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EXPERIMENTAL INVESTIGATION ON MECHANICAL PROPERTIES OF BACTERIAL CONCRETE

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Abstract- ***Comparatively, bacterial-based self-healing concrete is a new technology, so before being applied on larger-scale applications, it is important to gather more data in real-world conditions. Different kinds of bacteria used in concrete and how they are used as curing agents are discussed in this work. The different properties of concrete, which vary with the addition of bacteria, are also briefly defined in this article. Inherently, micro cracks in concrete are present, allowing the concrete to degrade, causing toxic chemicals to penetrate the concrete, contributing to structural degradation. Self-healing methods are used to resolve these conditions. Sources of calcite and calcium are created by the addition of bacteria that cause calcite precipitation in concrete. For sealing micro cracks in concrete, bio-mineralization technology provides promising results. A permanent process of hydration in the concrete will seal the freshly formed micro cracks. The benefit of concrete is that it is readily accessible, less expensive and easy to cast. Concrete structures are very prone to cracking, allowing chemicals and water to penetrate into the concrete that degrades the strength of the concrete, thus reducing the structure's efficiency. Eco-friendly concrete is planned to solve this problem. By injecting bacteria into normal concrete, this concrete is made. The bacteria that are grown are applied to the concrete of M- 25. The main aim of this research work is to evaluate the output of the specific filler induced and microbiologically obtained concrete. In this analysis, a variety of experiments are carried out at 7, 14 and 28 days on normal concrete and bacterial concrete including water absorption, compressive strength, ultrasonic pulse velocity (UPVT) test, flexural test and slumptest.***

Keywords- Ultrasonic Pulse Velocity Test (UPVT), Light Weight Aggregates (LWA), Graphic Nano Platelets (GNP), Scanning Electron Microscope (SEM), Energy Dispersive X-ray Spectrometer (EDS), X-ray Diffraction (XRD), Ordinary Portland Cement (OPC),

I. INTRODUCTION

1.1 Bacteria

Bacteria are microscopic organisms, living things that are single cell prokaryotes. Bacteria have various shapes and dimensions. In every habitat on earth, bacteria are present, growing in soil, acidic hot springs, radioactive waste, water, deep in the crust of the earth, and in living organisms, plants and animals. In one gram of soil, there are usually 40 million bacterial cells and one million bacterial cells are present in a million litres of fresh water. In short, about 5 billion (5 percent) bacteria have formed most of the world's biomass on earth.

1.2 Bacterial Concrete

The most commonly used construction material is concrete. The concrete material has many drawbacks in spite of its adaptability in building. There is very little concrete tensile strength, ductility and the ability to withstand cracks. Different modifications were made from time to time to overcome the inadequacies of cement concrete on the basis of ongoing research on a global scale. Continuous research in this field has led to the advancement of specific concrete technology, taking into account the speed of construction, the strength of concrete, the toughness and environmental friendliness of concrete, along with fly ash, blast furnace slag, silicon powder and other industrial raw materials [1]. It has been found in recent times that microbial mineral precipitation helps to boost the efficiency of concrete material
Due to the reaction of metabolic activities. Inside or outside the microbial cell, this process may take place or may be far away from the concrete. Bacterial movements usually cause a change in the chemistry of the solution that contributes to over saturation. The use of this definition of bio minerals results in the development of a new material known as bacterial concrete [2]. Generally, bacillus bacteria are used in microbial concrete.

Ii. Literature survey ramakrishnan et al. [2005] discussed biological Induced calcium carbonate known as calcite precipitation.

Micp (microbial-induced calcite precipitation) is a technology that belongs to a broader scientific category, known as bio-mineralization. This is a process in which the living molecules build an inorganic solid. Bacillus pasteurii is a common soil bacterium calcite precipitation. This technology can be used to increase the compressive strength and stiffness of cracked concrete specimen. Effects of different concentrations of bacteria on the durability of concrete have also studied. It turns out that all the light beams with bacteria behave better than that of control beam (no bacteria). Durability performance increases with increasing the concentration of bacteria.

Jonkers et al. [2007] applied “calcite –precipitation” bacteria to heal cracks in concrete. The species present in calcite creates end spores, stay alive concrete production and seal cracks by healing them with calcite. Authors have also examined the bacterial concrete’s mechanical strength. It has also been concluded that the bacterial method contributes to the self-healing properties of concrete. The bacteria have been incorporated with 109 have not affect the strength of concrete.

Wang et al. [2014] evaluated a self-crack healing capacity of cement along with water permeability. From the experiments, it has been evaluated that the self-healing capacity of bacteria is increased by 48% to 80% as compared to the cement used without adding bacteria. The largest crack length that has been healed by adding bacteria is 970 micro meters. Also, the water permeability of the concrete material has been reduced 10 times as compared to the concrete used without bacteria.

