IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

ANALYSIS OF BACTERIA BASED SELF HEALING CONCRETE OVER CRT (CATHODE RAY TUBES)

[1]Dr. P.Paramaguru, [2]Mr. V.Jayaprabaakar,

[1]Associate Professor, [2]PG Scholar
[1]Department of Civil Engineering,
[1]Ponnaiyah Ramajayam Institute of Science and Technology, Thanjavur, India

Abstract: In Concrete, cracking is a common phenomenon developed due to relatively low tensile strength. High tensile stresses may be developed in concrete due to external loads, imposed deformations, plastic shrinkage, plastic settlement and expansive reactions. It is expected that further development of this techniques will result in a more durable,sustainable and crack free concrete that can be used effectively for constructions in wet atmospheres where corrosion of reinforcement affects the durability, permeability and strength of concrete. It is expected that further development of this techniques will result in a more durable, sustainable and crack free concrete that can be used effectively for constructions in wet atmospheres where corrosion of reinforcement affects the durability, permeability and strength of concrete. In this paper compressive and split tensile strength of cubes, cylinders were tested.

Bacterial concrete achieves compressive strength about 29.87 N/mm2 and bacterial concrete with 4.75 and 2.36 mm achieves high compressive strength of 31.32 and 35.22 N/mm2. Bacterial concrete achieves split tensile strength about 2.98 N/mm2 and bacterial concrete with 4.75 and 2.36 mm achieves high compressive strength of 3.01 and 4.13 N/mm2. SEM results shows growth of bacteria in different concrete mixtures. ANSYS software gives maximum Load deformation and Equivalent total strain,Maximum combined stress.

INTRODUCTION

Rapid growth and development in the infrastructure can be seen over the past thirty years in the construction activities. In this development concrete plays an important role in the development of the infrastructure in the day-to-day life. Among all the building materials concrete is the artificially made building material which is gotspecial characteristics. Concrete is the most widely used building material in the construction activities due to its durability and high compressive strength. The capability of concrete in resisting the chemical attacks, weathering action and abrasion by maintaining their engineering properties desired can be seen. Over last decade self- healing approach have been adopted in showing promising results in the concrete structures. The durability of the properties refers to trouble-free performance. The ingress of moisture and other harmfull chemicals into the concrete may result in the decrement of strength and life.The durability of the concrete is decreased due to the ingress if sulphates and chlorides into the concrete. This may leads to the corrosion in the reinforcement.

In Concrete, cracking is a common phenomenon developed due to relatively low tensilestrength.Hightensilestressesmaybedevelopedinconcreteduetoexternalloads, imposed deformations, plastic shrinkage, plastic settlement and expansive reactions. Bacterially induced calcium carbonate precipitation has been proposed as an alternative and environmental friendly crack repair technique . It is found that microbial mineral precipitation as a result from metabolic activities of favorable bacteria inconcreteimproved the overall behaviour of concrete.

Effectively for constructions in wet atmospheres where corrosion of reinforcement affects the durability, permeability and strength of concrete. The major problem faced inthe recycling of cathode ray tube (CRT) waste sourced from discarded old computer monitors and televisions is the high content of lead in the neck and Funnel glass. Proper treatment of the CRT funnel glass is essential to avoid lead (a hazardous chemical) fromthe broken funnel glass leaching into soil and groundwater causing environmental pollution and risk to public health. The problem with the waste from electric and electronic equipment (WEEE), consisting of about 80% of television sets and computers containing a cathode ray tube (CRT) have just begun to deal with.

Cathode ray tubes (CRTs) are the video display components of televisions and computer monitors. Arisingproblem related with recovery and recycling of CRT glass stimulates examinations aimed at making cullet-based ceramic materials of reinforced mechanical strength.

PROPERTIES OF BACTERIAL BASED SELF-HEALINGCONCRETE

Different types of self-healing Approaches

- Spontaneous
- Medicalhealing
- Alternative medicalhealing
- Alternative healing
- Integravite healing
- Group healing
- Hybrid healing

Self-healing approaches are promising techniques for the remediation of micro- cracks in concrete. The autogenously self-healing techniques show better results in healing of micro cracks on the surface of the concrete. The formation of pervious layer on the existing layer of concrete shows precipitation of Calcite. As concrete is a high alkaline building material the bacteria are added should be alkali-resistant to withstand in high- alkali environment. The experiments showed cracks can be healed up to 0.46 mm wide cracks of bacterial specimens after 100 days of curing. The CSH gel is increased by treatment of bacteria in concrete specimens to precipitate calcite which affects the healing capacity by bacterial concentration. The presence of silicate substances in concrete matrix makes porous and reduce ingress of water into concrete. Calcium carbonate can be formed on the surface of the concrete by reacting with CO_2 present in the calcium hydroxide,

alcium hydroxide by following reactions:

$$CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O \qquad (1)$$

$$Ca(C_3H_5O_2)_2 + 7O_2 \rightarrow CaCO_3 + 5\,CO_2 + 5H_2O \qquad (2)$$

The $Ca(OH)_2$ is a soluble mineral will be dissolved in water, ingress into the crack and will be out at the time of leaching. This process is more efficient because of active metabolic conversions of calcium nutrients and bacteria present in the concrete.

