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Comparative Study of Bacterial Concrete Over Normal Concrete

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Abstract *- Concrete is the most important building material in construction process. Due to improper design of structure temperature effects like freezing, thawing, and shrinkage due to natural calonities and changing environmental Conditions produce cracks in the concrete. Cracks are one of the major weaknesses of concrete which loads to structural failure Do remediate such cracks in concrete. Bacterial concrete is new innovative technique in which bacteria are used during the mixing of concrete. The bacteria which we used in this processes produces calcium carbonate precipitate which remediate the cracks in the concrete structure automatically basically, the calcium carbonate precipitate crystals block the micro crack and fill the pores in concrete. The selection of the bacteria in according to their survival in the alkaline environmental such as B.pasteurii, B.subtilis, and B.sphericus, the concrete using B.subtilis bacteria is more useful and survive any extreme environmental condition. B.subtilis gives good strength compared to conventional concrete Bacteria improves the structural properties such as tensile strength water permeability, durability, compressive and flexural strength of concrete.*

Key Words: **Concrete, Bacterial Concrete, Calcium Carbonate**

1. INTRODUCTION

In construction industry it is also a very brittle material with low tolerance for strain so it is commonly expected to crack with time concrete is a very good material to resist the compressive load, to a limit but if the load applied on the concrete is more than their limit of resisting load, it causes the strength reduction of concrete by producing the cracks in concrete and the treatment of cracks is very expensive some of the structural properties such as durability, permeability, and strength of the concrete also decreases. Due to increase in permeability, the water easily pass through concrete and comes in contact with reinforcement of concrete structure which leads to the corrosion of steel so, it is necessary to repair the cracks. As there are many ways to repair the cracks in concrete structure such as epoxy resin, structural epoxy, epoxy mortar, and other synthetic mixtures. But they are not environmental friendly using those mixtures for the repairing of cracks in concrete can cause harm to the environmental and human health too. To overcome such problems bacterial concrete is the new technique which is the self healing agent for the repairing of cracks bacterial concrete can be able to increase the compressive strength of concrete over normal concrete bacterial concrete is the concrete which produce calcium carbonate precipitate by adding bacteria in the mixture of concrete. The selection of the bacteria is depend on the survive capability of bacteria in the alkaline environment according to microbial study genus Bacillus will be found to succeed in high alkaline environment.

1.1 Problems

- Weak structural nature of old concrete buildings leads to cracks micro as well as macro.
- Due to extensive traffic on concrete roads, live load gets generated leading to wear and tear of the roads.
- Water percolates through the cracks reaching the sub surface layer thus disturbing the structural integrity.
- This affects the durability of roads and can have hazardous impacts on the traffic.
- Due to their ancient nature of construction, fort has excellent durability yet due to the seasonal variation and weathering of rocks, their condition is started to deteriorate.
- Temperature variation leads to disturbance in the homogenous nature in the concrete structures leading to gradual formation of cracks.
- Conventional methods of production of bricks lead to environmental pollution and also wastage of the bricks.

1.2 Chemical Process of Healing

Preparation of Bacterial Concrete

Bacterial concrete can be prepared in two ways,

a) By direct application

b) By encapsulation in lightweight concrete

1.3 Chemical process of self-healing or bacterial concrete

Mechanism of Healing

The bacteria's which we used in bacterial concrete are soil bacterium which having the ability to precipitate $CaCO_3$. Calcium carbonate is responsible to heal cracks in concrete produced due to natural calamities.

The urea is produced by bacteria in concrete which hydrolyses into carbonate and ammonia. The process of producing urea for the hydrolysis of urea $CO(NH_2)_2$ into carbonate (CO_3^{2-}) and ammonia (NH_4^+) can be as follows-

$$CO(NH_2)_2 + H_2O \longrightarrow NH_2COOH + NH_3$$

$$NH_2COOH + H_2O \rightarrow NH_3 + H_2CO_3$$

$$H_2CO_3 \rightarrow HCO_3^- + H^+$$

$$2NH_3 + 2H_2O \rightarrow 2NH_4^+ + 2OH^-$$

$$HCO_3^- + H^+ + 2NH_4^+ + 2OH^- \longrightarrow CO_3^{2-} + 2NH_4^+ + 2H_2O$$

Characteristics of bacteria

- Bacteria should react only when aerobic conditions prevail.
- Bacteria should form spores.
- They should not evolve hydrogen sulphide (H_2S).
- They should not evolve carbon dioxide (CO_2).
- They should form calcite precipitate after reacting with water.

