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Experimental Investigation on Bacterial Concrete Using Bacillus Subtitles

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ABSTRACT

This Project deals with the present investigation is to obtain the performance of the concrete by the microbiologically induced special growth. One such has led to the development of a very special concrete known as bacterial concrete or otherwise called as self-healing concrete where the bacteria is induced in the mortars and concrete to heal up the faults. Researchers with different bacteria proposed different concrete. Here an attempt was made by using the bacteria "Bacillus Subtitles". The Study showed a significant increase in the compressive strength due to the addition of bacteria. When 30ml of Bacillus subtitles is added in M20 grade concrete is attains maximum compressive strength. In Concrete self-healing property is successfully achieved due to addition of bacteria. Bacillus subtitles is used to induce Caco 3 precipitation. The main part of work will focus on how the right conditions can be created for the bacteria not only to concrete but to produce as much calcite as needed to repair cracks.

Keywords: Suspension system, C40, C70 steel, Al-SiC composites, Static structural analysis, Helical Spring.

1. INTRODUCTION

Concrete is a homogeneous mixture and cracks in concrete are inevitable so there is a need for repair which affects the economic life of any structure. To overcome this problem an inherent biomaterial is developed a self-repairing material which can remediate the cracks in concrete. Bacterial concrete is a technique which is highly desirable because the calcium precipitation is induced as a result of microbial activities. This helps in increasing the strength and durability of concrete. As per the results it is clearly observed that there is increasing in compressive strength, tensile strength and durability in bacterial concrete as compared with normal concrete.

Review of Literature

1. International journal of civil engineering and technology (Feb 2017):

To remediate the structural failure due to cracks and fissures, an approach of using bio mineralization in concrete has evolved in recent years. In this method of enhancing the performance of concrete the calcite precipitating spore forming bacteria is introduced into

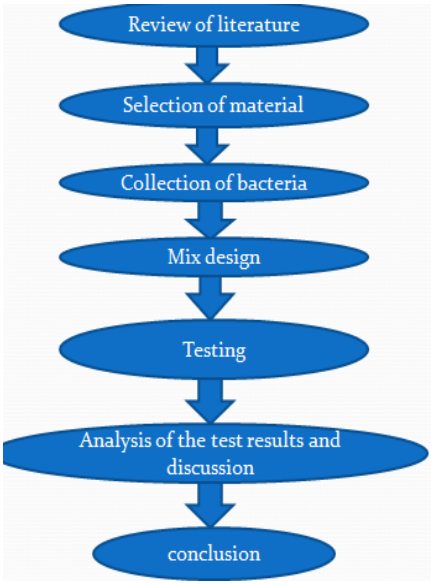
concrete. when water enters into the cracks it reacts with bacteria is introduced into concrete. when water enters into the concrete, it reacts with bacteria and forms precipitates of calcium carbonate, as a byproduct, which fills the cracks and makes crack free concrete.

2. Cement and Concrete Research, Kim Van Tittelboom (2016):

As synthetic polymers, currently used for concrete repair, may be harmful to the environment, the use of a biological repair technique is investigated. Ureolytic bacteria such as bacillus spahaericus are able to precipitate $caco_3$ in their micro environment by ammonium and carbonate.

3. Self -healing concrete repairs itself with bacteria, Ashley P.taylor (2014):

Concrete cracks for much reason, just for starters, the heating and cooling of changing seasons make it expand and contract and the stress produced can also cause cracks. But Dutch researchers are testing a new way to deal with a problem of cracking concrete. Bacteria that when exposed to water, from limestone.



1. METHODOLOGY

3. MATERIALS USED

3.1 Cement

Ordinary Portland cement of 53 grades available in local market is used in the investigation Cement comes in various types and chemical compositions.