Cement materials shows possibility to show self-healing characteristics in concrete. The influence of urea producing bacterial cells shows precipitation of Ca CO_3 in ureaextract medium (UYEmedium). The compressive strength that was similar or higher than the neat mortar was observed. The increment in compressive strength was observed up to 15 % and the decrease in porosity at 28 days was observed. The efficiency of the concrete may be defined as performing permeability tests on low pressure environments. Visual examination of the crack filling may be adopted to check the better performance of crack filling improvement.

Microbiologically Induced CaCO3Precipitation

Microbiologically induce $CaCO_3$ precipitation helps to bind the particles such as sand, gravel in the concrete to form a composite material in sealing orhealing the micro- cracks in concrete. The involvement of microorganisms in $CaCO_3$ precipitation leads to development of bio-based environment in the concrete as a durable building materials. Bacillus subtilis is robust ureolytic bacteria which is aerobic, spore forming bacterium uses urea as energy producing source and generates carbonate by increasing the pH environment.

By converting urea into ammonium and carbonate Bacillus subtilis JC3 can able to precipitate $CaCO_3$ in high alkaline environment. The mechanism of involvement of in $CaCO_3$ precipitation is of three types:

- spontaneous mechanism, by photosynthesis microorganism
- Through nitrogen cycle
- Through sulfur cycle

The bacterium which is capable of producing urea helps in precipitating calciumcarbonate on the surface of the cracked specimen with the help of calcium source. The $CaCO_3$ can be formed due to the CO_2 in the Ca(OH) present in the concrete as stated . The two self-healing agents i.e., bacterial spores and calcium based nutrients were introduce to the concrete at the time of mixing process;the agents which weremixed will not be active at the time of mixing.

The agent will be activated only when the cracks appear the ingress of water starts activating the healing agents. This mechanism may be defined as Microbiologically Induced Calcium Carbonate Precipitation (MICP). This precipitation happens due to hydration of non-hydrated cement particles in the concrete matrix with the contact of ingress of water into the cracks.

The $CaCO_3$ precipitation can be controlled by pH, calcium concentration, and carbonate concentration and nucleation sites presence. This formation of precipitated calcium carbonate can be viewed under Scanning Electronic Microscope (SEM). The process may result in bio-based crack sealing technique in concrete.

ROLE OF BACTERIA

Various selected type so bacteria were used as construction materials genus Bacillus was used for the precipitation of calcite on the surface of the concrete. The nutrients for the bacteria which are able to precipitate calcite are calcium sources, phosphorous and nitrogen sources. These bacterial components remain dormant inconcrete, when the seepage of water take place into the formed cracks helps in reacting with the nutrient to precipitate calcitei.e., $CaCO_3$.Various types of bacteria use din concrete are shown. This is able to precipitate $CaCO_3$ on the surface of the concrete cracks.

CRACK HEALING ABILITY AND SEALING OFMICRO-CRACKS

The durability of the concrete can be enhanced by incorporating the bio-based self-healing techniques. The quantification of crack healing potential of a two component self-healing agent in expanded clay particles was investigated by Virginie wiktoretal. When cracks are formed the bacterial spores and healing agent i.e., calcium lactate were released from clay particles by ingress of water. Results showed crack healing capacity was increased up to 0.46 mm wide cracks when compared to control specimens0.18mmwidecracks,after 100days of submersion in water. It is shown that durability in concrete structures under wet conditions. The creation of cracks may be oftwo types, samples with standardized cracks and realistic cracks. In freshly formed concrete micro-cracks can be seen with naked eye, this may cause due to debris or segregation. These types of cracks may be called as standard cracks.

The realistic cracks may be formed by wrapping fiber reinforced polymer [FRP] on concrete cylinders and they are coated with glass fibers then allowed for tensile tests to create cracks in the concrete specimens. The other method which tensile tests were carried out up to first crack is formed in the specimens and then they are allowed for curing.Theself-healingcapacityofthespecimenscanbeobservedbySEManalysisand XRDtechnique.

INTRODUCTION TOANSYS

ANSYS Stands for Analysis System Product. Dr. John Swanson founded ANSYS. Inc in 1970 with a vision to commercialize the concept of computer simulated engineering, establishing himself as one of the pioneers of Finite Element Analysis (FEA). ANSYS inc. supports the ongoing development of innovative technology and delivers flexible, enterprise wide engineering systems that enable companies to solve the full range of analysis problem, maximizing their existing investments in software and hardware. ANSYS Inc. continues its role as a technical innovator. It also supports a process-centric approach to design and manufacturing, allowing the users to avoid expensive and time consuming “built and break”cycles. ANSYS analysis and simulation tools give customersease-of-use, data compatibility, multi-platform support and coupled field multi-physics capabilities.

