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Microbial Concrete and Self Healing Property: A Review

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Abstract: *Concrete is the most common material, crack is the main problem that arises in a concrete structure. This causes corrosion in the steel reinforcement. The structure deteriorates with cracks, so due attention is needed to this problem. This work consists of various self-medication methods used by researchers to inhibit cracks and prevent further deterioration of the structure. To prevent cracks Microbiological induced calcite precipitation, ie. MICP is used in most literature to inhibit cracks. The use of bacteria in the healing of cracks has been more successful, and the strength of concrete is also increasing. This article discusses the different types of bacteria used to heal cracks. The maximum strength increased, and the width of the crack healed using these methods, also mentioned in the article.*

Keywords: Self-healing, microbial concrete, micro structure and CaCO3 precipitation

I. INTRODUCTION

The depth of precipitation of the CaCO3 layer was predicted when the results of the experiments and the results of the analytics are in good cooperation. The crack surface that is closed when the amount of precipitation CaCO3 is used in the appropriate amount [3]. The effectiveness of self-medication was observed 24.1%, 25.6%, 27.27% and 32.26% for samples when mixed with metacaolin, bentonite, Portland cement and limestone microfiler, respectively, calcium carbonate was produced, and surface cracks can be successfully healed [5].

The experiments were performed on the sample, and it was observed that RCA and virgin FA as a percentage of up to 50 in terms of bacterial immobilizers were good methods of crack healing, so that the crack width of about 1.1 mm can be successfully healed with increasing compressive strength of the sample. Synergy formulation as well as induction in the sample also showed a good effect on compressive strength [7].

After the crack developed on the surface, bacterial spores and a solution containing calcium lactate were inserted into the crack. Healing cracks up to 0.46 mm was possible when the solution is used in concrete for the self-medication process [9]. Concrete structures have been facing the problem of cracking plastic for a long time. This can reduce the strength of the structure, as well as reduce durability, and the service life of the structure prevents plastic through shrinkage. Plastic cracking is developed for many reasons, the primary is the calculation of solid particles in concrete or bleeding, and other causes may be the cause of this type of shrinkage [16]. The self-medication procedure is very well known to limit the spread of cracks in the concrete structure. There are various self-medication agents, as well as materials used in concrete with different applications, as well as performance [17].

Role of Superabsorbent Polymers (SAP)

Cement materials when mixed with superabsorbed polymers (SAP), then due to their properties, if resistance to cracks, as well as durability make this process attractive to new researchers. When SAP is induced in cement, the additional water in the mixture makes the mixture operational and has very less effect on mechanical properties. This process reduces the autogenous shrinkage process, and thus the crack resistance and durability properties are greatly improved [26].

The combined use of SAP and nanosilica proved to be a satisfactory solution when the experiments are performed on a sample to verify the behavior of plastic shrinkage cracks. Possibility of self-medication of the sample, which is increased when superabsorbent polymers are added to the cement content (SAP). Nanosilica and SAP are combined in self-medication experiments and found that durability increases significantly [24].

The role of different composites for self-medication

Healing in terms of autogenous for concrete structure, the heat produced continues to decrease as the concrete age increases. Prolonged hydration is observed in the case of GGBS concrete and silicate smoke, when the comparison is made for the normal use of Portland cement in concrete [22]. The use of pre-stressed hybrid tendons is used to heal cracks in concrete structures. Different types of tendons used in experiments to make effective reinforcement possible in the structure. Cracks can be cured with this system [13].

Clinker / polyvinylpyrrolidone(PVP) autolytic microsphere was made using a film coating method, a self-medicating material that is considered a cement clinker, while the autolytic film was used in the term PVP [15]. The grout was filled with cracks, and ultrasound equipment was used to control the crack healing process. Numerical modeling in terms of the 2-D area of the final difference was performed to determine the healing methods in the cement material [11].

Engineering cemented composites have great potential to study the self-healing ability of a surface crack [19]. The weight of ash in ECC was the most important factor in the crack healing process [10] [11]. Expansive chemicals as well as precipitation of CaCO3 were used in samples for concrete material to have more life and surfaces that do not contain cracks [12]. Dust with a filter cement bag was non-cemental, and when it was replaced with cement during partial replacement and used in bacterial concrete, then the compressive strength was at a good level [14]. Samples were prepared using ash to detect the effect of bacterial spore performance in concrete self-healing. Cement was replaced by golden flies as a percentage of 10 to 30% [21].

