EXPERIMENTAL INVESTIGATION ON BACTERIAL CONCRETE WITH COAL BOTTOM ASH

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Abstract: Now a day the waste material from industry are speedily growing. To utilize such materials and to reduce such type of waste in environment, the sand is replaced by the coal bottom ash contain of bacteria species called bacillus pasteurii in M40 design mix in this study. This thesis was study the material properties (cement, sand, coarse aggregate, coal bottom ash), way of preparation, procedure of test and ingredients used for culturing of bacteria species in laboratory and with all procedure. This study provides results on experimental investigations carried out to evaluate the effects of replacing aggregates (fine or sand) by coal bottom ash 20%, 30% and 50% in bacterial concrete with all other ingredients as constant. An experimental program was designed by analyzing the flexural strength and compressive strength properties of normal concrete, bacterial concrete with and without coal bottom ash at curing period 7, 28 and 56 days. As a result of this study bacterial concrete with 30% coal bottom ash has been maximum compressive strength and flexural strength than all concrete including in this experiment. Generally bacterial concrete with coal bottom ash has been better flexural strength and compressive strength than bacterial concrete and normal concrete. Improved the strength of bacterial concrete by coal bottom ash therefore, recommended that utilize coal bottom ash as replacing fine aggregate in bacterial concrete that gives the environment to eco-friendly.

***IndexTerms* - Bio concrete, coal bottom ash, flexural strength, compressive strength, Sporosarcina pasteruii**

I. INTRODUCTION

The main important material still used in construction industry is concrete but it's has disadvantage is weak in stiffness and inflexible. Also, problem like corrosion can result in structural failures with possibly serious long-term operational effect so, it cracks under sustained loading and due to aggressive environmental agents, which ultimately reduce the life of the structure which is built using these materials. This method of harm happen initial lifespan of the construction structure and during its lifetime. If this kind of trouble is occurred, the concrete quality is step-down one of that is strength and to decrease the problems used the artificial materials. But, they are reducing visual exterior, trim down the artistic appearance, costly, compatible, and expensive, and need continuous care. For that reason, species of bacteria that precipitate CaCO3 has been estimated as an environmental-friendly and crack remediation replaced material consequently improving the life period and strength of construction structure. Bio concrete is one of an advanced concrete type and it has the potential to repair itself freely to reduce micro cracks. Bacterial concrete is another benefit when bacteria species used in concrete helps in increasing the mechanical properties of concrete in both actual and laboratory condition. The pre-defined material used in concrete to remedy a crack and improving strength and durability were harm for the environment and also expensive than self-healing concrete and want constant care. But According to earlier study MICCP technology has been previously used for enhancement in strength of concrete and consolidation of sand this technique would save money and environment because of bacterial concrete is crack healing material by itself and recover mechanical properties of structural concrete compare with conventional concrete. Now a day the wastes from industry are speedily growing. Coal bottom ash is one of thermal power plant waste filled on environment and harmful for human being and other living things therefore utilization of coal bottom ash is gives the environment to eco-friendly. Generally in this paper compressive strength and flexural strength of bacterial concrete with coal bottom ash as a percentage of 20%, 30% and 50% are compared with conventional and bio concrete.

II SIGNIFICANCE OF RESEARCH

The main important of this thesis is to develop how to heal the micro cracks in construction project more and more to do this progress has been used bacterial species called bacillus pasteruii and enhancing mechanical properties of concrete by using replacement of sand with coal bottom ash. Another important significance of this study is to reduce environmental problems arising from filling it in the land of CBA.

III BACTERIAL CONCRETE

Bio concrete is a material that can effectively crack is remediated in concrete. Because of the MPI as an outcome of microbial actions is natural and pollution free this method is extremely advantageous.

3.1 Chemical Process of Bacterial Concrete

When the water comes in contact with the un hydrated calcium in the mixtures of concrete, Ca $(OH)_2$ is formed because of the presence bacteria, that used as a catalyst. This $CaCO_3$ reacts with CO_2 and forms $CaCO_3$ and water. The additional water is makes on going the reaction and then the cracks in structure is seals due to hardening of limestone by itself. Detail is in fig. 1

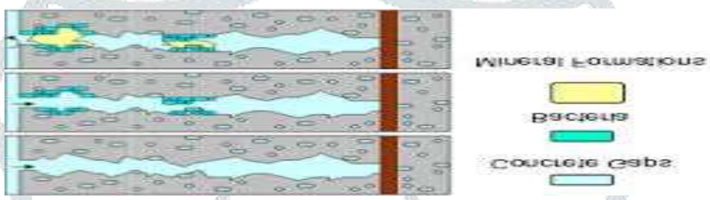

Fig. 1 Chemical procedure of bio concrete [38].

3.2 Benefits of Bio Concrete:

Upgrading the compressive strength.

Good resistant of freeze-thaw occurrence.

Decreased permeability.

Decreased corrosion of reinforcement.

Eco friendly.

3.3 Applications of bacterial concrete

The practice of bio concrete in civil engineering has become progressively current. [4]

Enhancement in the durability of Cementous materials to upgrading in fine aggregate behavior.

