A REVIEW ON SELF-HEALING CONCRETE

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Abstract:

Concrete is the most widely used construction material. The formation of cracks is a major drawback in concrete. In this paper an overview is given on the developments and advancement in self-healing mechanism.

I. INTRODUCTION

Concrete is an important and extensively used building material used for construction works. It is mainly used in heavy constructions because of its strength and durability. No matter how carefully the concrete is mixed or reinforced it eventually ends up in cracking at some point. There are many factors that affect the durability and strength of concrete, one of the most common hindrances is crack formation. Large cracks may affect the structural integrity while the small cracks reduce the durability of the structure. Cracks also increase the permeability of matrix thereby increasing the chances of corrosion in reinforcement. Therefore, the sole cause of structural failure is cracking. In order to reduce the chances of crack formation a structure requires regular maintenance which can be costly and may further increase the maintenance cost of the structure. One way to reduce such costs and to increase the durability of structure is to use a concrete that has self-healing mechanism.

II. LITERATURE REVIEW

Kusuma K et al (2018) In this paper the most important aspects of self-healing concrete were discussed. The bacteria used for the experiment was Bacillus Magneterium. The bacteria was isolated and the bio-concrete mechanism were explained in detail. All the basic tests for cement, fine aggregate and coarse aggregate was conducted and the results were tabulated. The study on the self healing concrete showed that there was an enhancement of compressive strength of concrete. It also showed that the water absorption and the water permeability of the concrete had a positive effect. The paper concluded that the use of bio concrete can be a competent alternative and high quality concrete sealant which is an eco-friendly and a cost -effective way when compared to conventional concrete.

Ms.T.Viduthalai et al (2018) In this paper the self healing properties of a concrete for the M25 mix is been elaborately discussed. All the necessary tests were carried out and explained on the materials used. The major tests done for the bacterial concrete were compressive strength test ,split tensile test, water absorption test. The compressive test results showed that there was a drastic increase in the 7^{th} day, 14^{th} day and the 28^{th} day tests. From the split tensile test results it was observed that the concrete specimens prepared by incorporating the micro-organisms yielded higher tensile strength as compared to conventional concrete. From the water absorption test conducted it was found that at the age of 28 days the percentage of water absorption in conventional concrete is more than that of the self-healing concrete. The self healing assessment was also carried out and reviewed in the paper.

Meseret Getnet Meharie et al (2017) This paper explained the factors affecting the self-healing efficiency of cracked concrete structures. The factors affecting are size of the crack, age of concrete and its crack, temperature, pressure , healing time, presence of water and air, dosage ,size and dispersion of capsules, healing agents and its viscosity, concrete material composition, expansive agents and mineral admixtures and most importantly the Ca_{2+} ions concentration. It is concluded from the paper that in order to realize self-healing efficiency and reliability, it is very essential to take care in opting a healing agent and a suitable approach for a specific application.

Gaurav Agarwal et al (2017) In this paper the author explained about the mechanism and working of self-healing concrete. Different types of bacteria are used for the study in this paper. The crack of size 0.2 mm are healed autogenously with the help of bacteria. The characteristics of the bacteria that is to be used is also explained briefly in the paper. The tests that are carried out are compressive strength of concrete, flexural strength of concrete and split tensile test on concrete. The sustainability tests are done using the Scanning Electron Microscope. It is also found that the bacteria can live in concrete for more than 100 years in the form of pores.

Jashira Bashir et al (2016) In this paper the author reviewed on the living concrete. The types of bacteria are explained in this journal. The method of using self-healing bacteria is also carried out. Most importantly the SEM/EDX and XRD Analysis is carried out on the self-healing bacteria. The compressive, split tensile and flexural strength of M20 bip-concrete is found to be higher than that of M20 conventional concrete. It is also found that it can reduce the chance of various defects that can take place in a structure like corrosion reinforcement and its crack. It is also said that the bacteria can be well used in the mortar and the bricks to. It is concluded that the use of bio-concrete is better than epoxy treatment.

Meera C M et al (2016) This paper discussed about the different types of self-healing mechanisms. The mechanisms are autogenous ,autonomous self-healing mechanism, hollow glass fibre system, microencapsulation system, shape memory alloy system and bacteria based system. The bacteria used for the experiment is Bacillus subtilis along with its nutrients. The use of this bacteria showed improvement in various properties of the concrete like compressive strength, split tensile test, porosity ,acid resistance and chloride resistance. It is also showed that the bacteria is safe and very cost effective.

Salmabanu Luhar et al (2015) The paper reviewed about the research done by different authors. According to the study in the paper it is shown that the cracks healed by autogenous mechanism in various sizes such as 0.5 mm to 0.87 mm .The condition of microorganism and its growth were studied on different kinds of bacteria. It was determined that the bacteria feeds on the nutrient source provided to it which in turn prodeuces the calcium carbonate in the form of limestone and heals the cracks.

S.Soundarya et al (2014) In this paper the author reviewed that the effect of the calcite precipitating bacteria and its self-healing mechanism. The biomineralization process is carried out to study on the calcite precipitating bacteria. The different kinds of bacteria and its properties are explained. The chemical process and its healing capacity is determined at the coarse of the paper. The application of the bacterial concrete, its advantages and disadvantages are briefly explained in the paper.

K. Van Tittelbloom(2013) This paper shows the most recent advances in the field of self-healing cementitious materials. In this paper it is said that the autogenous healing mechanism are most prone to the practical application. It is also found that the biggest bottleneck of this approach is to develop a suitable encapsulation for the growing medium. [9] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller. This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased. It is concluded that for the non- water transporting cracks it will be an advantage when the mechanism does not need any water source for the activation of the bacteria.

H.M.Jonkers (2011) In this paper the author discussed about the mechanisms of self-healing concrete. The study shows that the crack healing of self-healing concrete based on expanded porous clay minerals loaded with bacteria and calcium lactate is more efficient than of concrete of the same composition with empty expanded clay particles. Therefore the conclusion of the work is that the two component bio-chemical healing agent is a more promising bio-based and thus a sustainable alternative for the healing process of cracks in the concrete.

III. CONCLUSION

1) Due to its eco-friendly nature , self-healing abilities and increase in durability of many building materials, the bacterial concrete is found to be more advantageous than that of the conventional concrete.
2) Limitations of biotechnological applications on building materials could be clearly understood from the past literature studies.
3) Many cementitious and stone materials can exhibit enhanced compressive strength and reduction in permeability, water absorption, corrosion of reinforcement etc.,
4) Cementation by bacteria is very easy and convenient for usage. This will soon provide the basis for high quality structures that will be cost effective and environmentally safe, but more work is required to improve the feasibility of this technology from both economical and practical point of views.
5) Increase in compressive strength is mainly due to the consolidation of the pores inside the cement mortar with microbiologically induced calcite precipitation.
6) When bacterial concentration increases, the Calcium Carbonate (CaCO3) precipitation increases.
7) A lower permeability due to healing of cracks would result in a decreased ingress rate of the aggressive chemicals.

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