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Increasing the Strength of a Concrete Mix by Applying a Useful Micro-Organism (Bacteria) in It

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***Abstract* – The main aim is to interpretate the application of dormant (Alive but not growing) and having potential to work successfully in order to increase concrete mix strength. The potable water which will be in contact with concrete on curing will help in activating these microbes which ultimately will provide strength to concrete mix by metabolic activities and Calcium Carbonate precipitation. Although concrete provide unfriendly environment for microbes but "BACILLUS SPHAERICUS" is able to cope up in this environment having pH on higher side and deficiency of the nutrients. Still it helps in increasing overall strength of concrete mix and making it more durable than in controlled conditions. It was also found that this origin of microbes did not proved to have been adversely affecting the strength of concrete.**

***Keywords* – Freezing Effects, Microbes, Specific Gravity, Deficiency, Precipitation.**

I. INTRODUCTION

The basic cause of failure for a building is the creation of cracks in it which may be in the form of freezing effects and reactions, shrinking phenomenon or due to the forces like compressive and tensile loads. The basic disadvantage of cracks in concrete is that the reinforced bars undergoes corrosion due to action of chloride ions along with Hydrogen Dioxide. Thus the new technique is injecting helpful microbes which can help in the phenomenon of Calcium Carbonate precipitation; which has been well known as Microbiologically Enhanced Crack Remediation (MECR).

This type of concrete prepared by help of Bacteria is called as " Bacterial Concrete"[2] which can be prepared by the cells produced by Bacteria and helps in developing into new bacteria. As a result precipitation of Calcium Carbonate goes on, bacteria namely B.Sphaericus is utilized for precipitation. These Microbes convert Urea into Ammonia and Carbon Dioxide which ultimately increases pH causing collection of insoluble Calcium Carbonate.[3] This growth of microbes helps in improving the developed cracks of the concrete infrastructure.[4]

This accumulation of Calcite helps in preparing Bioconcrete. The main advantage is that the spores of B.Sphaericus remain upto 200years. The spores are such that they do not allow further growth of bacteria but as soon as they come in contact with water they become active. As a result they fill the cracks by Calcite precipitation.

Ultimately no more water and other additives can enter inside. On performing the acid test, it was found that bacterial concrete was able to bear acid attack with 4.5% more efficiency than normal concrete .These microbes break down urea and thus enhances pH to rise and helps in accumulating calcite. Thus their cells remains enclosed with carbonates of calcium.

II. MATERIALS AND METHODS

Cement available in market is taken along with fine aggregate passing 4.75mm sieve. The coarse aggregate should be of well grade. Water should be free from impurities. The nutrient agar slants were kept under controlled conditions so that no other microbes can grow.

III. TEST ON AGGREGATES

The gravels used should have certain characteristics like there specific gravity should be 2.88- 2.91 Their water absorption capacity should not exceed 1.95 % and the bulk density should not be more than 1.7

IV. TEST ON CEMENT

The specific gravity of cement used should be 3.12 , the consistency limit of cement should be 31.5 to 32.6% Its initial setting time should be around 85 to 90 minutes. The final setting time should be around 230 to 235 minutes.

Interpretation of Calcium Carbonate from Bacterial Cultures

The precipitation of Calcium Carbonates was calculated by the help of lased Raman Spectroscopy[10] The end stage of Bacterial test sample value was specified by EBT which converts steel from pink to blue colour.

Specimens used for different Test

For the testing of compressive load and Tensile load bearing capacities, different cubes of sizes 10cm*10cm*10cm and Cylinders having 10cm Diameter and 20cm height were prepared. These specimens were demoulded after a day but they were cured properly for 28 days. Cubes and Cylinders were prepared with and without the use of Bacillus Sphaericus.

Comparative Results

Both Compressive and Tensile Loads were done over normal and Bacterial Concrete. The result was that the Compressive Strength of specimen having microbes was more than conventional type of Concrete. It is shown in the form of Table 1 and 2.

V. Result of Compressive Test

Table-1

Type of specimen	Compressive Strength	% Change
Conventional	24.03	
Containing Micro-organism	36.47	51.76 % Increment

Table-2

Serial No.	Compressive Strength (Conventional Concrete) N/mm^2	Compressive Strength (Bacterial Concrete) N/mm^2	% Change
1.	19.46	24.76	27.23% increment
2.	22.94	33.84	47.51% increment
3.	33.85	45.32	33.88% increment

VI. Result of Tensile Strength Test

No. of days	Tensile Strength (Conventional Concrete) in N/mm^2	Tensile Strength (Bacterial Concrete) in N/mm^2	% Change
3	3.65	4.12	12.87% increment
7	4.47	5.19	16.10% increment
28	4.72	5.63	19.28% increment

Thus it was observed that compressive strength increased by 27.23% , 47.51% and 33.88% at 3rd, 7th and 28th day respectively by the help of microbes as compared to normal concrete.

Tensile Test

After 28days curing cylinder specimens were tested. The specimen containing microorganism had more tensile load bearing capacity than nominal concrete. There was an increase of 12.87%, 16.10% and 19.28% in tensile strength by help of B. Sphaericus microbe.

This study helped to justify whether bacteria can act as a helpful agent for concrete or not. This bacteria was able to develop at high pH only (about 11-12). Also their cell walls protected them from several mechanical and chemical effects. Hence these microbes can retard pH value of 12-13 in internal concrete and can be alive for nearly 180-195 years. A suitable no. of microbes are allowed to be mixed in concrete so that they do not grow but remain alive. They only start working when coming in contact with water. Finally the micro level pores can be filled or covered through precipitation of Calcium Carbonates, preventing further entry of water and chemicals.

VII. Conclusion

The final conclusion is that the vacant space can be sealed by these bacteria in addition of water having minerals. Also the ingression of these microbes has helped to maximise the strength and workability of concrete and can be very helpful field in upcoming time.

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