A Research on Performance Study and Utilization of Micro concrete

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Abstract-Construction sector which uses cement in its activities causing a release of CO_2 into the atmosphere. Currently, all the sectors are viewing seriously in reducing environmental pollution and hazards. In this scenario, the research in industrial wastes such as fly ash, slag, used foundry sand, marble dust, etc., lead to use in construction industries as sustainable materials, thereby contributing to reduction in environmental pollution. Retrofitting is the process of strengthening of modifying something after it has been manufactured. Engineers used different materials which can provide quick and reliable solutions to the deteriorating civil infrastructure. Micro concrete is cementations dry ready mix composition prepared for use in areas where defect occurs in concrete and area is limited in movement making the placement of conventional concrete cumbersome. This paper reviewed the performance study and utilization of Microconcrete in different field. Compressive, tensile strength performance of Microconcrete with addition of different industrial waste product has been studied.

Keywords Microconcrte, Industrial waste, Retrofitting, Deterioration.

1. INTRODUCTION

1.1 BACKGROUND

Micro-concrete (MC) is a composition of suitably graded sand, cement and water to simulate concrete in small scale models. The cement and sand mixed in dry condition are available in pre-packed bags. It is ready to use dry powder but requires only the addition of water and mixing before application. The required quantity of water is to be added for ensuring the flowability. It is formulated for use in repair works of concrete where placing of conventional concrete is difficult. It should be non-shrink and free flow in nature [1]. As it is prepacked, wastage is less. Application to structural elements is very easy due to its flow nature and finished surface quality is smooth when compared with conventional concrete. The ingredients of MC are not sustainable by themselves. Further, they affect the sustainability of the environment. The cement used in concrete is responsible for emitting CO_2 into the atmosphere, one Ton of cement releases approximately 0.9 Ton of CO_2 and construction industry is the second largest producers of CO_2 next only to the automobile industry [2].

1.2 MICRO CONCRETE

Micro concrete is a cement based coating which can be applied thinly (approximately 2-3mm) to a range of different surfaces including tile and wood. It provides the look and feel of concrete at a fraction of the cost and weight of real concrete. Microconcrete is a great option for bathrooms, kitchens as it provides a hygienic, and stain free surface. What is more, the material is anti-slip and mould free, making it a fantastic choice for floor surfaces inside and out [3].

Micro concrete which has high initial strength is generally used in repair and rehabilitation works. It is majorly used to increase the load bearing capacity of RCC column and used for the repair of beams and other reinforced concrete elements. Regardless of all this advantages, it has some drawback, the constituents in the Microconcrete are not disclosed and hence properties cannot be altered to our convenience. It is not economical for all construction projects. It is only used in repair purpose [4].

1.3 UTILIZATION OF MICROCONCRETE

Micro Concrete was initially developed to reduce the demand for water as compared to conventional concrete. As a result of its ease of use and capability to adhere to other materials, micro concrete was used effectively to repair cracked or ageing concrete structures. Also, no pumping is needed which reduces the requirement of heavy machinery. Not only does this reduce application costs, but it also makes micro concrete a good option for areas with limited access [5].

Micro Concrete is often used because it can dry quickly which gives designers and those wanting to redecorate their homes with a surface option that will minimally disrupt their other projects. Actually, it dries so quickly that the covered surface could be functional within one day.As Micro Concrete dries so quickly it can be applied one day, and then the item can be used the next making it a super choice for those wanting to get projects done quickly [6].

1.4 ADVANTAGES OF MICRO CONCRETE

1. Requires no compaction so no heavy machinery is needed
2. Low permeability which means that it is can be used outside and in kitchens and bathrooms.
3. Bonds well to almost any surface
4. Strong almost as soon as it is applied
5. Chloride free making it a safe and durable surface option
6. Will not shrink upon application which means that no cracks or folds will occur

1.5 WHAT IS THE BEST PRACTICE FOR APPLYING MICRO CONCRETE?

Micro concrete is unlike conventional concrete because it does not require special laying skills or machinery. However, in order to get the best finish possible it is important to follow best practice when applying the material [7].