Measure the Healing Process

It was confirmed that mineral precipitation on the cracked surface is a calcite crystal, this is tested using an electric field emission scanning microscope, as well as an X-ray diffraction analysis method [15]. The effectiveness of crack healing was tested for bacterial solution using UPV analysis tools and images. Self-healing of the mortar mixture was experimentally investigated using UPV and image analysis method [16]. Microbial calcite precipitate was observed on the crack surface by X-ray diffraction analysis [24], a scanning electron microscope was used for the imaging process, the energy dispersion spectrometer is also used for analysis [28] [17].

Healing indicators should be measured in terms of restoring the applied load on the sample, the efficiency of the crack seal and the permeability of the gas. The degree of hydration of various cement materials seemed to be a measure of age. The results obtained in terms of the proportions of calcite for the healing compounds formed are a tendency to increase according to the age of the cement sample [17]. Stable conditions can be effectively monitored when a constant water flow is applied so that the applied pressure gradients are not required, as the accuracy of the pressure measurements as found above for low flow [18].

II. CONCLUSION

The durability of the concrete structure increases if the correct self-treatment of cracks is built in. The strength of the structure has also increased to some extent. The width of the cracks to the main volumes can be completely healed under the necessary environmental conditions. Microbial concrete is very useful for crack healing and further development. The benefits of different bacteria for concrete healing are discussed in the article. Microbial concrete seemed a promising technology of structural strength. This concrete is also proving to be environmentally friendly as well as cost-effective technology for use in the construction sector.

REFERENCES

[1]. Achal, Varenyam, Xiangliang Pan, and NilüferÖzyurt. "Improved strength and durability of fly ash-amended concrete by microbial calcite precipitation." Ecological Engineering 37 (2011): 554-559.

[2]. Algaifi, Hassan Amer, et al. "Bio-inspired self-healing of concrete cracks using new B. pseudomycoides species." Journal of Materials Research and Technology 12 (2021): 967-981.

[3]. Algaifi, Hassan Amer, Suhaimi Abu Bakar, Abdul Rahman Mohd. Sam, Ahmad RazinZainalAbidin, ShafinazShahir, and Wahid Ali Hamood AL-Towayti. "Numerical modeling for crack self-healing concrete by microbial calcium carbonate." Construction and Building Materials 189 (2018): 816-824.

[4]. Alshalif, Abdullah Faisal, J. M. Irwan, N. Othman, A. A. Al-Gheethi, S. Shamsudin, and Ibrahim M. Nasser. "Optimisation of carbon dioxide sequestration into bio-foamed concrete bricks pores using Bacillus tequilensis." Journal of CO2 Utilization 44 (2021): 101412.

[5]. Andalib, Ramin, et al. "Optimum concentration of Bacillus megaterium for strengthening structural concrete." Construction and Building Materials 118 (2016): 180-193.

[6]. Azarsa, Pejman, Rishi Gupta, and AlirezaBiparva. "Assessment of self-healing and durability parameters of concretes incorporating crystalline admixtures and Portland Limestone Cement." Cement and Concrete Composites 99 (2019): 17-31.

[7]. Balzano, Brunella, John Sweeney, Glen Thompson, Cristina-LuminitaTuinea-Bobe, and Anthony Jefferson. "Enhanced concrete crack closure with hybrid shape memory polymer tendons." Engineering Structures 226 (2021): 111330.

[8]. Beglarigale, Ahsanollah, Yoldaş Seki, NaimYağızDemir, and HalitYazıcı. "Sodium silicate/polyurethane microcapsules used for self-healing in cementitious materials: Monomer optimization, characterization, and fracture behavior." Construction and Building Materials 162 (2018): 57-64.

[9]. Byoungsun, Park, and Cheol Choi Young. "Investigating a new method to assess the self-healing performance of hardened cement pastes containing supplementary cementitious materials and crystalline admixtures." Journal of Materials Research and Technology 8 (2019): 6058-6073.

[10]. Chahal, Navneet, Rafat Siddique, and Anita Rajor. "Influence of bacteria on the compressive strength, water absorption and rapid chloride permeability of concrete incorporating silica fume." Construction and Building Materials 37 (2012): 645-651.

[11]. Chahal, Navneet, Rafat Siddique, and Anita Rajor. "Influence of bacteria on the compressive strength, water absorption and rapid chloride permeability of fly ash concrete." Construction and Building Materials 28 (2012): 351-356.

