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Investigating the Use of Bacteria-Enabled Self-Healing Concrete for Pavement Crack Repair

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Abstract: ***The utilize of self-healing concrete gives an elective strategy to repair splits that shape over time as a result of natural impacts, overwhelming activity, and absconds within the fabric. This unmistakable run of concrete contains microorganisms, counting bacteria and organisms, beside supplements and recuperating substances. These organisms are enacted when water enters the breaks and starts to recuperate the concrete. They create calcium carbonate, a fabric that fills up the splits within the concrete and makes a difference it reestablish its quality. This prepare is known as "self-healing" since it parallels the way our bones mend themselves. Self-healing concrete amplifies the life of structures, counting bridges, buildings, and streets, whereas moreover making strides their toughness and bringing down support costs. This makes foundation more tough and versatile since it can endure corruption over time. In this inquire about work consider M20 concrete to perform exploratory work.***
Keywords: Self-healing concrete, Bacillus clausii, fly ash etc.

I. INTRODUCTION

Self-healing Concrete is known for having self-healing properties. The capacity of concrete to self-heal or self-repair permits for split correction and repair utilizing either independent or autonomous strategies. All of these forms are characterized by the toughness of concrete, which is one of its qualities. Concrete's materialistic strength makes a difference it stands up to itself against chemical or physical dangers. When toughness break down, the probability of break arrangement increments. In concrete, the special capacity of microscopic organisms as operators to self-heal is to a great extent decided by its unsaturated pores circuitry. The metabolic movement of a few bacterial species, like Bacillus subtilis and Pseudomonas aeruginosa permits them to deliver calcium carbonate (CaCO3). In another handle known as biomineralization, the microbes create calcium carbonate (limestone) inside and underneath concrete structures which reestablishes their basic astuteness.

A. Self-healing Concrete

Self-healing concrete is a type of concrete and it is capable for fixing the cracks on its own autogenously or autonomously. It not only repair the cracks but also recovers the mechanical properties of the structural element. It fills the cracks of max 0.8mm thickness. In self-healing concrete a additional bacteria bacillus clausii added which help to increase strength and stability of concrete.

Fig 1 Self-healing concrete

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II. OBJECTIVES

1) To increase the compressive strength and flexural strength of concrete.
2) Reduce the plastic shrinkage cracks through the action of bacteria.
3) To improve the strength regaining capacity of failure concrete.
4) To reduce the voids through the precipitation of calcites.
5) To investigate the effect of bacillus clausii bacteria in achieving strength in contrast to conventional concrete.

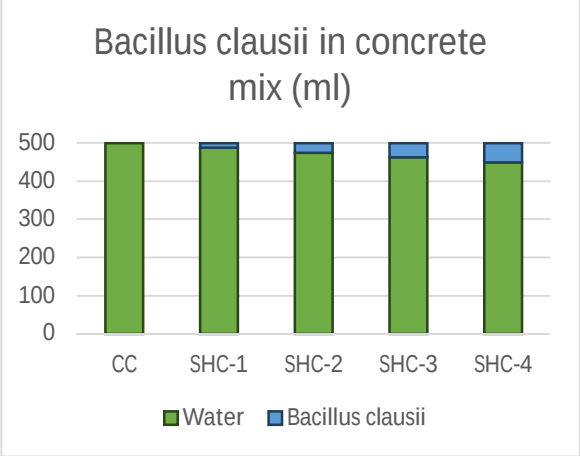
III. MATERIALS

A. *Materials*

Materials in Self-healing concrete is play a very important role in stability and strength increasing so various type of materials are mixing in self-healing concrete like cement, coarse aggregate, fine aggregate and bacillus clausii bacteria for increasing strength of concrete. When the cracks generate the bacteria (bacillus clausii) and fill due to hydration of clinker and carbonation and generate caco3 that fill in the cracks. The materials commonly used in self-healing concrete include.

