

Self-Healing Concrete- A Smart Technology

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ABSTRACT : Concrete is most widely used construction material because of its high compressive strength, relatively low cost etc. one adverse property of concrete is that it is sensitive to crack formation as consequence of its limited tensile strength. For that reason concrete is mostly combined with steel reinforcement to carry tensile loads. Although these re-bars restrict the crack width they are mostly not designed to completely prevent crack formation. Cracks endanger the durability of concrete structures as aggressive gases and liquids may penetrate into the matrix along these cracks and cause damage. Consequently cracks may grow wider and the reinforcement starts to corrode total collapse of structure may occur therefore it seems obvious that inspection maintenance and repair of concrete cracks are all indispensable. However crack repair becomes difficult when cracks are not visible or accessible. Moreover in Europe, costs related to repair works amount to half of the annual construction budget.

KEYWORDS :- Self-healing Concrete, bacillus subtilis, Coarse Aggregate, Bacteria Activation Process, Specimen Design, Compressive Strength.

I. INTRODUCTION

In Concrete is a mixture of cement, fine aggregate, coarse aggregate, and admixture. This mixture is then mixed with water in hand mixer or machine mixer for proper mixing. Fresh concrete or plastic concrete is a freshly mixed material which can be moulded into any shape. The relative quantities of cement, aggregate and water mixed together control the properties of concrete in the wet state as well as in the hardened state. A theoretical water cement ratio calculated from the considerations is not going to give an ideal situation for maximum strength. 100% compaction of concrete is an important parameter for contributing to the maximum strength. Lack of compaction will result in air voids whose damaging effect on strength and durability is equally or more predominant than the presence of capillary activities. Segregation of can be defined as separation of constituent material of concrete. A good concrete is the one in which all the ingredients are properly distributed to make a homogenous mixture. If a sample of concrete exhibits a tendency for separation of say, coarse aggregate from rest of the concrete then sample is said to be showing the tendency of segregation. Such concrete is not only going to be weak; lack of homogeneity is also going to induce all undesirable properties in the hardened concrete. There are considerable differences in sizes and specific gravities of constituent ingredients of concrete. Therefore it is natural that the materials show a tendency to fall apart. Segregation may be of three types viz.

Bleeding is sometime referred to water gain. It is a particular form of segregation in which some of the water from concrete comes out to the surface of the concrete being of the lowest specific gravity among all the ingredients of concrete. Bleeding is predominantly observed in highly wet mix, badly proportioned and insufficient mixed concrete. In thin members like roof slab or road slab and when concrete is placed in sunny weather show excessive bleeding.

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II. METHODOLOGY

1. General: For working out this project, we have done literature survey and collected materials, bacteria. After that we have designed the concrete mix design and casted cubes. The following steps are involved in the implementation of the project.