1. Surface Preparation

The first stage of applying micro concrete is surface preparation. The surface that is going to be covered has to be washed and cleaned, with any dust, gravel or dirt removed. Then, any metal or exposed reinforcement that could corrode needs to be cleaned, and then coated for protection [8].

2. Mixing

Micro concrete can be mixed by hand, but if a large quantity is needed then it is easier to use a mixing vessel. The amount of water needed varies dependent on the mix, however it is usually about 1:8 (water to micro concrete). To mix, the micro concrete needs to be added to water slowly whilst being constantly stirred.

3. Application

Once completely combined it is important to pour the micro concrete onto the prepared surface as soon as possible for the best flow and consistency. Then, using clean tools simply smooth the mix out and allow it to dry [9].

1.6 AREA OF APPLICATION OF MICRO CONCRETE

1. Repair of damaged reinforced concrete elements like beams, columns, wall, etc. where access is restricted and compaction is not possible.
2. For Jacketing of RCC columns to increase load-taking capacity
3. Micro concrete is a great option for bathrooms, kitchens as it provides a hygienic, and stain free surface.

2. LITERATURE REVIEW

Divya Chopra, Rafat Siddique and Kunalet al (2015) [1]studied the effect of replacement of cement with rush husk ash (RHA) as additional cementations materials and experimented its effect on strength, durability, and microstructure through their unique properties. The flow properties (Slump flow test, Funnel, U-Box and L-Box tests), mechanical properties (compressive strength and split tensile strength) and durability (porosity and RPCT) were tested. From the outcome, the fresh properties of self-compacting concrete with RHA revealed that increase in RHA decreases the workability. The compressive strength of self-compacting concrete with RHA increases up to 15% replacement of cement with RHA. The micro structural analysis (XRD and SEM) showed the huge formations of CS-H gel and steady state of hydration process at 15% replacement of cement by RHA which was the main reason for the improvement in the strength and durability of self-compacting concrete with RHA.

SalimBarbhuiya, PengLoy Chow and ShazimMemon et al (2015) [2]studied the microstructure, hydration and Nano mechanical properties of concrete with metakaolin. The incorporation of metakaolin in concrete was 0%, 5%, 10% and15% by mass of cement. The properties of concrete with metakaolin were tested by means of compressive strength test, sorptivity, accelerated carbonation, X-Ray Diffraction (XRD) analysis, mercury intrusion porosimetry (MIP) and Nanoindentation. From the test results, the compressive strength of concrete as increased with increase in the inclusion of metakaolin up to 10% of the mass of cement. At the low water-binder ratio, the sorptivity of concrete decreased with the inclusion of metakaolin. The carbonation depth of concrete was increased with 15% replacement of cement with metakaolin. The porosity of concrete reduces with increase in incorporation of metakaolin. The inclusion of metakaolin in concrete reduces the porosity and develops hydration process. The XRD pattern showed that the inclusion of metakaolin in concrete changes Portland into C-S-H gel which leads to modification relative properties of concrete.

Malkit Singh and Rafat Siddique et al (2014)[3] studied the possibility of utilization of coal bottom ash as substitute for fine aggregate in concrete. The test result showed that the compressive strength of concrete with bottom ash at the curing age of 28 days was not affected badly. However, after 90 days of curing age, compressive strength of bottom ash concrete surpassed that of conventional concrete. SEM and XRD studies indicated that the C–S–H gel structure was somewhat less monolithic than that of conventional concrete and total intensity of hydrous calcium aluminiumsulphate was not changed with the inclusion of coal bottom ash in concrete.

Yogesh Aggarwal and Rafat Siddique et al (2014)[4] investigated the influence of waste foundry sand and bottom ash in equal quantities as partial replacement of fine aggregates in various percentages (0% to 60%), on concrete properties The inclusion of waste foundry sand and bottom ash as fine aggregate does not affect the strength properties negatively as the strength remains within limits except for 60% replacement. The micrograph from SEM analysis showed the proper and clear fibrous pattern of C-S-H gel which makes the concrete more opposed to aggressive situation as observed from chloride penetration test values.

