

STRUCTURAL BEHAVIOUR OF SELF HEALED RC BEAM BY ENDOLITHIC BACTERIA AND CALCIUM CARBONATE

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ABSTRACT

From the olden days the major problem facing by each element like beams, columns, slabs, walls in the structures is cracking. In Civil engineering it is a great challenge to get rid of these problems and applying innovative and cost-effective methods for both curing and strengthening of concrete.

In modern days there are different methods applied in construction field itself about strengthening of concrete and for repair of cracks in concrete. One way to get around costly manual maintenance and repair is to incorporate an autonomous self-healing mechanism in concrete. One such an alternative repair mechanism has been currently being studied, i.e. a novel technique based on the application in biomineralization of bacteria in concrete.

From this research, using bacteria and calcium carbonate by 5, 10, 15, 20 percentages in cubes and optimized value for RC beams are used for the information about increasing the strength and the total durability of the concrete used in the present day will be gathered.

Keywords: Endolithic Bacteria, Calcium Carbonate, Self-healing, Biomineralization.

INTRODUCTION

Concrete is a major component in the construction Industry as it is cheap, easily available and convenient to cast. But the main drawback of these materials is that it is weak in tension and causes cracks under sustained loading and due to aggressive environmental agents which ultimately reduce the life of the structure which are built using these materials which is a combination of Cement[1-6], Coarse

aggregate, fine aggregate, and water. The presence of cracks, due to mechanical stresses or time dependent effects (shrinkage, creep...) is one of the major factors which can affect durability and serviceability of concrete structures in terms of resistance, permeability and transfer properties. It would be an enormous advantage if this concept could be translated to our engineering materials, such as concrete. Therefore, bacterial induced Calcium Carbonate (Calcite) precipitation has been proposed as an alternative and environmentally friendly crack remediation and hence the improvement of strength of building materials. This phenomenon is known as 'autogenously healing' or 'self-healing' of concrete[7-14].

Bacteria are relatively simple, single celled organisms. The bacteria used were Endolithic Bacteria. It is a bacterium with the ability to precipitate calcium carbonate in the presence of any carbon source. The bacterium is used in this project for the service and also for the improvement in the strengths of the concrete test specimens were observed.

The CaCO_3 solidifies on the cracked surface, thereby sealing it up. MICP (Microbially Induced Crack Remediation) is highly desirable because the Calcite precipitation induced as a result of microbial activities is pollution free and also natural no harm to humans. The technique can be used to improve the compressive strength and stiffness of cracked concrete specimens[15-25].

BACKGROUND

From the past history of research the result, says the strength of concrete increases using bacterial induced in calcium carbonate. Many researchers tested bacteria in mortar cubes and achieve the strength parameters. The strength of concrete increases using bacterial induced in CaCO_3 and environmental friendly crack remediation [1]. Bacterial deposition of a layer of calcite on the surface of the specimen resulted in a decrease of capillary water uptake and gas permeability [4]. Bacterial spores of these specialized cells, which can endure extreme mechanical and chemical stresses and spores of this genus are known to remain viable for up to 200 years [6]. The effects of bacterial carbonate precipitation on the durability of mortar specimens with different porosity, water absorption decreases depending upon the calcium carbonate crystals [26-31].

RESEARCH SIGNIFICANCE

The research goes on comparison of compressive strength and flexural strength of both bacterial concrete with calcium carbonated induced in concrete. The self-healing of concrete has also been observed where the concrete has been affected. This makes cost effective in the maintenance and strength improvement of a structure. Hence, it will be useful in many areas where the labors can't be placed for maintenance again and again like Bridges, Tunnels[32-37], Highways etc.,

EXPERIMENTAL SETUP

Compression Strength Test

The cubical Moulds with the size 150mm x 150mm x 150mm were cleaned and checked against the joint movement. A coat of oil was applied to the inner surface of the Moulds which is kept ready for the concreting operation. Meanwhile the required quantities of cement[8-15], fine aggregate and coarse aggregate (passing through IS sieve of 20 mm size and retained on 4.75 mm) for the particular mix are weighed exactly for concreting. Fine aggregate and cement were mixed thoroughly in a hand mixer such that the colour of the mixture is uniform. Then, weighed quantity of coarse aggregate taken is added to the mixer and then it rotated till uniform dry mixture is obtained. Then, calculated quantity of bacterial solution and water was added and mixing was continued for about 3 to 5 minutes to get identical mix. The wet concrete is now transferred into the Moulds and for every 2 to 3 layers and compacted manually. The corresponding identification marks were labeled over the finished surface and they were tested for 7, 14 and 28 day strengths in a compressive strength testing machine[38-43].