Overhaul of calcium carbonate monuments.

Cracks of concrete are sealing.

Used in construction of durable green housing.

Used in structure of low-cost durable roads

IV Methodology

Material

Cement: Grade 53 OPC is used for this experiment and its local available material and with having a 3.15 specific gravity.

Sand: Used locally available natural sand that is zone II this is confirming to table 2 of IS: 383 and sieved to remove coarser and unwanted material from the sand. Testes had conducted on sand according to Indian standard the results are summarized as follows in the table 1

Table 1 Properties of sand

S. No.	Properties	Amount

1.	S. g	2.60
2.	Water absorption	1.11
3.	Grading zone	II
4.	Fineness modules	2.80
5.	Free water content	1.6

Coarse aggregate: The main ingredient in concrete is coarse aggregate. According to IS tests are done on properties of coarse aggregate and shown in table 2. The aggregate used in this investigation is 20mm and single size aggregate confirming to table 2 of IS: 383

Table 2 Properties of coarse aggregate

S. No.	Properties	Result
1.	Specific gravity	2.71
2.	Size	20mm
3.	FM	6.9
4.	WA	0.8
5.	Free water content	0

Water: The one main important ingredient in concrete is water. In this experiment I was used the impurities free water and drinking water is required.

Coal bottom ash: Many thermal power plants produce CBA as waste that have the potential to replace the fine aggregate in the concrete. According to the previous study, CBA has more voids and less specific gravity than natural sand. CBA has been collected from the Vanakbori thermal power plant and with specific gravity of 2.15 and its less specific gravity than sand because of porous properties. A chemical property has been shown in table 3.

Table 3 Chemical composition of CBA

Chemical composition	Amount in percent
SiO2	57.76
Al2O3	21.58
Fe2O3	8.56
K2O	1.08
CaO	1.58
SO3	0.02
MgO	1.19
Na2O	0.14
LOI	5.80

Bacteria: Microorganism Bacillus pasteruii or sporosarcina pasteruii are obtained from Parul Institutes of Pharmacy Laboratory (PIPHL), Baroda.

4.1 Compressive strength

It's the most important concrete tests that are due to load of compression the mould undergoes side action and the steel restrains the expansion propensity of concrete to the side path. This is done according to IS 10262-2009 the sample is cured for 28days of normal concrete and bacterial concrete with and without coal bottom ash of M40 mix grade concrete. The test have been done on sample by 2000KN size worldwide testing machine and the cubes have been used in this experiment is 150x150x150mm.

4.2 Flexural tensile strength

To decide the properties of concrete on hardened case flexural tests is one of that and also its known as bend strength or fracture strength. The stress in a concrete before it's yielding in a flexural test its concrete properties called flexural strength. The tests were done on samples cured 28days and the size of the cube was used in this investigation is 500x100x100mm as per IS 516-1959 with the same mix design of M40 as guide lines of IS 10262-2009.

V MIX DESIGN

For M40 mix design has been determined in table 4

Table 4 mix design

Type of concrete	Mix of M40	Cement	FA	CA	CBA	Bacterial solution
NC	1:0.742:2.317	277.916	206.0924	643.872	-	-
BC	1:0.742:2.317	277.916	206.0924	643.872	-	752ml
BC 20% CBA	1:0.593:2.317:0.148	277.916	164.87392	643.872	41.21848	752ml
BC 30% CBA	1:0.519:2.317:0.222	277.916	144.26468	643.872	61.82772	752ml
BC 50% CBA	1:0.371:2.317:0.371	277.916	103.0462	643.872	103.0462	752ml

NC= normal concrete, BC= Bacterial concrete. FA= fine aggregate, CA= coarse aggregate, CBA= coal bottom ash

VI RESULTS AND DISCUSSION

Compression test

The concrete removed from the tank after their 7, 28 and 56 days of curing period. The cubes must be dry before putting the cubes under compressive machine. After cubes are dried completely then placed under compressive testing machine within intention to get the compressive strength of concrete, but first cleaning the surface of compression machine. The prepared sample cubes are tested under compressive strength machine and the load is applied in opposite sides of the cube cast. The sample centrally aligned on the base plate of the machine. The load gradually applied without shock and continuously at the rate of 5.2 KN/sec till the sample is fails and the maximum load is recorded.

As shown in the graph 2 compressive strength of bacterial concrete with coal bottom ash is better than normal concrete and bacterial concrete and also BC 30% CBA is maximum the compressive strength of concrete at 7, 28 and 56 days curing period than other concrete that included in this experiment.

