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PERFORMANCE EVALUATION OF SELF-HEALING CONCRETE

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Abstract - Self healing concrete can be defined as the concrete which is able to repair their own cracks by the addition of some healing agent. In this paper we have given an overview on the performance evaluation of self-healing concrete. Basically the micro cracks are common problem in the concrete. The available crack tend to allow the moisture and salty chemical into the concrete which leads to the failure of that structure various methods are available to repair the crack, but those methods are expensive. But nature gave an economical and eco-friendly material called bacillus subtilis and calcium nutrients of calcium lactate. We have used this material to produce capsules and added that into the concrete mix. After the required curing period, the capsules will be adopted inside the concrete &at the same time the bacteria present in the concrete will be inactive. When the cracks are formed in the concrete, it will allow the moisture through seepage in to that. The presence of moisture will activate the bacteria and that will heal the cracked concrete surface.
Key words: bacillus subtilis, bacteria concrete, bacteria capsules, special concrete, smart material

I. INTRODUCTION

The concrete is most commonly used material in construction. The concrete is strong in compression weak in tension, but cracks are common in concrete. The cracks provide pathway of water and chemical contents it do corrosion in the reinforcement it reduce the strength and lifetime of concrete. Nowadays various crack repair technique is available but expensive, affect the environment time consuming. So repair work need new technique that micro-organism used self-healing concrete. It's cost-effective, durable and eco-friendly. The concrete is alkaline material sometime bacteria is easy to Survive in the alkali environment. Bacteria with calcium nutrients added into the concrete at the time of mixing. If any cracks formed bacteria precipitation calcium carbonate is produce to seal the crack. The inactive bacteria should able to survive 200 years in dry conditions in the concrete. Crack developed in concrete allowswater and oxygen it activates the bacteria and it starts the calcium precipitation process on concrete and heals the cracks developed in concrete.

A. Bacteria and chemicals

The water and cement mixed have a pH value is high almost 13, most of micro -organism die in condition. So need able to withstand the micro-organism in this environmental condition.

They are identified as;

- Bacillus subtilis
- Bacillus sphaericus

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- Bacillus halodurans
- Bacillus cohnii
- Bacillus massiliensis
- Bacillus pseudofirmus
- Bacillus pasteurii
- Escherichia coli
- Bacillus megaterium
- AkkR5
- Shewanella species
- Bacillus flexus

Calcium lactate is a nutrient for bacteria. The calcium precipitation process after toproduce limestone.

B. Methodology of adding healing agent Encapsulation method:

To make a capsule used clay cover, infill bacteria and calcium lactate.The clay pellets dip in cement for secondary cover and finishing of capsules. The capsules produce oxygen demand for bacteria. It will present inactive. The concrete can mix with IS10262 nominal design as per ratio 1: 1.5: 3Mix for M 20 grade. The capsules can mix with 4% of total volume of concrete. Clay used 17% of cement content. Bacteria used 5% of water content (Concentration of bacteria is 10^5 per ml).Calcium lactate used 6% in cement content. It can add a time of mixing.

C. Healing mechanism:

When cracks are form in concrete after the bacteria contact with water and oxygen. It will active and do the calcium precipitation action. One day later softy or liquid limestone filled the 0.5mm cracks and the harden strata should take 18 days.

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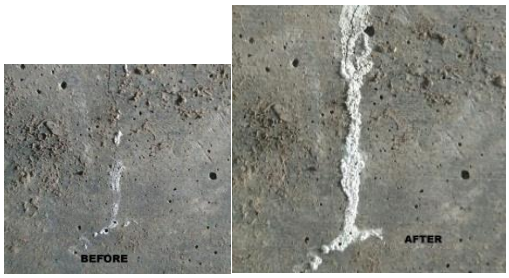

D. Chemical reaction:

$$C_aO + H_2O = C_a(OH)_2$$

$$C_a(OH)_2 + CO_2 = C_aCO_3 + H_2O$$

I. EXPERIMENTALTEST

TABLE 1: COMPARISON BETWEEN COMPRESSIVE STRENGTH OF BACTERIAL CONCRETE AND NORMAL CONCRETE

S.NO	Bacterial Concrete (Bacillus Subtilis)		Normal concrete	
	Compressive(N/mm^2)		Compressive(N/mm^2)	
	7 days	28 days	7 days	28 days
1.	22.35	33.94	20.58	28.96

TABLE 2: COMPARISON BETWEEN SPLIT TENSILE STRENGTH OF BACTERIAL CONCRETE AND NORMAL CONCRETE

S.NO	Bacterial Concrete (Bacillus Subtilis)		Normal concrete	
	Split tensile (N/mm^2)		Split tensile (N/mm^2)	
	7 days	28 days	7 days	28 days
1.	2.74	3.81	1.75	3.04

Advantages:

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- Self-repairing cracks on external aide.
- Significant increase in compressive strength and flexural strength when compared to normal concrete.
- Resistance towards freeze-thaw attacks.
- Reduction in permeability of concrete.
- Reduces the corrosion of steel due to the cracks formation and improves the durability of steel reinforced concrete.
- Bacillus bacteria are harmless to human life and hence it can be used effectively.

Dis-Advantages:

- Cost of bacterial concrete is double than conventional concrete.
- Growth of bacteria is not good in any atmosphere and media.
- The clay pellets holding the self-healing agent comprise 20% of the volume of the concrete. This may become a shear zone or fault zone in the concrete.
- Design of mix concrete with bacteria here is not available any IS code or other code.Investigation of calcite precipitate is costly.

II. CONCLUSION

- The compressive, split tensile strength of M20 bacterial concrete is found to be higher than M20 normal concrete.
- The percentage increase in compressive strength of bacterial concrete for 7 days is 6.42% and for 28 days is 9.65% higher than normal concrete.
- The percentage increase in split tensile strength of bacterial concrete for 7 days is 37.29% and for 28 days is 13.66% higher than normal concrete.
- Crack remediation using bacterial concrete is better than epoxy treatments

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