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Effect of Bacteria on 28days Split Tensile Strength of Concrete and Its Stress-Strain Curves

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Abstract: **Cracks in concrete are inevitable and are one of the inherent weaknesses of concrete. Water and other salts seep through these cracks, corrosion initiates, and thus reduces the life of concrete. Concrete structures usually show some self-healing capacity, i.e. the ability to heal or seal freshly formed micro-cracks. This property is mainly due to the presence of non-hydrated excess cement particles in the materials matrix, which undergo delayed or secondary hydration upon reaction with water. Scientists have developed a new type of self-healing concrete in which bacteria mediate the production of minerals which rapidly seal freshly formed cracks, a process that concomitantly decreases concrete permeability, and thus better protects embedded steel reinforcement from corrosion. Bacterial concrete is a material, which can successfully remediate cracks in concrete. This technique is highly desirable because the mineral precipitation induced as a result of microbial activities is pollution free and natural. As the cell wall of bacteria is negatively charged, metal accumulation (calcite) on the surface of the wall is substantial, thus the entire cell becomes crystalline and they eventually plug the pores and cracks in concrete. It was found that use of bacteria improves the stiffness and compressive strength of concrete.**

Keywords: **Bacterial concrete, Self-Healing Capacity, Crack Formation, Durability, Split Tensile Strength, Stress-Strain curves.**

1. INTRODUCTION

1.1 GENERAL:

Concrete is one of the most widely used construction materials in the world today. It is made by mixing small pieces of natural stone (called aggregate) together with a mortar of sand, water, Portland cement and possibly other cementations materials. Properly designed and constructed, concrete structures compare favorably with regard to economy, durability and functionality with structures made from other structural materials, such as steel and timber. It is the second most widely consumed substance on earth, after water. Microcracks are the main cause to structural failure.One way to circumvent costly manual maintenance and repair is to incorporate an autonomous self-healing mechanism in concrete. One such an alternative repair mechanism is currently being studied, i.e. a novel technique based on the application of bio mineralization of bacteria in concrete. The applicability of specifically calcite mineral precipitating bacteria for concrete repair and plugging of pores and cracks in concrete has been recently investigated and studies on the possibility of using specific bacteria as a sustainable and concrete embedded self-healing agent was studied and results from ongoing studies are discussed. bacteria like PSEUDONOMAS AEROGINOSA is currently being used for repair of concrete, hence the use of a biological repair technique in concrete is focused. Recently, it is found that microbial mineral precipitation resulting from metabolic activities of favourable micro-organisms in concrete improved the overall behaviour of concrete.

The Bacterial spores start germinating only when they make contact with concrete – triggered by the very specific pH of the material – and they have a built-in self-destruct gene that prevents them from proliferating away from the concrete target. Once the cells have germinated, they swarm down the fine cracks in the concrete and are able to sense when they reach the bottom because of the clumping of the bacteria, or so-called quorum sensing.

This clumping activates the concrete repair process and the cells differentiate into three types: cells which produce calcium carbonate crystals, cells which become filamentous – acting as reinforcing fibers – and thirdly cells that produce a glue that acts as a binding agent and fills the gap.

1.2 OBJECTIVE OF STUDY:

The objective of the project is to determine and compared the mechanical properties of Bacterial concrete and normal concrete such as compressive strength, flexural strength, split tensile strength, and analysing 28days stress-strain behaviour for conventional and 5ml,10ml,15ml bacterial concretes.

1.3 SCOPE OF STUDY:

Bacteria used in concrete can also be used while the construction of buildings ,so the entire scope of study is based on using bacteria under cool condition, added to concrete ,properly cured in water ,tests conducted for fresh concrete and hardened concrete.

The compatibility of Bacterial concrete in taking up load coming to the frame of the building is being found out by testing the laboratory specimen of beams and columns.