1) Cement
2) Bacillus clausii
3) Fine aggregate
4) Coarse aggregate
5) Fly ash and Clay

According to IS: 456: 2000 The water cement ratio for the M20 concrete lie between 0.4 to 0.6. In the experimental work water cement ratio consider 0.5 and according to water cement ratio the bacteria (Bacillus clausii) mix in the concrete mix the data given below.



Dig 1 Bacillus variation in concrete mix

IV. EXPERIMENTAL PROCEDURE

1) Slump test
2) Water absorption test
3) Compression test
4) Flexural strength test
5) Split tensile strength test

V. RESULTS

In this study results are collected from the various tests like compression test, flexural strength test, slum test and water absorption test. The every test provide a standard data and calculation after the test and increase the strength of concrete with the help of bacillus clausii bacteria.

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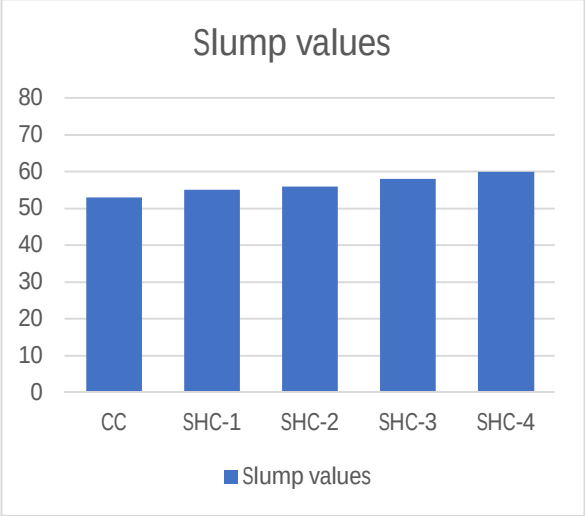
A. Slump Test

The slump values of specimen is lies between 53 to 68.The slump value for control concrete (CC) is 53. For self-healing concrete containing 2.5% Bacillus clausii, the slump value is 56. In the case of SHC-2 (self-healing concrete with 5% bacteria), the slump value is 61. For SHC-3 (self-healing concrete with 7.5% bacteria), the slump value is 63. Finally, for SHC-4 (self-healing concrete with 10% bacteria), the slump value is 68. It is found that there is an increase in slump value with the increase in bacteria percent and workability is also increase. The 13.2% increase in slump value of self-healing concrete-4 (SHC-4) as compare to the control concrete (CC).

Concrete mix	Slump value (mm)
CC	53
SHC-1	55
SHC-2	56
SHC-3	58
SHC-4	60

Table-1 slump test values



Dig 2 Slump value variation of concrete mix

B. Water Absorption Test

The water absorption test measure the water absorbed by the concrete after immersion in water for 24 hours. The value of water absorption for M20 concrete lie 1%-2%. The results shown in the table.

Specimen	**Water absorption [(w2-w1/w1)100] %**
CC	1.2%
SHC-1	1.24%
SHC-2	1.21%
SHC-3	1.22%
SHC-4	1.23%

Table-2 Water absorption values

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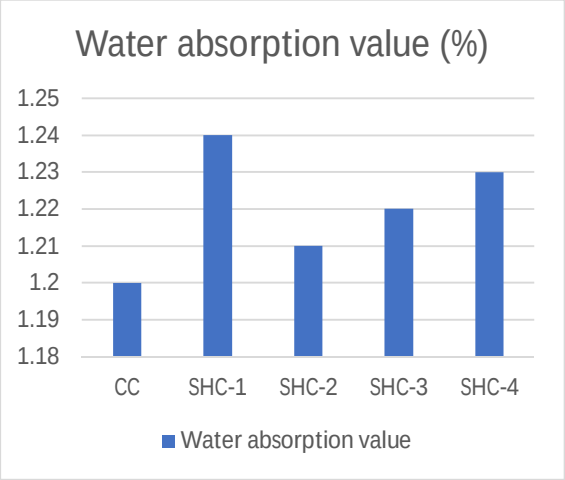

Dig. 3 Water absorption values variation in concrete mix

C. Compression Strength Test

The compressive strength test of concrete, often called the cube test, measure the concrete ability. The strength of concrete measure at the 7 and 28 days.