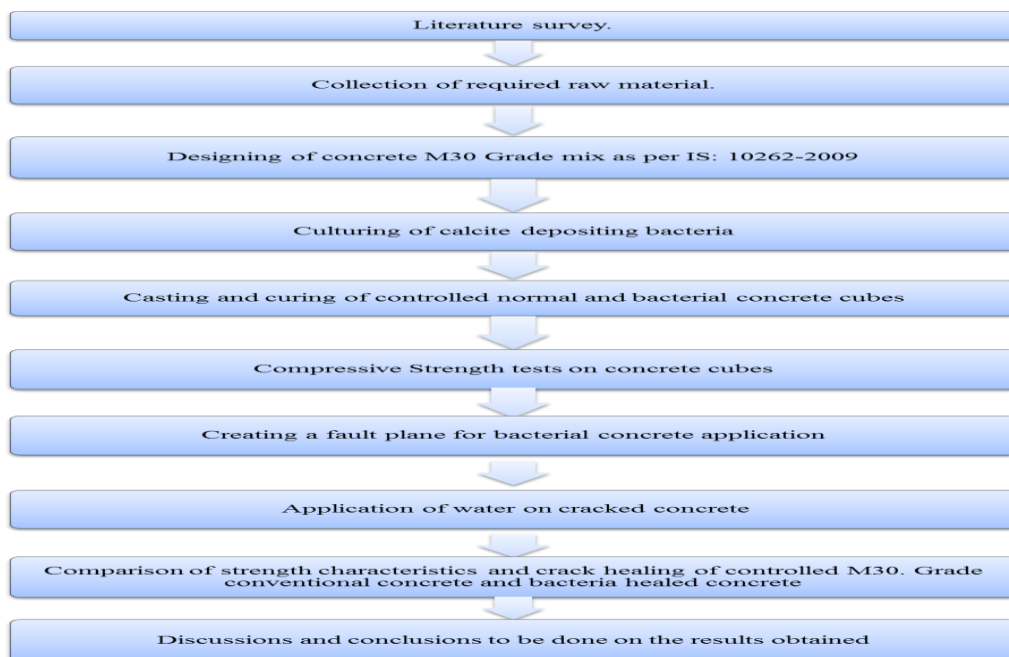


Fig.1 Flow Chart of Methodology

III. PROCEDURE

3.2 Bacteria Activation Process

Procedure:

1. Weigh accurately required quantity of nutrient broth and transfer in plate.
2. Dissolve nutrient broth medium by using sufficient quantity of water plug-it by cotton and wrap with aluminium foil.
3. Sterilize media in autoclave at 121°C temperature for 90 min.
4. After sterilization nutrient. Broil: media is cooled and used for cultivation or growth of bacteria.
5. Inoculate the culture in nutrient broth media and incubate it m incubator at 37°C temperature for 24 to 48 hrs.
6. After incubation, move the flask from incubator and see the results that are observe the growth of the bacteria in the form of turbidity.

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Fig 2: Bacillus Subtilis Bacteria Tube.

IV. EXPERIMENTAL RESULT

4.1 General

Compressive strength test was conducted to know the characteristics of the concrete cube. The test was conducted to investigate the optimum dosage of the bacterial solution under which the cube attains its maximum strength.

4.2 Compressive Strength:-

Compressive strength of concrete cube of M30 grade was carried out after curing period of 7 and 28 days. The results so obtained are tabulated below with their respective age.

Table 4.1. Compressive strength of concrete at 7 day age

Sr. No	Grade	Type of concrete	Notation for cube	Date of casting	Date of testing	Load on cube(KN)	Strength(KN)	Average (KN)
1	M30	Normal Concrete	N1	13/03/2017	10/04/2017	412	18.31	18.56
2	M30	Normal Concrete	N2	13/03/2017	10/04/2017	396	17.6	
3	M30	Normal Concrete	N3	13/03/2017	10/04/2017	445	19.77	
4	M30	1% bacteria	A1	23/03/2017	30/04/2017	616	27.37	27.48
5	M30	1% bacteria	A2	23/03/2017	30/04/2017	602	26.75	
6	M30	1% bacteria	A3	23/03/2017	30/04/2017	637	28.31	
7	M30	2% bacteria	B1	23/03/2017	30/04/2017	732	32.53	32.59
8	M30	2% bacteria	B2	23/03/2017	30/04/2017	754	33.51	
9	M30	2% bacteria	B3	23/03/2017	30/04/2017	714	31.73	
10	M30	3% bacteria	C1	24/03/2017	30/04/2017	825	36.66	37.52
11	M30	3% bacteria	C2	24/03/2017	30/04/2017	865	38.44	
12	M30	3% bacteria	C3	24/03/2017	30/04/2017	843	37.46	