EVOLUTION OFANSYS

ANSYS has evolved into multipurpose design analysis software program, recognized around the world for its many capabilities. Today the program is extremely powerful and easytouse. Each release hosts newand enhanced capabilities that make the program more flexible, more usable and faster. In this way ANSYS helpsengineers meet the pressures and demands modern product development environment.

Analysis types available:

1. Structural Static Analysis.
2. Structural Dynamic Analysis.
3. Structural Buckling Analysis.
    - Linear Buckling
    - Non Linear Buckling
4. Structural Non Line arities
5. Static And Dynamic Kinematics Analysis.
6. Thermal Analysis.
7. Electromagnetic Field Analysis.
8. Electric Field Analysis
9. Fluid Flow Analysis
    - Computational Fluid Dynamics
    - Pipe Flow
10. Coupled-Field Analysis
11. Piezoelectric Analysis.

TYPES OF STRUCTURALANALYSIS

Structural analysis is the most common application of the finite element method.The term structural (or structure) implies civil engineering structures such as bridges and buildings, but also naval, aeronautical and mechanical structures such as ship hulls, aircraft bodies and machines housings as well as mechanical components such as pistons, machine parts and tools.

There are seven types of structural analyses available in ANSYS. One can perform the following types of structural analyses. Each of these analysis types are discussed in detail as follows.

- Static analysis
- Modal analysis
- Harmonic analysis
- Transient dynamic analysis
- Spectrum analysis
- Buckling analysis
- Explicit dynamic analysis

STRUCTURAL STATIC ANALYSIS

A static analysis calculates the effects of steady loading condition on a structure, while ignoring inertia and damping effects such as those caused by time varying loads. A static analysis can, however include steady inertia loads (such as gravity and rotational velocity), and time varying loads that can be approximated as static equivalent loads (such as the static equivalent wind and seismic loads commonlydefined in many building codes.)

PROCEDURE FOR ANSYS ANALYSIS

Static analysis is used to determine the displacements, stresses, strains and forces in structures or components due to loads that do not induce significant inertia and damping effects. Steady loading in response conditions are assumed. The kinds of loading that can be applied in a static analysis include externally applied forces and pressures, steady state inertial forces such as gravity or rotational velocity imposed (non-zero) displacements, temperatures (for thermal strain).

A static analysis can be either linear or nonlinear. In our present work we considerlinear static analysis. The procedure for static analysis consists of these main steps:

- Building the model.
- Obtaining the solution.
- Reviewing the results

BACTERIA

Types of Bacteria

- Bacillus Pasteurii
- Bacillus sphareicus
- Bacillus coli
- Bacillus Cohnii
- Bacillus balodurans

Selection of Bacteria

There are various types of Bacteria's that can be used in the concrete such as Bacillus Subtilis, Bacillus Pasteurii, Bacillus Cohnii, and Bacillus Licheniformis etc. We have selected Bacillus Subtilis since this bacterium produces Calcium Carbonate and due to ease of availability from pharmacy department of AIKTC,we have used it for our future investigation. It is also formally known as Hay bacillus or grass bacillus, is a Gram- positive, catalane-positive bacterium, found in soil and the gastrointestinal tract of ruminants and humans .

A member of the genus Bacillus, Bacillus subtilis is rod- shaped, and can form tough, protective undo-spores, allowing it to tolerate extreme environmental conditions. Bacillus subtilis has historically been classified as an obligate aerobe, though evidence exists that it is a facultative aerobe. Bacillus subtilisis considered the best studied Gram-positive bacterium and a model organism to study bacterial chromosome replication and cell differentiation.

It is one of the bacterial champions in secreted enzyme production and used on an industrial scale by biotechnology companies.

Cultivation of Bacteria

The pure culture of bacteria i.e. Bacillus Subtilis is preserved on nutrient agarslants. It forms irregular dry white colonies on nutrient agar slants. Two colonies of the bacteria are inoculated into nutrient both of 350 ml in 500ml conicalflaskandincubatedatthetemperatureof37degreeCelsiusand150rpmorbital The medium composition used for growth of bacterial culture consists of Peptone, NaCl, yeastextract.

Fig 1.6: Bacterial solution in incubator

Safety Measures for Bacterial Solution

Bacteria are harmful for the health and it may lead to diseases, there fore precautions must be taken. It is compulsory to use gloves while dealing with the bacterial solution. The flask must be heated before pouring the bacterial solution. The whole procedure must be done between the two candles so that the bacterium doesn't get contaminated by the interference of the other bacteria's present in the environment.