The compression test results are shown in the table for 7 days in the result strength of control concrete (CC) is 13.5, self-healing concrete with 2.5% bacteria is 13.9 (SHC-1), For SHC-2 with 5% bacteria strength is 14.45, SHC-3 strength is 15.23 with 7.5% bacteria and SHC-4 strength is 16.53 with 10% bacteria.

Concrete mix	Compression strength (N/mm^2) (7 days)			
	1	2	3	Average
CC	13.3	13.7	13.5	13.5
SHC-1	13.5	13.9	14.3	13.9
SHC-2	14.9	14.6	13.86	14.45
SHC-3	14.9	15.1	15.7	15.23
SHC-4	16.8	15.9	16.9	16.53

Table-3 compression strength (7 days)

The compression test results are shown in the table for 28 days in the result strength of control concrete (CC) is 22.15, self-healing concrete with 2.5% bacteria is 22.3(SHC-1), For SHC-2 with 5% bacteria strength is 23.16, SHC-3 strength is 23.57 with 7.5% bacteria and SHC-4 strength is 24.67 with 10% bacteria.

Concrete mix	Compression strength (28 days)			
	1	2	3	Average
CC	22.05	21.9	22.5	22.15
SHC-1	22.1	22.6	22.2	22.3
SHC-2	23.5	22.9	23.1	23.16
SHC-3	22.8	24.1	23.81	23.57
SHC-4	24.6	24.01	25.4	24.67

Table-4 Compression strength (28 days)

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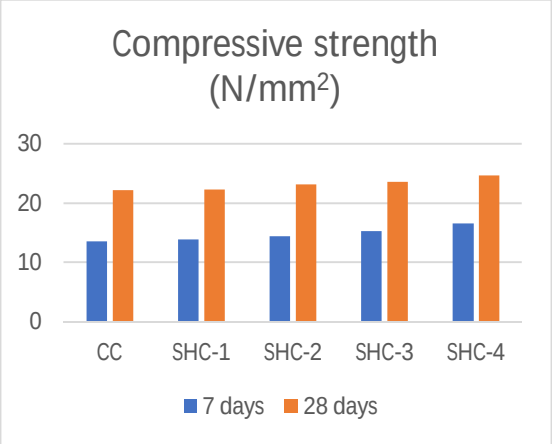


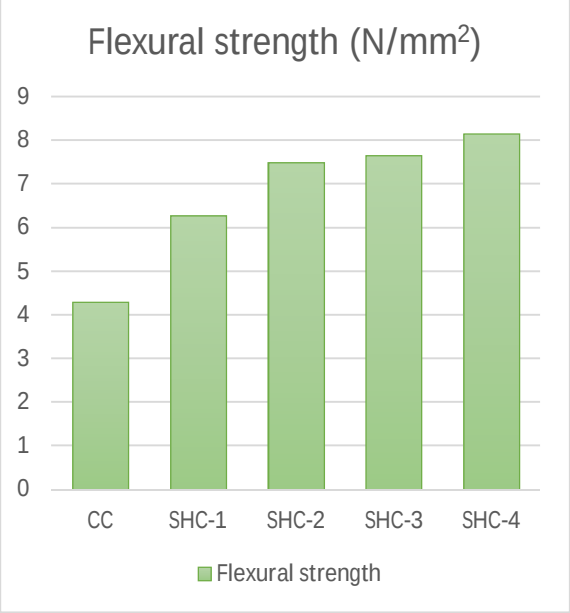
Dig-4 Compressive strength variations

D. Flexural Strength Test

Flexural strength also known as bending strength, is a material property that measures its ability to resist bending or breaking under stress. The average flexural strength of the control concrete (CC) is 5.93 n/mm^2.The results are show a increment in flexural strength after mixing bacteria. The flexural strength of Self-healing concrete (SHC-1) is 6.27 N/mm2, (SHC-2) 7.5, SHC-3 7.66 and SHC-4 8.16.

