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SELF HEALING CONCRETE

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Abstract

This paper is an overview of new developments obtained in research on Self Healing of Concrete. Concrete is a construction material that is used worldwide.However the drawback of this material is that it easily cracks due to its low tensile strength . It is a well-known fact that concrete structures are very susceptible to cracking whichultimately allows chemical and water to enter and degrade the concrete , eventually reducing its performance.Cracks of various sizes form in all concrete constructions which need to be sealed manually. Moreover it also requires expensive maintenance in the form of repairs .Self Healing Concrete is a revolutionary building material which is widely recognised as a remedial technique to improve durability of concrete . Self healing agents may be transferred through strong core microcapsules ,hollow reinforced fibre and even by forms of organic matter .All of these techniques are currently undergoing analysis and testing in order to test their durability and longevity. In this paper , natural , chemical and biological processes of self healing concrete technologies are reviewed. Therefore, we need to understand its properties and mechanism.

Keywords: *Self healing concrete ,natural crack healing process, chemical crack healing process, biological crack healing process*

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1. INTRODUCTION

Concrete is a vital building component of public infrastructure. However traditional concrete has a flaw, it tends to crack when subjected to tension.Rapid crack healing is necessary since it is easier for aggressive environmental substances to ingress into concrete through cracks than through concrete mix. It would be desirable if concrete cracks could be healed autonomously by releasing healing agents inside the matrix when cracks appear. Many researchers have been attempting to improve concrete in order to get a better longevity among many other things.

That's how the concept of self healing finds its way to concrete. Self healing concrete could easily solve the problem of concrete structures deteriorating well before the end of their service life. The innovation of self healing concrete is quite promising as it helps to enhance concrete resistance to these defects and degradation. Self healing concrete biologically produces calcium carbonate crystals to cracks that appear on the surface of the concrete structures. This paper aims to present a comprehensive review on self healing concrete based on 3key taxonomy i.e. natural self healing, chemical self healing and biological self healing.

1.1History of Self Healing of Concrete

Studies have found that concrete has been used since the Roman times, it is one of the most widely used materials in the world, but at some point, no matter how it is mixed, it will crack and deteriorate.

It was to this problem that microbiologist Hendrik Jonker set his mind. Thinking about how the body can heal bone through mineralization, he looked into whether a similar method could be usedwith concrete. By mixing it with limestone-producing bacteria, he found that any cracksthat formed in the concrete were patched over. There are two main areas of research when it comes to developing this kind of concrete; the natural way of hydrates to seal cracks over time, and the artificial way to seal cracks which needs a man-made intervention. The main purpose of such work is to increase concrete's durability, which will have a huge positive impact on both the environment and economics. On the other hand, it might also improve the architectural designs by forcing new design methods and hence, change the shape of internal spaces so that it serves many functions and provides flexibility.

2.Types of Self Healing Concrete

Self-healing concrete is a kind of smart concrete and becoming one of the research focus both in material and civil engineering field. Self-healing materials are artificially or synthetically created substances that have the built-in ability to automatically repair damage to themselves without any external diagnosis of the problem or human intervention. Types of Self Healing Concrete are :

- Natural Self healing process
- Biological self healing process
- Chemical self healing process

2.1 Natural Self Healing Process :

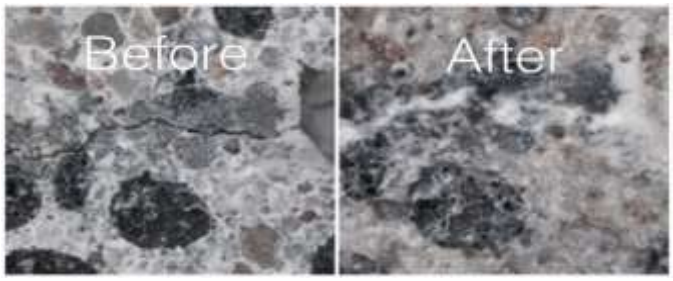
Several natural process can partially repair cracks. There are four types of processes which can block cracks. They are as follows :

(1) The formation of calcium carbonate or calcium hydroxide is another process to block crack.

(2) Crack is blocked by impurities in the presence of water.

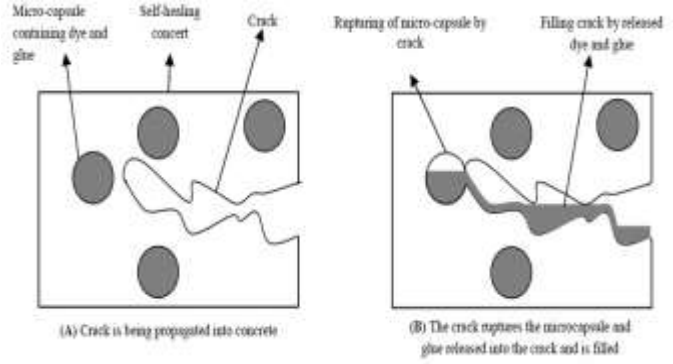
(3) Crack is further blocked by hydration of the unreacted cement or cementitious .

(4) Crack is blocked by the expansion of hydrated cementitious matrix in the crack flanks.