OBJECTIVES

- Develop a bacterial concrete by introducing the bacteria's of bacillus family(bacillus subtilis).
- To prepare mix design for bacteria concrete and ordinary concrete.
- To prepare cube for bacterial with CRT concrete and ordinary concrete.
- To test the Workability using with slump cone.
- To test the Compressive strength for bacteria with CRT concrete &conventionalconcrete using UTM.
- To test the spilt tensile strength for bacteria with CRT concrete and conventionalconcrete using UTM.
- To know the presence of void in the internal structure of concrete and growth ofbacteria concrete by SEM analysis.

LITERATURE REVIEW

Literature review is the selection of available documents on the topic, which contain information , idea, data and evidence written from a particular stand point to fulfill certain aims or express certain view on the nature of the topic and how it is to be investigated.

DETAILS OF LITERATUREREVIEW

1 *. S.Dinesh1, R.Shanmugapriyan2 & S.T.Namitha Sheen3(2017), 'A Review on Bacteria – Based Self-Healing Concrete'-Imperial Journal of InterdisciplinaryResearch (IJIR)Vol-3, Issue-1, 2017.*

It is found that microbial mineral precipitation as a result from metabolic activitiesoffavorablebacteriainconcreteimprovedtheoverallbehaviorofconcrete.Itis expected that further development of this techniques will result in a more durable,sustainable and crack free concrete that can be used effectively for constructions in wet atmospheres where corrosion of reinforcement affects the durability, permeability and strength of concrete.(water immersion and wet-dry cycles) through water permeabilitytests. It was found that the compressive strength of the mortar containing lightweightaggregates is not affected by the presence of the healing agent.

2 *. Paweł Walczaka, Jan Małolepszy, Manuela Rebenb, Karol Rzepab.(2015),'Mechanical properties of concrete mortar based on mixture of CRTglass cullet and fluidized fly ash'- 7th Scientific-Technical Conference Material Problems in Civil Engineering(MATBUD'2015)*

Based on obtained results both CRT glass cullet and fluidize fly ash improved compressive and flexural strength in respect of standard concrete mortar without these additives. The use of CRT glass as a sand replacement caused the increased of compressive strength of concrete mortar of about 16% and its flexural strength of about14%.

3 *. Jing Luo , Xiaobo Chen , Jada Crump , Hui Zhou , David G. Davies , Guangwen Zhou , Ning Zhang Congrui Jin (2015), 'Interactions of fungi with concrete: Significant importance for bio-based self-healing concrete'-Constructionand Building Materials 164 (2018)275–285.*

The goal of this study is to explore a new self-healing concept in which fungi are used as a self-healing agent to promote calcium mineral precipitation to fill the cracks in concrete. An initial screening of different species of fungi has been conducted. Fungal growth medium was overlaid onto cured concrete plate. X-ray diffraction (XRD) and scanningelectronmicroscope(SEM)confirmedthatthecrystalsprecipitatedonthefungal hyphaewerecomposedofcalcite.TheseresultsindicatethatT.reeseihasgreatpotential to beused in bio-based self-healing concrete for sustainableinfrastructure.

1. *StefanMaschio,GabrieleTonello,andErikaFurlani(2013June),'RecyclingGlass Cullet from Waste CRTs for the Production of High Strength Mortars' -Journal ofWaste Management Volume 2013, Article ID102519.*

Samples containing CRT mixed glass showed a more rapid Increase of strength with respect to the reference compositions,and materials with a superplasticizercontentof1%showedthebestoverallperformanceduetothefavourable influence of the small glass particles which increase the amount of silicate hydratedproduced.

2. Tung-Chai Ling , Chi-Sun Poon C.-S. (2013) 'Effects of particle size of treated CRT funnel glass on properties of cement mortar'-Materials andStructures; 46(1-2):25-34.

The use of finer glass particles slightly improved the flexural strength andreduced the risk of expansion due to ASR due to its pozzolanic reaction. The experimental results indicated that treated CRT glass can be utilized as 100 % replacement of sand in cement mortar regardless of its particlesize.

3. VijethNKashyap1,Radhakrishna(Nov-2013),'IJRET:InternationalJournalof
Research in Engineering and Technology' eISSN: 2319-1163 |pISSN: 2321-7308 IC-RICE Conference Issue – A study on effect of bacteria on cementcomposites.

Crack is commonly observed failure in the case of concrete. Crack may develop due to addition of excess of water to during mixing of concrete, or may be due to shrinkage and creep. In the present study, crack healing and improvement of physical properties of cement paste, mortar and concrete are studied. It is done by the addition of bacterials trains namely Bacillus Sphaericus and Sporosarcina Pastuerii. It is found that these bacteria when added at 106 concentration of cells/ml of water to cement composites increased by about 39.8% and 33.07% in paste. There is an increment of50% and 28.2% in mortar for two bacterial strains. The strength increment is found to be18.3% and 12.2% for Bacillus Sphaericus and Sporosarcina Pastuerii respectively for concrete. Ultrasonic pulse velocity of the bacterial concrete was in line with conventional concrete. SEM and XRD images revealed presence of $CaCO_3$ produced microbially. There is overall improvement in the bacterial composites compared toconventional composites.