[12]. Danish, Aamar, Mohammad Ali Mosaberpanah, and Muhammad UsamaSalim. "Past and present techniques of self-healing in cementitious materials: A critical review on efficiency of implemented treatments." Journal of Materials Research and Technology 9 (2020): 6883-6899.

[13]. De Muynck, Willem, Dieter Debrouwer, Nele De Belie, and Willy Verstraete. "Bacterial carbonate precipitation improves the durability of cementitious materials." Cement and Concrete Research 38 (2008): 1005-1014.

[14]. De Muynck, Willem, Kathelijn Cox, Nele De Belie, and Willy Verstraete. "Bacterial carbonate precipitation as an alternative surface treatment for concrete." Construction and Building Materials 22 (2008): 875-885.

[15]. El-Newihy, Adham, PejmanAzarsa, Rishi Gupta, and AlirezaBiparva. "Effect of Polypropylene Fibers on Self-Healing and Dynamic Modulus of Elasticity Recovery of Fiber Reinforced Concrete." Fibers 6 (2018).

[16]. Erşan, Yusuf Çağatay, Emma Hernandez-Sanabria, Nico Boon, and Nele de Belie. "Enhanced crack closure performance of microbial mortar through nitrate reduction." Cement and Concrete Composites 70 (2016): 159-170.

[17]. Erşan, Yusuf Çağatay, Filipe Bravo Da Silva, Nico Boon, Willy Verstraete, and Nele De Belie. "Screening of bacteria and concrete compatible protection materials." Construction and Building Materials 88 (2015): 196-203.

[18]. Erşan, Yusuf Çağatay, HilkeVerbruggen, Iris De Graeve, Willy Verstraete, Nele De Belie, and Nico Boon. "Nitrate reducing CaCO3 precipitating bacteria survive in mortar and inhibit steel corrosion." Cement and Concrete Research 83 (2016): 19-30.

[19]. Escoffres, P., C. Desmettre, and J.-P. Charron. "Effect of a crystalline admixture on the self-healing capability of high-performance fiber reinforced concretes in service conditions." Construction and Building Materials 173 (2018): 763-774.

[20]. González, Álvaro, et al. "Evaluation of Portland and Pozzolanic cement on the self-healing of mortars with calcium lactate and bacteria." Construction and Building Materials 257 (2020): 119558.

[21]. He, Ziming, et al. "Cement-based materials modified with superabsorbent polymers: A review." Construction and Building Materials 225 (2019): 569-590.

[22]. Hung, Chung-Chan, and Yen-Fang Su. "Medium-term self-healing evaluation of Engineered Cementitious Composites with varying amounts of fly ash and exposure durations." Construction and Building Materials 118 (2016): 194-203.

[23]. Huseien, GhasanFahim, Kwok Wei Shah, and Abdul Rahman Mohd Sam. "Sustainability of nanomaterials based self-healing concrete: An all-inclusive insight." Journal of Building Engineering 23 (2019): 155-171.

[24]. Jafarnia, Maedeh Sadat, Mehdi KhodadadSaryazdi, and Seyed Mohammad Moshtaghioun. "Use of bacteria for repairing cracks and improving properties of concrete containing limestone powder and natural zeolite." Construction and Building Materials 242 (2020): 118059.

[25]. Jiang, Zhengwu, Jun Li, and Wenting Li. "Preparation and characterization of autolytic mineral microsphere for self-healing cementitious materials." Cement and Concrete Composites 103 (2019): 112-120.

[26]. Jongvivatsakul, Pitcha, KarnJanprasit, PeemNuaklong, WiboonlukPungrasmi, and SuchedLikitlersuang. "Investigation of the crack healing performance in mortar using microbially induced calcium carbonate precipitation (MICP) method." Construction and Building Materials 212 (2019): 737-744.

[27]. Jonkers, Henk M., ArjanThijssen, Gerard Muyzer, OguzhanCopuroglu, and Erik Schlangen. "Application of bacteria as self-healing agent for the development of sustainable concrete." Ecological Engineering 36 (2010): 230-235.

[28]. Karimi, Mohammad M., Saeed Amani, Hamid Jahanbakhsh, BehnamJahangiri, and Amir H. Alavi. "Induced heating-healing of conductive asphalt concrete as a sustainable repairing technique: A review." Cleaner Engineering and Technology 4 (2021): 100188.

[29]. Kaur, Nimrat Pal, SubhraMajhi, Navdeep Kaur Dhami, and Abhijit Mukherjee. "Healing fine cracks in concrete with bacterial cement for an advanced non-destructive monitoring." Construction and Building Materials 242 (2020): 118151.