2.2ChemicalSelf Healing Process:

This process mainly refers to the artificial healing by injecting chemical compounds into the cracks for healing. Self healing concrete is designed by mixing chemical liquid glue with fresh concrete in small containers.



Encapsulation of glue is evolvefrom the eggs of birds or cells. The size for capsules containing glue used for SHC varies from microcapsules to nanocapsules. Cracks would rupture the implanted microcapsules. Hence the glue is released into crack faces through

2.Factors That Affect the Use of Self-HealingConcrete :

There are many factors that intervene with the usage of this kind of concrete. As it is noticed; it is not yet used in all new constructions as it is still being under development.

- The cost efficiency is one of the most important factors and will determine whether the material will have limited usage restricted to spots that are hard to fix and important constructions such as bridges and highways.
- Other than cost, long-term efficiency is one of the important factors as well alongside the size of the formed cracks which must not exceed 150 millimetres of depth to establish an ideal result.
- Some factors that will definitely determine whether SHC will be used as a replacement of concrete are; the economical factor, long-term efficiency, prospect suppliers and safety factors.

3. Applications:

3.1 Application in Architectural Designs and Structures:

Since the use of SHC seems promising, we must understand how that will affect the forthcoming architectural designs. A general prognosis is hard to make as the function and size of building plays a huge role to whether or not this kind of concrete might be suitable, and therefore, will be discussed separately**.**

3.2 Application in Large-Size Buildings and Roads (Residential and Public)

Size and function of a building usually determine the approximate life-span desired for this particular constructionSHC is particularly adequate for bridges and all road constructions as they often experience small-sized cracks due to heavy loads and constantly need maintenance. The use of this kind of concrete will reduce the maintenance cost significantly and will increase safety .Therefore, it's highly recommended to use due to its benefits. All large-size buildings will definitely get benefit from the use of this kind of concrete just as the infrastructure will be enhanced by providing safety and durability.

3.3 Application in Small-Size and Medium-Sized Buildings (Residential and Public) :

Small size buildings are usually residential and located either in the suburbs, towns or villages. And like most buildings, concrete is one of the main building materials used, especially for foundation (slabs or columns), as small residential buildings rarely change function it is practical to want to increase their life-span, and hence use SHC.

Medium-size buildings use more concrete than any other size of buildings, unlike like skyscrapers that use more steel and small-size buildings which use more stone or wood. Both residential and public middle-sized buildings seem to be eligible to the use of SHC, however, and especially in public buildings as the life-span increases, designs must be flexible and easy to change function of the inner space in order to be efficient to use of this kind of concrete. Therefore, instead of demolition there will be re-modelling when the service held within the building is no longer needed in a particular area, which in its turn has a positive effect in reducing the CO2 emission by avoiding construction.

4. Advantages and Disadvantages

4.1 Advantages:

a. Reduction in permeability of concrete.
b. It increases the durability of concrete.
c. Aesthetic appearance are not harmed through this.
d. It is pollution free, eco-friendly and natural
e. Decreased production of concrete
f. Lower repair & maintenance cost
g. Applicable to existing buildings in the form of spray.
h. Restricted carbon dioxide emission from concreteproduction .

4.2 Disadvantages

a. Cost of bacterial concrete is double than that of conventional concrete.
b. Growth of bacteria is not good in any atmosphere and media.
c. Study on investigation of calcite precipitation is costly.

Benefits it Can Serve in India :

The climate of India is diverse from region to region because of its topography. It observes a wide range of temperature changes from mountains, plains, forests, to beaches. Many cities such as New Delhi, Lucknow, Patna, Varanasi etc. observe severe temperature changes from very warm climate in April to mid-June to very cold climate between November and February. Extreme climates can decline the concrete surfaces and which may ultimately result in failure of structure. Bio concrete can be used as the best alternative for constructions in extreme climates. As India is a developing country, impressive infrastructure plays an important role so bio concrete can be used in the construction of crack resistant and durable high rise buildings and underground constructions. Apart from this bio concrete can be used for constructing structures meant for irrigationto provide the greatest global benefit over the coming years.

Conclusion

In this paper, different self healing techniques are discussed. A categorization was anticipated to cover all possible methods for the design namely natural, chemical and biological methods. Chemical methods were the conventional methods that have been used as anindividual method to design self healing concrete. Introducing the bacteria into the concrete makes it very beneficial it improves the property of the concrete which is more than the conventionalThis paper reviews intensively about the great potential of biological method, using the bacteria capable of precipitating calcite as providing the way forward for developing biological self healing concrete..With this method, large cracks in reinforced cement can be filled. The Bacterial self healing concrete technology is better than the other technologies because it is eco-friendly. According to many research groups, the cost of bacterial concrete is increases by 30% to conventional concrete. This method is easy and convenient. This process provides long life to structure. But more work is required on the following factors such as economical factors and quality of bacteria. The paper also describe by the application of bacteria in concrete. It is found that strength of the concrete increases with decrease in water transportation or water absorption, etc. Bacterial Concrete will be come soon in construction of durable, cost effective and eco-friendly high quality building.

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