METHODOLOGY

METHODS OF MIXING BACTERIAL SOLUTIONINTO CONCRETE

There are different methods of mixing the bacterial solution in the concretewhich are viz.

- Direct Mixing
- Indirect Mixing
- Injection method

In our investigation we have adopted the direct method in which, firstly the measuringjarsweresterilizedinovenforatemperatureofabout100˚for5min.After 5 min once it gets slightly cooled, the bacterial solution is poured form the flask in the Measuring jar.

The flask is firstly heated under the candle before pouring it into the the other bacteria's present in the environment. Once the bacterial solution is mixed inthe water, the water is properly stirred and then it is used for immersion in the concrete.

Fig 4.1: Method Adopted before mixing the Bacterial solution in the Mixing water.

EXPERIMENTAL TEST

Various test are performed on bacterial concrete in order to get the results invarious forms these experimental methods are summarized below

SLUMP CONETEST

The concrete slump test is an empirical test that measures workability of fresh concrete.Theslumpconetestindicatesthebehaviorofacompactedconcretetheaction of gravitational forces. The test is carried out with a Moulds called as slump cone. The slump cone is placed on a horizontal and a non-absorbent surface and filled in three layers of fresh concrete, each layer being tamped 25times with a standard tamping rod.The test issuitable only for concretes of medium to highwork ability's (i.e.havingslump values of 25mm to125mm).

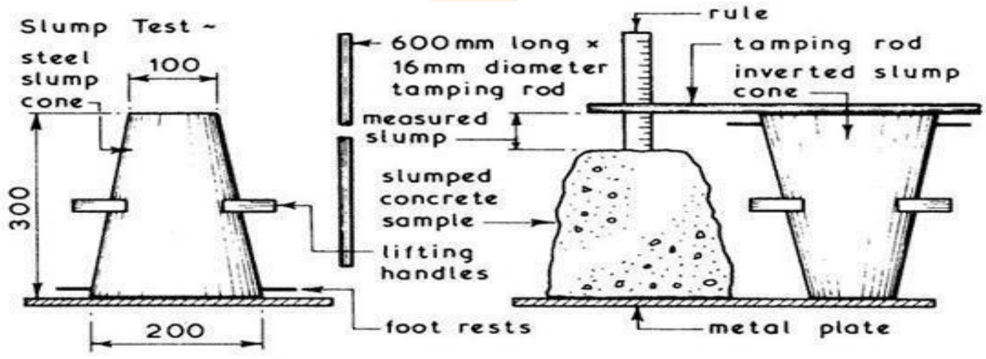
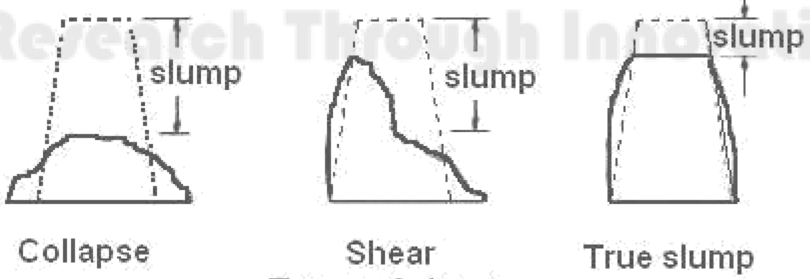


Fig 3.1 Showing the Slump Height.



Types of slump

The metal plate i.e. base is placed on a smooth surface and the container is filled with bacterial concrete in three layers, whose workability is to be tested. Each layer is temped 25 times with a standard 16 mm (5/8 in) diameter steel rod, rounded at the end. When the mould is completely filled with bacterial concrete, the top surface is struck off (leveled with Moulds top opening) by means of screening and rolling motion of the temping rod. The Moulds firmly held against its base during the entire operation so that it could not moveduetothepouringofconcretebymeansofhandlesorfootrests.Immediatelyafter filling iscompleted and the concrete is leveled, the cone is slowly and carefully lifted vertically, an unsupported bacterial concrete will now slump.

The slump is measured by placing the cone just besides the slump concrete and the temping rod is placed over the cone so that itshould also come over the area of slumped concrete.

COMPRESSIVE STRENGTH TEST

The concrete cubes were removed from the tank after their respective days of curing. The cubes were allowed to dry under the Laboratory condition. Once the cube were completely dried, placed under the compressive testing machine with an intention to get the compressive strength of concrete. The entire sample specimen tested under compressive testing machine.

