International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-1, November 2019

Compressive strength of bacterial concrete by varying concentrations of E.Coli and JC3 bacteria for Self-Healing Concrete

Rajani V Akki, Sunil S K, Jitendra S, Dhananjay M

Abstract: ***This paper focuses on how the bacterium produces calcite to repair cracks and thereby increases the strength and durability of the concrete. The bacterial concrete can be made by embedding bacteria in the concrete to make it constantly precipitate calcite. Bacillus E Coli and Bacillus Subtilis JC3 are used for this purpose. Bacillus E coli and Bacillus Subtilis JC3 induced at cell concentration 10^5 cells/ml improves properties of concrete. This paper campaigns for the induction of bacteria in concrete for the promotion of self-healing cracks.***

Keywords: Calcium Carbonate, Environmental friendly, Crack free concrete, Bacterial Concrete.

I. INTRODUCTION

A microbiological culture is a technique for copying microbial living creatures by allowing them to stay in predestined culture media under controlled lab conditions. Microbial social orders are used to choose the sort of living thing. High temperature is one of the most important property that influence the durability of concrete and may cause structural failures, bacteria is used in high strength concrete is exposed to high temperature and effect of compressive strength and weight loss. Advancement in concrete technology is in the strength improvement and its enhancement in durability using pollution free and natural method. It is observed that the strength improvement is significantly higher increase in the strength is due to the formation of calcite. Cracking in the surface layer of concrete mainly reduces its durability, when micro cracks reaches the reinforcement it causes corrosion it may cause structural failure. Microbial mineral precipitation resulting from metabolic activities of some species microorganisms in concrete to improve behavior of concrete. Bacillus E coli and Bacillus Subtilis JC3 induced at cell concentration 10^5 cells/ml has improved properties of concrete. The more calcium carbonate better self-healing effect concentration of bacteria and urea will affect the amount of precipitated calcium carbonate.

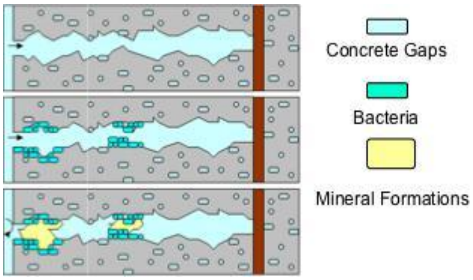

Fig 1: Concrete cube

II. METHODOLOGY

The methodology adopted for the execution of the project work is given below

1) Tests on the basic materials,
2) The culture of bacteria was done along with the counting of different types of bacteria
3) A proper mix design was formulated for M20 grade concrete
4) Various tests on fresh and hardened concrete were carried out.
5) Assessment of conventional concrete versus Self-Healing Concrete made

III. MATERIALS

Materials used for this research:

Table 1: Basic materials

Sl no	Material
1	Cement
2	Fine aggregate
3	Coarse aggregate
4	Bacteria (E.Coli and JC3)

IV. TEST RESULTS

1) **Test results of cement**

Various test conducted on cement (OPC 53 grade) are specific gravity, standard consistency, setting time, fineness test and the results are shown below

Revised Manuscript Received on November 30, 2019.
* Correspondence Author
Rajani V Akki*, School of civil engineering, Reva University, Bengaluru, India. Email: rajni.akki@gmail.com
Sunil S K, Civil engineering department, Acharya Institute of Technology , Bengaluru, India. Email: sunilsk@acharya.ac.in
Jithendra S, Civil engineering department, Acharya Institute of Technology , Bangalore, India. Email jithendras@acharya.ac.in
Dhananjay M, Civil engineering department, Acharya Institute of Technology , Bengaluru, India. Email dhananjaym@acharya.ac.in

Table 2: Test results of cement

Sl no.	Test	Result
1.	Specific gravity	3.16
2.	Initial Setting time	30minutes
3.	Standard consistency	33%
4.	Fineness test	5%

2) **Test results of fine aggregate**

Tests conducted on fine aggregate are specific gravity,water absorption,fineness modulus and the results are as follows

Table 3: Test results of fine aggregate

Sl no.	Test	Result
1	Specific gravity	2.64
2	Water absorption	1.09%
3	Fineness modulus	Confirms zone 2 type

