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# Experimental Study on Structural Behaviour of Bacterial Concrete in Framed Structure

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***Abstract:-*** **Concrete are the most important materials used in construction industries where the external forces more than the design loads mainly the lateral forces which leads to the deformation and produce cracks in the joints of the structural member.The usage of cement has been increased more over the world results in the air pollution which leads to the ozone depletion .To overcome these type of problem like crack formation and usage of cement content used for repair works can be reduced by using the self healing bacterial concrete.these are materials Which heals the crack automatically when the cracks are formed.These self healing is achieved by means of using the Biological healing aspect by using the bacterial concrete.Bacteria are used during the mixing of concrete will cure the cracks the automatically by means of it screeds known as calcium carbonateprecipitate.**

**In these study horizontal forces are applied to the three storey single bay framed structure by means of using the hydraulic jack in which the cracks are formed in the framed structure mainly the cracks are formed in the Beam-Column Joints.The Cracks leads to the penetration of oxygen inside the reinforcement area will forms the Corrosion.To avoid the formation of corrosion the cracks bacterial concrete along with 60% of fly ash are used which results in self healing process.These self healing which cure and arrest the cracks in the structure which gives the environment free pollution and sustainable structure.**

## 1. INTRODUCTION

Cement plays the vital role in construction industry.Cement act as a binding material in all concrete structures.The Major problem in concrete structure is minor cracks.These cracks are formed due to overloading, improper design, unskilled labours, quality of materials etc. The cracks that formed that allow unwanted pollutants to penetrate inside the concrete structure which leads to steel corrosion and also the production of cement emits equal tonnage of carbon dioxide ($Co_2$) into the atmosphere and leads to ozone depletion.In this study,We are going to reduce the production of cement which used for repair &maintenance work.Here we are going to introduce biological techniques moreover we are replacing 60% of flyash in cement for the preparation of concrete which have some healing ability.Therefore the flyash &bacteria will act as a healing agent in these biological concrete.In framed structure The cracks are formed at the Beam-Column joints ,if there is an seismic force.Since the concrete is brittle and N nos of cracks are formed at the structural element.The Cracks formed allow the oxygen to penetrate inside and starts the Multiplication of bacteria to heal the minor cracks .In these present study we are going to replace conventional concrete with biological concrete for casting of three respective frame .After healing the same test is repeated for the healed framed structure. This storey is compared with conventional frame which has biological frame

## 2. AIM AND SCOPE OF INVESTIGATION

*AIM*

The scope of the project is to develop a self healing concrete with the high volume fly ash being replaced for the cement and putting it into practical application in the field of Construction Civil Engineering.

*SCOPE OF INVESTIGATION*

- ✓ The aim of the study is to augmentation of bacteria (Bacillus family) to improve the crack self-healing capacity of Bacterial concrete.
- ✓ To study the performance analysis of automatically healed framed structure made by bacterial concrete.
- ✓ To assess the microscopic analysis in Bacterial concrete specimens.
- ✓ To shrink the production of cement and emission of $Co_2$ to the atmosphere by increasing the usage of bacterial concrete.
- ✓ To develop guidelines and recommendations of bacterial concrete to implement in construction industry.

## 3. MATERIALS

*General*

Material investigation is done to test the various materials that are used in making concrete cubes. According to these test results obtained we designed the mix ratios for the materials and prepared the concrete cubes, beams and cylinders. The information are given below,

*Cement*

OPC of 43 grades in one lot was procured and stored in air tight container. The cement used was fresh i.e.

used within three months of manufacture. It should satisfy the requirement of IS12262. The properties of cement are determined as per IS4031:1968 & results are tabulated.