VitoldasVaitkevicius, EvaldasSerelis and HaraldHilbig et al (2014) [5] conducted an investigational study that reports the micro structural variations of Ultra High Performance concrete (UHPC) with inclusion of glass powder. Four compositions are prepared with different quantity of glass powder. The four compositions of UHPC with glass powder were tested for its mechanical and micro structural properties. From the micro structural analysis, the hydration process was accelerated because of .increase in dissolution rate of Portland cement. This leads to formation and development of opaque microstructure of UHPC. The composition with blend of silica fume and glass powder showed good performance and increase in compressive strength.

Mahmoud Khashaa Mohammed, Andrew Robert Dawson and Nicholas Howard Thom et al (2013)[6]investigated production, microstructure and hydration characteristics of sustainable SCC using limestone powder and fly ash. The rate of replacement of both fly ash and limestone was 33% of cement content. The fresh and hardened properties of concrete samples were tested. X-ray Diffraction Analysis (XRD), Scanning Electron Microscope (SEM) and Energy-dispersive Spectroscopy (EDS) analysis were performed to examine the microstructural changes in concrete with fly ash and limestone. The microstructural study showed that SCC containing fly ash had dense microstructure than SCC containing limestone powder. Due to dehydroxylation of CH, high amount of Ca (OH)2 and CaCO3 was visualized in SCC with limestone powder. As a result, fly ash was suitable for creation of sustainable SCC.

Rafat Siddique, Yogesh Aggarwal, Paratibha Aggarwal, El-HadjKadri and RachidBennaceret al (2011)[7]explored the strength durability and microstructural properties of concrete partially replaced with used foundry sand. The proportion of fine aggregates in the mix was replaced with range of 0% to 60%. Strength and durability properties of concrete with used foundry sand and ordinary concrete were examined. From the outcomes of the tests performed, the optimal usage of foundry sand as partial replacement for fine aggregate was found out to be 30% and not more than 50%. The XRD and SEM analysis showed the dense microstructure with reduced voids which causes the increase in strength and resistance to violent environment. The development of C-S-H gel, micro cracks on the concrete were visualized through micrographs of concrete and interrelated with the mechanical uniqueness of the concrete.

Gai-FeiPeng and Zhi-Shan Huang et al (2008)[8] carried out the study on the change in microstructure of hardened cement paste due to elevated temperatures. The microstructure of hardened cement paste was tested using X-ray diffraction (XRD) and Scanning Electron Microscope (SEM) analysis. Mercury Intrusion Porosimetry (MIP) test was performed to determine the pore size distribution of hardened cement paste in concretes NSC-40, HPC70 and HPC-110.Due to coarsening effect of pore structure in hardened cement paste, the mechanical properties of HPC is affected. From XRD and SEM analysis, the rate of decomposition of C-S-H gel was increased with temperature above 600ºCwhich was the most important cause for the loss in strength of HPC.

PrinyaChindaprasirt, Chai Jaturapitakkul and TheerawatSinsiri et al (2007)[9] investigated the changes on microstructure and pore structure of blended cement paste with fly ash. Type I Portland cement was replaced with original fly ash (OFA) and classified fly ash (CFA).Portland cement were replaced with fly ashes at 0%, 20% and 40%. Pore size distribution (Mercury Intrusion Porosimetry) and microstructure (XRD and SEM) of blended cement paste with two different fly ashes were tested for 7, 28 and 90 days. The pore size of cement paste incorporated with original fly ash (OFA) was lower than the cement paste with classified Fly ash (CFA). From the XRD pattern, it was noticed that Ca(OH)2 decreased with increase in fly ash which leads to faster pozzolanic reaction and hydration process in blended cement paste with fly ash (40 % replacement). The SEM observations showed the dense and homogeneous microstructure of cement paste with finer fly ash which was mainly due to enhancement pozzolanic, hydration reaction and nucleation effect.