2. METHODOLOGY

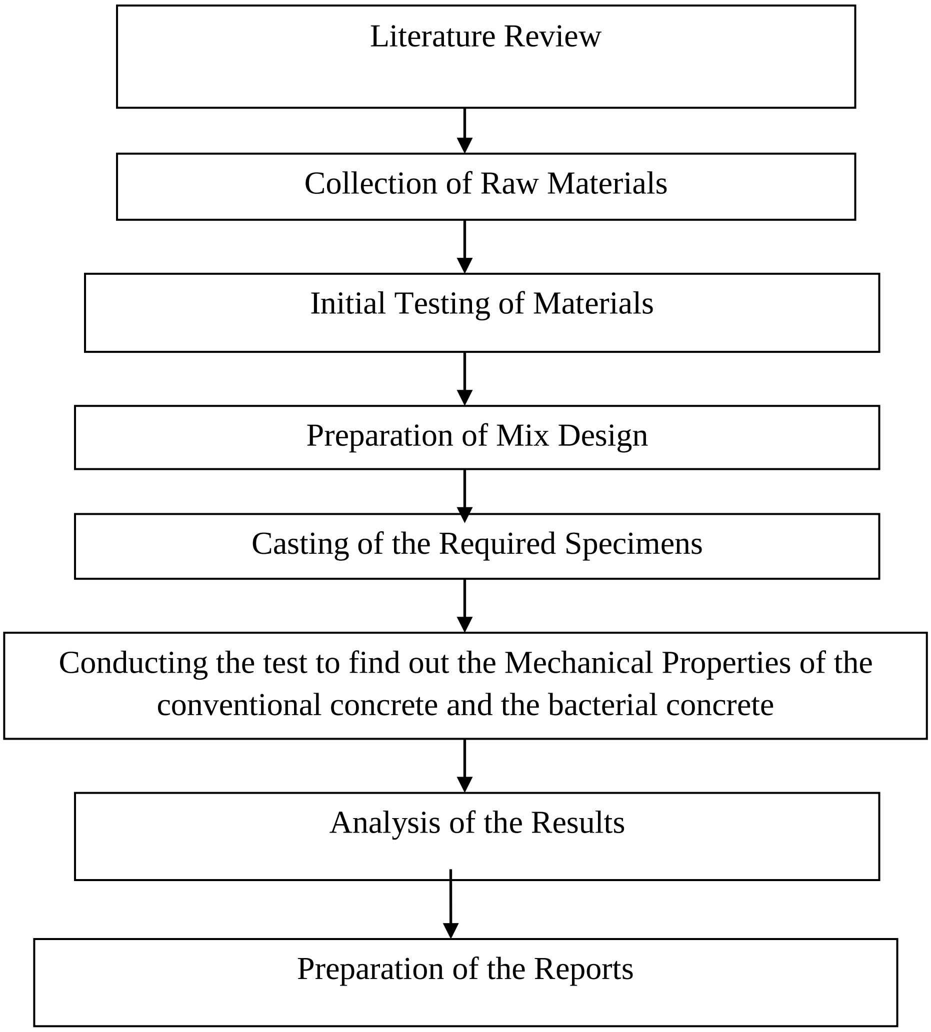

Figure:1

3. MIX DESIGN OF CONCRETE

The strength is mainly influenced by water cement ratio, and is almost independent of the other parameters the properties of concrete with a compressive strength of 20MPa,are influenced by the properties of aggregate in addition to that of water cement ratio. To obtain good strength, it is necessary to use the lowest possible w/c ratio which affects the workability of the mix. In the present state of art, concrete which has a desired 28days compressive strength of minimum 20 MPa, can be made by suitable proportion of the ingredients using normal methods for compacting the mixes.

4. MIX DESIGN PROCEDURE

4.1 MIX DESI GN FOR GRADE M_{20}(WITHOUT BACTERIA):

Cement: Fine aggregates: coarse aggregates: water

290: 696: 1429: 145

1: 2.4: 4.93: 0.5

4.1.1 5ML BACTERIAL MIX:

5ml of bacteria(pseudonomas aeroginosa) was added to every 500 ml of water while mixing concrete, so a total of 65ml of bacteria was added to 6.5 liters of water used for mixing cement of 14kgs.

