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INFULENCE OF BACTERIA FOR CRACK REPAIRING IN SELF HEALING CONCRETE

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Abstract— Cement was replaced with three percentages 30%, 40% and 50% with GGBS by weight and 20% fly ash, with a cells concentration of 106cells/ml of bacteria were used in making the concrete mixes. The tests were performed at the age of 7, 28 and 91 day. Concrete crack up to 0.5 mm width can be healed in 30 days' time period which shows effective solution in cracks. Oxygen is the agent that can induce corrosion but the bacteria will feed oxygen so the corrosion can be also reduce. The bacterial self-healing is novel approach towards the producing durable and crack free concrete by using the Industrial waste which leads to reduce the cost of repairing the cracks by conventional methods and reduce the chances to again development of crack in concrete. For this process bacteria's such as B.subtiles, B. spharies and B. pasteurii etc.

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Keywords— GGBS, fly ash, Bacillus Pasteurii, Cells Concentration, Compressive strength, Acid Attack test

I. INTRODUCTION

The concrete cost is small and easily available in the market without problem. Approximately 60% of our concrete highway need repair and 40% of our concrete highway bridge are structurally deficient or functionally obsolete. Concrete is composite material composed of aggregate sand and water bonded by the cement which becomes hard in some time. Concrete is the most widely used conventional construction material which is widely used everywhere in industry such as roads, sidewalk, house, bridge, pipes, dams, canals, silos, and nuclear waste containment. Crack size more than 0.8mm is more difficult to be repaired however with the use of bacteria cracks can heal with the calcite precipitation. When it is subjected to tension it start to crack, which is why it is reinforced with steel; to withstand tensile self-healing concrete consists of a mix with bacteria(bacillus pasteurii) incorporated into the concrete and calcium lactate food to support those bacteria when they become active. The bacteria heal the damage done and can also reduce the amount of damage sustained by the concrete structure in place. This paper aims to find the optimum percentage of fly ash and ggbs in microbial concrete containing bacillus pasteurii to achieve the best strength properties. Bacteria are microscopic organisms, single-celled prokaryotic creatures. Bacteria come in different shapes and the sizes. Bacterial self-healing concrete is a current advanced concrete in which selective cementation by microbiologically-induced CaCO3 precipitation has been introduced for remediation of micro cracks.in the construction industry concrete is the major component which is easy available, cheap and convenient to use. The crack in the concrete is the major problem which causes reduce the durability of the structure and strength of concrete. This technique is highly desirable because the mineral precipitation (CaCO3) induced as a result of microbial activities is pollution free and natural. As the cell wall of bacteria is anionic, metal accumulation (calcite) on the surface of the wall is substantial, thus the entire cell becomes crystalline and they eventually plug the pores and cracks in concrete. The technique can be used to improve the compressive strength and stiffness of cracked concrete specimens. Cracks less than 0.2mm can be auto fill by concrete. But if cracks are more than .2mm then concrete itself fail to heal itself thus opening passage to chemicals and other cooroding materials. In bio-concrete if water is in the contact with the concrete though the cracks the bacteria get activated from its stage of dormancy and through its metabolic activities formed calcite which further in calcium carbonate which acts as a healing material . When the cracks is fill completely by the bacteria it again went to the stage of dormancy again.

Again if in future if cracks get widen and the foreign particles tends to enter through the cracks the bacteria get activated and thus heel the cracks. Thus acting as a long lasting healing agent.

II. EXPERIMENTAL STUDY

1) *Cement :* Ordinary Portland cement of 53 grade available in local market is used in the investigation. The cement used has been tested for various properties as per IS:40311988 and found to be confirming to various specifications of IS:12269-1987 having specific gravity of 3.15.

2) *Fine Aggregate:* The sand used for the experimental program was natural river sand (Bodeli, Gujarat) locally procured and was confining to zone –II of IS: 383-1970. The specific gravity of fine aggregate was found to be 2.60

3) *Coarse Aggregate:* The size of coarse aggregates were used in this study maximum is 20mm. as shown in the table the physical properties of course aggregate. The sieve analysis of coarse aggregate is shown in Table. The aggregates were tested as per IS 2386 (Part: 1, 2, 3) –1963 and IS: 383– 1970 .

