

**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH  
TECHNOLOGY****SELF HEALING CONCRETE BY ECO FRIENDLY MATERIAL ( UREA)****Jadhav Prachi Fulchand<sup>\*1</sup>, Shirsat M.N.<sup>2</sup> Kharmale P.V.<sup>3</sup>**<sup>\*1</sup> Research Scholar, Department of Civil Engineering, G.H.R. College of Engineering, Chas, Ahmednagar, India.<sup>2,3</sup> Assistant Professor, Department of Civil Engineering, G.H.R. College of Engineering, Chas, Ahmednagar, India.**ABSTRACT**

Concrete which forms major components in the construction Industry as it is cheap, easily available and convenient to cast. But drawback of these materials is it is weak in tension so, it cracks under sustained loading and due to aggressive environmental agents which ultimately reduce the life of the structure which are built using these materials. The process of damage occurs in the early life of the building structure and also during its life time. Synthetic materials like epoxies are used for remediation .But, they are not compatible, costly, reduce aesthetic appearance and need constant maintenance. In this article we studied self-healing concrete by ecofriendly material. We studied on urease enzymes bacteria induced Calcium Carbonate (limestone) precipitation has been proposed as an alternative and environment friendly crack remediation and hence improvement of strength of building materials.

**KEYWORDS:** Self-healing, Micro-cracks, Bacteria, Hydration, Bacillus pasteurii. Etc.**INTRODUCTION****1. General**

Concrete which forms major components in the construction Industry as it is cheap, easily available and convenient to cast. But drawback of these materials is it is weak in tension so, it cracks under sustained loading and due to aggressive environmental agents which ultimately reduce the life of the structure which are built using these materials. This process of damage occurs in the early life of the building structure and also during its life time. Synthetic materials like epoxies are used for remediation .But, they are not compatible, costly, reduce aesthetic appearance and need constant maintenance .Therefore bacterial induced Calcium Carbonate (calcite) precipitation has been proposed as an alternative and environment friendly crack remediation and hence improvement of strength of building materials

**2. Self-Healing Bacterial Concrete:**

Autogenously crack-healing capacity of concrete has been recognized in several recent studies. Mainly micro cracks with widths typically in the range of 0.05 to 0.1mm have been observed to become completely sealed particularly under repetitive dry/wet cycles .The mechanism of this autogenously healing is chiefly due to secondary hydration of non or partially reacted cement particles present in the concrete matrix. Due to capillary forces water is repeatedly drawn into the micro cracks under changing wet and dry cycles, resulting in expansion of hydrated cement particles due to the formation of calcium silicate hydrates and calcium hydroxide. These reaction products are able to completely seal cracks provided that crack widths are small.

**3. Advantages of Using Bacteria in Concrete**

Around five per cent of all manmade carbon dioxide emissions are from the production of concrete, making it a significant contributor to global warming .Finding a way of prolonging the lifespan of existing structures means we could reduce this environmental impact and work towards a more sustainable solution.

[Jadhav\* *et al.*, 6(2):February, 2017]

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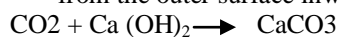
- This could be particularly useful in earthquake zones where hundreds of buildings have to be flattened because there is currently no easy way of repairing the cracks and make them structurally sound
- Fills the crack in an efficient period of time so that the life period of a concrete structure can be expected over 200 years
- Prevents the use of cement in future used as a maintenance structure by drilling and grouting process, so in this way, less use of cement can be seen
- As we know more of cement content, more will be carbon dioxide gases released causing global warming, affecting the ozone layer. By using this bacteria, the structure does not need to be repaired except for the less cases and so results in less use of cement

## MATERIALS AND METHODS

### Main points

#### 1) *Carbonatation process*

Carbon dioxide from air can react with the calcium hydroxide in concrete to form calcium carbonate. This process is called carbonatation, which is essentially the reversal of the chemical process of calcination of lime taking place in a cement kiln. Carbonatation of concrete is a slow and continuous process progressing from the outer surface inward, but slows down with increasing diffusion depth



#### 2) *Urease*

It is an enzyme that catalyzes the hydrolysis of urea into carbon dioxide and ammonia.

