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A Review On Self Healing Concrete By Using Bacillus Megaterium

Anmol G Jadhav, Kiran M Deore

[1] *B.E Student, Department of Civil Engineering, Late G.N.Sapkal College of Engineering, Nashik, Mahatashtra, India.*
[2] *Assistant Professor, Department of Civil Engineering, Late G.N.Sapkal College of Engineering, Nashik, Mahatashtra, India .*

Abstract : The Cracks form in the concrete are not avoidable , and it is natural occurring process if the load is greater or the mortar would not in a proper proportion then there would be weakness in the concrete. Through these cracks water, salts and others chemical components can seep in to the concrete structure. It is the initial corrosion process which further reduced the life of the concrete structure. Therefore to prevent from the corrosion which simultaneously help to not to decrees the life span of the concrete structure Therefore is was necessary to develop an a self-repairing technology from which where would be prevention from the cracks Bio-concrete is one kind of material which can strongly prevent from cracks in concrete structure. This technology is very fascinating as a result of the act of crack remedy it is also an eco-friendly and naturally occurring substance .Due to the crack on the concrete structures There are some adverse effect on the compressive strength, water absorption etc of cement concrete It was found in the study that with the use of Bacillus Megaterium substance improves the compressive strength and stiffness of concrete structure and also reduction in water absorption and water permeability when it is compared to general concrete structure. The bacteria that goes to be introduced in concrete, should to have the property of alkali-resistance and it jointly should be kind spore, so it will stand up to the stresses produced in concrete in the process of mixing, transportation of concrete like RMC and while placing the concrete.

Key Words: **Concrete , Self Healing , Cracks , Bacillus , Durability**

1.0 Introduction :

Concrete, it is the most widely used for construction material. Concrete is weak in tension and strong in compression and cracks are unavoidable in concrete. Once cracks form in concrete Structure it star reducing the lifespan of the concrete structures. The Micro-cracks and pores in concrete are excessively because they create a way for the water and the substances which leads to the corrosion of reinforcement provided in the concrete structure and it also reduces the strength durability etc of concrete. There are many repair techniques which are available to repair the cracks present in the concrete structure , but they are vey expensive and time consuming process. There are some moderate techniques to repair the cracks in the concrete structure by itself is called as “Self-Healing Concrete”. This bacterial restoration technique are better than other techniques present in the current scenario as it is a bio-based, environment friendly, economical and durable. Concrete is a very alkaline material, the bacteria which is added is capable of preventive alkali environment. Bacteria with calcium nutrient source are added into the concrete at the time of mixing the concrete . If any would be any kind of cracks will be formed in concrete the bacteria prematurely calcium carbonate then it will seal the cracks present on the concrete structure. The Crack which are more than 0.8mm is very difficult for the repaired purpose with the use of bacteria crack can repaired with the help of calcium carbonate precipitation.

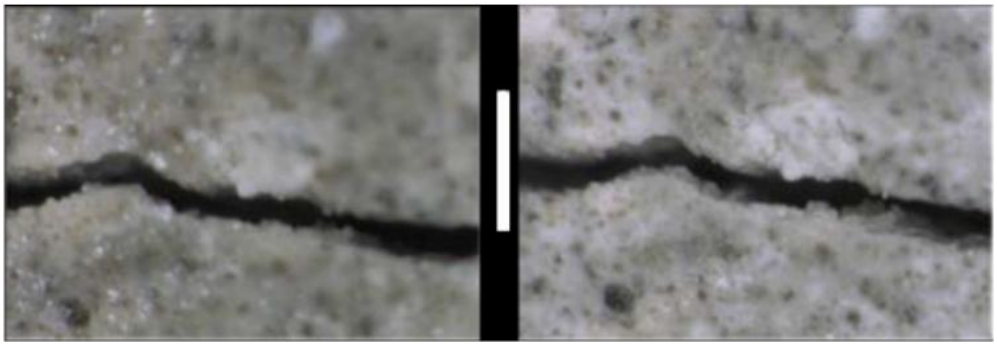
This eco-friendly method was firstly adopted for the used of repair of cracks on the concrete structure to prevent leaching in channels , with the help of the bacteria Bacillus megaterium, Bacillus pasteurii, Bacillus , Bacillus subtilis, Bacillus aerius, Sporosarcina pasteurii, Shewanella Speciesand Bacillus flexus etc. Bacteria used in this kind of work is Bacillus megaterium Bacteria of one hundred and five cells/ml of water. These bacterium based mostly self-healing agent is believed to stay hibernated at intervals the concrete for up to two hundred years.The bacterial spores begin microbic activities once they are available in direct contact with water and oxygen due to which the development of cracks in concrete. Recently, the self healing approaches are exhibiting promising leads to remediating the cracks within the earlier stages of formation of cracks.