Fig 3.1 Cement

"Ordinary Portland Cement" 53 Mega Pascal grade of cement is used for concrete. The properties of cement were determined as per the IS 8112:1989 and results are given in the table

Table 3.1 Physical Properties Of Cement

S.No	Properties	Values
1	Fineness	1%
2	Initial setting time	28min
3	Final setting time	2-3hours
4	Standard consistency	29%
5	Specific gravity	3.15

3.2Coarse Aggregate

Crushed angular aggregate of size 20mm.The material retained on 4.75mm sieve is termed as coarse Aggregate. Crushed stone and natural gravel are the common materials used as coarse aggregate for concrete. Coarse aggregate are obtained by crushing various types of granites, schist, crystalline and lime stone and good quality sand stones. For coarse aggregate crushed 20mm, normal size graded aggregate was used. The specific gravity and water absorption were found to be2.85and1.0%.The grading of aggregate should be conformed to requirement as per IS: 383-1970. Fineness modulus of coarse aggregate is given in the table.

Fig 3.2COARSE AGGREGATE

Table No: 3.2 Physical Properties of Coarse Aggregate

S.No	Properties	Values
1	Fineness	5.7%
2	Initial Setting Time	30 mins
3	Final Setting Time	2- 3 hours
4	Standard Consistency	29%
5	Specific Gravity	3.15

3.3 Fine Aggregate

Natural M-sand is used. The M-sand is one of the major industrial wastes produced in the quarries, several tones of crusher sand is produced. The size of M-Sand is same as the fine aggregate. It is collected from quarries. The M-sand could be used as partial replacement for sand

for some construction application such as concretes, manufacture of pre-cast concrete elements, cement blocks etc. This is mainly used in road works, concrete, cement blocks and as a filler.

Fig.3.3 Fine Aggregate M-Sand

Table No 3.2 Physical Properties of Fine Aggregate

S.No	Property	Natural sand
1	Specific gravity	2.60
2	Bulk relative density(kg/m^3)	1460
3	Absorption (%)	0.98
4	Moisture Content (%)	1.50
5	Fine particles less than 0.075mm (%)	0.6

3.4. Water

Potable water is used. Ordinary drinking water available in the construction laboratory was used for casting all specimens of this investigation. Water helps in dispersing the cement even, so that every particle of the aggregate is coated with it and brought into ultimate contact with the ingredients. It reacts chemically with cement and brings about setting and hardening of cement. It lubricates the mix and compact property. Potable water, free from impurities such as oil, alkalis, acids, salts, sugar and organic materials were used. The quality of water was found to satisfy the requirement if IS456-2000

3.5 Micro Organisms

- Generally classified into 3 categories: 1. On the basis of shape (e.g. spirilla, bacilli, cocci).
- On the basis of gram strain (e.g. gram positive and gram negative). 3. On the basis of oxygen demand (e.g. aerobic and anaerobic).
- This classification is irrespective of the bacteria categorization.
- Various types of bacteria used in construction area are

In this project “BACILLUS SUBTILIS” is used,

- Gram positive soil based bacteria is taken out from a vegetation is used.
- A member of the genus bacillus, bacillus subtitles is rod shaped, and can form a tough protective endosperm allowing it to tolerate extreme environmental conditions. Laboratory cultured bacteria is used.

Fig 3.5 Bacillus Subtilis

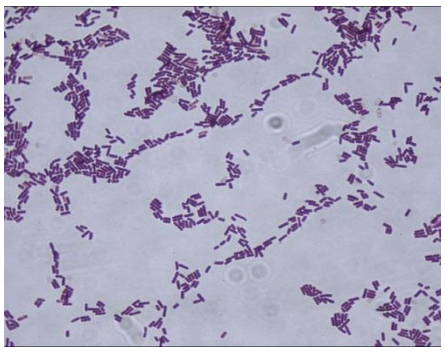


Fig.3.6 Microscopic View of Cultured Bacteria

4. MIX DESIGN

Mix design can be defined as process of selecting suitable ingredients of concrete M20 such as cement, aggregate, water and determining their relative proportions with the object of producing concrete of required minimum strength, workability and durability as economically as possible.

For M20 (1:1.5:3) 10ml, 20ml, 30ml of Bacillus subtitles is mixed.

