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Experimental Study on use of Bacteria in Mortar

Sohit Sharma [1], Prof. Archana Tiwari[2.] Asst Prof. Sunita sharma[3]
[1]*P.G. Student,* [2]*Professor, Department of Civil, Madhav Institute Of Technology & Science Gwalior- 474005, Madhya Pradesh, India*
[3]*Asst .Professor, Department Of Biotech Engineering, Madhav Institute Of Technology & Science, Gwalior- 474005, Madhya Pradesh, India.*

Abstract: ***This research was aimed to find the possibility of applying E-coli integrated into mortar matrix as a self-healing agent to seal cracks. Various researchers from around the world have developed cement mortar, which posses the quality of strength recovery, using specific chemical or bacteria. It has been observed that specific types of micro-organisms can be used to repair cracks in existing solid structures. The new cement mortar that is prepared using these micro-organisms may exhibits a potential to heal cracks and recover concrete's mechanical properties, thus decreasing the maintenance cost and increasing the life of structure.*** *Escherichia coli* ***(E. coli) and Microbiologically induced calcite precipitation (MICP) together form an exceptionally impermeable calcite layer over an existing solid layer, and microbial exercises of microscopic organisms seal breakages in the solid structure. The phenomenon of formation of micro cracks in mortar cubes is common. This causes degradation of strength properties of concrete and also causes corrosion of reinforced members and subsequently decreases the ability of structure. Self - healing technique should be adopted to overcome such situations In this paper I have investigated for the methods for culture of bacteria (Escherichia coli) ,study of strength behavior of concrete including the bacteria concentration and compare it with conventional concrete strength and checking for various parameters like durability resistance to chemical attack of cement mortar***

Keywords: Self-healing, cement mortar, crack, bacteria, E-coli, Calcium carbonate

I. INTRODUCTION

E-coli bacteria have attracted lots of interest as a promising, natural, environmental friendly novel technique to improvement of concrete characteristics. Considerable research has been conducted on utilizing microbial-induced carbonate precipitation to mitigate several concrete problems such as crack repair, reduction and modification of porosity and permeability. Furthermore, *Escherichia coli* bacterial carbonate precipitation (bio deposition) has shown positive influences on compressive strength improvement of concrete. In the meantime, it seems that the study related to the optimum dosage of bacterial solution and its effect on the durability of concrete has not been comprehensively investigated. Therefore, it is decided to carry out an investigation of determining optimum dosages of bacterial solution required for concrete by forming various concrete cube samples having variations of bacterial solution . The concrete contains spores of dormant bacteria that are added during the mixing process and remain locked inside the dried material. When a crack occur, bacteria, a reaction occurs that creates calcium carbonate ($CaCO_3$), the prin-cipal component in limestone, thereby sealing the crack and preventing further leakage curs and water makes its way inside the concrete and comes into contact with the .

A. Bacterial Cement Mortar

The "Bacterial Cement mortar" can be made by embed bacteria in the concrete that are able to precipitate calcite. *Escherichia coli* is a soil based bacterium, can continuously precipitate a new impermeable calcite layer over the existing surface layer of an already existing concrete layer. The favorable conditions do not directly exist in a concrete but have to be created by phenomenon of self healing . A Main part of my research is based on preparation of this .

II. MATERIAL AND METHODOLOGY USED

Control mortar samples (dimensions 70.6 mm× 70.6 mm ×70.6 mm) were prepared by mixing ordinary were similarly maintained .The LB medium, host cell Dh5α were used in the cement- sand- water mixture in the same ratio mentioned earlier for preparing the test mortar specimens. The concentration of Dh5α cell in the test mortar specimen was varied from 10□ to 10□ cell per ml water used. Whereas four different concentration (10□ ,10□, 10□, 10□ cell per ml were determined by directly noting optical density (OD) of the bacteria growing culture media at 620 Serial dilution for the required cell concentration was done by the adding the

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required volume of deionizer water to the bacteria-incorporated growth medium. The required volume of water was replaced by LB media only in the case of LB medium- based sample preparation . The mortar cubes were cured under air and water for 3, 7 and 28 days at room temp. to observe the gradual development of mechanical properties within the bacterial mortar samples. A compressive strength machine to determine the compressive strength of those bacterial cement mortar cubes.

After 3,7 and 28 days water curing ,It was observe that the compressive strength of the Dh5α bacteria-incorporated mortar sample increased with the increasing concentration of cell and time as compared to that of the control sample (without adding bacteria).The maximum strength achieved at a bacterial cell concentration of 10□ cell per ml of mixing of water and checked all ages (3, 7, and 28 days) when cured under water .