4) *Ground Granulated Blast Furness Slag:* GGBS has been shown to be an effective addition for concrete providing increased cohesion and reduce sensitivity to changes in water content. GGBS used in the experiment was obtained from Surat (Gujarat). The greatest advantages of ground granulated blast furnace slag is used with Portland cement such as ensure the higher durability of structure, reduce the temperature rise and help to avoid early – age thermal cracking, improve the workability, it help soften the visual impact of large structure such as bridge and retaining walls.Ground granulated blast furnace slag significant providing the ultimate strength when added to Portland cement makes it the preferred material in the construction.

5) *fly ash:* Fly ash is the byproduct of the combustion of coal at thermal power plant. All the country's growth mainly depends on the power, in our country also, the principal source of power is coal. Approximate 60% power is generate by using the coal. In India the coal was used by the power plant and in industry is very low calorific value and which has very high ash content ultimately great amount of ash is produced in the coal based thermal power plant. Thermal power plant may have mainly four types of fly ash. It is also obtained from Surat(Gujarat)

6) *Water:* Clean water available in the laboratory, was used for the preparation of specimens and for the curing of specimens.

7) *Bacteria:* The pure culture of Bacillus Pasteurii NCL NO 2477 was obtained from National Chemical Laboratory, Pune. The sub culture of bacteria was made in laboratory of Department of Bioscience

TEST

A. Compressive strength

The test is done for 7days, 28 days, 91 days and the size of the cube 150x150x150mm. the concrete mix design is carried out as per IS 10262-2009 for M30,M35,M40 mix grade. in this text cube is placed with the cast faces not in contact with the platens of testing machine. Load has been applied at a constant rate of stress equal to 15mpa/min according to the relevant IS code and the load at which the specimens failed has been recorded. Thus from the results, the compressive strength is obtained.

B. Acid attack test

The concrete cube specimens of various concrete mix of size 150mm x 150mm x 150mm were cast and after 28 days of water curing the specimens were removed from the curing tank and allowed it to dry for one day. The weights of concrete cube specimen were taken. The acid attack test on concrete cube was conducted by immersing the cubes in the acid water for 91 days after 28 days of curing. HCL with ph of about 2 to 5% weight of water was added to water in which the concrete cubes were stored. The pH was maintained throughout the period of 90 days. After 90 days of immersion, the concrete cubes were taken out of acid water. Then the specimens were tested for the compressive strength. The resistance of concrete to acid attack was found by the % loss of compressive strength on immersing concrete cubes in acid water.

C. Culture of bacteria

For Culturation of bacteria nutrient broth is required.

Nutrient Broth is prepared in a conical flask (Beef extract = 10g, NaCL = 5g, Peptone = 10g, Distilled water = 1Lit.). Then conical flask is covered with thick cotton plug and made it air tight with paper and rubber band. Then allow it for sterilization for 10-20minute. After sterilized process 1ml of bacteria is added into the flask. And kept it into the shaker for 24 hr. at 150 – 200 RPM. After 24 hr. bacterial solution was found to be whitish yellow turbid solution.

In this study bacterial solution is used, bacteria are diluted in to the water and prepare the bacterial solution.

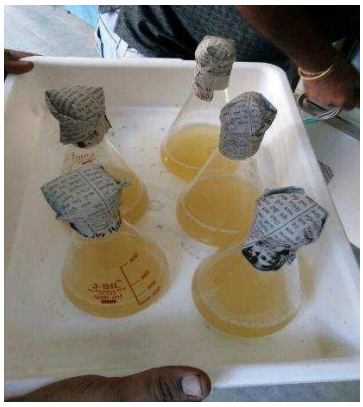


Fig 1 culture bacteria

III. Result and Discussions

A. Compressive strength Test Results*:*

Compressive strength test was conducted according to IS 516:1959. The cube specimen of size 150 mm was used. In this study the cube are prepared without bacteria conventional concrete. The test was done after 7, 28 and 91 days of water curing. Concrete with bacteria for 4 different mix with fly ash and ggbs for every mix 3 cubes casted. The size of cube 150mm x 150mm x 150mm .the most and useful parameters is compressive strength because it is a desirable characteristic of concrete properties and also quantitatively related to compressive strength. The bacterial concrete strength is increased when compared to normal concreted. Bacterial concrete with fly ash and ggbs is increased to conventional concrete. Result shown in chart 1, chart 2,chart3.