Fig.4.1Preparation of Dry Mix

Fig.4.2 Addition Of Bacteria

4.2 FRESH CONCRETE TEST

4.1.1 Slump Cone Test

The slump test is an empirical test that measures workability of fresh concrete. More specifically it measures the consistency of concrete is that specific batch. This test is performed to check consistency of freshly made concrete. The slump test result is a slump of the behavior of a compacted inverted cone of concrete under the action of gravity. It measures the consistency or the wetness of concrete.

Fig 4.1.1 slump cone test

Table 4.1.1 Slump Cone Test

S.No	Mix Type	Quantity Of Bacteria Adding	Slump Value
1	M1	0 ml	98mm
2	M2	10 ml	110mm
3	M3	20 ml	115mm
4	M4	30 ml	120mm

4.1.2 Specimen Preparation

- Ordinary grade concrete design mix is made an cubes of 150mm*150mm*150mm are made.
- The cubes are cast with bacteria and without bacteria as per mix design.
- After casting the specimens are re-mould after 24 hours and immediately submerged in clean fresh of the curing tank.

Fig.4.1.2 Specimen Preparation

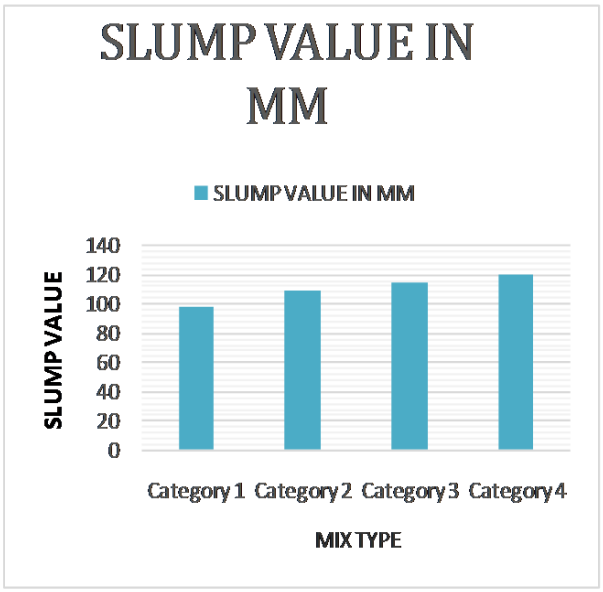


Chart No.4.1.1 Comparison of Slump Cone Test by Bar Chart

4.1.3 Curing

After the cube preparation, immediately submerged in clean fresh water of curing tank. After the completion of curing period the specimens are taken and kept in shade to dry off. The cubes are tested after 7 days, 14days, and 28days and the compressive strength of the cubes have been obtained, using compressive testing machine.

Fig.4.1.3. Curing of Concrete

5. RESULTS AND DISCUSSION

5.1 GENERAL

Testing of concrete plays an important role in controlling and confirming the quality of cement concrete. Cubes and cylinders are tested for its strength characteristics.

5.2 TESTING OF SPECIMEN

To know the strength and structural behavior of concrete we have to conduct tests for observing performance of cubes under certain loading conditions. Here we taken out

1. Compressive Strength Test for 7,14,28 days
2. Scanning Electron Microscope Test

5.3 COMPRESSIVE STRENGTH TEST

The cubes of size 150x150x150mm are placed in the machine such that load is applied on the opposite side of the cubes as casted. Align carefully and load is applied, till the specimen breaks. The formula used for calculation

Compressive Strength= Total Failure Load / Area of the Cube

Fig 5.3 Compression Testing Machine

Table No: 5.3.1 Compressive Strength For 7 Days

S.No	Mix Type	Ml Of Bacteria	Load (Kn)	Compressive Strength N/Mm^2
1	M1	0ml	270	12
2	M2	10ml	280	12.67
3	M3	20ml	350	15.55
4	M4	30ml	375	16.67

