Experimental Study on M25 Grade of Self- Healing Concrete

Raja Sulochana. B[1], Kasarada Srikanth[2]
[2] Assistant Professor
[1, 2] Kakinada Institute of Engineering & Technology-II College, Korangi, AP, India

Abstract- *Concrete is the most commonly used building material, but the cracks in concrete create problem. Cracks in concrete occur due to various mechanisms such as shrinkage, freeze-thaw reactions and mechanical compressive and tensile forces. Cracking of the concrete surface may enhance the deterioration of embedded steel bars as ingression rate of corrosive chemicals such as water and chloride ions in to the concrete structure increased. Therefore a novel technique has been developed by using a selective microbial plugging process, in which microbial metabolic activities promote calcium carbonate (calcite) precipitation; this technique is referred as Microbiologically Enhanced Crack Remediation. In this technique urolytic bacteria are used hence the concrete is called Bacterial concrete.The objective of the present investigation is to study the potential application of bacterial species i.e. Bacillus pseudomonas to improve the strength of cement concrete. Here we have made an attempt to incorporate dormant but viable bacteria in the concrete matrix which will contribute to the strength of the concrete. Water which enters the concrete will activate the dormant bacteria which in turn will give strength to the concrete through the process of metabolically mediated calcium carbonate precipitation. Concrete, however, is due to its high internal pH, relative dryness and lack of nutrients needed for growth, a rather hostile environment for common bacteria, but there are some extremophilic spore forming bacteria may be able to survive in this artificial environment and increase the strength and durability of cement concrete. In this study we found that incorporation of spore forming bacteria of the species Bacillus will not negatively affect the compressive of the cement concrete.*

The "Bacterial concrete" can be prepared by adding spore forming bacteria in the concrete that are able to continuously precipitate calcite, this process of production of calcite precipitation is called Microbiologically Induced Calcite Precipitation (MICP). Bacillus pseudomonas is used to induce calcite precipitation in concrete. The basic principle for this process is that the microbial urea's hydrolyzes urea to produce ammonia and carbon dioxide and the ammonia released in surrounding subsequently increases pH, leading to accumulation of insoluble calcium carbonate. Bacterial cultures improve the strength of cement sand mortarand crack repair on surfaces of concrete structures.

Keywords- calcium carbonate (calcite) precipitation, Bacterial concrete, Microbiologically Induced Calcite Precipitation (MICP), Bacillus pseudomonas.

I. INTRODUCTION

Concrete is the most widely used construction material. Despite its versatility in construction, it is known to have several limitations. It is weak in tension, has limited ductility and little resistance to cracking. Recently, it is found that microbial mineral precipitation resulting from metabolic activities of favorable microorganisms in concrete improved the overall behavior of concrete. The process can occur inside or outside the microbial cell or even some distance away within the concrete. Use of these Bio mineralogy concepts in concrete leads to potential invention of new material called ―Bacterial Concrete.

II. LITERATURE REVIEW

Chiara Barabesi et al, (2007): The calcium carbonate precipitation, a widespread phenomenon among bacteria has been investigated for its scientific and technological importance. Nevertheless, little is known of the molecular mechanisms by which bacteria foster calcium carbonate mineralization. In his laboratory, he has studied calcite formation by Bacillus subtilis, in order to identify genes involved in the bio mineralization process. A previous screening of UV mutants and of more than one thousand mutants obtained from the European Bacillus subtilis Functional Analysis project allowed him to isolate strains altered in the precipitation phenotype.

Day J L et al, (2003): This paper describes the results of an innovative approach in concrete crack remediation utilizing microbiologically induced calcite. A common soil bacterium, Bacillus pasteurii, was used to induce calcite precipitation. The basic principles for this application are that the microbial urease hydrolyzes urea to produce ammonia and carbon dioxide, and the ammonia released in surroundings subsequently increases pH, leading to accumulation of insoluble calcite. To protect the cells from the high pH of concrete, the microorganisms were immobilized in polyurethane polymer, lime, silica fume, and fly ash, and then applied in concrete crack remediation.

Rama Krishnan et al, (2001): He proposed a novel technique in remediating cracks and fissures in concrete by microbiologically inducing calcite precipitation. Microbiologically induced calcite precipitation is a technique that comes under a broader category of science called bio mineralization. Bacillus pasteurii, a common soil bacterium can induce the precipitates of calcite. As a microbial sealant, Calcite exhibited its positive potential in selectively consolidating simulated fractures and surface fissures in granites and in the consolidation of sand. MICP is highly desirable chemical reaction because the calcite precipitation induced is a result of microbial activities. The technique can be used to improve the compressive strength and stiffness of cracked concrete specimens. A durability study on concrete beams treated with bacteria, exposed to alkaline, sulfate and freeze-thaw environments was studied by him. The effect of different concentrations of bacteria on the durability of concrete was also studied by him. It was found that all the beams with bacteria performed better than the control beams (without bacteria). The durability performance increased with increase in the concentration of bacteria. Microbial calcite precipitation was quantified by X-ray diffraction (XRD) analysis and visualized by SEM.

