Behavioural Study of Bacterias In Formation of M35 Grade Concrete As A Bioconcrete

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Abstract- *As there is massive growth in civil engineering in construction department the main ingredient used is concrete the various grades utilize for the minimum particle size of cement thus increasing the strength of concrete but due to greater extent of hybrid cement used it is susceptible to cracks generated by microcracks. Recent invention by Dr. Henk Jonkers as a great solution on this micro cracks our project deals with "Behavioral study of bacteria's in formation of M35 grade concrete as a bio-concrete". The research informs increasing the strength and durability of concrete by using bacteria's by process of bio-calcification as a part of metabolism of bacteria. In this bacterium secretes calcium precipitation and fill up the voids in concrete matrix, reducing the porosity and making it more compact A comparative study and analysis was done with the concrete cubes and beams subjected to compressive and flexural tests of infused bacterial specimen. In the study we found that there was increasing strength and calcium precipitation inside the concrete matrix.*

Keywords- microcracks, bio-concrete, bio-calcification, bacterium, concrete matrix.

I. INTRODUCTION

In the olden days, the structure was built with the structure the locally available materials such as stones, mud, sand, lime etc. after that cement was used as a binding material. Later on, steel was adopted with cement building material for the sustainability of the structures and the durability of the structure and is known as RCC Structure. There is an excess demand of concrete nowadays. The rapid haphazard development of cities required for super-structures such as Dams, Retaining Walls, Skyscrapers etc. but concrete of high grades requires special kind of admixtures which gives better result of concrete and requires skilled labour for utilization. The main disadvantage of concrete is that all structures made from it will induce cracks at some point, due to shrinkage the cracks are induced increasing the permeability of the structure causing the reduction in the strength of the structure and finally structure fails.

Due to large cracks, structural integrity is affected while due to micro cracks the durability of structure reduces. The micro cracks further lead to the formation of porous matrix of concrete leading to increase chances of corrosion of steel reinforcement. In order to reduce crack formation the structure periodical inspection and maintenance. The average maintainer's costs up to 20-200 billion of dollars. One of the best way of reducing this maintenance cost is to adopt bio-concrete also called as bacterial concrete or self healing concrete. In scientific terms the bio-concrete is basically Biomineralization of specific bacteria in a concrete. The strength and durability of concrete is increased by using these microorganism or bacteria's as binder and fillers. The other treatment such as epoxy treatment are currently used which is harmful to environment, emitting toxic fumes and harmful gases causing serious skin problem and breathing issues.

Hence biomineralization technique in a concrete leads as a green building material. The carbon dioxide is emitted during the formation of the concrete also heat is emitted due to the C3S content present in Ordinary Portland Cement leading it to increase the temperature and green house effects. The Carbon Dioxide emitted from it is absorbed by the bacteria present in bio concrete reducing the effects of green house effect.

II. MATERIALS & METHODS

- **CEMENT:** Ordinary Portland Cement manufactured by Ambuja was used. Test conducted on cement were normal consistency, initial setting time, fineness test and specific gravity.

- **FINE AGGREGATE:** Fine aggregates locally available were used and were tested, the results were as per Indian standards BIS: 383: 1970. Specific gravity of fine aggregate was 2.8 of zone 1.

- **COARSE AGGREGATE:** Coarse aggregate of size 4.75 mm-20mm (passing through 4.75 mm and retained on 20mm IS sieve). Specific gravity of coarse aggregate is 2.83 of zone 1 which is within the permissible limit (BIS: 10262, BIS :383). Water absorption of coarse aggregate was 0.9%. No aggregate which has water absorption more than 2% shall be used in concrete mix.

- **WATER:** Potable water was used for production of concrete with the pH value 7.3 at zero turbidity.

- **Calcium Lactate :** Calcium lactate was adopted readily in an powder form from the dealer.

- **Bacterial Stock solution preparation:**

Materials used for preparation of bacteria were as follows:

1. BACTERIAL CULTURE: bacterial culture was given by National chemical laboratory (N.C.L)Pashan in test tube i.e. bascillus pasturii and shwenella sp.
2. Water : water used was distilled water of ph. value 7 and zero turbidity
3. Glassware: - it includes the test tubes, Petridishes, cylindrical jars, stirrer etc
4. Bacterial medium: it included the Luria broth powder and nutrient broth powder, agar agar powder.

- **Bacterial preparation of medium:**

The medium was prepared under various laboratory safety measures concerning the local safety steps and various reference papers The bacterial culture was given by the national chemical lab in Pune, near Pashan which was requested by us via mail to concern person, it was stored in an Incubator at a temperature of less than 5^0C. Then the colony was developed by forming the gel medium of stock solution by slant process in a petri dish After the whole colony was developed in a petri dish the following procedure was adopted separately for two bacterial species

Process of preparation of medium for Bacillus pastuerii involves following steps:-

Day 1- We have taken the required proportion of Nutrient Broth media,we have prepared 100 ml 1 number of solution.

Day 2- We have taken the required proportion of Nutrient Broth media,we have prepared 120 ml of 2 number of solution

Day 3- We have taken the required proportion of Nutrient Broth media, we have prepared 100 ml solution from above 100 ml solution we have prepared 4 samples of 100 ml solution

Day 4- We have taken the required proportion of Nutrient Broth media, we have prepared 100 ml solution from above 200 ml solution we have prepared 8 samples of 100 ml solution

Day 5- In this way Finally we have prepared 1.6 Liters of solution which we are using for the concrete mix i.e. Bacterial concrete.

