Experimental Study On Compressive Strength Of Self Healing Concrete With Different Proportion Of Bacteria

Rajput shivam R.Singh[1], Vipul M. Parjapati[2], Nishant Kotiya[3]
[1, 2, 3] Dept OF Civil Engineering
[1, 2, 3]alpha College Of Engineering And Technology

Abstract- *Nowadays large number of development occurred in the field of concrete technology. Many scientists and researcher have been developed several techniques to improve strength parameter of the concrete. The use of bacteria in the production of concrete can results in major saving if energy and cost. It also helps to improve strength, durability and chemical resistance of concrete.*

The present study investigates the effect of bacteria on the strength of concrete. Total 9 no. of cubes of 150 X 150 X 150 mm size shall be cast, 3 for 7 days testing, 3 for 14 days testing, 3 for 28 days testing. The main aim of the project is to find out the strength in comparison with conventional and bio concrete cubes. The results suggest that there is significant increase in the strength of concrete. The method is applicable due to various facts like it is pollution free and natural.

Keywords- Bacillus Sphaericus, Bacillus Pasteurii, compressive strength, crack,

I. INTRODUCTION

Nowadays, cracking is common phenomenon due to low tensile strength if the proper treatment is not applied on the structure than it tends to expand further and eventually require costly repair. Henk Jonker and his microbiology researches group invented a special type of concrete. Other names of self healing concrete are:-

1. Bio concrete.
2. Bacterial concrete.

Lifespan and durability of concrete structure can also be increased by using the self healing concrete in the structure. The production of Portland cement is not only costly and energy intensive, but it also produces large amount of carbon emission and use of self-healing concrete will reduce this problem. The advantages of using self-healing concrete will increases the compressive strength. We can use self-healing concrete in Air craft run way, Bridges and Dams reducing the maintenance cost.

II. EXPERIMENT PROCEDURE

2.1 Materials and Moulds Used:

The following materials and moulds size was used for our experiment are there:

1. Cement:

Cement-Ordinary Portland cement of 53 Grade (JK Lakshmi) available in local market is used in this investigation. The cement used has been tested for various properties as per IS: 4031-1988 and found to be confirming to various specifications of IS: 12269-1987 having specific gravity of 3.0 and the consistency of cement is found out to be 33%. River sand is used in our project.

2. Sand:

In our investigation we have used the Gujarat sand confirming the zone III according to IS-383.Specific gravity of sand was found out to be 2.60 and water absorption of sand is 0.237.

3. Coarse Aggregate:

The coarse aggregate is strongest, hardest, toughest and porous component of concrete. Presence of coarse aggregate reduces the drying shrinkage and increases the strength other dimensional changes occurring on account of movement of moisture. In our investigation we had used the aggregate passing through 20mm IS-Sieve and retaining on 10mm sieve. The specific gravity of aggregate was found out to be 2.50. The water absorption of sand is 0.2. We use broken stone of granite in our project.

4. Water:

Locally available portable water confirming to IS 456 is used. Water used shall be clean and reasonably free from various quantities of deleterious material such as oil, alkalines, salts and vegetable growth. We used portable water.

5. Bacteria:

There are various types of Bacteria's that can be used in the concrete of bacillus group such as B. Subtilis, B. Pasteurii, B. Sphaericus etc. We have selected Bacillus Sphaericus (for surface treatment) and Bacillus Pasteurii (crack healer) since these bacteria produces Calcium Carbonate and due to ease of availability from the nearest laboratory, we have used it for our investigation. It is also formally known as Hay bacillus or grass bacillus is a Gram-positive, catalane-positive bacterium, found in soil and many more places the gastrointestinal tract of ruminants and humans.

FIG.1 BACILLUS SPHAERICUS AND BACILLUS PASTEURII

6. Cube Moulds:

The cube Moulds (150mm X 150mm X 150mm) was placed in position on an even surface. All the interior faces and sides were coated with mud oil to prevent the sticking of concrete to the Moulds and also it is easy to remould after the hardy of concrete.

2.2Safety measures for the Bacterial solution

Bacteria are harmful for the health and it may lead to diseases like(diarrhea and headache), therefore precautions must be taken. It is compulsory to use gloves and covered your month while dealing with the bacterial solution. The flask must be slightly heated before pouring the bacterial solution. The whole procedure must be done between the two candles so that the bacterium doesn't get contaminated and polluted by the interference of the other bacteria's present in the environment.