*Fine Aggregate*

A fine aggregate obtained from the river is used for experimental purpose. The less amount of clay and silt (<3% by weight). The hire from silt, clay, salt and organic material and it was clean and dry. It is of size retained in 1.19 micron sieve. **Chemical Composition of Natural Sand**

| Constituents | Natural sand(%) | Test method |
|---|---|---|
| $SiO_2$ | 80.78 | IS: 4032-1968 |
| $Al_2O_3$ | 10.52 | |
| $Fe_2O_3$ | 1.75 | |
| CaO | 3.21 | |
| MgO | 0.77 | |
| $Na_2O$ | 1.37 | |
| $K_2O$ | 1.23 | |
| $TiO_2$ | Nil | |
| Loss of ignition | 0.37 | |

*Bulking of Fine Aggregate*

- Table the representative of sample of sand, from the available lot at sight.
- Fill the graduated jar with sand up to certain weight compacting.
- Level the sand surface by gentle motion and note down this height.
- Now pour the water into the graduated jar containing sand till the sample is submerged.
- Cover the jar with the disk and give some motion.
- The tamping rod should be moved through out into sample in the jar, so as to ensure to removed of entrapped air completely.

| S.No | Initial height of sand | Height of sand after adding water | Bulking factor |
|---|---|---|---|
| 1. | 600 | 550 | 9.09 |
| 2. | 650 | 590 | 10.17 |
| 3. | 700 | 650 | 7.14 |
| **Percentage Of Bulking** | | | **8.8** |

*Coarse Aggregate*

The coarse aggregate is strongest and porous component of concrete. Presence of coarse aggregate reduces the drying shrinkage and other dimensional changes occurring on account of movement of moisture. The coarse aggregate used passes in 19 mm and retained in 11.4mm sieve. It is well graded (should of different particle size and maximum dry packing density and minimum voids) and cubical in shape.

*Water*

Ordinary drinking water available in the construction laboratory was used for casting all specimens of this investigation. Water helps in dispersing the cement even, so that every particle of the aggregate is coated with it and brought into ultimate contact with the ingredients.

It reacts chemically with cement and brings about setting and hardening of cement. It lubricates the mix and compact property. Potable water, free from impurities such as oil, alkalis, acids, salts, sugar and organic materials were used. The quality of water was found to satisfy the requirement if IS456-2000.

## 4. MIX DESIGN

*General*

Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. The main objective is to stipulate the minimum strength and durability. The mix design adopted in our project for the grade of M40.

*Fly Ash*

Ordinary Class F fly Ash of Cementitious property collected from the nearer Thermal power plant of specific gravity 2.31 is taken. The quality parameters of flyash for use in concrete confirming to IS 3812(part 1) has been used.

*Micro-organisms(Bacteria)*

Bacillus subtilus, a model laboratory soil bacterium is cultured and grown at NASC (Nandha Arts and Science College, Erode)

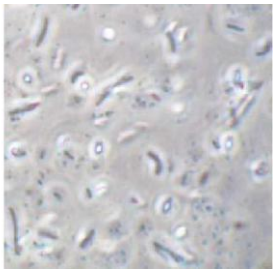

Fig shows Broth Culture

Bio technology was used at total cell concentration of $10^5$ cells per ml by serial dilution in the concrete.

***Casting***

*Mould Preparation*

The cube mould was placed in position on an even surface. All the interior faces and sides were coated with mud oil to prevent the sticking of concrete to the mould.

*Mixing*

The concrete using grade M30 (1:1.02:2.26) with water cement ratio 0.38 were used. Concrete is mixed in roller type of mixing machine.

*Placing Concrete*

Concrete is properly placed beneath and along the sides of the mould with help of trowel.

*Compaction*

Hand compaction was done for all the cubes used in the test. The damping mild steel rods having point ends were used to poke the concrete and it is placed in vibrating table to make compaction complete.

*Curing*

The mould is striped after 24 hours. The test cubes were cured for duration of 7 and 28 days in a curing tank. After the wet curing the specimens were air cured for minimum period 2 Hours under laboratory conditions.

## 5. TEST RESULTS

Testing of concrete plays an important role in controlling and confirming the quality of cement concrete. Cube, beam and cylinder are tested for its strength characteristics.