Hong-Sam Kim, Sang-Ho Lee and HanYoung Moon et al (2007) [10] conducted an experimental study on the strength and durability of high strength concrete using metakaolin as a cementitious material. Nine different mixes containing different proportions of metakaolin and silica fume were prepared with 5%, 10%.15% and 20% weight of the binder. The strength (compressive, tensile and flexural strength) and durability (Rapid chloride penetration test, Acid attack test, Freezing and thawing test and Accelerated carbonation test) of concrete samples were tested. The Strength tests showed the best possible strength characteristics were obtained for 10% and 15% replacement of metakaolin. The fine powder of metakaolin and silica fume showed improves the resistance against the chemical attack which was mainly due filler effect of the two binders. It was confirmed that mechanical and durability characteristics of concrete with metakaolin and concrete with silica fume are considerably similar. From the overall experimental analysis, the metakaolin exhibits as a capable alternative for silica fume.

Tao Ji et al., et al (2005) [11]conducted a study on water permeability and microstructure on concrete with nano silica. Normal concrete (NC) and nano silica concrete (SC) are the two mix proportions used along with the super plasticizers (TW-7). In nano silica concrete (SC), a part of cement was replaced with nano silica. Fresh and hardened properties of normal concrete and nano silica concrete were tested by means of slump flow test, compressive strength, permeability test at the age of 28 days. The microstructural analysis was performed by means of ESEM techniques. The study revealed that nano silica concrete has enhanced water penetration resistance than the normal concrete. The ESEM test revealed the microstructure of nano silica concrete which has homogeneous and dense microstructure than normal concrete. The nano silica particles filled the voids of C-S-H gel and form a tight bond with the particles of C-S-H which makes binding paste matrix more compact and improves durability and mechanical properties of concrete.

Hui Li, Hui-gang Xiao, Jie Yuan and JinpingOu et al (2004) [12] carry out an investigational study on the microstructural behavior on cement mortar with nano-particles such as nano-Fe2O3 and nanoSiO2. The mechanical and microstructural properties of the cement mortar with nanoparticles were experimentally studied by means of compressive strength, flexural strength and SEM analysis. From the experimental study, the strength properties of the cement mortars with nano-SiO2 and with nano-Fe2O3 were improved much higher than the ordinary cement mortar mixture with same water binder ratio (0.5).The micrograph obtained from SEM analysis showed the microstructure of the cement paste with nanoparticles have a uniform and compact microstructure. The nanoparticles not only acts as a filler but also acts as an activator to endorse the hydration and improve the microstructure of cement paste if the nanoparticles are evenly dispersed.

HulyaKus and Thomas Carlssonet al (2003)[13] experimentally demonstrated the chemical degradation of autoclaved aerated concrete (AAC) through natural and artificial weathering conditions. The samples are prepared and exposed to natural and artificial weathering conditions. The microstructural changes and ageing of samples were examined through light optical microscopy, X-ray Diffraction technique (XRD) and Scanning Electron Microscope (SEM). The transformation of tobermorite into calcium carbonate was observed during the exposure time. Due to weathering, calcite and gypsum were developed as noticed in the SEM and EDS Analysis. Hence, the microstructure and ageing in both naturally and artificially weathered are similar based on the mineralogical data obtained from the microstructural analysis.

ZhaohuiXie and Yunping Xi et al (2001)[14]conducted an experimental study on the hardening mechanism of class F fly ash activated by water-glass and NaOH. Two different compositions of pastes are prepared. The mineralogical details of the two samples are identified and analyzed using XRD, SEM and EDS. SEM micrograph of hardened paste made of class F fly ash with water-glass showed that the paste formed into a sphere-shaped gelatinous matrix due to the reaction between class F fly ash and water-glass. The XRD pattern also showed the presence of quartz, hematite, and magnetite in the hardened paste containing fly ash. The dissolved fly ash and water-glass in a state of the low-ordered crystalline structure were observed through XRD pattern. The mixture of class F fly ash, water-glass and NaOH revealed the formation of huge quantity crystalline structures were observed using SEM and EDS. Due to reduction in modulus of water-glass from 1.65 to 1.0, the crystalline sodium silicate in the past results in compact structure which improve the strength of the material.

