1 Material

2.1.1 Cement

As per standard requirement, ordinary portland cement of 53 grade is considered for mix design of concrete.

2.1.2 Water

Locally available potable water is used for mixing of concrete.

2.1.3 Fine Aggregate

As per standard requirement, Natural sand is used as fine aggregate for entire mixing work.

2.1.4 Coarse Aggregate

As per standard requirement, crushed granite stone of size 20 mm are used.

2.1.5 Bacteria

The bacteria used for self-healing of concrete are pseudomonas fluorescens. Bacteria is added in concrete with different percentage such as 1% to 5% of cement mass.

2.2 Methodology

2.2.1 Culturing of Bacteria

The pure culture is maintained on nutrient agar slant. The strains of bacteria are kept in liquid solution for the growth of bacteria. The bacteria kept for 72 hours in laboratory and then it stored in seal packed bottles.
These bottles prevent the bacteria from direct contact with sunlight. The bacteria are kept in 30-37oC temperature to survive easily.

Fig. 2 Storage Bottles

3 Culturing of bacteria

2.2.2 Methods of mixing bacteria in concrete

There are different types of method which can be used for adding bacteria in concrete i.e. i) The bacteria is directly added in concrete ii) Bacteria mixed with organic matter and then small balls of organic matter which are mixed with bacteria, they are added in concrete iii) The encapsulation method in which the bacteria are fill in capsules and then capsules are mixed with concrete iv) The bacteria is injected or directly sprayed in the crack or surface of the crack after crack develops in concrete structure.

2.2.3 Cube Casting

The concrete used for this work is M25 grade concrete. The concrete cubes having size 150mmX150mmX150mm are casted as per bacteria proportion in it and then they are compared with conventional concrete in which no bacteria were added.

2.2.4 Curing of Cubes

After 24 hours, the cubes are kept for curing in clean fresh water in curing tank.

Fig. 4 Curing of Cubes

2.2.5 Testing of Cubes

The cubes are tested on 7, 14 and 28 days for the compressive strength. After that the cubes in which bacteria are introduced they are again submerged in water for curing and to check the formation of calcite precipitation on surface of cubes after some period of time.

2.2.6 Analysis of Self-healing concrete

After some weeks, the cracks are filled by the calcium carbonate which is generated due to bacterial activities.

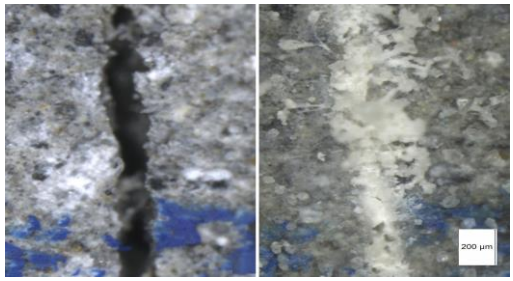

Fig. 5 Precipitation of Calcite

III. LITERATURE REVIEW

Varenyam Achal, Abhijeet Mukherjee and M.Sudhakara Reddy have studied the bacillus subtilis CT-5 bacteria in their study. The study has identified the positive effect of bacillus CT-5 on compressive strength of cement mortar cubes and it increased the strength of concrete. The results showed 36% increase in compressive strength of cement mortar cubes.

Awolusi T.F., Akinkurolere O.O., Oke O.L. have studied the optimum value for w/c ratio and bacterial medium for constitution of concrete and they were found to be 0.50 and 20 % respectively. They replaced the sand by using laterite but the negative trend is observed from it. In this work, Taguchi's approach of experimental design was adopted in order to reduce the number of trials required to gather necessary data.

Pradeepkumar A., Akila Devi, Anestraj S., Santoshkumar A. have studied the bacillus subtilis bacteria which is added in M20 grade concrete. The experiment results in increase of compressive strength of concrete when 30 ml of bacteria is added in concrete. The strength of M20 grade concrete results came equals to M25 grade concrete. In this study, the main focus was on how right condition can be created for bacteria not only to survive in concrete but to produce as much calcite as needed to repairs cracks.

S. kavitha and A. Aswin kumar have found that the self-healing can only occur for cracks smaller than 0.2 mm. In their study, they use pseudomonas fluorescens, bacillus subtilis and E-coli with 1 % to 5% in M30 grade of concrete. A significant increase in strength was observed due to addition of bacteria in this study.

Virginie Wikator, Henk M. Jonkers have studied O2 consumption held by bacteria. The main aim of study was quantify the cracks healing potential of specific and novel two component bio chemical self-healing agent embedded in porous expanded clay particles, which acts as reservoir particles and replace part of regular concrete aggregate.

IV. CONCLUSION

From above studies done by researchers finally we conclude that the self-healing of concrete can be done by pseudomonas fluorescens bacteria.

The strength and durability is increases due to the addition of bacteria. The ability of bacteria to heal the crack is fulfilling by pseudomonas fluorescens bacteria.

The compressive strength is increased with maximum percentage due to pseudomonas fluorescens bacteria as compared to other bacteria added in concrete. Hence pseudomonas fluorescens bacteria are preferable.

V. FUTURE SCOPE

From the conclusion, we know this addition of bacteria results in major development of concrete work. Due to this initial cost of construction is increases in some amount but it reduces the maintenance cost of structure and also it results in longer durability of structure which will be main viewpoint in upcoming construction work.

REFERENCES

1. Varenyam Achal, Abhijeet Mukherjee, M. Sudhakara Reddy "Microbial concrete: A way to enhance durability of building structure" [June 2010]
2. Awolusi T.F., Akinkurolere O.O., Oke O.L. Laboratory investigation on short term Compressive strength of laterized concrete" Civil Engineering and Architecture, 2013
3. Pradeepkumar A., Akila Devi, Anestraj S., Arun S., Santoshkumar A. "An experimental work on concrete by adding bacillus subtilis" International Journal of Emerging Technologies and engineering Volume 02, Issue 4) [April 2015]
4. S. Kavitha, A. Aswin Kumar "Experimental study on behavior of self-healing concrete" International journal of modern trend in Engineering and research (volume 04, Issue 8) [August 2017]

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