2.0 Mechanism Of Healing :

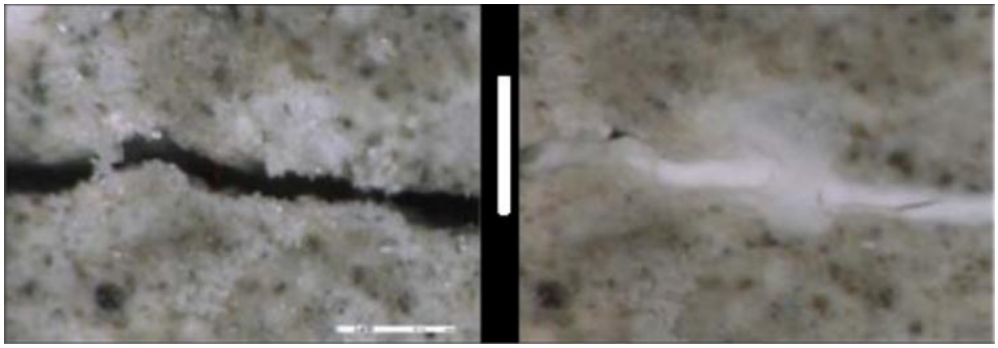
The capsules which cointains bacteria and calcium lactate are inserted in the concrete , the reason to use it within the capsule kind is to avoid interaction between them. The capsules used are passive and may last upto a century. The concrete structures is meant to own small cracks by the physical reactions that decrease durability of the concrete structure. The capsules need

water for his nutrition to grow its self that gets leaked into the cracks after they exposed to atmosphere. once reaction with water, salt forms sedimentary rock that heals the cracks. It spreads throughout the cracks resulting in the healing of the cracks.

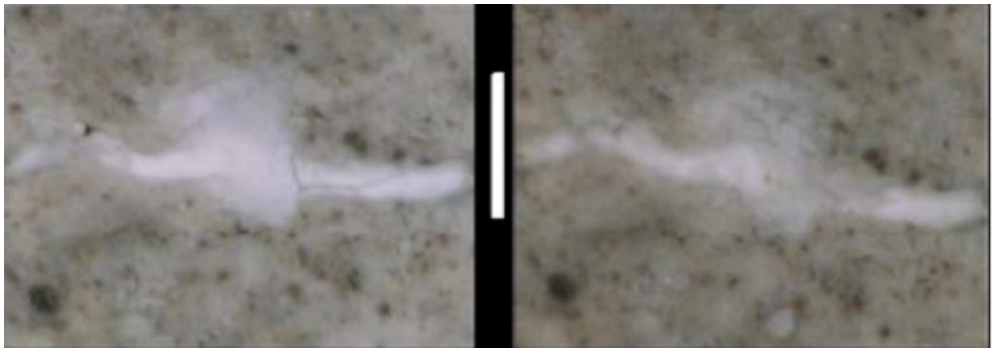
After formation of the salt forms sedimentary rock, the chances of the water leakage inside the concrete structure is not possible . by this it increase in the sustainability of the concrete structure . basically they are added as spores so that they can be the inactive having very high survival rate and once the extant conditions are against the odd then the active bacteria once again forms spores.