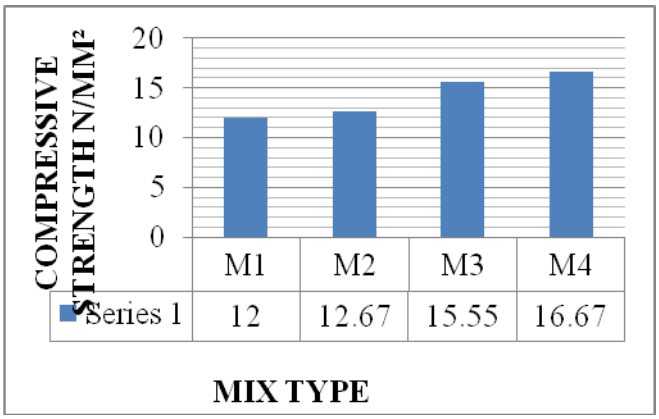


Chart No 5.3.1 Comparison of Compressive Strength for 7 Days

Table No: 5.3.2 Compressive Strength For 14 Days

S.No	Mix Type	Ml Of Bacteria	Load (Kn)	Compressive Strength In N/Mm^2
1	M1	0ml	295	13.11
2	M2	10ml	340	15.11
3	M3	20ml	410	18.22
4	M4	30ml	550	24.44

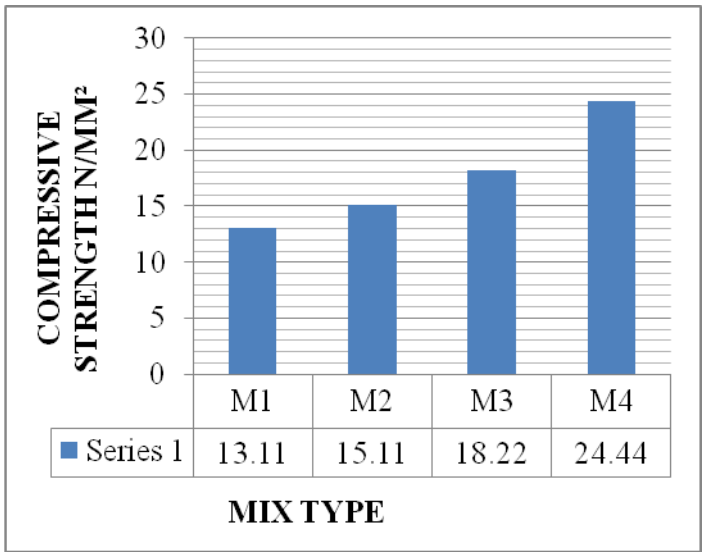


Chart No: 5.3.2 Compressive Strength For 14 Days

Table 5.3.3 Compressive Strength For 28 Days

S.No	Mix Type	Ml Of Bacteria	Load(Kn)	Compressive Strength In N/Mm^2
1	M1	0ml	490	21.78
2	M2	10ml	595	26.43
3	M3	20ml	660	29.32
4	M4	30ml	750	33.32