Fig.3.1 Compressive testing machine (UTM)

After removing the specimen from water over specified curing time and wiped out excess water from the surface. Cleaning out the bearing surface of the testing machine. The various sample specimens were placed one after another in the machine in such a mannerthattheloadshallbeappliedtotheoppositesidesofthecubecast.Thespecimencentrally aligned on the base plate of the machine. The load gradually applied without shock andcontinuously at the rate of 5.2 KN/sec till the specimen fails. The maximum loadrecorded and any unusual features in the type of failure noted down. Concrete cubesplaced in the CTM machine before crushing and after crushing .Readings of eachbacterial concrete sample viz. conventional, 15ml, 30ml, 45ml, 60ml and 75ml weretaken each time after curing interval of 7days, 14 days and 28days.

SPLIT TENSILETEST

Moreover, the concrete is very weak in tension due to its brittle nature. Hence, it is not expected to resist the direct tension. So, concrete develops cracks when tensileforces exceed its tensile strength. Therefore, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

Furthermore, splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The procedure based on the ASTM C496 (Standard Test Method of Cylindrical Concrete Specimen) which similar to other codeslike IS 5816 1999.

Fig 3.2 Split tensile testing

Initially, take the wet specimen from water after 7, 28 of curing; or any desiredage at which tensile strength to be estimated. Then, wipe out water from the surface of specimen. After that, draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place. Next, record the weight and dimension of the specimen.

Set the compression testing machine for the required range. Place plywood stripon the lower plate and place the specimen. Align the specimen so that the lines marked on the ends are vertical and centered over the bottom plate. Place the other plywood strip above thespecimen.Bringdowntheupperplatesothatitjusttouchtheplywoodstrip.

Applythe load continuously without shock at a rate within the range 0.7 to 1.4MPa/min (1.2 to 2.4MPa/min based on IS 5816 1999) Finally, note down the breaking load (P).

SCANNING ELECTRON MICROSCOPE(SEM)

The Morphology and mineralogical composition of the deposited calcium carbonate crystals were investigated using scanning electron microscope (SEM).

Fig 3.3 Scanning Electron Microscope Machine

SEM micrographs were obtained using a Joel JSM 5600 LV model Philips XL 30 attached with EDX unit, with accelerating voltage 30K.V. magnification 10x up to 400000x and resolution for W. (3.5 nm). Samples surface were first coated with carbon then with gold.

RESULTS AND DISCUSSION

Various tests were conducted to know the characteristics of the concrete cube. The testwasconductedtoinvestigatetheoptimumdosageofthebacterialsolutionunderwhich the cube attains its maximum strength.

Table.4.1 Specific Gravity test for Coarse Aggregate

Samples	Sample 1	Sample 2	Sample 3	Average
Specific Gravity	2.62	2.64	2.63	2.63

Table.4.2 Specific gravity for Fine Aggregate

Samples	Sample 1	Sample 2	Sample 3	Average
Specific gravity	2.59	2.60	2.63	2.61

Table.4.3 Slump cone test

Conventional Concrete	Bacterial concrete	Bacterial concrete with 4.75mm	Bacterial concrete with 2.36mm
107mm	83mm	90mm	96mm

COMPRESSIVE STRENGTH OF CONCRETE

Type of concrete cube	7 days	14 days	28days
Normal Concrete	14.61	19.94	21.74
Bacteria Concrete	18.76	24.09	29.87
Bacteria concrete with CRT less than 4.75mm	18.92	23.17	31.32
Bacteria concretewith CRT less than2.36mm	20.75	26.27	35.21

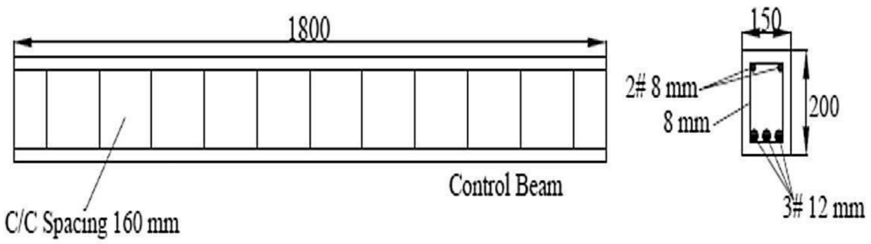
Fig 4.1 Compressive Strength Comparison between different types of cube

SPLIT TENSILE STRENGTH OFCONCRETE

Type of concrete cube	7 days	14 days	28 days
Normal Concrete	1.71	1.94	2.14
Bacteria Concrete	2.33	2.51	2.98
Bacteria concrete with CRT less than 4.75mm	2.54	2.91	3.01