W.W.J. Chan and C.M.L. Wu et al (2000) [15] studied the durability properties of concrete by replacing cement with silt and clay. Carbon black particles, Crushed granite, silts and clay with size under 150µm and finely crushed granite sizes between 75µm and 150µm were used for high cement replacement in concrete. These non-reactive waste materials replace the cement content with different mix proportions. The physical characteristics such as compressive strength, sorptivity and water permeability of concrete were tested on 8 different trial mixes. Additionally, the variations in microstructure of concrete due to hydration process were also studied through XRD, SEM and EDS Analysis. As a result, the increase in strength of concrete would decrease the sorptivity and permeability of water in the given concrete mixes. The XRD,SEM and EDS results showed that the non-reactive materials used as a replacement for cement could also give micro filler effect and nucleation site for hydration on cement.

M. Monisha et al(2017)[16] have conducted an overview of new development obtained in experimental study on self-healing concrete. An attempt is made in Bacterial-concrete with spore forming, calcite mineral precipitating bacterium "Bacilliussubtilis". Concrete prepared was M20 grade concrete with different bacterial cell concentration such as 10 4 10 5 and 10 6 per millilitre of water. Polyethylene fiber is used as reinforcement and it is kept at constant as 0.4%. The overall development of strength and durability of self-healing concrete using Bacilliussubtilis and polyethylene fibre has investigated and compared with that of conventional concrete. The polyethylene fibres were bridging over the crack and crystallization products became easy to be attached to a large number of polyethylene fibre. The optimum strength is found to be at 10 5 bacterial cell concentration. It increases the compressive strength by 13.2%, split tensile strength by 21.4% and flexural strength by 16.04%. The percentage of improvement in strength shows that the self-healing concrete is advantageous.

Roshni John et al(2017)[17] have done research to compare the best effect of self-healing of cracks in concrete structures. It has led to the development of a special concrete known as Bio concrete where bacteria from the genus bacillus know as bacillus subtilis (JC3) is used. It is combined with another special concrete known as Super absorbent polymer concrete. It was found that Bacteria Bacillus subtilis plays an important role in increasing compressive strength of conventional concrete by 21.33% for 28 days and 25.78% after 90 days. The optimum cell concentration was found to be 10 5 cells/ml and when the concentration increases more than optimum, the strength started to decrease. Super absorbent polymer which is also called as slush powder, are polymer which can absorb and retain extremely high amount of liquids compared to their own mass. Addition of super absorbent polymer beyond the dosage of 0.5% of cement weight starts to decrease the strength of concrete. From SEM & EDM test it is concluded that bacterial concrete produce extra amount of calcium carbonate which improves the compressive strength of concrete .

MohanadossPonraj et al (2016) [18] conducted research with five different cell concentrations of Bacillus megaterium that is, 10×10^5 to 50×10^5 cfu/ml which is introduced into the concrete structures so as to find out the optimum concentration of bacteria. It was found that there is a significant improvement in the strength in the case of 30×10^5 cfu/ml at different ages. The compressive strength of highest grade of bio concrete has improved about 24% as compared to lowest grade which is 12.8% due to calcification mechanism. Microbial calcite precipitation was measured using X-ray diffraction analysis, visualized by scanning electron microscopy and analyzed by using energy dispersive spectrometer. It was found that the optimum concentration of Bacillus Megaterium has a positive effect on high strength concrete structures and it is clear that mineral precipitation has a positive effect to enhance the resistance. It is found that optimum concentration of bacteria has a potential on high strength concrete structures. The consequences of this research provides a significant and innovative contribution for understanding about the effects of bacteria on the performance of concrete structures. Therefore, the bio concrete using Bacillus megaterium can be recommended to be used as a green building material in the construction industry as a construction material against the process of degradation

Deepika.B, et al (2016), [19] made an experiment on the study on strength of bacterial concrete in Bacillus Megaterium. In this paper an investigation is made on the compressive strength and split tensile strength of the bio concrete. In this research different mix proportions for M30 grade of concrete with addition of bacteria Bacillus Megaterium of 5g in 1lit/m3 of water is incorporated. The proportions of ingredients of the control concrete of grade M30 was obtained by mix design as per IS code. Workability of fresh bio concrete was determined by the slump test according to Indian standards. The typical size of cube 150mm×150mm×150mm was used for the determination of the Compressive strength. Split tensile strength was done using the cylinder with dimensions 150mm diameter and 300mm height. The bacterial concrete using bacillus megaterium could obtain compressive strength, split tensile strength and porosity. The incorporation of more numbers of bacteria in the cracks of the concrete cube results a significant gain of property of bacteria, since the repairing of cracks in concrete is increasing with the increase in the concentration of bacterial quantity.