M30	**M35**	**M40**
10^6	**10^6**	**10^6**
26.92	30.92	35.55

Table 1 cell concentration for bacteria

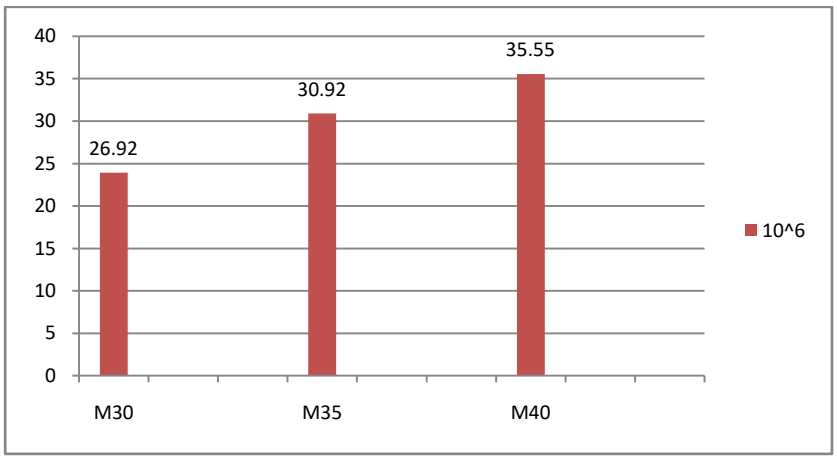


Fig 2 compressive strength of bacterial concrete

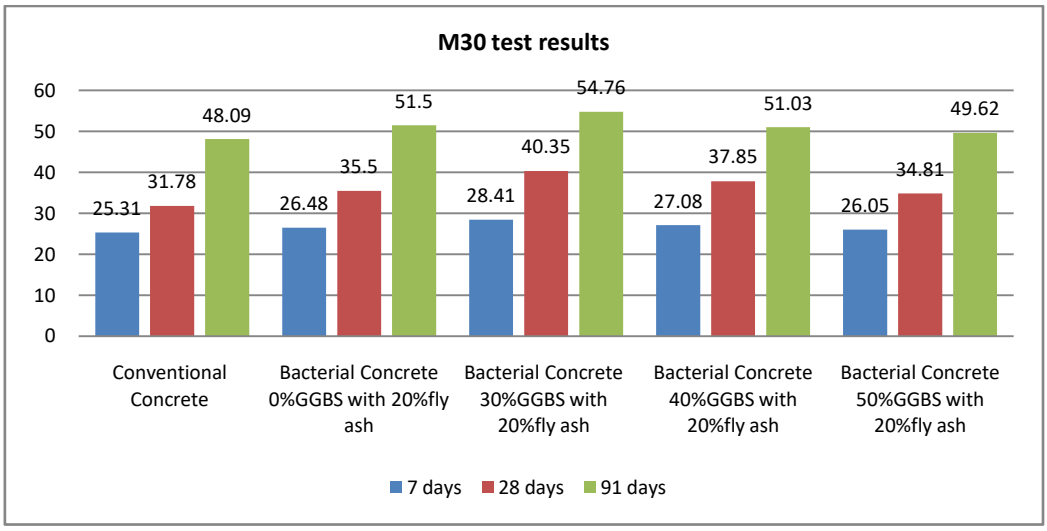