Luo et al. [2015] presented a bacterial based crack healing technique that has been designed by entering the micro agents using mineral precipitation process. The precipitations have been created at the surface of cement cracks and analyzed with sem (scanning electron microscope) t h a t is attached with an eds (energy dispersive x-ray spectrometer) and then examined with xrd (x-ray diffraction). Area repair along with anti-seepage repair rate have been examined. Maximum crack size that has been healed by author is of size

0.8 mm. It has also been observed that when the crack is more than 60 days the rate of crack healing is very less.

Rupawate et al. [2018] proposed a method to find out the concrete strength by replacing the coarse aggregate with “recycled aggregates”. Concrete material has been casted and strength by examine to measure the compressive strength. “split tensile strength” along with “flexural

When et al. [2016] proposed a less weight mortar that is integrated with bacteria in order to enhance crack sealing in case of wet dry period as compared to regular water concentration. The increased capacity of the proposed work has been measured by knowing the movement of bacteria on the basis of basis of oxygen consumption measurement. The compressive strength value of the self-healing agent has been decreased from the normal weight sand.

Wang et al. [2014] presented a self-healing process that utilize hydrogel encapsulates bacterial spores. The activities of specimens with and without bio hydrogels have been studied quantitatively using light microscopy. In order to check self- healing properties of the specimen, ‘x-ray computed micro- tomography’ has been used. The allocation of healing agent in the entire matrix has been determined. The analysis indicates that the concrete block with bio-hydrogel have high healing capacity as compared to the specimen without bio agent. The cracks less than 0.3mm healed with an healing ratio of (70% -100%) whereas without bio agent the crack upto 0.18mm has been improved.

Ling et al. [2017] examined the defensive effects of “microbial self-healing cracks”, in the course of numerous characterization methods like as electrochemical test, visual inspection of cracks surface, ‘weight loss rate of Reinforcements along with chloride ion substance. Author had determined the value of corrosion current which has been obtained for self-healing agent and normalspecimen.

Bhaskar, et al. [2017] discussed the effect of inserting two various mineral creating bacteria into the different types of “cementation mortar matrix” in order to increase the self- healing capability for autonomous crack repair. To defend bacteria in large ph atmosphere that is normally present in concrete “zeolite” has been utilized as a transmission material. The spore creating capability and ureolytic operation of zeolite- immobilized bacteria have been examined to determine the potential for generating healing substance. The self- healing capability of bacteria built-in normal and fiber resistant mortars has judged as per the expansion of compressive strength and penetration properties of broken specimens with age along with micro-structural features of crack healing substances using ‘scanning electron microscopy’ (sem), energy _dispersive_ spectrometer (eds) and x-ray. Strength”. The results have been examined for 7, 14 and 28 days. It has been concluded that for 10% and 20% substitution of coarse aggregate with recycled aggregates with a maximum strength of 26.67&

24.95n.

Xu et al. [2018] designed an essential defensive carrier for ureolytic which is based on bacteria (self-healing) agent. Authors have designed a “low alkali” concrete substance which is created by calcium _sulphoaluminates” cement by utilizing,

20% silica material. Bacterial substances have been fruitfully inserted into the carrier. The encapsulation technique results in a viability loss whereas the bacterial properties may be reserved for a long time. The strength of concrete has been analyzed by

Using low alkali carrier along with caco3 precipitation. The recovery rate of compressive strength and water tightness has been increased by 130% and 50% as compared to thesimple mortar.

Seitan et al. [2018] presented a Seitan of bacteria along with 'iron oxide Nano-particles'. In this paper, the effect of bacteria in the concrete material has been identified. From the experiment it has been observed that the compressive strength of concrete has been improved by adding stabilized Bacillus substances with iron material has.

Saranya et al. [2018] presented a method to enhance the quality of concrete by adding the self-healing agent. In this paper, authors have added bacillus material into concrete which increase the compressive strength of material. The comparative analysis of comparative strength with normal concrete has been performed that indicates that the compressive strength upto 10% has been increased.

Jonker's et al. [2010] studied the capacity of bacteria that is used as a self-healing agent in the concrete, i.e. Their capability to repair happening cracks. An exact group of alkali- resistant spore-creating bacteria associated to the genus bacillus has been chosen for this reason. Bacterial spores have been inserted directly to the cement paste mixture which is remained feasible for at least 4months.

II. AIM OF THE OBJECTIVES

Based upon the research gaps identified the following objectives were formulated:-

1. To evaluate the output of the specific filler induced and microbiologically obtained concrete.
2. To make the concrete readily accessible, less expensive and easy to cast.

III.MATERIALS AND MIX DESIGN

3.1 CEMENT

It is all-important to use cement of adapted grade and type for specific applications and ambiance conditions. OPC is generally used for major construction practices conforming to IS 269-1976. Grade 43 OPC is the most used cement in general purpose masonry and other construction works. The chemical requirements of OPC as per Indian standard code, IS 8112: 2013 are as follows:

1. The Ratio of percentage of CaO to percentages of Silo2, Al2O3 and Fe2O3 should lie in between 0.66-1.02.
2. The minimum ratio of percentage of Al2O3 and Fe2O3 should be 0.66.
3. The maximum insoluble residue percent by mass should be 4.0.
4. The maximum magnesia percent by mass, should be 6.0.
5. The maximum total Sulphur content in terms of sulphury anhydride should be 3.5 percent by mass.
6. The maximum loss on ignition (in terms of mass percentage) should be 5.0
7. The maximum chloride content percent by mass should be 0.1
8. The maximum alkali content for prestressed structures should be 0.05.