III. MATERIAL

3.1 Cement:

Cement Ordinary Portland cement of 43 grade, available in local market is used in the investigation. The cement used for all tests is from the same batch. The cement used has been tested for various properties as per IS: 4031-1988 and found to be conforming to various specifications of IS: 12269-1987

3.2. Coarse Aggregate:

Normal aggregate that is crushed blue granite of maximum size 20 mm was used as coarse aggregate. We are conducting tests on coarse aggregate are Water Absorption Capacity, Specific Gravity and Fineness Modulus of coarse aggregate.

3.3 Fine Aggregate:

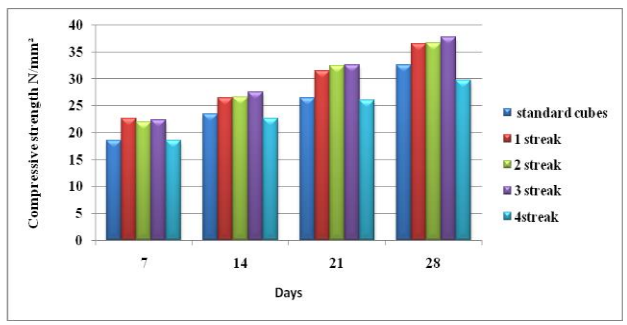
Well graded river sand passing through 4.75 mm was used as fine aggregate. The sand was air-dried and sieved to remove any foreign particles prior to mixing. We are conducting tests on fine aggregate are Water Absorption Capacity, Specific Gravity and Fineness Modulus of fine aggregate

3.4 Water:

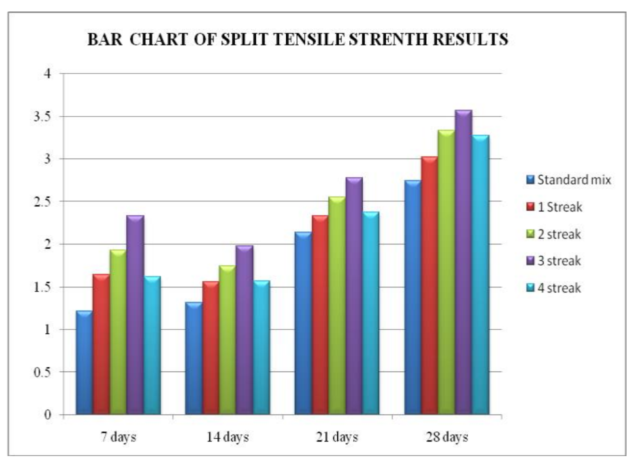
Water used for mixing and curing is fresh potable water, conforming to IS: 3025 – 1964 part 22, part 23 and IS: 456 – 2000.

3.5 BACTERIA:

Bacillus pseudomonas, a laboratory cultured bacterium is used. It is found in soil, water, skin flora, and most man-made environments throughout the world. It thrives not only in normal atmospheres, but also in hypoxic atmospheres, and has, thus, colonized many natural and artificial environments. It uses a wide range of organic material for food; in animals.



Graph: 1 Compressive Strength for 7 Days, 14 Days, 21 Days, 28 Days



Graph: 2 Split Tensile Strength at 28 Days age

IV. CONCLUSION

1. In ordinary grade concrete the compressive strength is increased by 14% at 28 days by addition of Bacillus pseudomonas bacteria when compared to standard concrete.
2. It is concluded that strength of the concrete is increased by adding bacteria of streak 1,streak 2,streak 3 from streak 4 strength of concrete is slightly decreases.
3. It is concluded that bacterial concrete will have the higher life compared to conventional concrete. Bacterial concrete will have high life than the standard concrete because calcite precipitate crystals impermeable the concrete specimens and resists the harmful solutions into the concrete there by decreasing the deleterious effects they may cause.
4. The Bacterial concrete mixes have shown improved stress values for the same strain levels compared to that of Conventional concrete mixes at all the ages both in ordinary grade concrete and standard grade concrete.
5. 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 making them structurally sound
6. The ability of bacteria that could grow quickly to cover the Cracks in the Structure made of concrete.
7. Healing of cracks by injection of different concentrations of cells could not give the proper results.

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