4.1.2. 10ML BACTERIAL MIX:

10ML of bacteria (pseudonomas aeroginosa) was added to every 500 ml of water while mixing concrete,so a total of 126ml of bacteria was added to 6.5 liters of water used for mixing cement of 14kgs.

4.1.3 15ML BACTERIAL MIX:

15ML of bacteria (pseudonomas aeroginosa) was added to every 500 ml of water while mixing concrete,so a total of 195ml of bacteria was added to 6.5 liters of water used for mixing cement of 14kgs.

5. EXPERIMENTAL RESULTS

5. 1 WORKABILITY TEST RESULTS:

- **CONVENTIONAL CONCRETE:**

compaction factor =0.88

vee-bee value= 8 sec

slump loss=5mm

- **5ML BACTERIAL COCNCRETE:**

compaction factor =0.89

vee-bee value= 4 sec

slump loss=13mm

- **10ML BACTERIAL COCNCRETE:**

compaction factor =0.94

vee-bee value= 4 sec

slump loss=15mm

- **15ML BACTERIAL COCNCRETE:**

compaction factor =0.95

vee-bee value= 3 sec

slump loss=17mm

5.2 FINAL TEST RESULTS:

Type of Concrete	Mix Designation	ml of bacterial Addition in water	Average split tensile Strength of 3 cubes(Mpa) @28 days
Conventional Concrete	T0	0	1.82
Bacterial Concrete	T1	5	2.36
Bacterial Concrete	T2	10	2.59
Bacterial Concrete	T3	15	2.65

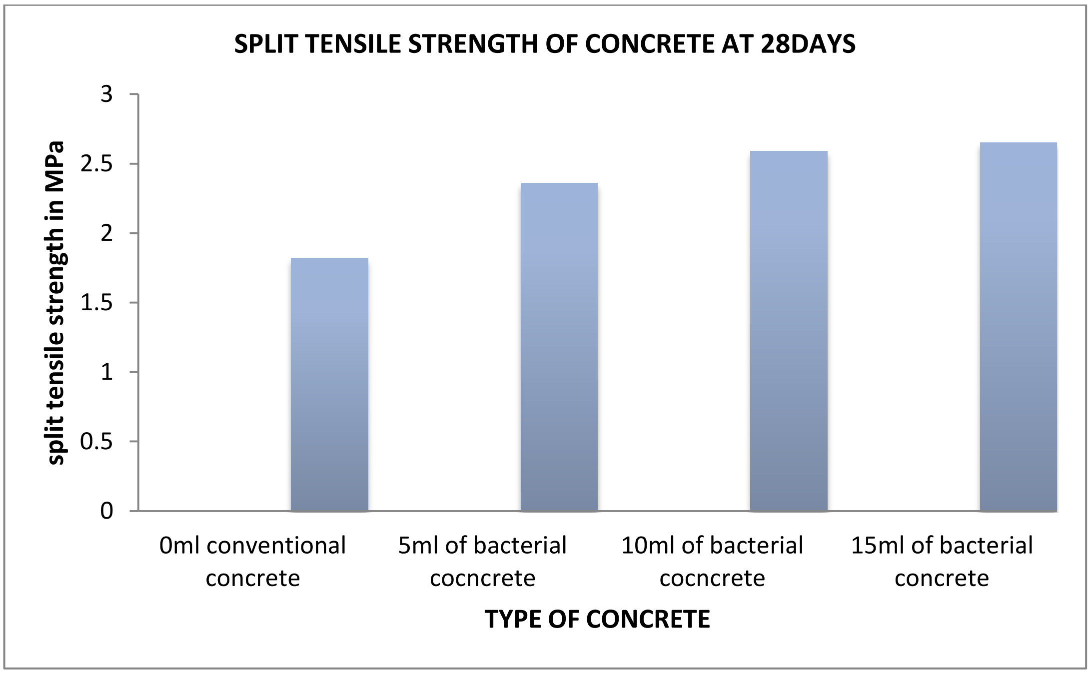

Figure:2 Showing Comparison of Split Tensile strengths of conventional concrete & Bacterial concrete at 28 days