Due to the incorporation of bacteria in concrete, there got a slight increase in compressive strength and split tensile strength. The porosity reduced about 12%. From the results it shows that the Bacillus Megaterium can be safely and easily used in improving the characteristics and performance of concrete

Jasira Bashir et al (2016) [20]carried out an experiment on the Self-healing bio-concrete and an attempt has been made to use different microorganisms so as to observe and compare the strength gain as a result of sprouting of filler materials inside the concrete that is in cement sand matrix pores. Compressive strength test, split tensile strength test and flexural strength test are conducted to evaluate the concrete strength. Scanning Electron Microscopy (SEM) and X-Ray Diffraction (XRD) analysis is further carried out to show the involvement of the isolated ureolytic bacteria in calcium carbonate precipitation. From the tests carried out on various specimens of bacterial concrete using different bacteria, a proper comparison could be made for analyzing strengths of different specimens of bacterial concrete using different bacteria with that of convention concrete. The results obtained from the experiment concludes that when water seeps into concrete cracks, the dormant bacteria gets into activated state by the process of metabolically mediated calcium carbonate precipitation and it increases the strength of bio concrete as compared to the conventional concrete. It is found that Bio concrete is durable, eco-friendly and offers better resistance to freeze thaw and also for corrosion.
Crack remediation using bio-concrete is better than epoxy treatments and other external treatments. The percentage increase in compressive strength of bio concrete using Bacillus Subtilis is 6.42% for 7 days and 9.16% for 28 days, higher than conventional concrete and the percentage increase in compressive strength of bio concrete using Bacillus Sphaericus is 65.93% and 52.42% for 7 days and 28 days respectively.
The percentage increase in compressive strength of bio concrete using Bacillus Pasteurii is 29.99% and 29.97% for 7 days and 28 days respectively. The percentage increase in split tensile strength of bio concrete using Bacillus Subtilis is 38.17% for 7 days and 14.41% for 28 days, higher than conventional concrete. The percentage increase in split tensile strength of bio concrete using Bacillus Sphaericus for is 31.14% and 2.76% for 7 days and 28 days respectively. The percentage increase in flexural strength of bacterial concrete using Bacillus Pasteurii for is 17.34% and 11.18% for 7 days and 28 days respectively

B. Arthi et al (2016)[21]have studied on the strength and self-healing characteristics of Bacterial concrete. This project shows the results of an experimental investigation for evaluating the influence of two bacteria Bacillus Subtilis and Bacillus Licheniformis on the compressive strength, split tensile strength, flexural strength, water absorption and its self-healing properties. Bacterial concentration 10 5 cells/ml cells/ml are added and tests were conducted at 7, 14 and 28 days. The compressive strength of concrete cubes using Bacillus Subtilis has been increased up-to 8% and using Bacillus Licheniformis has been increased up-to 15%. The compressive strength of Bacillus Licheniformis is 46.66% of Bacillus Subtilis. The split tensile strength of concrete cubes using Bacillus Subtilis has been increased up-to 6.66% and for Bacillus Licheniformis it has been increased up-to 12.69%. The split tensile strength of Bacillus Licheniformis is 47.52% of Bacillus Subtilis. The flexural strength of concrete cubes using Bacillus Subtilis has been increased up-to 6.87% and Bacillus Licheniformis has been increased up-to 9.25%. The flexural strength of Bacillus Licheniformis is 25.73% of Bacillus Subtilis. The water absorption value of concrete has been decreased up-to 46.93% by using Bacillus Subtilis and 52.04% by using Bacillus Licheniformis. The water absorption of Bacillus Licheniformis is 9.82% of Bacillus Subtilis. From the above it can be concluded that Bacillus Subtilis and Bacillus Licheniformis can be easily used and safely handled in improving the strength and permeability characteristics of concrete .