2.3 Proportions of Bacteria in Self-healing Concrete:

For the proportion of bacteria in self-healing concrete, first we have prepared mortar cubes of moulds size 70mm X 70mm X 70mm with different proportion of bacteria like 5ml, 10ml, 15ml, 20ml, and 25ml in it for healing purpose. And found that we are getting better results in 5ml proportion of bacteria in mortar cubes. According to cement content from self healing mortar to self healing concrete the proportion of bacteria in self healing concrete is found by

- Self healing mortar
  160 gm = 5 ml
- Self healing concrete
  1480 gm = (?)
- From interpolation
  160 = 5 ml
  1480 = (?) (46.25 ml)

So for self healing concrete we used 46.25 ml of bacteria in 1 mould of concrete Cubes. But we do not know that 46.25 give better result or not so we have taken 40 ml, 46.25 ml and 50 ml. The proportion or mix design of self-healing concrete is same as the mix design of conventional concrete but the percentage of bacteria is taken in self-healing concrete. All the equipments and process of self-healing concrete is same as conventional concrete but the difference in the process of self-healing concrete is that we are adding bacteria in the water while taking the water in wet mixing of self-healing concrete.

2.4 Preparation of cubes:

In this experimental study, mix design is prepared for M25 grade of concrete by the use of IS: 456 – 2000 & IS: 10262 – 2009. For M25 grade, cement sand and aggregate ratio is 1:1:2. Sample of concrete shall be taken at the mixer or if it is not possible to have mixer then it can also be mix by hand this process is called hand mixing. After the dry mixing, the water is added to the conventional aggregate and water + bacteria are added to the self-healing concrete. Now the cube mould plates should be removed properly cleaned assembled all the bolts should be fully tight. A thin layer of oil then shall be applied on all the faces of the mould. It is important that cube side faces must be parallel. The concrete sample shall be filled into the cube moulds in 3 layers, each layer approximately 5 cm deep. Each layer shall be compacted

either by hand or by the vibration. Each layer of the concrete filled in the mould shall be compacted by not less than 35 strokes by tamping rod. After 24 hours cubes should be remould and kept for curing.

2.5 Compressive tests:

After the curing, concrete cubes were removed from the tank after their respective days. The cubes were allowed to dry under the Laboratory condition. Once the cubes were completely dried, they are placed under the compressive testing machine to get the compressive strength of concrete.

Figure 2: Compressive Strength Machine Setup

Total 9 no. of cubes of 150 X 150 X 150 mm size shall be cast, 3 for 7 days testing, 3 for 14 days testing, 3 for 28 days testing for one proportion of bacteria. Readings of each concrete sample i.e. conventional and bacterial concrete cubes were taken each time after curing interval of 7days, 14days and 28 days.

III. RESULTS

As we perform the compressive strength test on the concrete cubes on different days to know the strength taking capacity of cubes. So the results of 7, 14 and 28 days strength of concrete are given below in form of bar chart.