Chart 1 M30 Compressive strength results

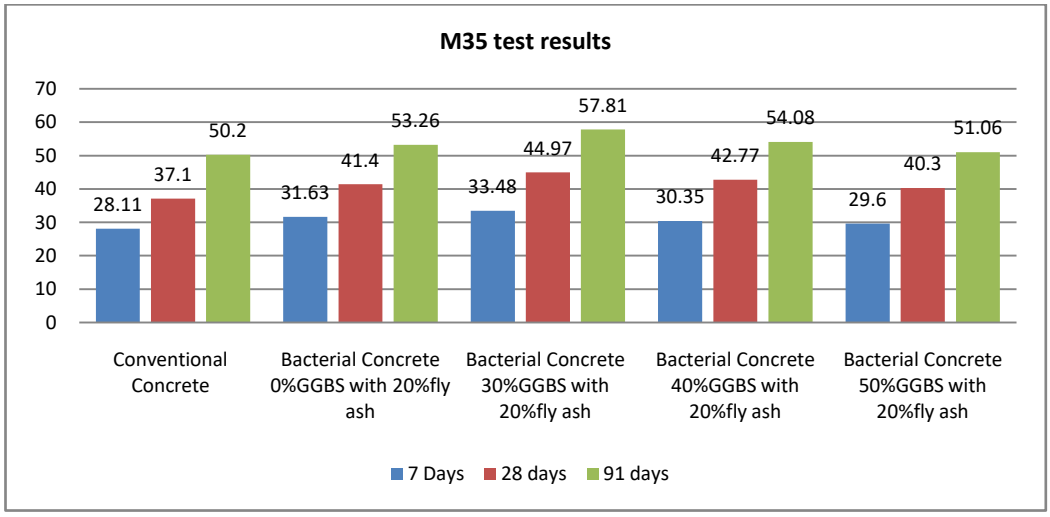


Chart 2 M35 Compressive strength results

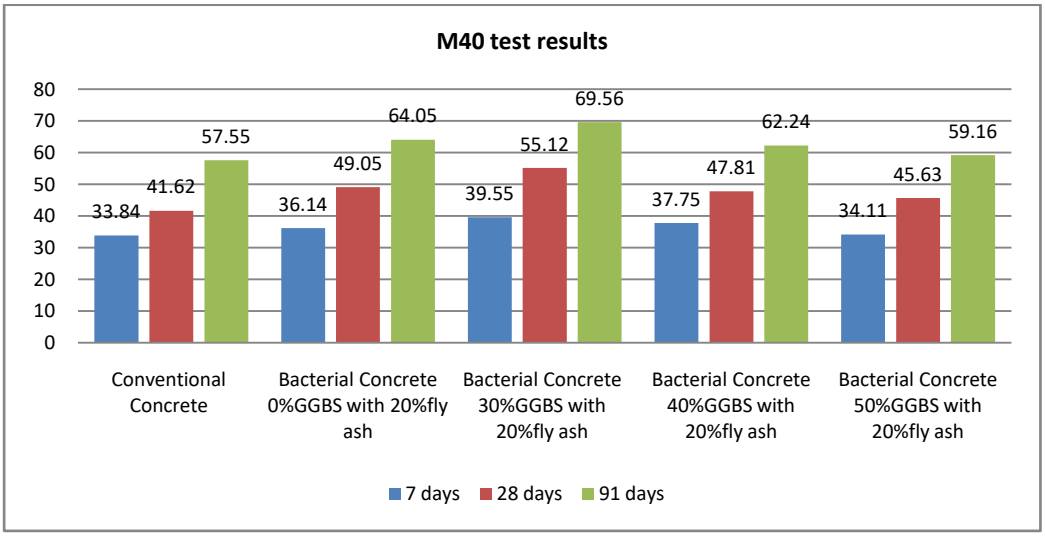
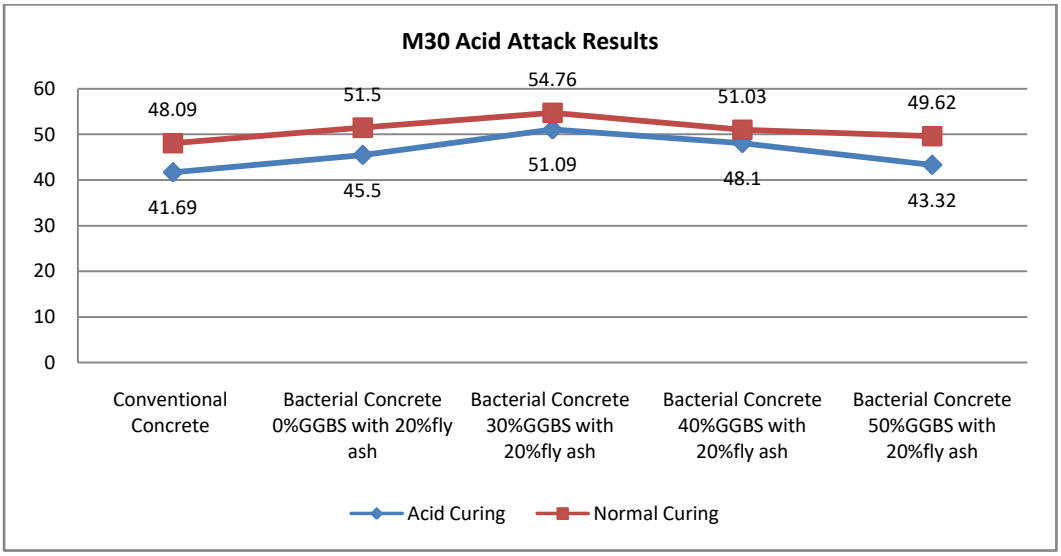