5.3 STRESS-STRAIN CURVES OF M20 CONVENTIONAL CONCRETE, 5% BACTERIAL CONCRETE, 10% BACTERIAL CONCRETE AND 15% BACTERIAL CONCRETE (28 days):

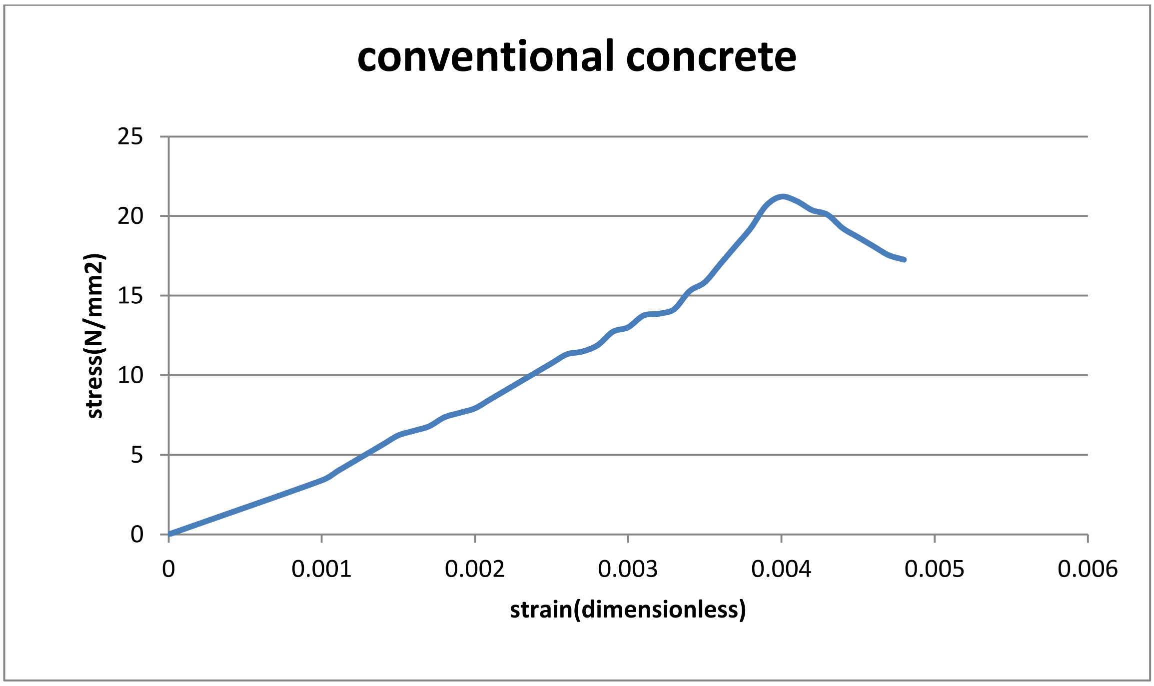

Figure:3 Stress-Strain curve for 28days conventional concrete

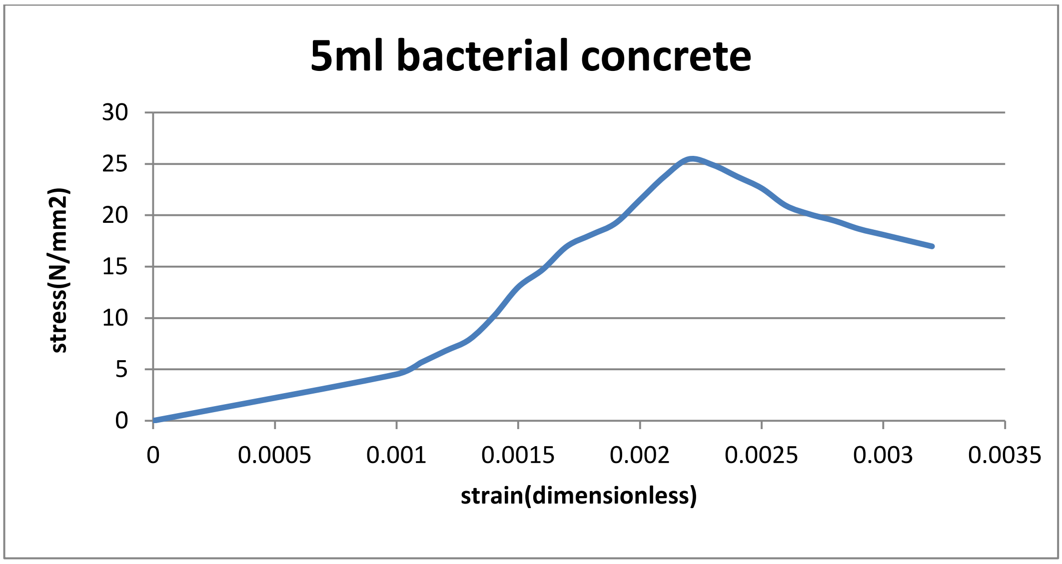

Figure:4 Stress-Strain curve for 28days 5ml bacterial concrete

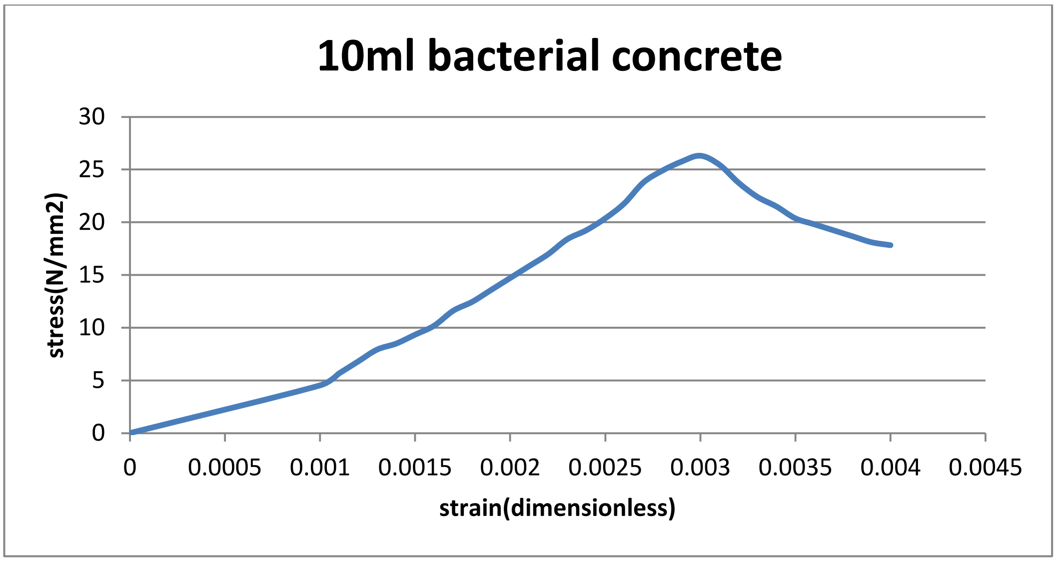

Figure:5 Stress-Strain curve for 28days 10ml bacterial concrete

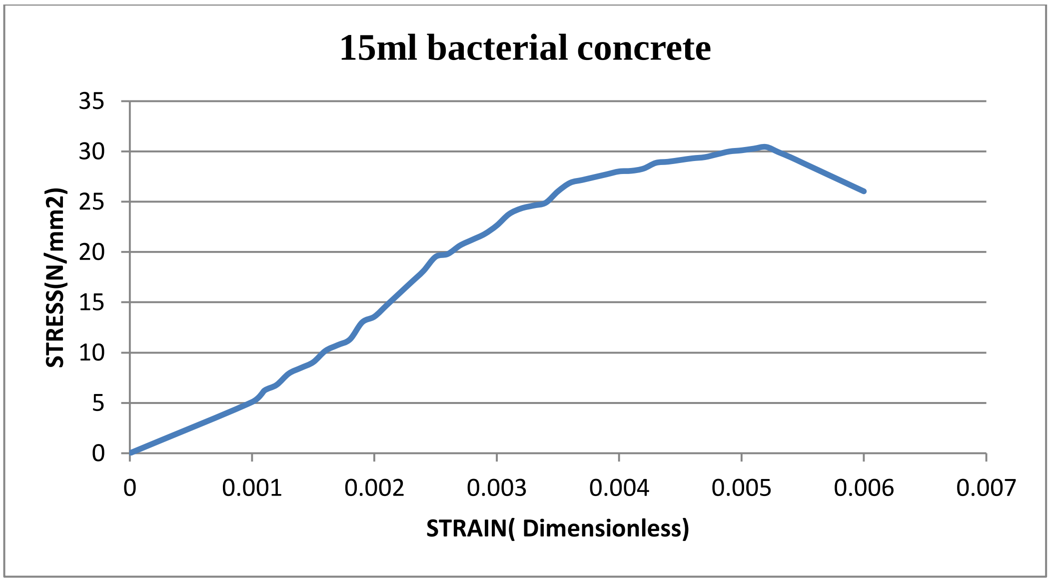

Figure:6 Stress-Strain curve for 28days 15ml bacterial concrete

6. DISCUSSION OF TEST RESULTS

1. With the addition of 5ml,10ml,15ml bacteria into concrete, the average Split Tensile strength increased by 29%,42%,46% respectively at 28 Days

2. The above mentioned addition in strength may be due to the interaction of bacteria with concrete forming a precipitate which furthers helps in providing a bond between cement molecules.

7. CONCLUSION

From the tests conducted on bacterial and Conventional Concrete Specimens, the following conclusion have been drawn

- The above addition in strength is because of adding bacterial liquid to concrete, which generates calcite precipitate in concrete matrix.