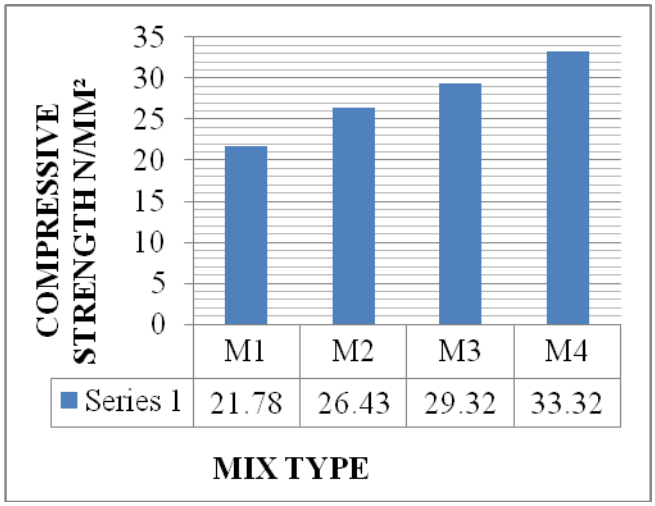


Chart 5.3.3 Comparison of Compressive Strength for 28 Days

5.4 SCANNING ELECTRON MICROSCOPE TEST

Microbial activity of bacterial concrete is tested from scanning electron microscope test. In this scanning electron microscope test analysis the pores were partially filled up by the material growth (added bacteria – bacillus subtitles). Reduction in pore due to that material growth will obviously increase the material strength. Concrete cubes without addition of bacteria were cast and it is observed that there is an improvement in compressive strength for cubes with addition of bacteria.