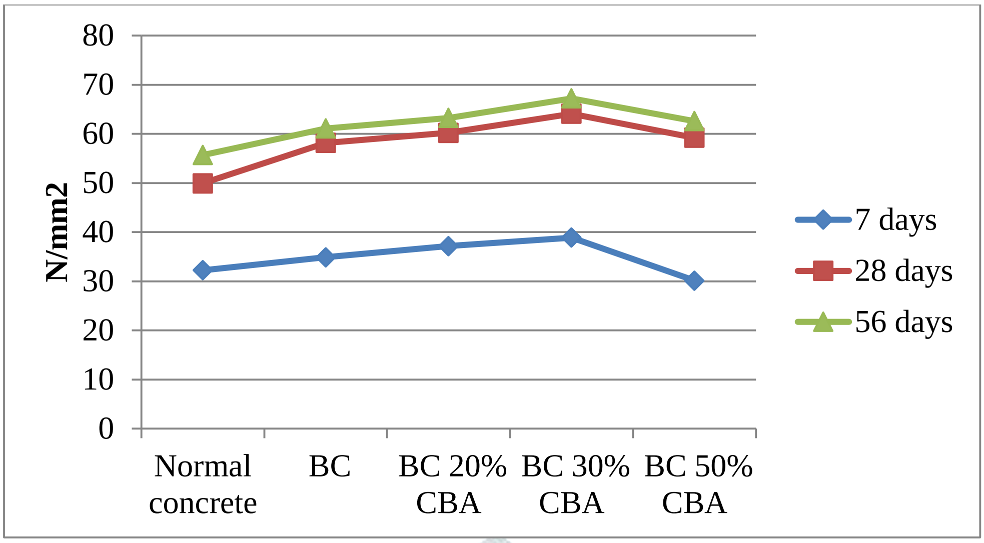

Fig.2 Comparison compressive strength of normal concrete with bacterial concrete and CBA concrete at 7, 28 and 56 days

Flexural tensile strength test:

This test was carried out to find out the modulus of rapture of concrete .For flexural test beams of 100*100*500 cubic mm size were adopted. The load was applied without shock and was increased until the sample is failed, and the maximum load applied is recorded by digital system.

In all curing period bacterial concrete with coal bottom ash is greater flexural strength than normal concrete and bacterial concrete without CBA From the following graph flexural tensile strength of normal concrete, bacterial concrete with CBA and bacterial concrete increase with increase curing period. Comparisons has been shown in fig.3

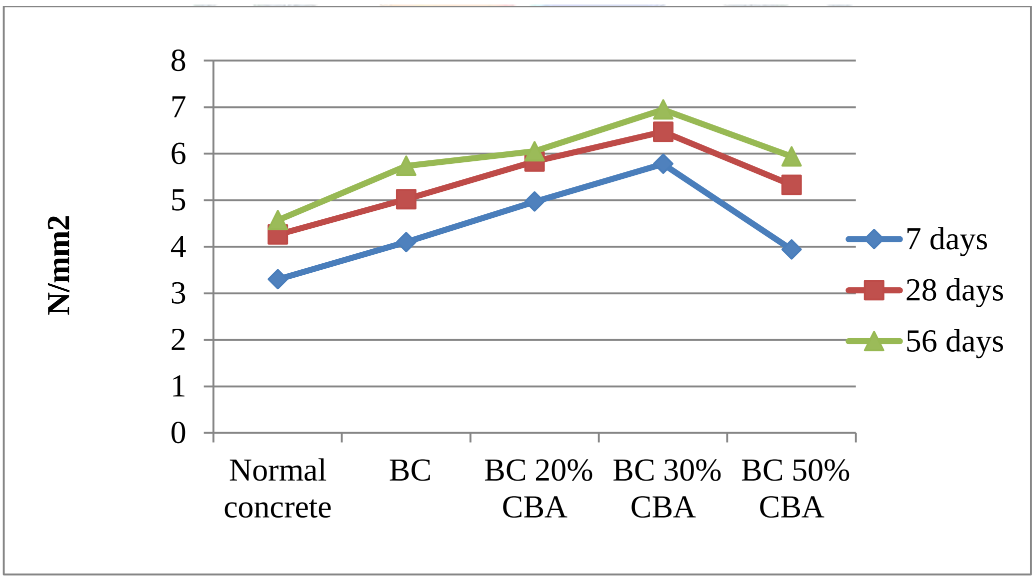

Fig. 3 Comparison flexural tensile strength of normal concrete with bacterial and CBA concrete at 28,56 and 7 days.

VII CONCLUSION

Generally Based on the results collected from the test on compressive and flexural strength of all concrete and information gathered from the literature review, the following conclusion drawn:

✓ Addition of bacillus pasteruii in concrete is improved the compressive strength and flexural strength of concrete.

✓ CBA used as replacing sand in bacterial concrete is enhance the compression and flexural tensile strength of bacterial concrete in 20%, 30% and 50% different percent of CBA.

✓ Bacterial concrete of 30% coal bottom ash has been maximum compressive and flexural strength than normal concrete, bacterial concrete, bacterial concrete with 20% and 50% CBA at 56, 28 and 7 curing period.

✓ Replacing of sand by CBA at 50% has been lower strength than 20% coal bottom ash bacterial concrete and 30% CBA bacterial concrete but it has been higher strength than bio concrete and conventional concrete.

✓ Therefore from the above conclusion bacterial concrete with coal bottom ash is better compression and flexural strength than conventional concrete and bacterial concrete by species bacteria called bacillus pastuerii.

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