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BACTERIAL SELF-HEALING EFFECT IN DIFFERENT TYPES OF ADVANCE CONCRETE – A REVIEW

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Abstract *—**Concrete is most efficient and worldwide using material after the water due to easily available and casting on site. In the present study, deterioration of concrete in terms of cracks and voids is studied. The durability always play vital role to decide the life span of structure More or less concrete is a composite material composed of coarse aggregate bonded together with a fluid cement pest which hardens over the time. So there are many chances and reasons to develop a voids and cracks in the concrete while casting and placing. And to resolve this problems various admixtures and other construction chemical used before and after the construction work. Here some biological experimental work is been carried out to filled up the pre and post construction cracks. In present study, my dissertation work is carried out to study the self-healing process in different type of sustainable concrete and to check effect on compressive strength. The experiments also done on existing structure for fill up the cracks. For fulfill of my object various literature studied on biological self-healing process as a part of my research work. My scope of research work to study the mechanical properties such as compressive strength on High Volume Fly Ash Concrete (HVFAC), Ultra High Strength Concrete (UHSC) and Light Weight Concrete (LWC) with application of self-healing agents.*

*Keywords- Bacillus Pasteurii**,** Compressive Strength, Supplementary Cementitious Material (SCM), Calcite precipitation.*

INTRODUCTION

In the construction industry concrete is the major component which is easy available, cheap and convenient to use. The crack in the concrete is the major problem which causes reduce the durability of the structure and strength of concrete. Based on the current research carried out the globe, several modifications have been made from time to time to overcome the deficiencies of cement concrete. Durability of concrete in terms of cracks and voids is very important aspect in design consideration. There are many reasons to developed cracks in concrete as post construction and pre construction cracks. The pre-construction cracks developed in structure due to shrinkage and creep, less water availability and curing reason while post construction structural cracks developed within the structure is due to cyclic effect of loading, some accidental load like earth quake and wing considerations. As all Know that Concrete is strong in compression and weak in tension so that the steel reinforcement is used in concrete. Some temperature or thermal also leads to cracks in structure. To resolve this defect in structure, many physical and chemical solution Applied. Biological or Bacterial self-healing in concrete is a current advanced concrete in which selective cementation by microbiologically-induced CaCO3 precipitation has been introduced for remediation of micro cracks. In the concrete technology the current research has led to production of some special concrete in consideration the speed of the construction work, strength of the concrete structure, durability of the concrete, economical by using the industrial material such as rise husk, fly ash ground granulated blast furnace slag etc. In the literature study, it has been found that the microbial mineral precipitation from metabolic activities of favorable microorganisms in concrete can improve the behavior of concrete. By inserting the suitable types of bacteria in the concrete which should able to transform the soluble organic nutrients in insoluble inorganic (CaCO3) calcium carbonate. This process is called as microbiologically induced calcite precipitation. In the self-healing process bacteria incorporated in to the concrete and calcium lactate food to support those bacteria when they become active. In this paper, the processes that are behind bacterial self-healing concrete and will describe the component that are induced in the process and how they work independently and collectively.

I. OBJECTIVE OF STUDY

The main objective of this study is to use the bacteria for self-healing processes in the concrete with various supplementary cementitious materials for economical construction and enhance the various important engineering properties of the concrete such as durability, strength etc.

II. MECHANISUM OF SELF-HEALING PROCESS

The principal of self-healing of bacteria is that they should be able to covert the soluble organic nutrients in to insoluble inorganic calcite crystals which is seal the micro cracks. The bacteria and the nutrients which are incorporated in the

concrete should not disturb the integrity of the cement sand matrix and also should not negatively affect other important engineering properties in fresh and hardened state of concrete. It was reported that if the bacteria is added directly in to the concrete mixture in suspension, their life time is reduced due to main two reasons first one is continues cement hydration resulting in reduction of cement sand matrix pore-diameter and second is due to insufficient nutrients to precipitate calcite crystals. A novel method of protecting the bacteria spore by immobilization before addition to the concrete mixture appeared to substantially prolong their life time.