Fig.5.4.1 Scanning Microscope

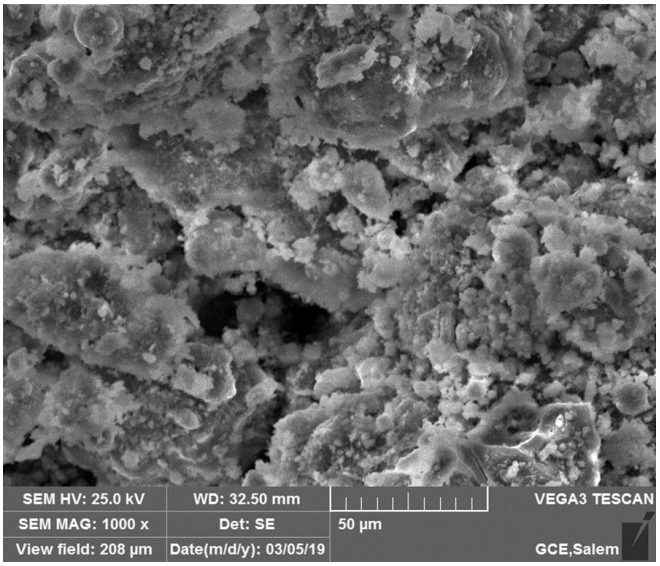


Fig No 5.4.2 ***Sem Result M20grade Concrete***

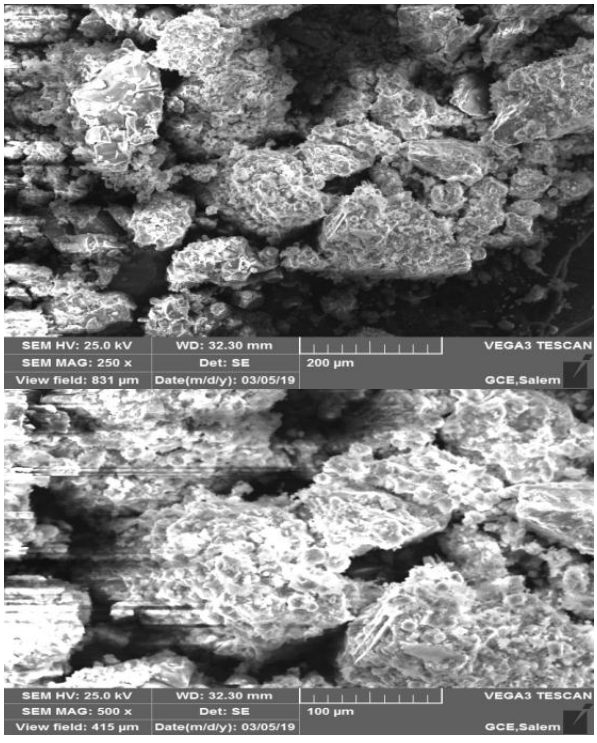


Fig 5.4.3 Sem Results for 10ml Bacterial Concrete At 250 & 500 Magnitude

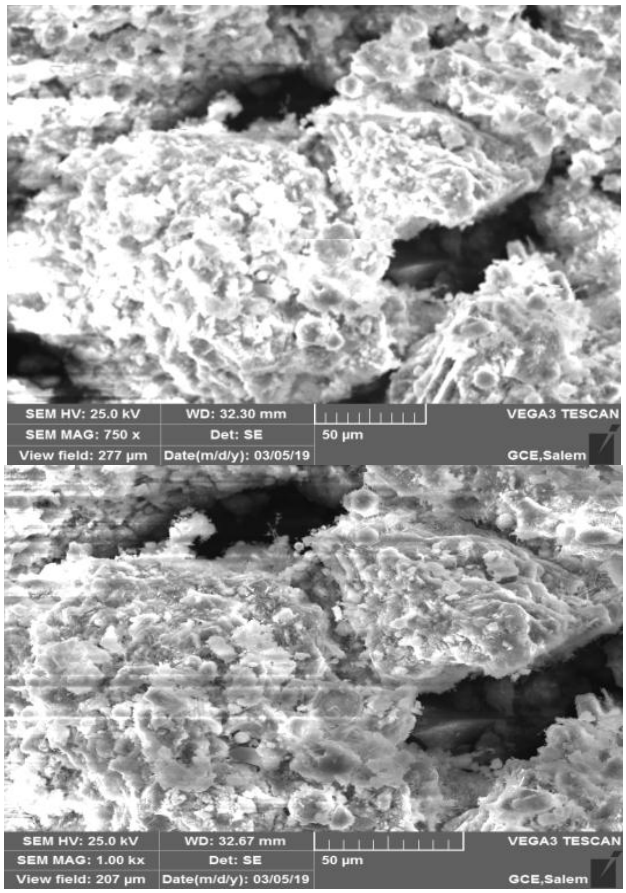


Fig 5.4.3 Sem Results for 10ml Bacterial Concrete At 750 & 1000 Magnitude

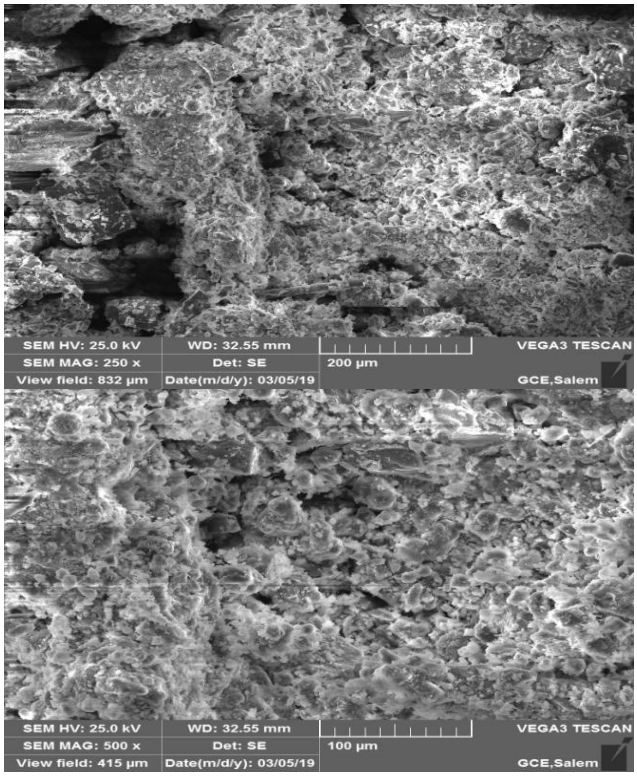


Fig 5.4.4 Sem Test Result for 30ml Baterial Concrete At 250 & 500 Magnitude

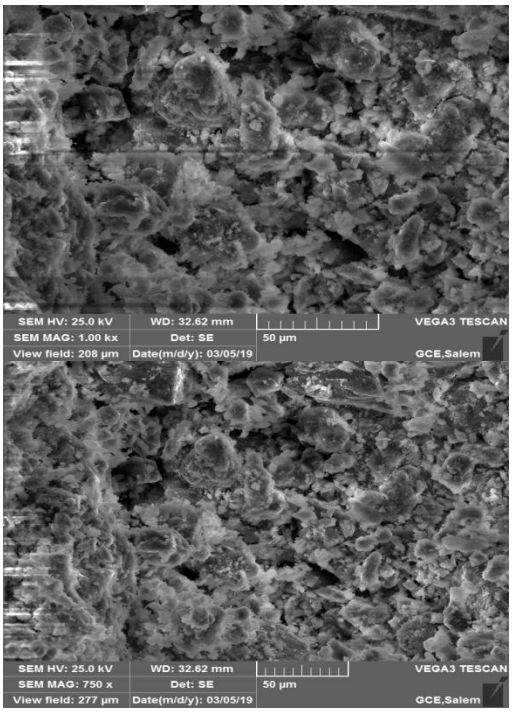


Fig 5.4.5 Sem Test Result For 30ml Bacteria Concrete at 750 & 1000 Magnitude

CONCLUSIONS

Introducing Bacteria in the concrete makes it very beneficial, It improves the property of the concrete which is more than the conventional concrete. Bacteria repairs the cracks in concrete by producing the Calcium Carbonate crystal which block the cracks and repair it. The development of calcium carbonate crystal Decreases the water permeability by decreasing the width of cracks from 0.5 to 0.35mm.The regular inspection of the concrete will be less need due to use of self-healing material used in the concrete. The life of the concrete will be high while comparing to conventional concrete. It gives the high durability and strength while comparing to normal conventional concrete. By the addition of 30ml bacteria in M20 concrete, it gives the compressive strength equal to M25 concrete.

REFERENCES

1. IS 10262," Recommended Guideline for Concrete Mix Design".
2. IS 456:2000," Plain and reinforced concrete code of practice".
3. Cement and Concrete Research, Kim Van Tittelboom (2016)
4. Self -healing concrete repairs itself with bacteria, Ashley P.taylor (2014)
5. Bio-concrete uses bacteria to heal itself, kyta Mandel (2013)