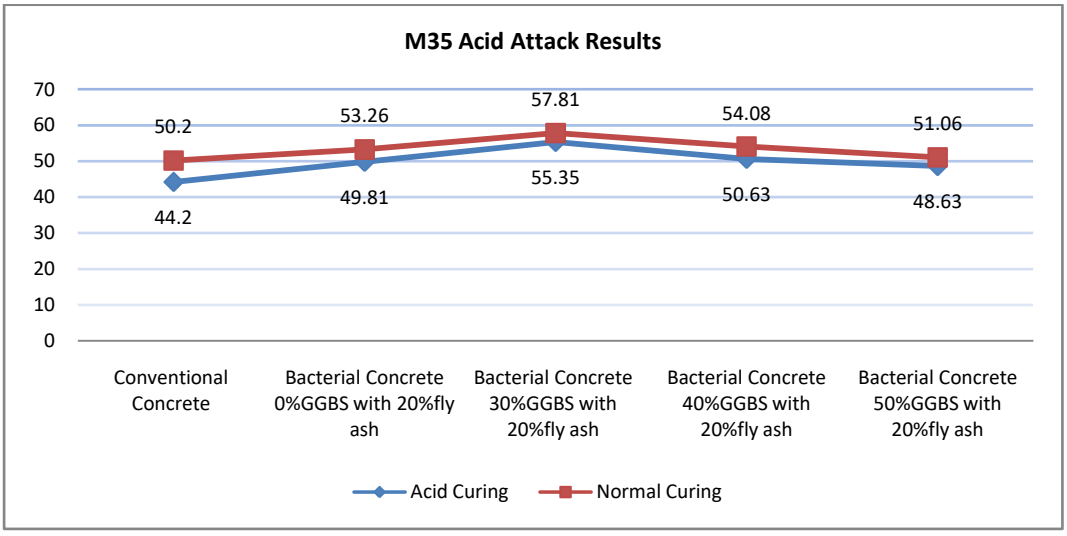
Chart 3 M40 Compressive strength results