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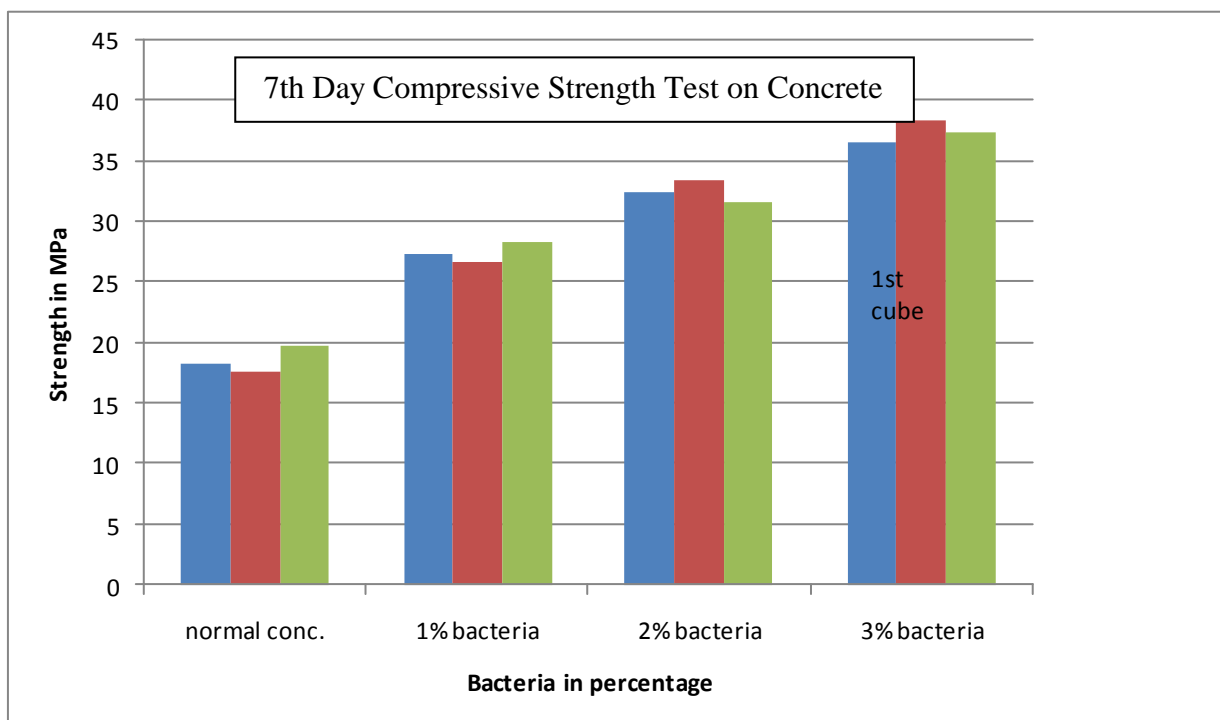
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Table 4.2 Compressive strength of concrete at 28 day age

Sr.No	Grade	Type of concrete	Notation for cube	Date of casting	Date of testing	Load on cube(KN)	Strength (KN)	Average (KN)
1	M30	Normal Concrete	N4	13/03/2017	10/04/2017	639	28.4	30.42
2	M30	Normal Concrete	N5	13/03/2017	10/04/2017	742	32.97	
3	M30	Normal Concrete	N6	13/03/2017	10/04/2017	673	29.91	
4	M30	1% bacteria	A4	24/03/2017	30/04/2017	1028	45.68	47.12
5	M30	1% bacteria	A5	24/03/2017	30/04/2017	1044	46.4	
6	M30	1% bacteria	A6	24/03/2017	30/04/2017	1109	49.28	
7	M30	2% bacteria	B4	24/03/2017	30/04/2017	1268	56.35	54.96
8	M30	2% bacteria	B5	24/03/2017	30/04/2017	1238	55.02	
9	M30	2% bacteria	B6	24/03/2017	30/04/2017	1204	53.51	
10	M30	3% bacteria	C4	24/03/2017	30/04/2017	1296	57.65	58.02
11	M30	3% bacteria	C5	24/03/2017	30/04/2017	1304	57.95	
12	M30	3% bacteria	C6	24/03/2017	30/04/2017	1317	58.53	