6. Sathishkumar.R,"Experimental study on properties of concrete made with alternate construction material", International Journal of Modern Engineering research (IJMER), vol.2, issue.5, sep-oct-2012.
7. Self-healing concrete repairs itself with bacteria, Ashley P. Taylor(2012)
8. Engineered bacteria can fill cracks in aging concrete Prof.clayDillow, (2011)
9. Engineered bacteria can fill cracks in aging concrete, professor. Clay Dillow, 2010 Bacterial concrete, Alan R.Wilson, (2010)
10. S. S. Bang, J. J. Lippert, U. Yerra, S. Mulukutla,and V.Ramakrishnan,"Microbial calcite,abio-basedsmart nanomaterialin concrete remediation," *International Journal of Smart and Nano Materials*, vol.1, no.1,2010, pp. 28–39.

11. N.DeBelieandW.De Muynck,"Crack repair inconcreteusingbio deposition, *"Concrete Repair, Rehabilitation and Retrofitting II*,2009, pp.777–782.
12. Self-healing concrete, Damian Arnold, (2008)
13. Bacterial concrete, SakinaNajmuddin saifaat.al, (2007)
14. Bacterial concrete, Ravindranath, N. Kannan, Likhit M.L[2], (2007)
15. Self-healing concrete, Jagadeesha Kumar B g, R.Prabhakara and pushpa, (2005)
16. V. Ramakrishnan, R. K.Panchalan,S.S.Bang, andR.City,"Improvementof Concrete Durability By Bacterial Mineral Precipitation," *InternationalConferenceonFracture*,2005.
17. V. Bang, S.S., Galinat, J.K., and Ramakrishnan,"Cal-cite PrecipitationInduced by Polyurethane Immobilized Bacillus Pasteurii,"*Enzymeand MicrobialTechnology*, vol.28,2001, pp.404–409.
18. Stocks-Fischer, S., Galinat, J.K., and Bang, S.S."MicrobiologicalPrecipitationof CaCO3," *Soil Biology and Biochemistry*, 31, 1999, 1563-1571.

Conflict of Interest

None of the authors have any conflicts of interest to declare.