SAND

It is the utmost needful material in mortars and concrete for the construction purpose. Depending on the sieve size, the classification of sand is as follows:

1. Fine sand with dimensions as 0.075 to 0.425 mm
2. Medium sand with dimensions as 0.425 to 2 mm
3. Coarse Sand with dimensions as 2.0 to 4.75 mm

3.3 WATER

Potable water is generally considered satisfactory for concrete as per Indian standard code, IS 456-

2000. It means that the water should be clean and must not contain injurious quantities of alkalis, acids, oils, salts, sugar, organic materials, vegetable growth or other substance that may be deleterious to bricks, stone, concrete or steel. The physical and chemical properties of water should be tested to confirm the following limits:

To neutralize 100ml sample of water, using phenolphthalein as an indicator, it should not require more than 5ml of 0.02 normal NaOH.

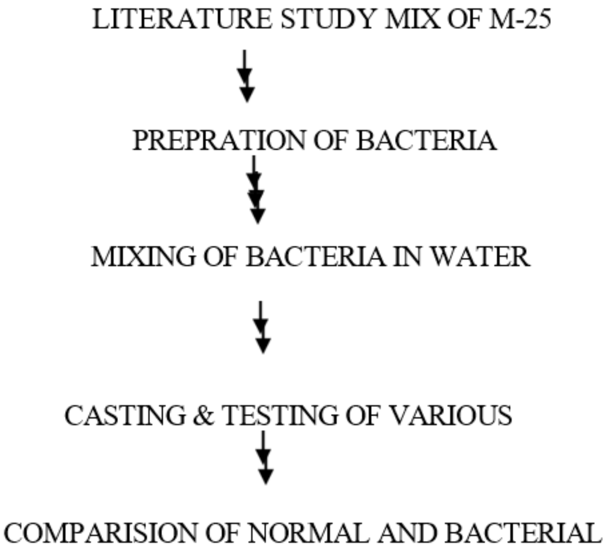
agar plate in the natural environment. 100 ml flask has been taken in which 50 ml of basic solution (Alkaline) is added. The solution is kept in temperature ranges from

25<temperature<37 degree Celsius. The procedure undertaken to simulate the work is described in this section. Initially, the existing work of the bacterial concrete is performed by various researches being studied. The bacteria are prepared in agar plate under natural environment. In 100ml of the flask, 50 ml basic solution of Alkaline is added and the grown condition is maintained between 25 degree Celsius and 37 degree Celsius. The generated bacteria are mixed into the water. Then, different load of 386.2 KN, 456.1 KN and 610

KN is applied on different cubes. At last, the parameters are measured to observe the efficiency of the bio- concrete material.

Step 2: To study the strength behavior of concrete

The study is carried out to determine the strength of cement mortar. Different set of cubes are casted for a period of 7days, 14 days and 28days.



Step 3: A concrete mix developed in step-2 is examined for durability aspects such as water absorption value, compressive strength and flexural

strength test.

V.RESULT AND DISCUSSION

In this section, the results obtained for measuring the compressive strength (N/mm2), flexible strength test with varied load, for normal and bacterial concrete are discussed. The test is conducted for 14 to 28 days. The test has been conducted on normal as well as on bacterial concrete. The comparison between the performance of normal and bacterial concrete have been drawn to analyze the effectiveness of the concrete. Initially, Slump test has been performed for both normal and bacterial concrete M-25. This test is performed to determine the workability of the concrete that represents the strength of the material. Workability is the characteristic of concrete that describes the ease with which the concrete can be mixed which again depends upon the amount of water, aggregate grade. In this research work, the slump test value ranges from 55 to 78 mm.

VI. CONCLUSION

At present, the design of bacterial concrete is the most popular research topic for researchers. Till now, it has been found that the use of bacterial concrete can enhance durability, mechanical properties and Infiltration of concrete. In this research work, the test has been conducted for 7, 14, and 28 days for measuring various parameters such as water absorption, compressive strength test, UPVT, flexural strength test and slum test. Based on the experiments the following points are drawn:

A. The water absorbing capability of the bacterial concrete has been decreased by 1.93 % from normal concrete which is better for the construction, as the concrete absorbs less water, the probability of steel corrosion and the crack damage decreases and hence, the strength of the concrete increases.The compressive strength of the bacterial concrete has been increased from normal concrete by 3.51 %.

B. The percentage increase in the flexural strength from the normal concrete to the bacterial concrete is 2.71%. Thus, if we are using self-healing concrete, the failure in bending can be reduced and the tensile strength can be increased.
C. The cracks with a size of 0.04mm to 0.09 mm are healing up easily.
D. No extra cost has been taken for preparing the concrete
E. The design concrete is very beneficial when used in the temperature zone of 10 to 50 degree Celsius.

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