3 Days **Fig - 01** 7 Days



14 Days **Fig – 02** 28 Days



40 Days **Fig - 03** 200 Days

3.0 Selection Of Materials :

3.1 Methyl Methacrylate :

The different varieties of healing agents have already been tested on their potency to be used in self-healing concrete. Generally, In the business healing agents is being used whereas their properties are adjusted for the manual crack repair and not for autonomous crack healing. Consequently, the amount of regain in properties because of self-healing of cracks is restricted in the concrete structure.

Once the required properties were obtained, the healing agent was encapsulated and screened for its self-healing potency , they're capable to scale back the water porosity however regain a lot of strength. methyl radical methacrylate, a self-healing agent which might restore high strength more than the desired once healing of cracks. methyl radical methacrylate encapsulated in an exceedingly microcapsules will be side with the concrete structure . once the crack reaches the microcapsule, the capsule breaks and also the chemical compound bleeds into the crack, wherever it will polymerize and mend the crack. These microcapsules were crammed with a liquid chemical compound (methyl methacrylate). If a small crack happens during this concrete, the microcapsule can rupture and also the chemical compound can fill the crack. After wards it'll polymerize and autogenously heal the cracks of the Concrete structure.

3.2 Industrial Waste Steel Scrap :

The Steel waste materials are the waste materials which are collected from the different workshops and other steel industries at a very minimum cost it is also called as Steel scrap . They are look like the steel fiber but they did not have a define shape or size . The dimension may accordingly with the nature of source which depends upon the type of industries. Scraps are recyclable materials and is the unwanted parts of the vehicles, building materials etc According to analysis conducted by the United States of America , Environmental Protection Agency, utilization scrap metals may be quite helpful to the *atmosphere*. daily around eight to ten kilogram is generated by every shaping machine industries and dropped within the soil there by contaminating the soil and well water, that creates AN environmental issue. therefore by adopting correct management by utilization the shaping machine scrap with concrete is taken into account to be one in all the simplest solutions. The test were conducted as per the Indian standard procedure for its mechanical properties like flexural, tensile strength, compressive strength etc and compared with ordinary PCC. At The seventh days strength of the shaping machine scrap concrete shows a rise in its compressive strength in comparison with ordinary PCC concrete .

Fig - 04 Industrial Waste Steel Scrap

3.3 Sand :

Fine aggregate or sand is Associate in Nursing accumulation of grains of mineral matter derived from the disintegration of rocks. it's distinguished from gravel solely by the dimensions of the grains or particles, however is distinct from clays that contain organic materials. Sands that are sorted out and separated from the organic material by the action of water or by winds across arid lands are usually quite uniform in size of grains. Sand is used for creating mortar and concrete for sprucing and sand blasting. The fine mixture was passing through 4.75mm sieve and had a selected gravity of 2.68 . The grading zone of the mixture was zone three as per Indian commonplace specifications

Fig – 05 Sand

3.4 Coarse Aggregate :

Coarse Aggregate area unit which is the crushed stone is used for creating concrete. crushed and hierarchal. a lot of of the crushed stone used is granite, rock and entice rock. hierarchal crushed stone typically accommodates just one quite rock and is broken with sharp edged. The sizes area unit from 0.25 to 2.5 inches (0.64 to 6.35cm) though larger sizes could also be used for large concrete mixture. Machine crushed granite broken stone angular in form was used as coarse Aggregate. the highest size of coarse mixture was 20 mm and relative its specific gravity is of 2.78.

Fig – 06 Coarse Aggregate

3. 5 Water :

The Water which is suitable for drinking is mostly suitable for the creating of concrete as per the IS Code 456-2000 the ph value should be in between 6-7 . Water should to be free from impurities like acid impurities , oils impurities , alkalis impurities , vegetables or alternative organic impurities. The impure water made concrete structure weaker. Water has two function in a concrete structure mix. Firstly, it reacts in a chemically with the cement to form a cement mortar in which the inert aggregates are held in suspension until the cement mortar has hardened. Secondly, it act as a bonding agent between fine aggregate and cement

3. 6 Cement :