3) **Test results of coarse aggregate**

Various tests conducted on coarse aggregate are specific gravity, water absorption, aggregate crushing value, aggregate impact value, flakiness index value, elongation index value, fineness modulus and the results are given in the table below

Table 4: Test results of coarse aggregate

SL. No.	Particulars	Results
1	Specific gravity	2.6
2	Water absorption	0.47%
3	Aggregate crushing value	21.34%
4	Aggregate impact value	20%
5	Flakiness index value	8.02%
6	Elongation index value	16.04%
7	Fineness modulus	6.89

4) **Bacteria culture**

Bacillus Subtilis JC3 and E.Coli bacteria were cultured in nutrient broth and different standard samples were taken of 400,500 & 600 micro litres/litre. The media is then sterilised in autoclave using distilled water. The components used were peptone, beef extract, Nacl. Urea was also added to it. The pressure is 15lbs for 15 minutes at a temp of 121 degree. The media was then taken for incubation and it is subjected to UV lamps and hepa filter for 15 minutes to further sterilise it and then it is inoculated. The bacteria is then incubated for 24 hours at 37 degree Celsius. Growth and counting of bacteria- It is done using spectrophotometer and haemocytometer respectively. It has been ascertained from the literature evaluation that the optimum concentration for B. Subtilis JC3 is 10^5 cells/ml and for E.Coli is 10^5 cells/mlBacterial solution added to each cube: 100ml. Amount of calcium lactate added to each cube:100gm. Two bacteria specimen were added one being Bacillus Subtilis JC3 another one E.coli

5) **Tests on fresh concrete**

Various tests conducted on fresh concrete are slump cone , vee bee consistometer,compaction factor test and the results are given in table below

Table 5: Test results of fresh concrete

Sl no.	Test	Result
1.	Slump cone	75mm
2.	Vee bee consistometer	2 seconds
3.	Compaction factor	0.92

6) **Tests on hardened concrete**

A cube of 15cmx15cmx15cm dimension cubical moulds are used. These specimens were tested by compression testing machine after 7, 14 and 28days of curing. Load was applied gradually at the rate of 140kg/cm^2/min till the specimen fails and test results are shown in table below. Specimen 1, specimen 2 and specimen 3 are M20 normal grade concrete

Table 6: Test results of hardened concrete

Days	7days	14days	28days
Specimen 1	13.61	19.81	21.94
Specimen 2	13.98	20.01	22.62
Specimen 3	12.85	19.73	22.47

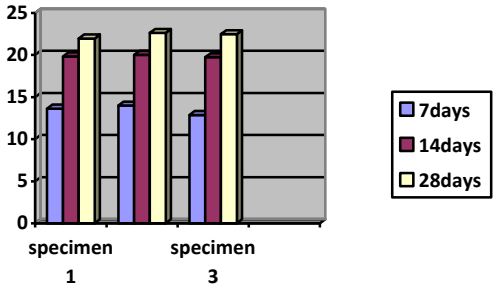

Fig 2: Compressive strength for M20 normal grade concrete

7) **Compressive strength for Bacillus subtilis JC3 at different concentration**

Compressive strength for Bacillus subtilis JC3 at different concentration of 10^3,10^4, 10^5,and 10^6 . The test results are as follows

Table 7: Basic materials

Specimen	7days	14days	28days
SHC(subtilis JC3)10^3	15.86	18.56	22.31
SHC(Subtilis JC3)10^4	17.35	20.91	24.6
SHC(Subtilis JC3)10^5	20.82	26.19	29.64
SHC(Subtilis JC3)10^6	18.5	24.14	26.8

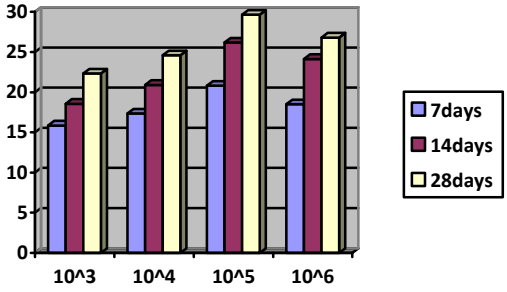

Fig 3: Compressive strength for Bacillus subtilis JC3 at different concentration

8) **Compressive strength for Bacillus E.Coli at different concentration**

Compressive strength for Bacillus E.Coli at different concentration of 10^4, 10^5, 10^6 and10^7 . The test results are as follows