After day 5 the whole medium was mixed as a concrete as per the design with an addition of calcium lactate powder.

- **Safety measures taken into considerations :**

As handling an bacterial culture safety measures must be adopted so as to be safe from probable hazards .

The bacteria used by us was non pathogenic so there was very less risk of hazards ,0but safety considerations was given a prime importance Safety measures considered the following habits for handling the bacteria:

1. Wearing clean medical gloves in hands and washing hands disinfectant soap, before and after wearing medical gloves
2. Wearing sanitized mask for protection from inhaling the microorganisms and preventing the pure bacterial culture from any other bacteria's present inside us
3. Using the Inoculation chamber for transferring the bacteria and preparation of medium with an UV ray tube-light inside it
4. Sanitizing the glassware and medium inside the autoclave for 15 minutes at 180^0C
5. Wearing apron while handling bacterial fresh cultures for more safety and less dilution of other parasites
6. Also working place that shall be utilized in process of bacteria was cleaned with an pure alcohol such as ethyl alcohol with an medical tissue or cotton plucks
7. Each bottle was closed by medical cotton plugs and paper with rubber bands
8. It was ensured that no spillage of liquid medium was occurred while transfer
9. Each bottle was heated a little before the transfer so as there may a as less chances of contaminating the required bacteria by others present in an air
10. The obtained stock solution was stored in incubator at a temperature less than 5^0c

- **Preparation of cubes and beams:**

As per the design the proportion of cement, aggregates and water was fixed also the addition of stock solution was determined and amount of calcium lactate was fixed for preparing the blocks and beams Moulds were utilized of size 150*150*150mm and beams were also adopted The moulds were cleaned and greased with an oil before pouring

the concrete into it All moulds were properly tightened by means of screws present on it The concrete was poured in a step by step manner and mixed using vibration table The mould were untightened after the concrete form a stiff block and beam and carefully placed for curing as 7 days 28 days etc.

- **The design was adopted as per IS10262-2009 for M35 grade concrete as follows:**
- Cement content = 492.9 Kg/m3
- Water content = 197.0 Kg/m3
- Fine aggregate = 680.25 Kg/m3
- Coarse aggregate = 1095.50 Kg/m3

III. TESTS ON HARDENED CONCRETE

COMPRESSION TEST

The test was carried out confirming to IS 516 – 1959 to obtain compressive strength of concrete at the age of 7, 14, 28 days. The cubes were tested using Compression Testing Machine (CTM) of capacity 2000 KN.

Compressive Strength = P/A
Where, P =ultimate load .
A= Cross-sectional Area of the cube.

RESULT TABLE

Table 1. Trial Mix 1(Bacillus Pastuerii)

Sr. No.	TYPE OF MIX	GRADE DESIGNATI-ON	DAYS OF CURING	NO OF CUBE TESTED	CALIBRATION LOAD (KN)	COMPRESSIVE STRENGTH (MPa)	AVERAGE COMPRESSIVE STRENGTH (MPa)
1	Trial mix 1	M35	7	3	410 440 470	18.22 19.56 20.89	19.56
			28	3	800 790 850	35.55 35.11 37.77	36.14

RESULT TABLE

Table 2. Trial Mix 2(Shewanella sp.)

Sr. No.	TYPE OF MIX	GRADE DESIGNATI-ON	DAYS OF CURING	NO OF CUBE TESTED	CALIBRATION LOAD (KN)	COMPRESSIVE STRENGTH (MPa)	AVERAGE COMPRESSIVE STRENGTH (MPa)
1	Trial mix 1	M35	7	3	420 440 480	18.66 19.55 21.35	19.89
			28	3	920 880 890	40.88 39.11 39.55	39.85

Figure 1. M35 grade Cube Testing (Bascillus pastuerii)

The test was carried out confirming to IS 516 – 1959 to obtain flexural strength of concrete at the age of 7& 28 days. They were tested using Universal Testing Machine (UTM) of capacity 600 KN.

The testing machine may be of any reliable type of sufficient capacity for the tests and capable of applying load at the rate specified. The permissible error should not be greater than 0.5 % of the applied load where the high degree of accuracy is required and not greater than 1.5% of the applied load for commercial type of use.

Flexural Strength = Pl/bd2

Where, P = maximum load applied to specimen in N.
l = Span length on which specimen was supported in Meter.
b = Width of a specimen in mm.
d = depth of specimen in mm.

RESULT TABLES:

Table 3. Trial Mix 1(Bacillus pasturii)

Sr. No.	TYPE OF MIX	GRADE DESIGNATI-ON	DAYS OF CURING	NO OF BEAMS TESTED	CALIBRATION LOAD (KN)	FLEXURAL STRENGTH (MPa)	AVERAGE FLEXURAL STRENGTH (MPa)
1	Trial mix 1	M35	7	3	13.21 14.24 16.17	3.96 4.27 4.85	4.36
			28	3	24.18 23.18 26.02	7.25 6.95 7.80	7.33

Figure 2. M40 Grade Beam Testing

IV. CONCLUSION

The overall conclusion from the work proposed using the adopted bacterial cultures i.e bacillus pastuerii and shwenella sp. has shown the considerable result in compression and flexural test than ordinary concrete also the reaction with calcium lactate has reduce the cracks in an eco-friendly way and in a sustainable way for alternating chemical based healing agent.

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