III. LITERATURE REVIEW

At present literature study, the bacterial self-healing concrete produced with various supplementary cementitious industrial materials such as fly ash, GGBS, silica fume, rise husk is used as economical consideration. The aim of this study is that the biological self-healing effect on different types of advance concrete using application of bacteria.

Chintalapudi Karthik, Rama Mohan Rao, shown that the ability to heal the micro-cracks with the help of bacteria bacillus pasteurii as self-healing agent was seen by SEM analysis and confirmed by XRD ,that the calcium carbonate precipitation which help to sealing the micro cracks. The quantity of bacteria added in to the bacterial self-healing concrete which affects the chloride penetration and result showed that high amount of bacteria added gives unsatisfied results. The results of the compressive strength of the bacterial self-healing concrete at 91 day which compared to 28 days by added the bacillus pasteurii concentration 105 cells/ml as shown in figure. Bacillus pasteurii showed reduction in water absorption which increase the durability of the concrete structure and also helps in improving the mechanical performance of concrete. The ability of the bacteria to seal the cracks is checked by the SEM and XRD analysis. Bacillus pasteurii incorporated in to the bacterial concrete which capable to precipitate the calcite in concrete composition and silica gel in concrete which help in protecting the bacteria in high pH environment. The biological self-healing concrete results in cracks sealing and decrease the water permeability of concrete. The advantages of bio-based cement composite primarily reduce the maintenance cost, repair cost and hence result in increase of durability of structure.

Pradeep Kumar A, Akila Devi, at all, study of compressive strength of the biological self-healing concrete of M20 grade and M25 grade by additions of the bacillus subtilis microorganisms proportion 10 ml, 20ml and 30ml. based on the experimental investigation the compressive strength of the bacterial concrete by using bacillus subtilis is 33.32 which is maximum when addition of 30 ml bacteria. In this study the compressive strength of the bacterial concrete of M20 grade of concrete having higher than the compressive strength of the M25 bacterial concrete as shown in figure 2. So we can say that and proved the self-healing concrete technology by using the certain bacteria to be better than the many conventional technology as a result of the producing the ecofriendly and convenient for usage. So that the biological self-healing concrete technology will be safe and effective which cause this technology has alternatively used.

S. Soundharyal, Dr. K .N Nirmal Kumar, has been carried out the integrated bacteria applied and affiliated to alkali-resistant spore germinated species of the genus bacillus. In this research paper the bacteria inserted in the concrete matrix as a healing agent checked the healing capacity bacterial bio-mineralization precipitation of calcite. Study of the spore forming bacteria related to the genus bacillus represent promising candidates for application as self-healing agent in concrete and probably other cement based material. The bacterial spores which are capable to transform the calcium lactate to calcium carbonate.

M.V.Seshagiri Rao, Ch. Sasikala, in this research paper the researchers investigate the performance of the concrete by the microbiologically produced special growth, the development of the special concrete is alternatively know as bacterial concrete which heal the cracks effectively. The bacteria taken by the researchers is bacillus subtilis for effective cracks healing purpose. In this research paper the addition of bacterial concentration 105 cells per ml of mixing of water which showed the significant increase in the compressive strength up to 14.92%.with addition of bacteria it is observed that bacterial concrete is more durable in term of “acid durability factor” than conventional concrete and bacterial concrete is less attacked in terms of “acid attack factor” than conventional concrete. Based on present experimental investigation bacillus subtilis can be produced from lab which is proved to be a safe and cost effective. The percentage weight loss and percentage strength loss with 5% H2SO4 released that bacterial concrete has less weight and strength losses than the conventional concret.so that it can proved that the bacillus subtilis can be easily cultured and safely used in improving the performance characteristics of concrete.