Bacteria concrete withCRT less than 2.36mm	3.19	3.51	4.13

Fig 4.5 Split tensile Strength Comparison between different types of cylinder



BEAM MODEL USING ANSYS

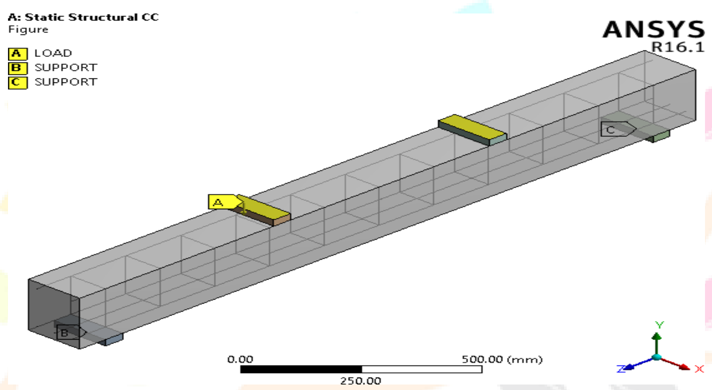


Fig.4.9 Beam model

TOTAL DEFORMATION OF CONVENTIONAL CONCRETE

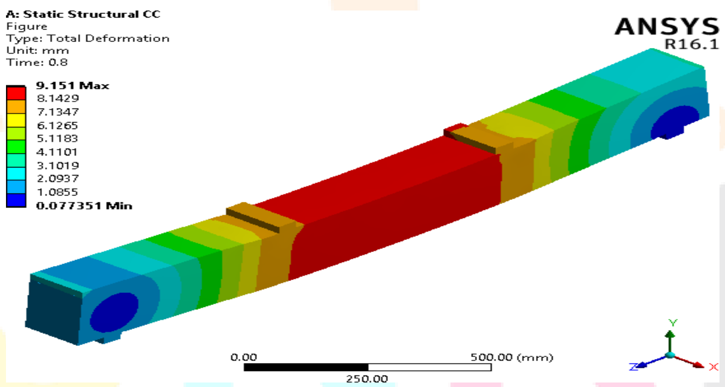


Fig . 4.10 Total deformation of conventional concrete

EQUIVALENT TOTAL STRAIN OF CONVENTIONALCONCRETE

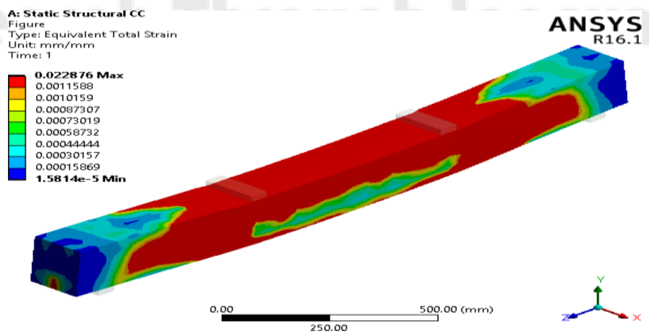


Fig .4.11 Equivalent total strain of conventional concrete

MAXIMUM COMBINED STRESS OF CONVENTIONALCONCRETE

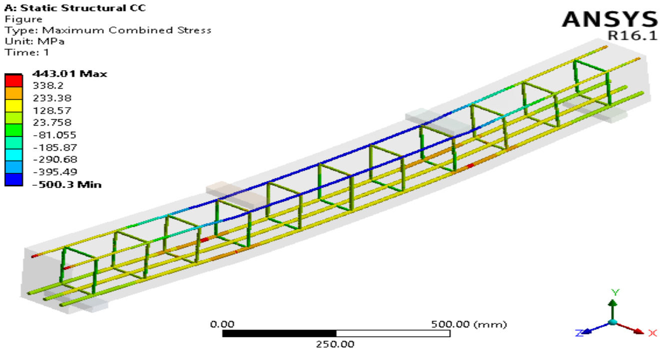


Fig .4.12 Maximum combined stress of conventional concrete

GROWTH OF BACTERIA BY SEMTESTING

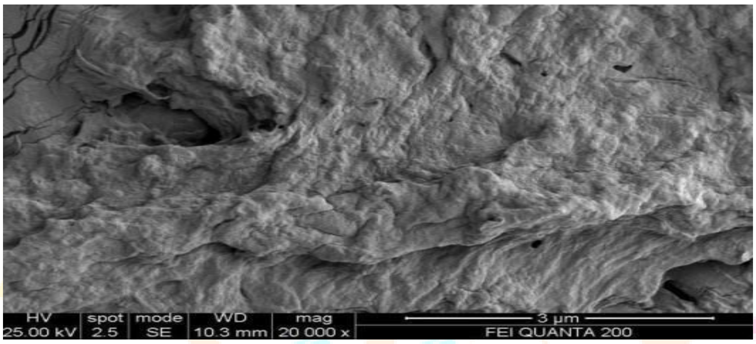


Fig .4.7.1 SEM Conventional concrete

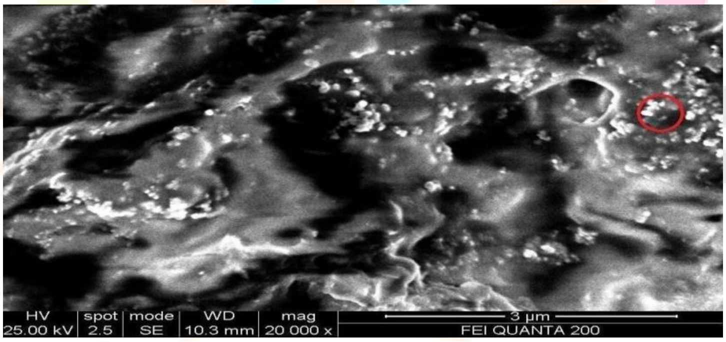


Fig .4.7.2 SEM Healing of bacteria

CONCLUSION

Self-healing concrete is a kind of smart concrete and becoming one of there searches focuses both in the material and civil engineering field .The addition of bacillus subtilis bacteria increases compressive strength of concrete and it is cost effective because it reduce maintenance. The problem with the waste from electric and electronic equipment (WEEE), consisting of about 80% of television sets and Computers containing a cathode ray tube (CRT) have just begun to deal with. By using CRT glass e-waste are reduced and demand of fine aggregate also reduced.

Bacterial concrete achieves compressive strength about 29.87 N/mm^2 and bacterial concrete with 4.75 and 2.36 mm achieves high compressive strength of 31.32 and 35.22 N/mm$^{2.}$

Bacterial concrete achieves split tensile strength about 2.98 N/mm^2 and bacterial concrete with 4.75 and 2.36 mm achieves high compressive strength of 3.01 and 4.13 N/mm^2 .

SEM results shows growth of bacteria in different concrete mixtures .

ANSYS software gives maximum Load deformation and Equivalent total strain, Maximum combined stress.

\

REFERENCE

1. Paweł Walczaka, Jan Małolepszy, Manuela Rebenb, Karol Rzepab.(2015),'Mechanical properties of concrete mortar based on mixture of CRT glass cullet and fluidized fly ash'- 7th Scientific-Technical Conference Material Problems in Civil Engineering(MATBUD'2015)