- Therefore, due to addition of small amount (5ml) of bacterial liquid to the conventional concrete, a great addition in Split tensile is observed. This is mainly due to production of calcite precipitate in concrete (hardened) when it is cured properly with water,thus this calcite acts as a cement agent and recovers the whole cracked area to the inner side of concrete surface.

- However, among the different proportions of bacteria added (5ml, 10ml, 15ml) to concrete mix, 15ml bacterial concrete gives the best results in Split Tensile test.

- The main advantage of bacterial concrete is that we can improve the life span of a concrete structure up to 200 years if this technology has been further enhanced and bring into special importance.

- These bacterial concrete is a self-healing concrete which heals cracks for effective duration of initial 5 hours up to as long as possible and the bacterial cell life is 200years.

- These bacterial usages can save the cement and the construction of a building can be made economical, as we know cement production gives rise to production of carbon dioxide to the higher levels, so further controlling is made very effective.

- These bacterial concrete usages can be made common in next few decades heading towards victory of civil engineering structures as per the scientific view of highly authorized laboratories.

REFERENCES

[1] International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 9- Sep 2013

[2] IS 10262-2009 Concrete mix proportioning - Guidelines' Bureau of Indian Standards, New Delhi, India.

[3] IS 12269-1987 Specification for 53 grade Portland Cement' Bureau of Indian Standards, New Delhi, India.

[4] Neville, A.M. (1996) Properties of concrete (4th edition). Pearson Higher Education, Prentice Hall, New Jersey.

[5] Ramachandran, S.K., Ramakrishnan, V., and Bang, S.S. (2001) remediation of concrete using micro-organisms. ACI Materials Journal 98(1):3-9.

[6] Self-healing of concrete (Gruyaert E., Snoeck D., Steuperaert S., Van Tittelboom K, Wang J.)

[7] Microbial Concrete: A Way to Enhance Durability of Building Structures Varenyam Achal1 , Abhijit Mukherjee2 , and M. Sudhakara Reddy1

[8] Achal, V., Mukherjee, A., Basu, P. C., and Reddy, M. S. (2009a). "Lactose mother liquor as an alternative nutrient source for microbial concrete production by Sporosarcina pasteurii." Journal of Industrial Microbiology and Biotechnology, 36, 433-438.

[9] Achal, V., Mukherjee, A., Basu, P. C., and Reddy, M. S. (2009b). "Strain improvement of Sporosarcina pasteurii for enhanced urease and calcite production." Journal of Industrial Microbiology and Biotechnology, 36, 981-988.