Compressive testing machine

Flexural Strength Test

Moulds of 230mm x 300mm x 1500mm are used for the beam and the Moulds are cleaned and the joints between the sections of Moulds shall be thinly coated with Moulds,oil and a similar coating of Moulds with oil shall be applied between the contact surfaces of the bottom of the Moulds and the base plate in order to ensure that no water escapes during the filling. The interior faces of the accumulatedMoulds shall be thinly coated with Moulds oil to prevent adhesion of the concrete. Meanwhile the required quantities of cement, fine aggregate and corresponding coarse aggregate for the specific mix are weighed accurately for concreting[23-29]. Fine aggregate and cement were mixed thoroughly in a hand mixer such that the colour of the mixture is uniform. Then, weighed quantity of coarse aggregate collected is added to the mixer and then it rotated till uniform dry mixture is obtained. Then, calculated quantity of water and bacterial solution were added and mixing was continued for about 3 to 5 minutes to get a uniform mix. The wet concrete is now poured into the Moulds in 2 to 3 layers and compacted manually. After concreting operations, the upper surface is level and finished with a masons trowel. The corresponding identification marks were labeled over the finished surface and the beams were tested for 7 and 28 days strengths[44-45].

RESULT AND DISCUSSION

The test results showed a substantial difference in the specimens tested, with and without bacteria and also concrete with calcium carbonate. Here are the following tables and charts which will give clear evidence about the compression and flexural strength test results.

Table -1: compressive strength test with Bacteria

Bacteria	7 Days	14 Days	28 Days
0%	16	19	28.2
5%	22	27.2	35
10%	26.5	33	42.5
15%	29	37	47.3
20%	21	25	32

Table -2: compressive strength test with Calcium Carbonate

Calcium Carbonate	7 Days	14 Days	28 Days
0%	16	19	28.2
5%	21	24.5	31.1
10%	24	28.6	34
15%	19	25.6	31.2
20%	16	23.2	28.5

GRAPHS

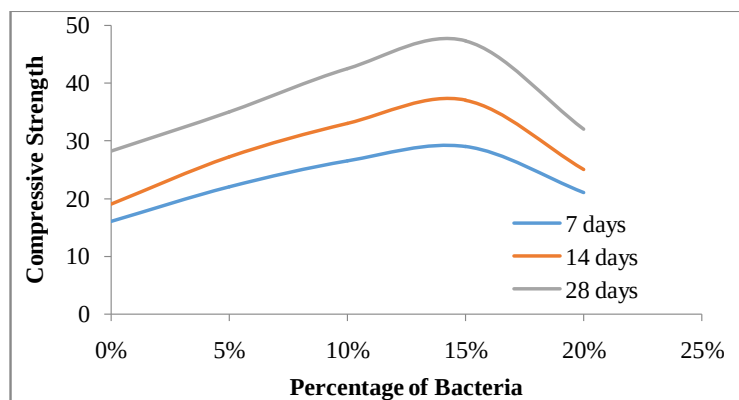
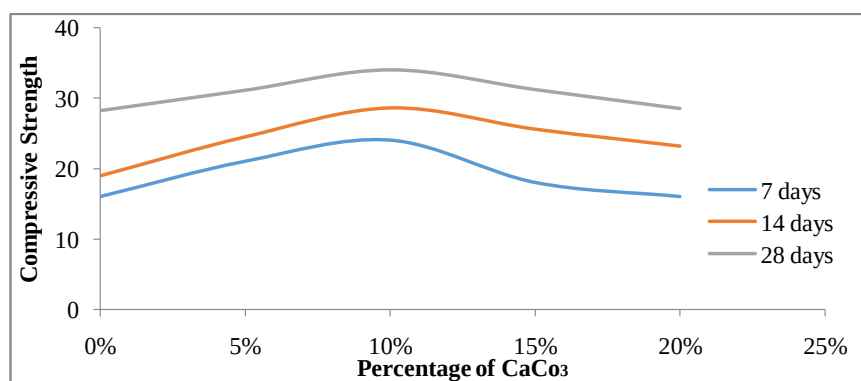
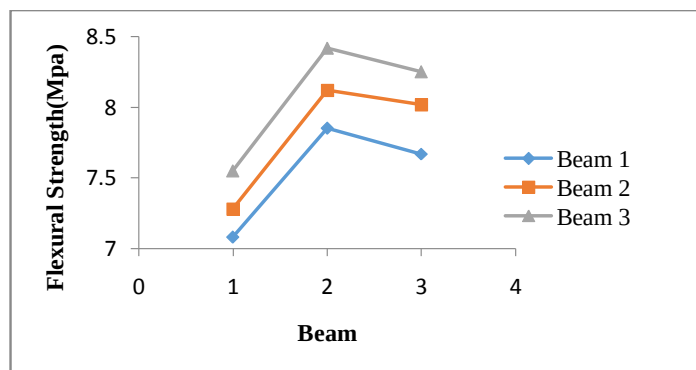
Graph 1: Compressive strength with Bacteria**Graph 2:** Compressive strength with Calcium Carbonate

Table -3: flexural strength test results

	Conventional	Bacterial	Calcium Carbonate
Beam 1	7.08	7.85	7.67
Beam 2	7.28	8.12	8.02
Beam 3	7.55	8.43	8.25

Graph 3: flexural strength for beam

CONCLUSIONS

The microbe verified to be efficient in improving the properties of the concrete by achieving a very high initial strength increase and thus we can conclude that the produced calcium carbonate has occupied some percentage of void volume thereby making the texture more compact and resistive to discharge. When bacterial concrete is fully established, it may yet become another alternative method to replace OPC and its hazardous effect on environmental pollution. Hence it can be used for construction as it has resistant to corrosion as well. As compared to the other methods this is one of the innovative methods and the application will be very easy. It is an economical method.

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