Vidhya Lakshmi et al (2016)[22] conducted an experimental investigation on self-healing bacterial concrete giving information about improving the durability of the concrete structures by incorporating bacterial cell and other required nutrients for the process known as bio-calcification where the micro-organisms precipitates calcium carbonate (Calcite) layer thus sealing the cracks. The materials used in this experimental work are ordinary Portland cement of 53 grades, coarse aggregate of nominal size 20mm, river sand, calcium lactate and bacteria from the genus Bacillus Pasteurii. Concrete mix proportions used was in the ratio 1:1.5:3 for the preparation of specimens. In comparison with the conventional concrete it is found that the compressive strength of concrete cubes casted with the bacteria is similar. The maximum amount of calcium carbonate precipitation occurred in the area near to the surface of the cracks in concrete cubes. This is because of the fact that the bacterial cell growth is higher in the presence of oxygen and precipitation of calcium carbonate is higher around the surface area of the cube. The corrosion of the reinforcement caused due to the ingress of gases, liquids and other ions can be ceased and thus the permeability of the concrete can be reduced and thus the durability of the structure is increased.

LuoMian, et al (2015)[23] have done research on the efficiency of concrete crack-healing, based on biological carbonate precipitation. The self-healing agent consisted of substrate and bacteria and spore-forming alkali-resistant bacteria were used for the research. Crack-healing capacity of the cement paste specimens with this biochemical agent was studied. The main study carried out was for finding the reduction in permeability after calcite precipitation. After performing compression test, the cracked specimens were then immersed in water for self-healing incubation. The specimens were taken out after 7 day and 28 day of immersion in water and carried out the permeability test. The water permeability test result demonstrates that the bio calcification process can significantly decrease the water permeability of the cement paste specimens. SEM and XRD analysis results show that the white precipitation in cracks is because of calcium carbonate, which displays as spherical crystal morphology. It was found that the crack with a width of 0.48 mm was completely healed by white precipitation of calcite after for 80 days. The water permeability of specimens with the biochemical agent decreases by 84% after 7 days and 96% after 28 days of immersion in water. Thus concluded that the bacteria-based concrete appears to be a promising approach to increase durability of the concrete

Santosh Ashok Kadapure et al (2016)[24]have done a laboratory investigation on the production of sustainable bacteria blended fly ash concrete. Fly ash has been used as an alternative as a replacement of cement. This work aims to develop a sustainable fly ash concrete by blending with varying the bacterial concentration. The incorporation of Bacillus sphaericus in concrete increases the mechanical and durability properties of concrete. The Bacillus sphaericus was able to grow at pH of 9 to 12. Hence, the bacteria are called as alkaliphilic spore-forming bacteria, since it is able to grow above 9 pH . The concrete specimens were tested after 7 days and 28 days of curing for compressive strength, split tensile strength, shear strength and permeability test. The results showed that bacterial concrete has a significant effect in reducing permeability property in the presence of fly ash. Test results demonstrate that the combination of fly ash and microbes leads to further enhancement of durability properties of the concrete structure. Fly ash concrete was found to be having similar properties with that of conventional concrete at 28 days of curing. The combination of 30% fly ash and 10 5 cells/ml of Bacillus sphaericus would be an economical approach to get similar mechanical properties as that of conventional concrete.

Smitha et al (2016) [24] conducted a research on performance enhancement of concrete through bacterial addition. The process behind bio mineralization is called micro biologically induced calcite precipitation (MICP).The main process is the microbial urease, hydrolyzes urea, to produce ammonia and carbon dioxide and the ammonia released in surroundings subsequently increases the pH which leads to the accumulation of insoluble calcite precipitation. Different types of bacteria from the genus bacillus can be used for preparing the bacterial concrete and the spore forming gram positive bacteria gives the most effective and desirable results. The spore forming bacteria can remain in concrete for about 200 years. But the other chemicals which are used for crack repairing will remain for one application only. They found that the bacterial concrete prepared with admixtures such as silica fume, fly ash etc. gives better mechanical property and durability property. They have also found that in the case of cracks up to 0.2mm size, self-healing of cracks is much effective.