E-coli was cultured in LB media and colonies are grown in nutrient agar . Different dilution of microbial culture was prepared in various proportion ie, 1:10:: 1:100::1:1000 and incubated for 18 hours . then optical density of each diluted microbial culture was measured by using spectrometer at nanometers . in cement mortar the micro cracks upto .2 to .4 mm wide are healed homogeneously due to hydration of non – reacted cement .if excess amount of water which is not contributing in hydration process may be consume by the bacteria so this reduce the water cement ratio in the mix leading to reduction in water cement ratio and result in increase of strength of cube .

Figure 1 : E-coli bacteria growth

III. LABORATORY INVESTIGATION AND RESULT

Cement Mortar Samples were prepared by incorporating different cell concentration (10^4-10^7 cells per ml water used) of the isolated strain Dh5α into the cement sand mixture to observe the strength –increasing properties. A water *vs.* cement ratio of 1: 0.4 and a cement *vs.* sand ratio is 1:3 were used . The compressive strength of the bacteria embedded sample were measured by a compression testing machine are different-different numbers of days(3,7and 28 days) air curing and water curing described earlier.

Table 1 :Physical properties of ordinary Portland cement

Cement used	OPC 43 grade
Specific gravity	3.14
Normal consistency	33 %
Initial setting time	45 min (not less than 30 min)
Final setting time	220 min (not more than 600 min)
Soundness by lechatlier	1.4 mm (not more than 10 mm)
Fineness of cement	2% (less than 10%)

Table 2: Sieve analysis of fine aggregate :

Sr .no	IS sieve size	Weight retained (gm)	% weight retained	Cumulative percentage Weight retained	Cumulative percentage Weight passed	Grading Limits IS 383-1970 Zone II
1	10 mm	0	0	0	100	100
2	4.75mm	8	8	0.8	99.2	90-100
3	2.36mm	40	48	4.8	95.2	75-100
4	1.18mm	200	248	24.8	75.2	55-90
5	600mm	350	598	59.8	40.2	35-59
7	300 micron	315	913	91.3	9.7	8-30
8	150 micron	80	993	9.3	0.7	0-10
9	Less than 150 micron	7	-	-		
	Total	1000		280.8		

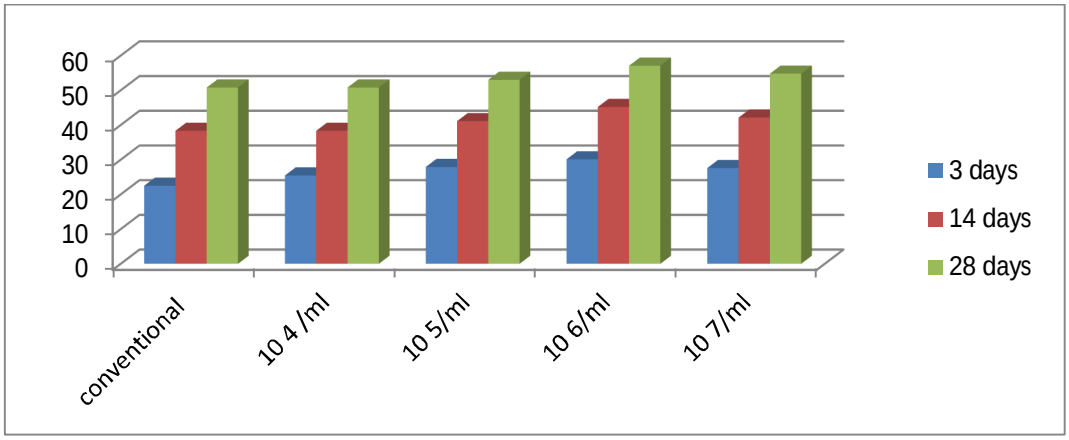
Fineness modulus = sum of cumulative percentage of weight retained /100 =
=280.8/100 = 2.808 And the fine aggregate belongs to Zone II .

Table 3 :Properties of fine aggregate

Sr.no	Property	Fine aggregate	Coarse aggregate
1	Specific gravity	2.65	2.70
2	Water absorption	0.9%	0.4%

Table 4 :Effect of E-coli DHα5 bacteria addition on cement mortar strength :

Cell concentration per ml of mixing water	Average compressive strength of mortar on MPa	% increase or decrease in compressive strength	Average compressive strength of mortar on MPa	% increase or decrease in compressive strength	Average compressive strength of mortar on MPa	% increase or decrease in compressive strength
	3 days		7 days		28 days	
Nil	22.50	-	35.24	-	48.20	-
10^4	25.46	+13.1%	38.34	+08.79 %	50.81	+05.41%
10^5	27.91	+24.4 %	41.11	+16.65 %	53.02	+10.37%
10^6	30.11	+33.82%	45.21	+28.29%	57.09	+18.44%
10^7	27.61	+22.71%	42.15	+19.60%	54.79	+13.67%