2. Stefan Maschio, GabrieleTonello, and ErikaFurlani (2013June),'Recycling Glass Culletfrom Waste CRTs for the Production of High Strength Mortars' - Journal of Waste Management Volume 2013, Article ID102519.

3. Tung-Chai Ling , Chi-Sun Poon C.-S. (2013) 'Effects of particle size of treated CRTfunnel glass on properties of cement mortar'-Materials and Structures; 46(1-2):25-34. 4.S.Dinesh1, R.Shanmugapriyan2 & S.T.Namitha Sheen3(2017), 'A Review on Bacteria
–Based Self-Healing Concrete'-Imperial Journal of Interdisciplinary Research(IJIR)Vol-3, Issue-1,2017.

5.Vijeth N Kashyap1, Radhakrishna2(Nov-2013),'IJRET: International Journal of Research in Engineering and Technology' eISSN: 2319-1163 |pISSN: 2321-7308 IC-RICE Conference Issue – A study on effect of bacteria on cement composites.

6.E. Schlangen, H. Jonkers, S. Qian & A. Garcia(2010), 'Fracture Mechanics of Concrete andConcreteStructures'-RecentAdvancesinFractureMechanicsofConcrete-B.H.Oh, et al.(eds) 2010 Korea Concrete Institute, Seoul, ISBN 978-89-5708-180-8.

7. Jing Luo , Xiaobo Chen , Jada Crump , Hui Zhou , David G. Davies , Guangwen Zhou , Ning Zhang Congrui Jin (2015), 'Interactions of fungi with concrete: Significant importance for bio-based self-healing concrete'- Construction and Building Materials 164(2018)275–285.

8. Luthfi M.Mauludin , Xiaoying Zhuaang , Timon Rabczulk (2018), 'Computtional modelingoffractureinencapsulationbasedslefhealingconcreteusingcohesiveelements'- Composite Structure196(2018)63-75.

9. Doo-Yeol Yoo , Soonho kim , Min-Jae kim , Doyeong kim , Hyun-Oh Shin(2018),'Selfhealing capability of asphalt concrete with carbon based matrials'JMRTEC-427.

10. Luthfi Muhammad Mauludin , Chahmi Oucif , (2018) 'Interaction between matrix crack and circular capsule under uniaxial tension in encapsulation – based self healing concrete'.

11. Tomoy Nishiwaki , Sukmin Kwon , Daisuke Homma ,Makoto Yamada and Hirozo Mihashi,(2014)'Slef healing capability of Fiber-Reinforced Cementitious Composites forrecovery of water tightness and mechanical properties' –ISSN1996-1944.

12. Kim Van Tittelboom , Philip Van den Heede and Nele De Belie ,(2018) 'Self healing concrete with encapsulated polyurethane'-Eco efficient Repair and Rehabilitation of concrete Infrastructure.