Cement is a construction material which is for construction purpose it is generally in the form of powder form that it can be made into a cement mortar by the adding of water and, when wrought or poured, can set into a solid mass. varied organic

compounds used for adhering, or fastening materials, are known as cements, however these are classified as adhesives, and also it is the term as cement alone suggests that a construction material. the foremost wide used of the development cements is Portland cement. it's a bluish-gray powder obtained by finely grinding the clinker created by powerfully heating associate intimate mixture of carbonate and clayey minerals. The chief raw materials could be a mixture of high-calcium sedimentary rock, called cement rock, and clay or sedimentary rock. Blast-furnace scoria can also be employed in some cements and also the cement is named Portland scoria cement (PSC). the colour of the cement is due primarily to iron chemical compound. within the absence of impurities, the colour would be white, however neither the colour nor the precise gravity could be a check of quality.

3. 7 Hydroxyethyl Cellulose :

Hydroxyethyl polyose could be a non-ionic soluble chemical compound derived from polyose. It can be ready to dissolves promptly in cold or quandary. it's excellent flow properties that modify the fibers to meet the world of concrete. It is a viscous agent. it's additionally used as a binder, stabilizer in concrete to push higher bonding between cement paste and aggregates. It additionally is protecting mixture throughout chemical action of alkyl methacrylate.

Fig– 07 Hydroxyethyl Cellulose

3. 8 Silica Fume :

Silica fume, additionally called small silicon oxide|oxide}, is Associate in Nursing amorphous (non-crystalline) organism of silicon dioxide, silica. it's Associate in Nursing ultrafine powder collected as a by-product of the Silica and ferrosilicon alloys production and it is also consists of the spherical particles with a median particle. the most of the field of application is as pozzolanic material for the top performance concrete. silicon dioxide fume is intercalary to Portland cement concrete to boost its properties, specifically its compressive strength, bond strength, and abrasion resistance. Addition of silicon dioxide fume additionally reduces the porousness of concrete to chloride ions, which protects the reinforcing steel of concrete from corrosion. silicon dioxide fume additionally blocks the pores within the recent concrete thus water at intervals the concrete isn't allowed to come back to the surface and reduces harm.

It had shown that Portland cement-basedconcretes containing silicon dioxide fumes had terribly high strengths and low porosities. Since then the analysis and development of silicon dioxide fume created it one in every of one in every of most respected and versatile admixtures for concrete and cementations product.

Fig– 08 Silica Fume

4. 0 Methods Of Self Healing Of Concrete :

4. 1 Autogenous Self Healing :

Autogenous self healing relies on the composition of concrete and is accomplished by hydration reaction of cementitous products within the matrix, or by reaction of polymeric substances in the matrix. Autogenous self healing has been widely studied .One of the weaknesses of this approach is the limitation posed by crack width. Autogenous healing is primarily effective for very narrow cracks; different researchers studied the effectiveness of this technique in sealing cracks of different widths, of 5–10 μm, 200 μm, and 300 μm. It has been acknowledged that wider cracks that are deterimental to durability of concrete structures cannot be effectively healed by autogenous healing. Furthermore, a constant supply of water must be present to support the hydration process so that cracks can be completely sealed.

Therefore, the development of self-produced healing is also additional distinguished in contemporary or young concrete, whereas carbonate precipitation is also the pronounced mechanism at later stage. Several researchers tried at mistreatment supplementary cementitous materials, like ash and furnace slag, to stimulate self-produced healing. Materials like ash and slag hydrate at slower rate than cement and so, unhydrated particles of such minerals promote self-produced healing at later stage of concrete.

4. 2 Vascular Self Healing :

The vascular view of the self healing Concrete is closely shows the vascular network present in the system of the human body. The network of the vascular tubes can be placed in the concrete to bring a healing agent to the cracked or damaged sites. In this way the self healing agents are compact in hollow tubes or network of hollow tubes and supplied by other source. There are two means of achieving self-healing by vascular approach: single-channel and multiple-channel systems. once solely a single-component of self healing agent is employed, the single-channel vascular-shaped structure approach is used when it involves healing by the reaction of two healing agents, multiple channels square measure used. though external provide of healing agent is effective, technically it's not self-healing in and of itself, since it needs external intervention. Moreover, though possible at laboratory scale, it's tough to forged concrete with a network of pipes vascular self-healing on self-healing on actual construction sites.