*Compression Test*

The cubes of size 150x150x150mm are placed in the machine such that load is applied on the opposite side of the cubes as casted. Align carefully and load is applied, till the specimen breaks. The formula used for calculation

**Compressive Strength= Total Failure Load / Area of the Cube**

***Compression Test***

*Compressive Strength Results:*

Compressive Strength for 7 Days

| S.No | Fly ash concrete (N/mm$^2$) | Bacterial concrete (N/mm$^2$) |
|---|---|---|
| **1** | **23** | **27** |

Compressive strength for 14 days

| S.No | Fly ash concrete(N/mm$^2$) | Bacterial concrete(N/mm$^2$) |
|---|---|---|
| **1** | **32** | **37** |

Compressive Strength for 28 Days

| S.No | Fly ash concrete (N/mm$^2$) | Bacterial concrete (N/mm$^2$) |
|---|---|---|
| **1** | **28** | **42** |

*Split Tensile Test*

The test is carried out by placing cylinder specimen of dimension 150mm diameter and 300mm length, horizontally between the loading surface of compression testing machine and the load is applied until failure of the cylinder along the vertical diameter. The failure load of the specimen is noted.

The failure load of tensile strength of cylinder is calculated by using the formula

**Tensile strength = 2P / 3.14 DL6.2.2**

Where,

P - Failure of the specimen

D - Diameter of the specimen

L - Length of the specimen

Split Tensile Test

*Split Tensile Strength Results:*

*Split Tensile Strength for 7Days*

| S.No | Fly ash concrete (N/mm$^2$) | Bacterial concrete (N/mm$^2$) |
|---|---|---|
| **1** | **0.989** | **1.257** |

Split Tensile Strength for 14 Days

| S.No | Fly ash concrete (N/mm$^2$) | Bacterial concrete (N/mm$^2$) |
|---|---|---|
| **1** | **2.26** | **2.857** |

Split Tensile Strength for 28 Days

| S.No | Fly ash concrete (N/mm$^2$) | Bacterial concrete (N/mm$^2$) |
|---|---|---|
| **1** | **3.68** | **4.24** |

*Flexural Test:*

The test is carried out to find the flexural strength of the prism of dimension 100 x 100 x 500 mm. The prism is then placed in the machine in such manner that the load is applie d to the uppermost surface as cast in the mould. Two points loading

adopted on an effective span of 400 mm while testing the prism .The load is applied until the failure of the prism. By using the failure load of prism



**Flexural strength = Pl/bd$^2$**

, P - Failure load of the prism
l - Length of the prism
b - Breadth of the prism
d - Depth of the prism

Flexural Test results

**Flexural strength for 7 days**

| S.No | Fly ash concrete (N/mm$^2$) | Bacterial concrete (N/mm$^2$) |
|---|---|---|
| **1** | **5.24** | **6.4** |

**Flexural strength for 14 days**

| S.No | Fly ash concrete (N/mm$^2$) | Bacterial concrete (N/mm$^2$) |
|---|---|---|
| **1** | **7.24** | **8.2** |

**Flexural strength for 28 days**

| S.No | Fly ash concrete (N/mm$^2$) | Bacterial concrete (N/mm$^2$) |
|---|---|---|
| **1** | **8.64** | **9.48** |

## 6. RESULT AND CONCLUSION

- The use of bacteria in concrete proves to be more effective with increase in strength. It also proves that healing property is more and is effectively increasing the risk of failure.
- Compressive strength of bacterial concrete is increased by 10 to 14 % than the conventional HVFA concrete. The split tensile test and flexural test of conventional HVFA to Bacteria HVFA concrete is increased by 10.6%.
- Total ultimate load carrying capacity of the healed specimen is devastatingly higher. Since the load carried is about 85kN whereas the ordinary is about only 72kN
- The study on the use of bacteria and the flyash replacement in the concrete shows to be more significant.

## 7. SUGGESTION FOR FUTURE WORK

- Crack filling and its behaviour in other building material like granite, brick and marble.
- Investigation of production of bio bricks where instead of burning of moulded bricks to bind the earth, bio cementing is to be tried.
- Water permeability testing and fire resistant parameters of the bacterial concrete.
- The autogenic crack healing can be studied under the Electron Microscopic analysis.

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