More specifically, urease catalyzes the hydrolysis of urea to produce ammonia and carbamate; the carbamate produced is subsequently degraded by spontaneous hydrolysis to produce another ammonia and carbonic acid. Urease activity tends to increase the pH of its environment as it produces ammonia, a basic molecule. Ureases  $\text{CO}(\text{NH}_2)_2$  are found in numerous bacteria, fungi, algae, plants and some invertebrates, as well as in soils, as a soil enzyme.

#### 3) *Calcium lactate*

Calcium lactate is a black or white crystalline salt made by the action of lactic acid on calcium carbonate. It is used in foods (as an ingredient in baking powder) and given medicinally. It is created by the reaction of lactic acid with calcium carbonate or calcium hydroxide.

#### 4) *Bacillafill*

The bacteria would be released as spores which would germinate upon coming into contact with the pH of concrete. Upon germination, the bacteria would descend into cracks in the concrete. The bacteria use quorum sensing to determine when enough bacteria have accumulated, triggering production of a mixture of calcium carbonate and "bacterial glue", which combines with the bacterial cells to fill the crack. This mixture hardens to be as strong as the surrounding concrete.

### Preparation of Bacterial Solution

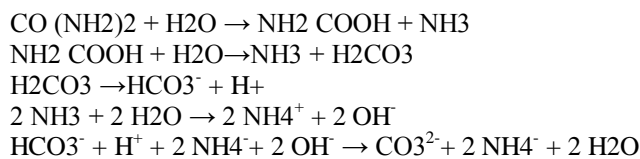
- Primarily 12.5g of Nutrient broth (media) is added to a 500ml conical flask containing distilled water.
- It is then covered with a thick cotton plug and is made air tight with paper and rubber band.
- It is then sterilized using a cooker for about 10-20 minutes. Now the solution is free from any contaminants and the solution is clear orange in color before the addition of the bacteria.
- Later the flasks are opened up and an exactly 1ml of the bacterium is added to the sterilized flask and is kept in a shaker at a speed of 150- 200 rpm overnight.
- After 24 hours the bacterial solution was found to be whitish yellow turbid solution.



*Fig 1: Solution without bacteria (only media)*

### Preparation Of to CaCo3 precipitation:

The process of producing urease for the hydrolysis of urea  $\text{CO}(\text{NH}_2)_2$  into carbonate ( $\text{CO}_3^{2-}$ ) and ammonium ( $\text{NH}_4^+$ ) can be as follows



1 mol. of urea is hydrolyzed intracellular to 1 mol. of carbonate and 1 mol. of ammonia, carbonate hydrolyses to form 1 mol. of ammonia and carbonic acid additionally, these components form 1 mol. of bicarbonate and 2 mol. of ammonia and hydroxide ions. These reactions give rise to pH increase resulting in the formation of carbonate ions. In the above equations, the cell wall of bacteria is negatively charged; cations from the environment were drawn by bacteria. Including  $\text{Ca}^{2+}$  to deposit on cell surface, subsequent reaction with  $\text{CO}_3^{2-}$  ions can be seen by  $\text{Ca}^{2+}$  ions leads to  $\text{CaCO}_3$  precipitation at the cell surface.

### CONCLUSION

Bacterial concrete technology has proved to be better than many conventional technologies because of its eco-friendly nature, self-healing abilities and increase in durability of various building materials. As we seen that, Urea is contact with soil (as a medium) and water, It produce urease enzyme by using Nutrient broth. This Urease enzyme is used in concrete. When minor cracks are creating in concrete and this enzyme is contact with air and water, produces to  $\text{CaCO}_3$  precipitation.

In bacterial concrete interconnectivity of pores is disturbed due to plugging of pores with calcite crystals. Since interconnected pores are significant for permeability, the water permeability is decreased in bacteria treated specimens.

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