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BACTERIAL CONCRETE : Development OF Concrete To Increase The Compressive and Tensile Strength Using Bacillus Subtilis- A Review

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Abstract: Cracks formed in concrete are inescapable and are one of the major reasons for the weaknesses of concrete.. The Purpose of present research work is to promote sustainable development for repairing cracks formed in concrete. Various researches have shown positive results by adding $CaCo_3$ precipitating bacteria in concrete, also known as bacterial concrete or self-healing concrete. This research is dedicated to check the suitability of mixing these self-healing $CaCo_3$ depositing bacteria with concrete in order to increase the compressive strength of concrete, reduce its permeability and seepage of water by bio-mineralization process. Considerable increase in strength is observed in concrete specimens when casted with bacterial solution. The study has discovered methods or ways to test the effect of use of bacteria in concrete. Tests on concrete with various combinations of bacterial solution as well as varied percentage of bacterial solution have been conducted. Results have been compared with conventional concrete. Biological modifications of construction materials are the need of the hour for strength improvement and long term durability. The present study propose to Increase compressive, tensile strength and self healing for concrete

Keywords: Bacteria, Bacillus Subtilis, Self- healing, durability.

I. INTRODUCTION

Strength is very important part of any construction stability. from ancient time Cement concrete is one of the most widely used material for construction works. This is mainly due to low cost of materials and construction, low cost of construction. Concrete can bear a large compressive strength, but is weak in tensile strength. Because of this steel reinforcement is provided and the steel bars takes the load when the concrete cracks in tension. cracks occur during the process of concrete hardening and this finally leads to weakening of the buildings. Due to this Water droplets, Air, moisture entered into the concrete structure can damage the steel reinforcement present in the concrete member if there is a high permeability. When this phenomenon occurs, the strength of the concrete decreases and which results in the decay of structure. Due to this the maintenance cost should become high and sometime may failure in structure may be occur.

Often bacterial activities simply trigger a change in solution chemistry that leads to over saturation and mineral precipitation. Use of these Bio mineralogy concepts in concrete leads to potential invention of new material called - "Bacterial Concrete" Now Bacterial concrete are used to improve performance and augment the weakness of concrete for high performance. Research leading to microbial Calcium Carbonate precipitation and its ability to heal cracks of construction materials has led to many applications like crack remediation of concrete.

II. LITERATURE REVIEW

The concrete structures have various durability issues due to the different physiological conditions and it results to irretrievable damage to the structure and eventually reduction in the strength of concrete structure. The main reason behind the downgrading of the durability and mechanical aspects of concrete is the pore structure of concrete. In the recent years MICCP (microbiologically induced calcium carbonate precipitation) by the bacteria considered as an environment friendly method to enhance the properties of concrete, also for the repair of concrete structure and to consolidate different construction materials.

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bacteria repair the cracks in concrete by producing the calcium carbonate crystal which seal the micro cracks and increase its strength and the durability. Many researchers done their work on the bacterial concrete and they had found that bacterial concrete improves the strength of conventional concrete 15% in 7 days and 18- 20 % in 28 days approximately. Microbiology induced precipitation of calcium carbonate (calcite) fills the voids and decreases the water permeability by decreasing the width of cracks. Addition of bacteria also shows better resistant to corrosion, drying shrinkage, resistance to acid attack and sulphate attack.

III.BACTERIAL CONCRETE

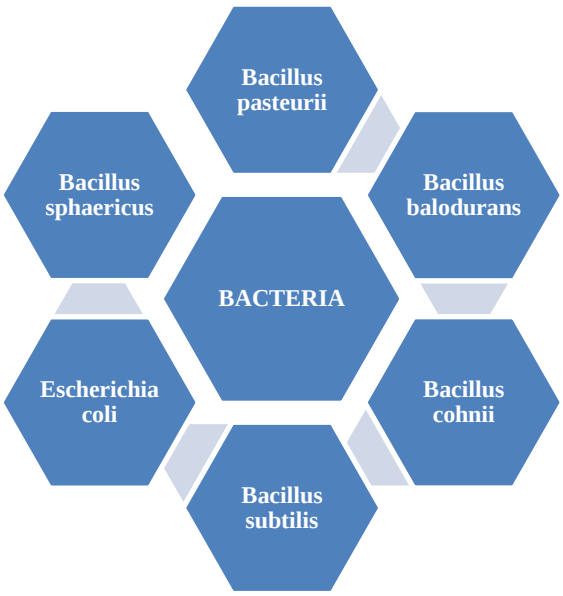
Bacterial concrete is a material, which can successfully heal cracks in concrete. This technique is mostly desirable because the mineral precipitation induced as a result of bacterial activities is pollution free, less hazardous and natural. The principle of bacteria-based self-healing concrete is that carbonate precipitating bacteria are added into concrete during the mixing process. The bacteria will be activated to precipitate CaCO3 to in-situ heal concrete cracks. Due to this the compressive and tensile strength of concrete increases.