Chithra. P Bai et al (2016),[25] have done an experimental investigation on the strength properties of Bacterial concrete with fly ash. For this research, the bacteria Bacillus Subtilis was used with different cell concentrations of 10 3 10 5 and 10 7 cells/ml for preparing the fly ash based bacterial concrete. Cement was partially replaced by 10%, 20% and 30% of fly ash by weight for making the concrete. M30 grade concrete was prepared. Tests like Compressive strength, Split tensile strength, Flexural strength and Ultrasonic Pulse Velocity were carried out after 28 days and 56 days of curing. It was found that the maximum compressive strength, split tensile strength, flexural Strength and Ultrasonic Pulse Velocity values were found for 10% fly ash replacement. The maximum compressive strength, split tensile strength, flexural strength, and Ultrasonic Pulse Velocity values were found for the bacteria cell concentration of 10 5 cells/ml for the bacterial concrete. The increase in the mechanical properties of fly ash concrete is because of the precipitation of calcium carbonate in the micro environment by the bacteria Bacillus Subtilis.

Jagadeesha Kumar B G et al (2013)[26] have carried out the effect of bacterial calcium carbonate precipitation on compressive strength of mortar cubes. This paper is about the experimental investigations on mortar cubes which were subjected to bacterial precipitation by different bacterial strains. It also evaluates the influence of bacterial calcium carbonate precipitation on the mortar cubes on 7 days, 14 days and 28 days of bacterial treatment. Three bacterial strains Bacillus flexus, Bacillus pasteurii and Bacillus sphaericus were used for the research. The cubes were immersed in bacterial and culture medium for 28 days with control cubes immersed in water. After 28 days of curing the specimens were tested for compressive strength. The result shows that there is an increase in the compressive strength. Among the three strains of bacteria, the Bacillus flexus has shown maximum compressive strength than the other two bacterial strains and control cubes. It was concluded that the improvement in compressive strengths is mainly because of the sealing of the pores inside the cement mortar cubes with micro biologically induced Calcium Carbonate precipitation. The three strains of bacteria were tested for urease activity and found all the three strains were urease positive. This was indicated by the change of the colour of the media from yellow to pink, showing urease positive. X-ray diffraction analysis was also done to analyse the chemical composition of the precipitation due to the bio mineralization.

Summary

From this review of articles, it was observed that the change in the microstructure of concrete reflects the changes in properties of concrete. Thus, the microstructural change in concrete is mainly due to surrounding conditions such as time, temperature, chemical degradation due to acid attack etc., the microstructure of concrete varies with respect to the proportion of concrete ingredients such as cement, aggregates, and water content. The concrete microstructure can also be modified through replacement of concrete ingredients with other waste and cheap byproducts which will be more useful to produce sustainable high performance concrete.
Many research on Microconcrete with combination of industrial waste in appropriate proportion showing best performance in mechanical and durable properties in comparison with plain Microconcrete

CONCLUSION

Independently of the W/B ratio as well as the mineral additions used, the tensile and compressive strength of RPC increases with time (7d, 28d). Independently of the additions, the RPC mechanical strengths made with W/B =0.30 are above those of the RPC with W/B=0.27, this expansion leads to a lessening of pores in the RPC by the lower content of water and so, a densification of the second leads to excessive strengths.
The RPC mechanical strengths with additions (SF, S, SD) and generally the RPC (SF) are obviously above those of RPC (control) with no additions, - For a certain addition, the Rc/Rtratios considerably improve with time, that shows that additions weaken the RPC thinking about the slow evolution of tensile strengths compared compressive ones.
The project describes that due to its self-healing abilities, eco-friendly nature, increase in durability etc, it is better than the conventional technology. It is very effective in increasing the strength and durability of concrete. It also shows better resistance to drying shrinkage, resistance to acid attack, better sulphate resistance. Micro environmental concrete prepared with admixtures like silica fume, fly ash etc, also gives better strength and durability. This project improved our understanding on bacterial concrete. Due to the introduction of bacteria into concrete there has been increase in the compressive and flexural strength with decrease in permeability, water absorption and corrosion of reinforcement when compared to conventional concrete.

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