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STUDY ON STRENGTH OF BACTERIAL CONCRETE IN BACILLUS MEGATERIUM

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ABSTRACT

Concrete a strong, durable material composed of cement, aggregate and water is the most used building material in the world. Concrete has an ultimate load bearing capacity under compression but the material is weak in tension. The steel reinforced bars take the load when the concrete cracks in tension. To increase the strength and durability of the structure either crack that are formed should be repaired conventionally using epoxy injection or latex treatment or by providing extra reinforcement in the structure during the design phase to ensure that the crack width stays within a permissible limit. A reliable self-healing biological app of water approach is first proposed by V.Ramakrishnan to make use of bacterial concrete to heal cracks in concrete structure. In this paper an attempt is made to investigate the compressive strength and split tensile strength of the bio concrete. In this study different mix proportions for M_{30} grade of concrete with adding bacteria (Bacillus Megaterium) of 5g in 1lit/m^3 of water.

KEYWORDS: Mechanical properties,Characterestic strength, Bacillus megaterium bacteria

INTRODUCTION

Concrete is the most widely using building material in the world. Concrete has a large load bearing capacity for compression load, but the material is weak in tension. The steel bars provided in concrete take over the load when the concrete cracks in tension. . Cracks widths in concrete structure should be limited, mainly for durability reasons. If cracks Widths are too large the cracks need to be repaired or extra reinforcement is needed already in the design. If a method could be developed to automatically repair cracks in concrete this would save an enormous amount of money, both on the costs of injection fluids from cracks and also on the extra steel that is put in structures only to limit crack widths. For structural reasons this extra steel has no meaning. A reliable self-healing method for concrete would lead to a new way of designing durable concrete structures, which is beneficial for national and global economy. The "Bacterial Concrete" can bacteria in the concrete that are able to constantly precipitate calcite. This phenomenon is called microbiologically induced calcite precipitation.. A main part of the research will focus on this topic. How can the right conditions be created for the bacteria not only to survive in the concrete but also to feel happy and produce as much calcite as needed to repair cracks. Furthermore the bacteria should be suspended in a certain concentration in a certain medium before they are mixed through the concrete ingredients. Optimization is needed here, which involves experimental testing.

BACILLUS MEGATERIUM

Bacillus Megaterium is a gram positive, endospore forming, rod shaped bacteria. It is considered aerobic. It is found in soil and considered a saprophyte. Bacillus Megaterium has often been used in the laboratory, and is used as an industrial organism that is able to produce a variety of proteins and sources of bioremediation. Bacillus Megaterium is a good source of industrial proteins because it is both a desirable cloning host and produces a large variation of

enzymes. The organism does not have alkaline proteases; which allows for recombinant protein synthesis. Using Bacillus Megaterium scientist has developed numerous proteins that are commonly used in the medical and agricultural field

EXPERIMENTAL INVESTIGATION

The experimental investigation is conducted as detailed below. All the materials tests were conducted in the laboratory as per relevant Indian Standard codes. Basic tests were conducted on fine aggregate, coarse aggregate and cement to check their suitability for concrete making. The study aims to investigate the strength related properties of concrete of M30grade.The proportions of ingredients of the control concrete of grade M30 had to be determined by mix design as per IS code. Workability of fresh concrete was determined by the slump test according to Indian standards. The typical size of cube 150mm×150mm×150mm was used to determine the Compressive strength. Split tensile strength was carried out on the cylinder with 150mm diameter and 300mm height.

MATERIALS

Cement

The cement used in this experimental investigation was 53 grade OPC manufactured by Chettinad cements.

Fine aggregate

The sand used for experimental program was locally produced and conforming to zone II. The sand was primarily sieved over 4.75 mm size sieve to take out any units bigger than 4.75 mm. The fine aggregates were tested as per Indian Standard Specification IS: 383-1970

Coarse aggregate

Locally available coarse aggregates were used in this work. Aggregates passing through 20mm sieved and tested as per Indian Standard Specifications IS: 383-1970.

Water

The tap water available in the campus was tested for its suitability. Necessary properties such as pH value, chloride content, total hardness and total dissolved solids were evaluated.

Mix design

The mix design for M30 grade concrete is done according to the IS design method to obtain the optimum mix. Once the optimum mix is determined, it is used to produced different concentration of bacteria adding 5grms in 1 lit/m^3 of water.