A] MECHANISM OF BACTERIAL CONCRETE

The bacteria used for manufacturing of bacterial concrete should able to effective crack sealing mechanism during its lifetime serviceability. The principle behind bacterial concrete is that the bacteria should able to transform soluble organic calcite into insoluble inorganic calcite crystals which seals the cracks . As the bacteria feeds oxygen is consumed, the soluble calcite in bacterial concrete is converted to insoluble $CaCo_3$. Then the $CaCo_3$ solidifies on the cracked surface, thereby healing it up . On the surface of concrete, Calcium Carbonate will be formed due to the reaction of CO2 present with Calcium Hydroxide present in the concrete matrix

The self-healing process in bacteria incorporated concrete is much more efficient due to the active metabolic conversion of Calcium nutrients by the bacteria present in concrete. Here Calcium Carbonate is produced directly due to microbial metabolic process and also indirectly due to independent healing.

B] TYPES OF BACTERIA USE IN BACTERIAL CONCRETE



C] Classification of Bacteria

Classification on the Basis of Shapes

(bacilli), spiral Bacteria are classified into five groups according to their basic shapes: spherical (cocci), rod (spirilla), comma (vibrios) or corkscrew (spirochaetes). They can exist as single cells, in pairs, chains or clusters.

Classification on the Basis of Gram Strain

The Gram stain characterizes bacteria based on the structural characteristics of their cell walls. By combining morphology and Gram-staining, most bacteria can be classified as belonging to one of 4 groups (Gram-positive cocci, Gram-positive bacilli, Gram-negative cocci, and Gram-negative bacilli).

Classification on the Basis of Oxygen Requirement

Obligate Aerobes: oxygen required

Facultative: grow in the presence or absence of oxygen Microaerophilic: grow best at very low levels of oxygen

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Aerotolerant Anaerobes: oxygen not required for growth but not harmful if present
Obligate Anaerobes: grow only in complete absence of oxygen; if present it can be lethal

D] APPLICATION OF BACTERIA IN CONCRETE

Type of bacteria	Applications	Metabolism
Bacillus cereus	Biological mortar	Oxidative deamination of amino acids
Bacillus subtilis	Crack in concrete remediation	Hydrolysis of urea
Bacillus sphaericus	Crack in concrete remediation, for surface treatment	Hydrolysis of urea
Bacillus pasteurii	Crack healer in concrete	Hydrolysis of urea

E] COMPRESSIVE AND TENSILE STRENGTH OF BACTERIAL CONCRETE

As per literature reviews we have studied that ,The compressive strength of concrete for specimens with different bacterial concentrations at 7 days, 14 days and 28 days, It was observed that the compressive strength of bacterial concrete showed a serious increase result than conventional concrete. There was an improvement in compressive strength and Tensile strength for every 10ml bacterial mix samples when compared to any other.

ADVANTAGES

- This could be particularly useful in earthquake zones where hundreds of buildings have to be flattened because there is currently no easy way of repairing the cracks and make them structurally sound.
- By the use of bacterial concrete the life period of concrete structures will be extended upto 200 years.
- Future Maintenance cost is very low due to that there is no need of extra construction materials.
- By using bacterial Concrete, the structure does not need to be repaired except for the less cases and so results in less use of cement , As we know more of cement content, more will be carbon dioxide gases released causing global warming, effecting the ozone layer.
- By using bacterial concrete the compressive and tensile strength of concrete will increase.

DISAVANTAGES

- There is no design of bacterial concrete is mentioned in IS code or any other codes.
- Cost of this concrete is comparatively higher than conventional concrete it is about 10-30% of conventional concrete.
- The growth of bacteria is not suitable in every environment.
- Bacterial concrete is costly than conventional concrete.
- Contact with bacteria for longtime is not good for human health.

IV. CONCLUSION

The bacteria within the concrete performs extremely useful it improves the attribute of the concrete, which is higher than the conventional concrete. The study reviewed about different types of bacteria that can be used for healing cracks in concrete. Bacteria repair the cracks in concrete by producing the $CaCo_3$ crystals which block the cracks and repair it. The Present experimental investigation was conducted to study the suitable use of self-healing capacity of Bacillus Subtilis Concrete the concrete as the life of bacteria is more than the life of building. Bacterial concrete is becoming advanced over the special concrete.

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