1. Performances of bacteria
2. Microbiologically induced calcite precipitation
3. Cracks remediation
4. Durability increases with increase in bacterial culturing
5. Bacteria's inclusion in concrete achieved approximately 10% increase in compressive strength and 30% increase in flexural strength

2. SUMMARY OF LITERATURE REVIEW

M. Monishan and Mrs. S. Nishanthi [1], investigated strength of concrete using Bacillus subtillis and polyethylene fiber. M20 grade concrete is prepared with different bacterial cell concentration of 10', 10 and 10 cells per ml of water and polyethylene fiber added constant as 0.4%. The strength and durability of self-healing concrete using Bacillus subtilis and polyethylene fiber has investigated and compared with control concrete. The optimum strength is obtained at 10' cells concentration, which increases the compressive strength by 13.2%, split tensile strength by 21.4% and flexural strength by 16.04% and polyethylene fiber were bridging over the crack. The more CaCo, precipitations, the better the self-healing effect

Vijeth N Kashyap, Radhakrishna (2), studied effect of Bacillus Sphaericus and Sporosarcina Pasteurii bacteria on cement concrete. After experimental investigation It was found that these bacteria when added at 10° concentration of cells'ml of water to cement composites increased by about 39.8% and 33.07% in paste. The strength increment was found to be 18.3% and 12.2% for Bacillus Sphaericus and Sporosarcina Pastuerii respectively for concrete. It was. concluded that Bacillus Sphaericus and Sporosarcina Pasteurii stains can improve the characteristics of cement composites due to calcite precipitation inside the cement composite specimens which are produced microbially.

D. Gardner et.al [3). Published a paper on a survey on problems encountered in current concrete construction & Self healing mechanism. The market research survey was done in the UK and it was found that the annual costs for repair, maintenance and replacement of civil infrastructure projects involve significant expenditure. The market research results verified that sell-healing concrete may tackle some of the main concerns facing civil engineering infrastructure. Self healing concrete seduced cost of repair and maintenance over whole life and better durability. Some of the beucfits will be self healing of cracks, reduce use of over design cost excess cover to reinforcement, scale porosity and prevent absorption etc.

Erik Schlaugeu and Senot Sangadji (4). Published a paper on infrastructure durability and sustainability by self healing mechanisms. An overview is given of new developments obtained in self healing concrete. Three projects discussed of Delft University running to study self healing mechanisms. In first, bacteria added in concrete that can precipitate calcite in a crack and with that make concrete structures water tight and enhance durability. In a second project hybrid fiber reinforced cementaticious materials SAP are studied that can mechanically repair cracks when they cure. The last project discussed on porous asphalt concrete and how to heal its damage by incorporating embedded microcapsules self healing capacity is enlarged by using encapsulated oil and micro-steel fibers.

Willem De Muynck et.al. [5). published a paper on Bacterial carbonate precipitation improves the durability of cementitious materials. The bacterial carbonate precipitation improves the durability of mortar specimens with different porosity. Three cubes of 100mm X 100mm X 100mm were tested for 28 days B. sphericus bacteria were introduced by immersing cubes in a plastic tub for 24 hrs. Various bio decomposition of bacteria at varying depths; weight increase were studied. Durability was assessed from the permeation properties and resistance towards degradation processes. It was observed that the surface deposition of calcium carbonate crystals and microbial

biomass decreased the water absorption with 65 to 90% depending on the porosity of the specimens. The carbonation rate and chloride migration decreased by about 25-30% and 10-40% respectively. An increased resistance towards carbonation, chloride and freezing and thawing was also noticed. Hence it was concluded that presence of a layer of carbonate crystals on the surface has the potential to improve the resistance of cementitious materials towards degradation.

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