Concrete mix	Flexural strength (N/mm^2) (28 days)			
	1	2	3	Average strength
CC	5.7	5.9	6.2	5.93
SHC-1	6.1	6.4	6.31	6.27
SHC-2	8.3	7.3	6.9	7.5
SHC-3	8.1	7.6	7.3	7.66
SHC-4	7.4	8.4	8.7	8.16

Table-5 Flexural strength (28 days)



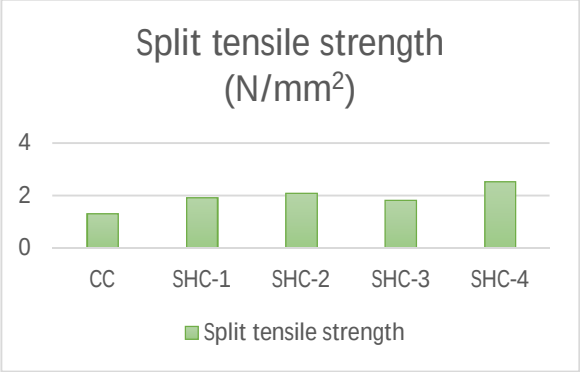
Dig-5 Flexural strength variation

E. Split Tensile Strength Test

The average Split tensile strength of the control concrete (CC) is 1.33 n/mm^2.The results are show a increment in flexural strength after mixing bacteria. The Split tensile strength values of various self-healing concrete with different amount of bacteria (bacillus clausii) Self-healing concrete (SHC-1) is 1.93 N/mm2, (SHC-2) 2.1, SHC-3 1.83 and (SHC-4) 2.56.

Concrete mix	Split tensile strength (N/mm^2)			
	1	2	3	Average strength
CC	1.3	1.5	1.2	1.33
SHC-1	1.8	1.7	2.3	1.93
SHC-2	2.7	2.2	1.9	2.1
SHC-3	2.1	1.6	1.8	1.83
SHC-4	2.7	2.6	2.4	2.56

Table-6 Split tensile strength (28 days)



Dig-6 variation of split tensile strength (28 days)

VI. CONCLUSION

1) The overall development of strength and durability of self-healing concrete by using bacillus clausii bacteria and other material has investigated and compare with control concrete (CC).

2) Bacillus clausii utilized its ability precipitate calcium carbonate (CaCo3) to seal the crack of the concrete and improve its strength.

3) According to IS: 456: 2000 the water cement ratio for the M20 concrete is lies between 0.4 to 0.6 and in the concrete mix it used at 0.5.

4) The compression strength, Flexural strength and split tensile strength is increased after mixing the bacteria (bacillus clausii) as compered to the common concrete.