Table 8: Basic materials

Specimen	7days	14days	28days
SHC(E.Coli) 10^4	17.43	21.03	24.1
SHC(E.Coli)10^5	18.18	21.89	24.88
SHC(E.Coli)10^6	17.93	21.23	24.21
SHC(E.Coli)10^7	16.89	20.32	23.42

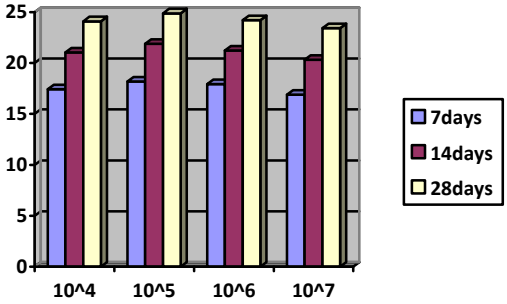

Fig 4: Compressive strength for Bacillus E.Coli at different concentration

V. CONCLUSIONS

The conclusions made from this research,

1) Compressive strength of M20 grade concrete was more at 28days

2) Compressive strength for Bacillus Subtilis JC3 increased substantially at the concentration of 10^5 cells/ml

3) E. Coli induced concrete also showed better properties than the conventional concrete at the concentration of 10^5cells/ml

4) Compressive strength for Bacillus Subtilis JC3 is more than the compressive strength for E.Coli induced concrete

5) Self healing concrete can be developed by the use of different concentrations of bacteria

REFERENCES

1. Use of bacteria to repair cracks in concrete by Kim van Tittelboom a, Nele De BELIE
2. Gollapudi et al,. 1995 stocks-fischer et al.2006 rodriguez Navarro et al. 2003
3. Rafat Saddique, Navneet Kaur chahal, " effect of of ureolytic bacteria on concrete properties", construction and building Materials 25
4. Klass van breugel, Self healing Material Conceps as solution for Aging Infrastructures, 37th conference on our world in concrete and structures August 2012
5. Yuequiang sui, mechanical behaviour of self healing concrete, Master thesis, Louisana State University and agricultural and mechanical college
6. Sonja then, gan seng , Optimisation of Microcapsulation Process for self healing Polymeric Material,Sain Malaysian 40(7)(2011); 795-802
7. Sclangen E, Sangadji S. Addressing infrastructure durability and sustainability by self healing mechanism- Recent advances in self healing concrete and asphalt. Procedia Eng [Internet]. Elsevier B.V.; 54(2013)39-57
8. Pacheco- Torgal F, Labrincha JA. Biotech cementitious materials: some aspects of an innovative methodology for concrete with enhanced durability. Constr Build Mater [Internet]. Elsevier Ltd; 40(2013)1136-57.

AUTHORS PROFILE

Mrs. Rajani V Akki, assistant professor, School Of Civil Engineering , Reva university, Bangalore, holds mtech degree in concrete technology from KIT Mangalore and B. E in civil engineering from JNNCE Shimoga. I have 5years of experience in teaching. I am pursuing Ph.D under VTU. My research intrest are in the areas of concrete technology. I have 2international publication and 2 paper in national Conference

Sunil S K, Assistant professor, Acharya institute of technology (AIT), Holds MTech degree in Structural engineering from VVIT, VTU and B.E in Civil Engineering from JNCCE, Shimoga. I have 5 years of experience in teaching. My research interests are in the areas concrete technology and structural application. I have 2 international publication and 1paper in National Conference

Dhananjay M, Assistant professor, Acharya institute of technology (AIT), Holds MTech degree in Highway Technology from RASTA, VTU and B.E in Civil Engineering from SIT, Tumkur. I have 6 years of experience in teaching. My research interests are in the areas of Traffic Engineering, Pavement Design and Highway Materials. I have 4 international publication and 3 paper in National Conference

Jithendra S, Assistant professor, Acharya institute of technology (AIT), Holds Mtec degree in Environmental Engineering from BMSCE VTU and B.E in civil engineering from PES VTU. I have 6 years of experience in teaching. My research interest are in the areas of Water and waste water treatment, Air pollution and in Biodegradation of oil spills. I have 2 national publication and one paper in National conference. Received beat faculty award in Sambram college of engineering