4. 3 Cementitious Composites Self Healing :

The serviceability limit of concrete structure by cracking could be overcome by the crack management methodologies the improved service lifetime of concrete structures would cut back the demand for crack maintenance and repair. specially, the use of self healing technologies has high potential as a replacement repair methodology for cracked concrete This trend shows that it's necessary for each the commercial and analysis fields to develop concrete as well as self healing crack. Therefore, the aim of this study is to develop a building material composite at traditional or high water/cement ratios, the self-healing properties of concrete incorporating geo-materials as a partial cement replacement were investigated in terms of

recrystallizations. This study centered on 2 primary issues: (1) experimental and analytical style of building material materials with self-healing capabilities, (2) development of a self-healing concrete victimisation new building material materials at traditional water/binder magnitude relation [over W/B=0.45].

4. 4 Bio-Concrete Method Of Self Healing :

In this study the potential of microorganism to act as a self healing in concrete is investigated. the thought of use of microorganism and integrate them within the concrete matrix might appears odd initially ,it is not a microbiological read purpose. microorganism naturally occur each wherever on earth not solely on surface however additionally deep at intervals. To the date the most conclusion of this current researches are the experiment tired this study show the alkaliphilic spore forming microorganism intergrated in concrete matrix will actively precipitate carbonate minerals. Water, required for the activation of endospores will enter the concrte structure through freshly shaped cracks.

4. 5 Bacteria Based Self Healing :

Research resulting in microbic carbonate precipitation and its ability to heal cracks of construction materials has lead to several applications like crack correction of concrete, sand consolidation, restoration of historical monuments and alternative such applications. thus it will be outline as "The method will occur within or outside the microbic cell or maybe a ways away at intervals the concrete. typically microorganism activities merely trigger a amendment in answer chemistry that ends up in over saturation and mineral precipitation. Use of those Bio geology ideas in concrete ends up in potential invention of latest material referred to as referred to as Concrete". Self healing concrete could be a product that may biologically turn out stone to heal cracks that seem on the surface of concrete structures. Specially hand-picked kinds of the genus Bacillus, beside a calcium-based nutrient referred to as salt, and chemical element and phosphorus, area unit extra to the ingredients of the concrete once it's being mixed. These self healing agents will lie dormant at intervals the concrete for up to two hundred years.

CONCLUSIONS:

- Self Healing Concrete Is A New Technology Developed In Delft University, Netherlands. This Concrete Has Bacteria In The Form Of Capsules Which Remain Dormant Till 100 Years Unless It Receives Water Which Is Its Nutrient To Become Active And Multiplicate. Capsules Receive Water Only When Exposed To The Environment Which Is Possible When Cracks Appear In The Structures.
- The Bacteria Heal The Cracks Or Gap Within Three To Four Weeks By Producing Limestone As Its By Product.
- Structures Can Be Improved Exponentially And Hence Incur Savings In The Cost Of Maintenance.
- We Can Prepare Bricks Using Self Healing Concrete Which Are Environmental Friendly As They Are Not Produced In Kilns And Are More Durable Than Conventional Bricks.
- The Study Has Also Showed That There Is Enhancement Of Compressive Strength Of Concrete.
- It Also Showed That Use Of Such Bacteria Has Positive Effect On Water Absorption, Sportivity And Water Permeability In Concrete.
- The Present Study Represent That Using Self Healing Concrete Can Be A Competent Alternative And High Quality Concrete Sealant Which Is Ecofriendly, Cost-Effective And Also Results In Improvement In The Durability Of Building Materials.
- Addition Of Steel Scrap In The Percentages Of 5% And 10% To The Self-Healing Concrete Leads To A Considerable Increase In The Tensile Strength Of Concrete, Because It Has The Property Similar To The Steel Fiber.

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BIOGRAPHIES:

BE Student, Department of Civil Engineering, Late G.N.Sapkal College of Engineering, Nashik, Mahatashtra, India.

Assistant Professor, Department of Civil Engineering, Late G.N.Sapkal College of Engineering, Nashik, Mahatashtra, India.