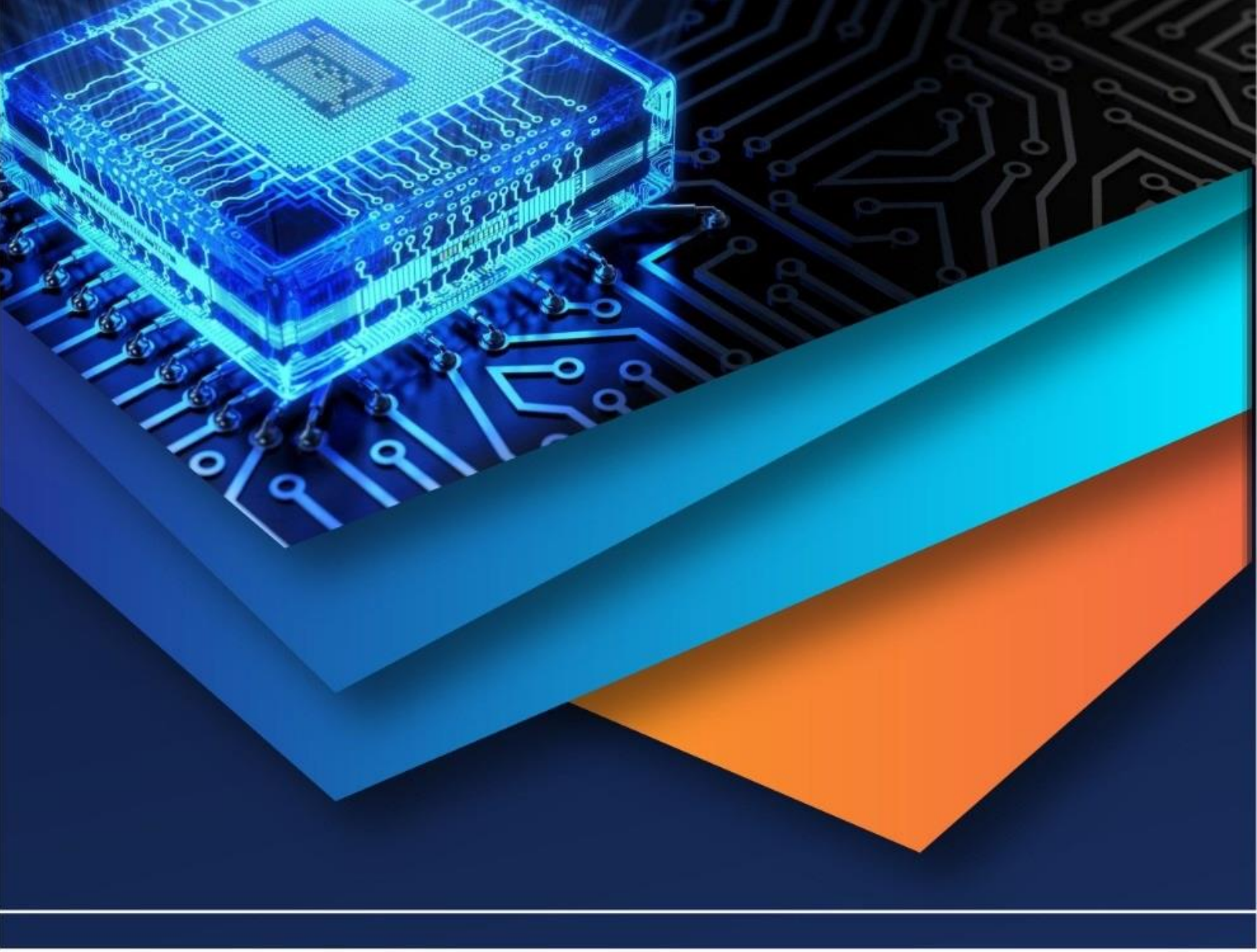
5) Self-healing concrete is not only fill the cracks and voids it also restored the mechanical properties of the structural element partially or completely.

6) The highest compressive strength gained by the SHC-4 (Self-healing concrete-4) with 10% bacteria of the water cement ratio of the concrete and increased the strength of concrete and similarly the flexural strength and split tensile strength is slightly increase after mixing bacillus bacteria.

7) Using of bacteria in concrete is an eco-friendly alternative to traditional repair methods.

REFERENCES

[1] IS 10262:2009 “Indian standard code of recommended guidelines for concrete mix design”, Bureau of Indian standard, New Delhi.
[2] IS: 456:2000 “Indian standard cod for reinforced concrete cod and for water cement ratio” Bureau of Indian standard, New Delhi.
[3] Ghan Shyam, Deepak Mathur “A study of self-healing concrete prepared with bacteria to pavement cracks (2024).
[4] Bang S.S., Galinat J.K. and Ramakrishnan V., ―Calcite precipitation induced by polyurethane immobilized Bacillus pasteurii.” Enzyme Microb. Technol., pp 404– 409,2001.
[5] De Muynck W., Cox K., De Belie N. and Verstraete W. “Bacterial carbonate precipitation as an alternative surface treatment for concrete” Constr. Build. Mater.Vol.22, pp.875 -885,2008.
[6] M. Monishaa, Mrs. S. Nishanthi, “experimental study on strength of self-healing concrete”,



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