TABLES

Table 1. Physical properties of cement

PROPERTY	VALUE
	3.0
	5
	32
Standard consistency	%
Setting time	
(i) Initial setting time	50 minutes
(ii) Final setting time	217 minutes
Fineness	2.5%

Tables 2. Chemical composition of cement

COMPONENT	%
Sio2	21.8
Al2O3	4.8
Fe2O3	3.8
CaO	63.3

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SO3	2.2
MgO3	0.9
P2O5	<0.04
Loss of ignition	2
Insoluble residue	0.4

Table 3. Physical properties of Fine Aggregate

PROPERTY	VALUE
Specific gravity	2.5
Fineness modulus	2.515
Bulk density	1.65kg/m^3
Type of sand	Medium sand (zone2)
Total water absorption	1.0%

Table 4. Physical properties of Coarse Aggregate

PROPERTY	VALUE
Specific gravity	2.63
Density	1567kg/m^3
Fineness modulus	7.42
Impact value	22.12% <45%
Crushing value	24.44% <45%
Total water absorption	0.6%

Table5.Concrete mix design proportion(M30grade)

UNIT	WATER	CEMENT	FA	CA
Kg/m^3	191.6	491	528.75	1127
Ratio	0.39	1	1.07	2.2

RESULTS AND DISCUSSION

Compressive strength

Compression test has been carried out on concrete cubes withstandardsconfirmingtoIS516-1999.All the samples were tested in a1000KN capacity universal testing machine. After 28 days of curing, the cubes were permitted to turnin to dry condition before testing. Plane surfaces of the specimen were between platens of compression testing machine and subjective to loading. The compressive strength of the concrete cubes are given in Table

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Table6.Characterestic compressive strength of cubes in MPa(M30grade)

Days of curing	Type of bacterial concrete	Different concentration of bacillus megaterium concrete						
		10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}
7 days	Type I	14.76	15.3	16.5	17.2	19.05	18.45	18.08
	Type II	14.5	14.9	17.8	17.9	18.7	17.2	16.4
28 days	Type I	32.5	32.3	33.5	37.02	39.58	38.03	38.2
	Type II	33.1	32.8	34.08	37.5	41.76	38.9	38.04

Tensile Splitting Test

The split tensile strength of a concrete is carried on cylindrical specimen of diameter 150mm and length 300mm.Two wooden-bearing strips are placed. The specimen was loaded until it fails. The test is done at the age of 7, and 28 days. The machine used was the same UTM that used for compression test.

Tabl7.Split Tensile strength in MPa(M30grade)

Days of curing	Type of bacterial concrete	Different concentration of bacillus megaterium concrete						
		10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}
7 days	Type I	2.53	2.64	2.78	2.95	3.15	3.09	2.83
	Type II	2.61	2.58	2.67	2.92	3.11	3.02	2.92
28 days	Type I	3.52	3.76	3.82	3.95	4.56	3.82	3.80
	Type II	3.49	3.53	3.85	3.97	4.12	3.78	3.52

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***Figure**: Fig.1 Comparison of compressivestrength of bacterial concrete for type 1&2 -M30 grade*

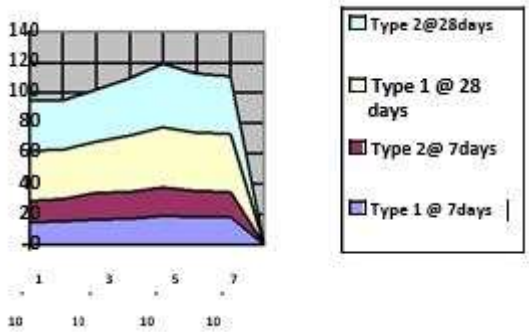
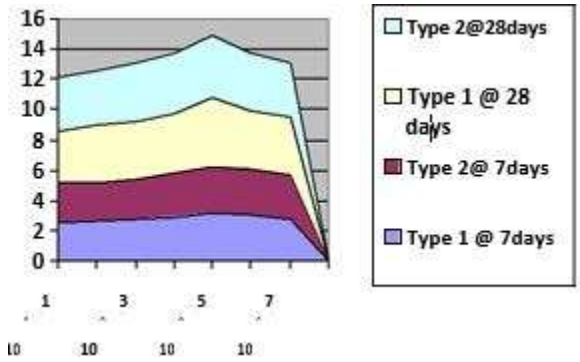


Fig.2 Comparison of split tensile strength of bacterial concrete for type1& 2-M30 grade



CONCLUSION

- The bacillus megaterium concrete obtained compressive strength , split tensile strength and porosity results the incorporation of more numbers of bacteria in the cracks of the concrete cube.
- The result in a significant gain of property of bacteria.
- As the repairing of cracks in concrete is increased with the increase in the concentration of bacteria number.
- Due to the inclusion of bacteria in concrete ,we achieved slight increase in compressive strength , split tensile strength and also 12% increase in porosity.
- From the results it can be concluded that easily cultured Bacillus Megaterium can be safely used in improving the performance and characteristics of concrete.

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