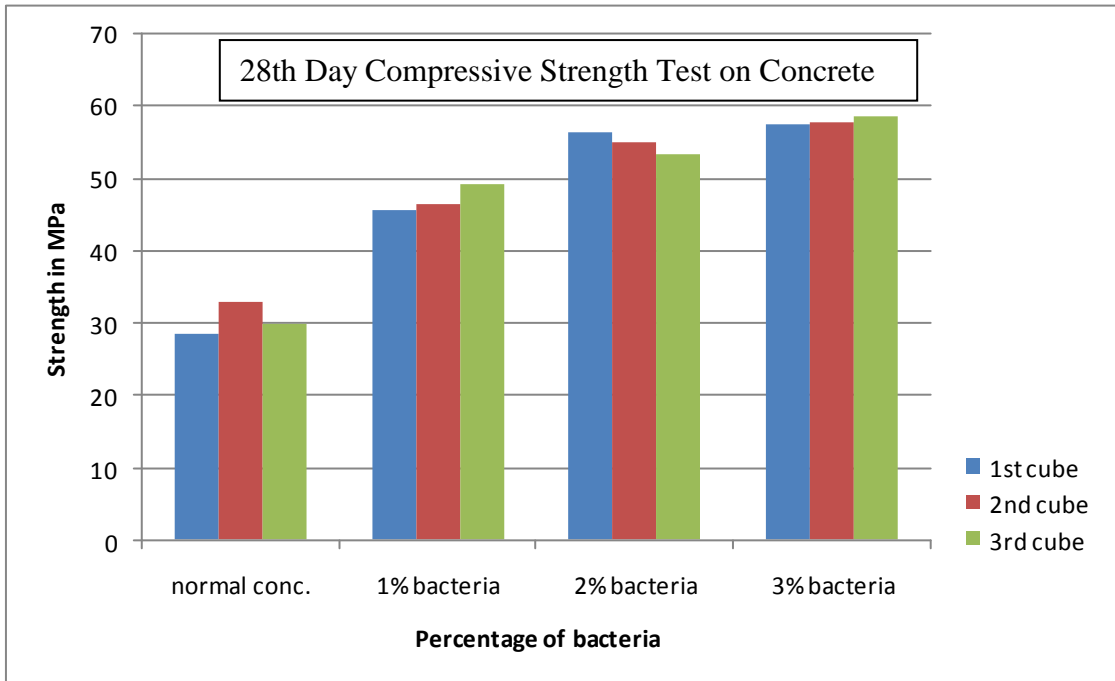
Graph 4.1 7 Day Compressive Strength Tests on Concrete Cube

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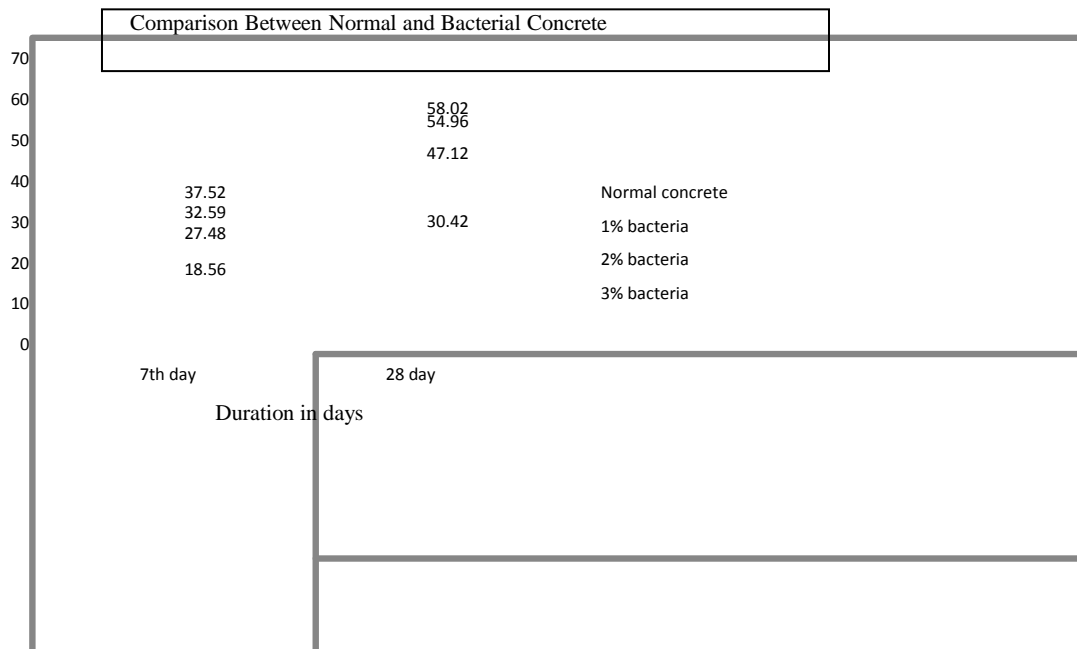
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Graph 4.2 28 Days Compressive Strength Test On Concrete Cube