L.Soundari, C.S.Maneesh Kumar, S. Anthoniraj at all, study the effect of the bacterial species on the various Engineering properties such as compressive strength, tensile strength of the concrete for improvement. In this study the bacillus subtilis used in the dormant state but viable bacteria in the concrete mixture which will enhance the property of concrete as effectively.in this paper the M25 grade of the bacterial concrete produced under the mix design by is code. In this study the bacillus subtilis of MTCC used as a soil bacterium which can capable to precipitate the urea in to calcite which prevent the air molecules in the concrete. The compressive strength of the bacterial concrete is increase 12.32%, 30.05%

at different age of M25 concrete by addition of bacteria in optimum concentration. The tensile strength of the concrete is increased with bacteria in percentage is to be 13.80% to 18.45 % of the M25 concrete. Flexural strength of the concrete is increased 13.19% to 15.56% of M25 grade of concrete. The bacterial concrete is cost 15 % then conventional concrete but it should be economical than many special types of concrete.

Willem De Muynck, Kathelijn Cox, Nele De Belie, Willy Verstraete, in this paper durability study of the bacterial precipitated calcium carbonate during the bio-mineralization process. In this study compared their effectiveness in relation to conventional surface treatment. Calcium carbonate solidified on concrete surface around the cracks which result in the decrease the permeability of the concrete. Based on the studied properties, the conventional method to protect concrete from degradation appears to fulfill their function properly. The precipitated calcite on the concrete surface solidified which cause capillary water reduces and permeability of concrete decrease. The use of the pure media of the bacteria will give better result in the decrease water permeability of concrete structure.

Rafat Siddique, Karambir Singh, Kunal, Malkit Singh, Valeria Corinaldesi, Anita rajor, in this study the researchers were investigate the properties of bacterial concrete to added the rice husk ash with various proportion of bacterial broth. In this study the cement is partially replaced by the (5%, 10%, and 20% by weight). In the casting of bacterial concrete the concentration of bacillus aerius (10^5 Cells/ml) was mixed in the water during making of concrete. In this study the test were performed for compressive strength, water absorption porosity, and chloride permeability and abrasion resistance up to the age 56 day for all concrete mixture with and without bacteria. The addition of the bacteria will further increase in the compressive strength and permeation properties of rice husk ash concrete. The compressive strength of the bacterial concrete were increase by 9% and 11.8% at the age of 28 and 56 days was observed compared to control concrete due to plugging of the pores inside the concrete matrix by bacterial induced calcite precipitation. The bacteria added in concrete causes reduction in water absorption and porosity due to calcite precipitation which in turn increase the durability of concrete structure. The abrasion loss was less in bacterial concrete mixes compared to control concrete mixes at all ages.

IV. MAJOR FINDING

The self-healing technology to be proved that is much better than any other conventional technology for healing and sealing the cracks and fissures in the concrete structure as effectively. Also enhance the various engineering properties of the structure such as compressive strength, tensile strength, flexural strength, permeability of water. The bacteria can be converting the soluble organic nutrients in to insoluble inorganic calcite crystal which seal the cracks. The compressive strength and durability of the concrete structure will be increase by using bacteria so that this technology will be used in near future.

V. CONCLUSION

The engineering properties of concrete can be enhanced by addition of the bacteria by the several researchers and following major finding by study.

This self-healing technology by using bacteria has proved to be better than many old technologies because this technology has eco-friendly in nature. The compressive strength of the bacterial concrete cube is increased when the addition of the bacillus pasteurii of optimum concentration, and which will give effective self-healing. The compressive strength of the fly ash concrete is improved with up to 20% with addition of bacillus pasteurii. The addition of the healing agent in bacterial concrete will give better compressive strength decrease in permeability, water absorption and also protect the steel reinforcement from corrosion. When the bacillus pasteurii addition in bacterial concrete which will heal the cracks up to 0.5 mm which is maximum. The compressive strength improved up to the 12.93% after 28 days by addition of the bacillus pasteurii.

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