Fig 3. 91days healing concrete

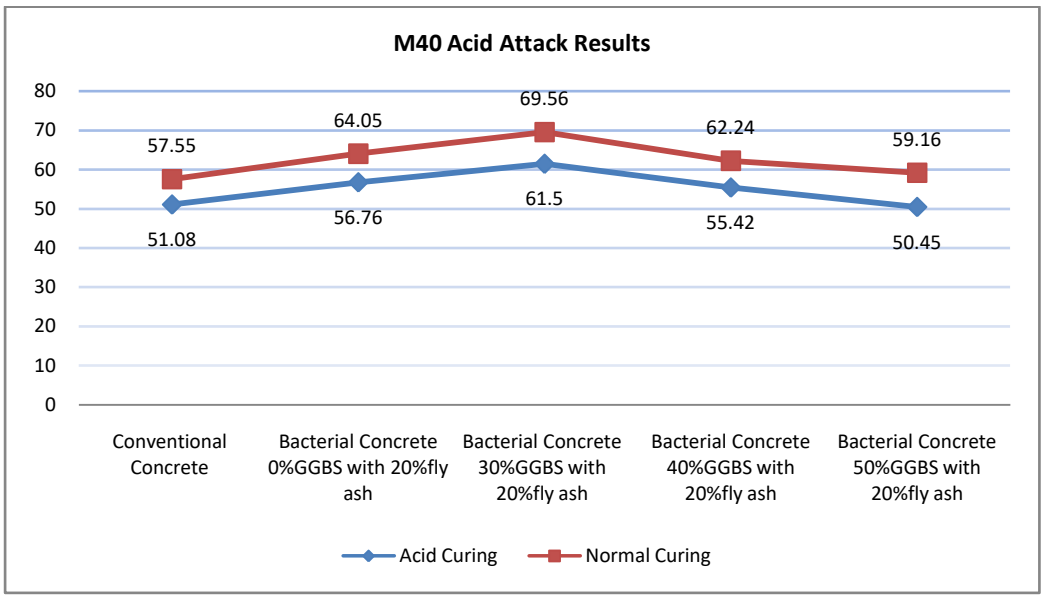
B. Acid Attack Test Results



Graph 1 M30 Acid attack results



Graph 2 M35 Acid attack results



Graph 3 M40 Acid attack results

Fig 4 acid test

IV. CONCLUSIONS

Based on the present experimental investigation the following conclusion are drawn

- Thus we studied the percentage increasing in compressive strength of bacterial concrete compared to control concrete.
- Bacillus pasteruii can be produced from laboratory which is proved to be a safe and cost effective.
- From the above it can be also concluded that the Bacillus pasteruii with fly ash and ggbs can be easily cultured and safely used in improving the performance characteristics of concrete.
- It is also concluded that the maximum strength obtained at 30% replacement of GGBS 20%.
- Use of bacteria improve the resistance against acid attack
- From the above it can be concluded that bacillus Pasteurii can be easily cultured and safely used in improving the performance characteristics of concrete.

REFERENCES

[1] J. Wang, J. Dewanckele, V. Cnudde, S. Van Vlierberghe, W. Verstraete, N. De Belie, X-ray computed tomography proof of bacterial-based self-healing in concrete, Cem. Concr. Compos. 53 (2014) 289–304.

[2] J.Y. Wang, D. Snoeck, S. Van Vlierberghe, W. Verstraete, N. De Belie, Application of hydrogel encapsulated carbonate precipitating bacteria for approaching a realistic self-healing in concrete, Constr. Build. Mater. 68 (2014) 110–119.

[3] J. Qiu, D. Qin, S. Tng, E. Yang, Surface treatment of recycled concrete aggregates through microbial carbonate precipitation, Constr. Build. Mater. 57 (2014) 144–150.

[4] F. Bravo, D. Silva, N. Boon, W. Verstraete, N. De Belie, Screening of bacteria and concrete compatible protection materials, vol. 88, 2015, pp. 196–203.

[5] Mian Luo Chun-xiang Qian, Rui-yang Li "Factors affecting crack repairing capacity of bacteria-based self-healing Concrete Construction and Building Materials 87(2015) 1-7(ELSEVIER)

[6] V.wiktor H.M.Jonkers "Field performance of bacteria-based repair system: Pilot study in a parking garage" Case Studies in Construction Materials 2015 (ELSEVIER)

[7] Y. Zhang, H.X. Guo, X.H. Cheng, C.À. Caco, C.À. Ca, Role of calcium sources in the strength and microstructure microbial mortar, Constr. Build. Mater. 77 (2015) 160–167

[8] Siddique, K. Singh, M. Kunal, V. Corinaldesi Singh, A. Rajor, Properties of bacterial rice husk ash concrete, Constr.Build. Mater. 121 (2016) 112–119.

[9] R. Siddique, V. Nanda, Kunal, Influence of bacteria on compressive strength and permeation properties of concrete made with cement baghouse filter dust, Constr. Build. Mater. 106 (2016) 461–469.

[10] N. Zakari et al., Tests and methods of evaluating the self-healing efficiency of concrete: a review, Constr. Build. Mater. 112 (2016) 1123–1132.

[11] Kunamineni Vijay , Meena Murmu, Shirish V. Deo "Bacteria based self healing concrete" Construction and Building Materials 152 (2017) 1008–1014(ELSEVIER)

[12] Dilja Rose Joseph, Life John "Strength Assessment of Fly Ash Modified Microbial Concrete" Volume 7 Issue No.4 2017 IJESC