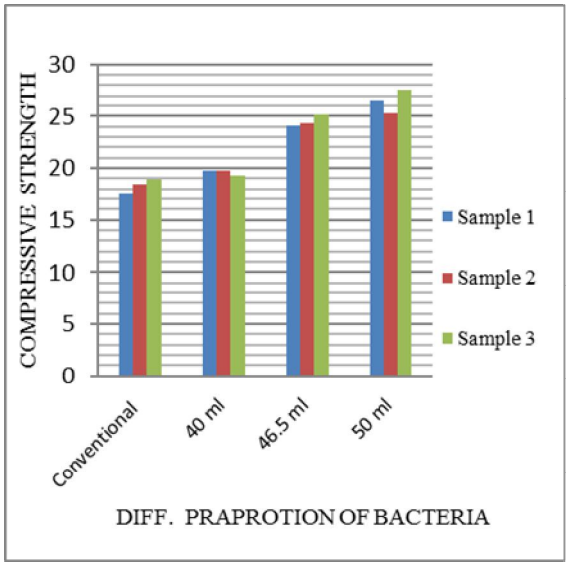

Figure 3: Graph of 7th day of Compressive Strength

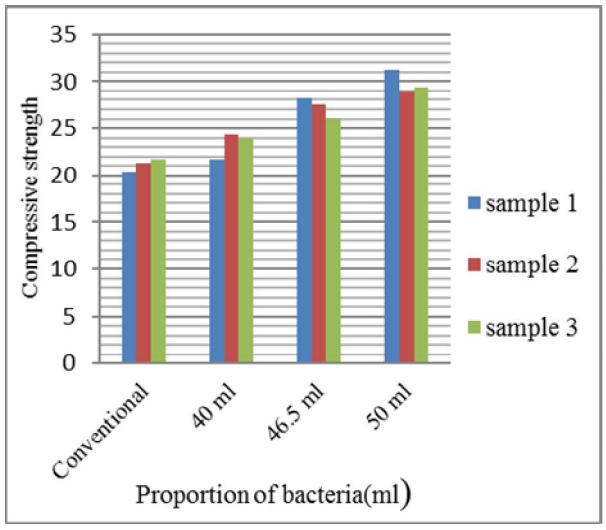

Figure 4: Graph of 14th day of Compressive Strength

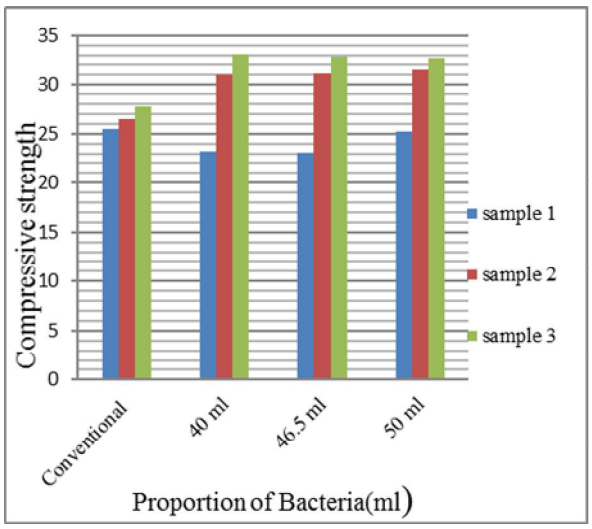

Figure 5: Graph of 28th day of Compressive Strength

From the above graph, it is clearly shown that the compressive strength value of self-healing concrete is greater than conventional concrete on 7th day, 14th day and 28th day.

We have also checked for healing properties of self healing concrete, for that we take 46.5 ml proportion of bacteria and cast the cubes and after casting we generate crack in cubes. We found that 80-85% crack is healing after 33 days.

Figure 6: Before healing and after healing

IV. CONCLUSIONS

- As the Self-healing concrete is eco-friendly in nature, an as it increases the durability of many building materials, the self-healing concrete is found that is more advantages than conventional concrete.
- Reduction in permeability.
- As the bacterial concentration increases, the formation or precipitation of calcium carbonate is also increases.
- Reduction in reinforcement corrosion.
- It is profitable to consumer because the repair cost will reduce.
- Increases in compressive strength is mainly due to consolidation of cracks
  Inside that there are small pores which will fill by microbiologically induced calcium precipitation.

REFERENCES

[1] H.M. Jonkers, A. Thijssen, G. Muyzer, O. Copuroglu, E. Schlangen, Application of bacteria as self-healing agent for the development of sustainable concrete Ecol. Eng. 36 (2) (2010) 230–235.

[2] H.M. Jonkers, E. Schlangen, A two component bacteria-based self-
Healing concrete, in: Concrete Repair, Rehabilitation & Retrofitting II, Taylor &Francis Group, 2009, pp. 215–220. ISBN 978-0-415-46869-3.

[3] H.M. Junker, E. Schlangen, Development of a bacteria-based self healing concrete, in: Taylor Made Concrete Structures, Taylor & Francis group, London,2008, pp. 425–430.

[4] V. Ramakrishnan, Ramesh K. Panchalan and Sookie S. Bang improvement of concrete durability by bacterial mineral precipitation, the South Dakota School of Mines & Technology, SP-225-2 2001.

[5] E Schlangen H. Jonkers, S. Qian and A. Garcia, recent advances of self-healing concrete, ISBN: 978-89-5708-180-8, 2010.

[6] Kartik M. Gajjar, A Study of Performance of Bacillus Lentus on Concrete Cracks, , ISSN - 2250-1991, Volume : 2 | Issue : 7 | July 2013.

[7] Mayur Shantilal Vekariya, Bacterial Concrete: New Era For Construction Industry, International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 9- Sep 2013.

[8] Navdeep Kaur Dhami, M. Sudhakara Reddy and Abhijit Mukherjee, improvement in strength properties of ash bricks by bacterial calcite, Ecological Engineering 39 (2012) 31– 35.