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IV. CONCLUSION

Comprehensive strength of cement mortar (1:3) improves seen in hydrated structure of cement mortar cube using with and without bacteria The concentration of Dh5α cell in the test mortar specimen was varied from 10□ to 10□ cell per ml water used. Whereas four different concentration (10□ ,10□, 10□, 10□ cell per ml were determined The investigation is carried out at 3 days ,7 days ,28 days at various cell concentration of mortar .From investigation are conclude as:

A. The experimental results conclude that with the increment in the percentage of cell concentration of bacteria the optimum results were at obtained at concentration of 10□/ml of E-coli bacteria
B. At 07 days strength is observed to be increased with a % of 33.82
C. At 14 days strength is observed to be increased with a % of 45.21
D. At 28 days strength is observed to be increased with a % of 18.44

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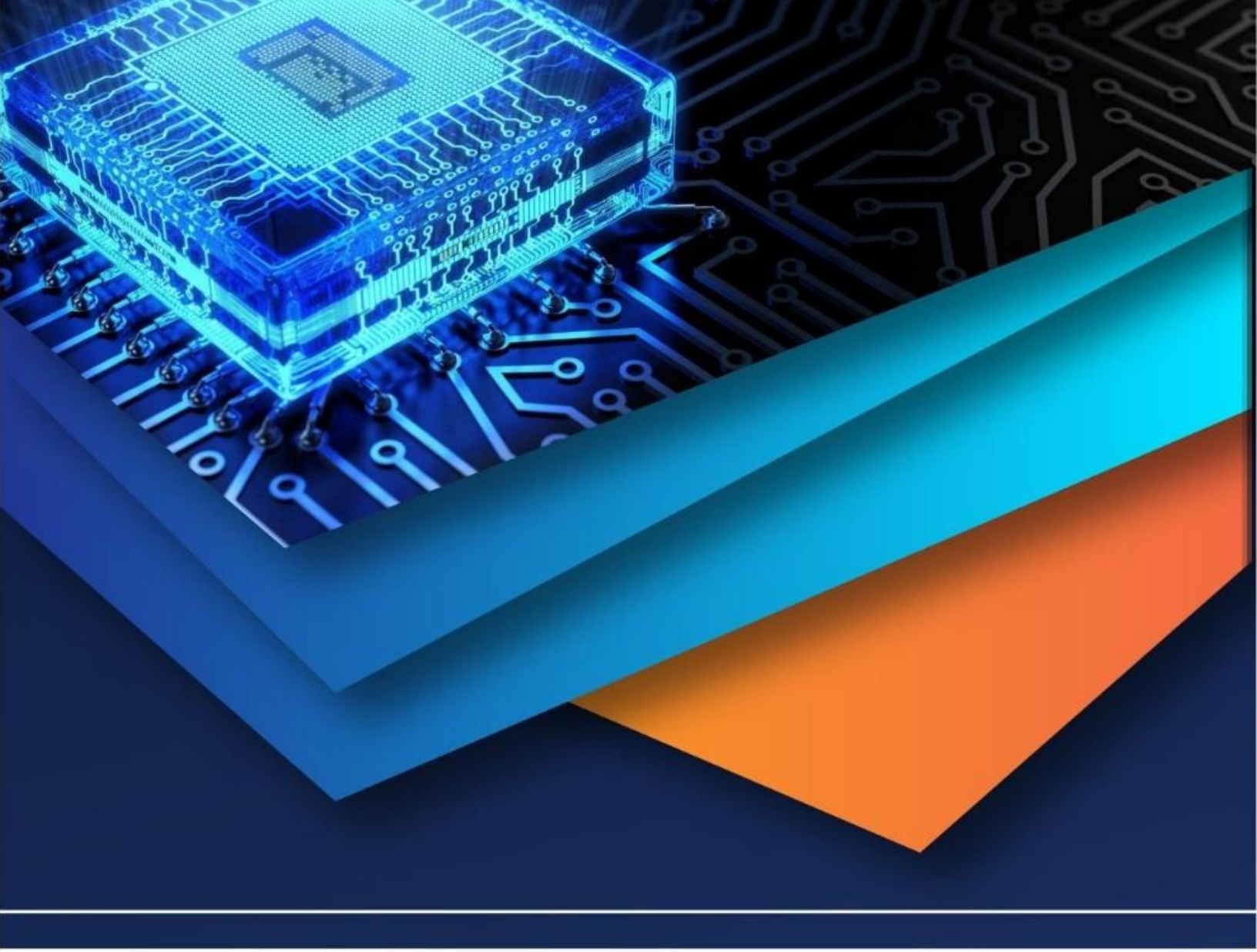

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