Graph 4.3 Comparison Between Conventional Concrete And Bacterial Concrete

V. CONCLUSION

The microbe proved to be efficient in enhancing the properties of the concrete by achieving a very high initial strength increase and thus we concluded that the produced calcium carbonate has filled some percentage of void volume

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thereby making the texture more compact and resistive to seepage. When bacterial concrete is fully developed it may become another alternative method to replace and its hazardous effect on environmental pollution. From the experimental study, it concluded that the bacillus subtilis improve the characteristics of cement composite and strength of bacterial concrete increases up to twice of normal concrete.

VI.FUTURE SCOPE

- More study required to reduce the cost of self-healing concrete.
- Further study required to overcome on the limitations of bacillus subtilis bacteria.
- More work should be done on the long term effect of bacteria on human life.

REFERENCES

- 1) K. Van Tittelboom (May 2013), "Self-Healing in Cementitious Materials", ISSN 1996-1944, Vol 6, pp. 2182-2217.
- 2) J. Wang (2012), "Use of silica gel or polyurethane immobilized bacteria for self-healing concrete", XIII International Conference on Durability of Building Materials and Components.
- 3) Kunal R. Patil (February 2016), "Effect of bacteria calcite precipitation on compressive strength of general concrete cubes", International Journal of Innovative Science, Engineering & Technology, ISSN Vol. 3 Issue 2, pp 2348-7968.
- 4) Emily Herbert (2012), "A Sustainable Self-healing Construction Material", Journal of Advanced Concrete Technology, Vol. 10 pp.207-218.
- 5) H. M. Jonkers(2013), "A two Component Bacteria-based Self-healing Concrete", Journal of Concrete Repair, Rehabilitation and Retrofitting II- Alecender et 2009 Taylor & Francis Group, London, ISBN 978-415 pp46860-3.
- 6) Dr. Henk Jonkers (2011), "Bacteria-based self-healing concrete", HERON, Vol. 56 (2011) No. 1/2.
- 7) Tae-Ho Ahn and Toshiharu Kishi (June 2010), "Cracks Self-healing Behavior of Cementitious Composites Incorporating Various Mineral Admixtures", Journal of advanced Concrete Technology Vol. 8, No. 2, PP. 171-186.
- 8) N. De Belie (2014), "Microscopy and Computed Micro-Tomography For Microbial Self-healing In Concrete", XIII International Conference on Durability of Building Materials and Components.
- 9) Hariharan Hari Krishnan (2015), "Improvement of Concrete Durability by Bacterial Carbonate Precipitation", South Indian Journal of Biological Science 2015, 1(2); 90-96 ISSN:2454-4787 .
- 10) Pradeep Kumar A. (April 2015), "An Experimental Work on Concrete by Adding Bacillus Subtilis", International Journal of Engineering Technologies and Engineering (IJETE), Vol. 2, Issue 4, ISSN 2348-8050.
- 11) M. Hanumanth Rao (December 2015), "Improvement in Sulphate Environment Experimental study on Bacterial Cement Composite", International Journal of Computer Engineering in Research, Vol. 2, Issue 12, pp. 953-958.