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A STUDY ON BIO CONCRETE AND BACTERIA BASED SELF HEALING CONCRETE

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ABSTRACT

Concrete is a strong durable material it consists of cement, fine aggregate, coarse aggregate and water and it is most used building material in the world. The cracks in the concrete structures have to be in limit, if cracks are too large then they are to be repaired. The use of bacteria is environmental friendly method, it works by repairing the concrete structures by process of the MICCP (microbiologically induced calcium carbonate precipitation). In this paper, two types of bacteria are used namely Bacillus Sphaericus and Proteus Vulgarious. Where the Bacillus Sphaericus is a gram positive bacteria and Proteus Vulgarious is a gram negative bacteria.

In this, M20 and M30 grade concrete of the 36 Cubes, 36 Cylinders, 36 Prisms were casted and tested under Compression strength, Split tensile strength and Flexural strength. The used bacteria will repair cracks in the concrete and evaluate the strength in the comparision with the conventional concrete & bacterial concrete. By the evaluated results, we found that the bacterial concrete results are higher than the conventional concrete.

Key words: Bacillus Sphaericus, Proteus Vulgarious, MICCP.

INTRODUCTION

Bacterial concrete has the ability to repair itself automatically and it is a special type of concrete. Bacterial concrete is the introduction of bacteria and it helps in enhancing the properties of concrete. From the previous studies it has found that MICCP has used for improvement in strength of concrete. When the bacteria is added in the concrete mix it gives the strength and act as an self healing agent. Self healing agents such as fibres, epoxy resins and bacteria. In all these agents the bacteria mixed in concrete is used very effectively. The self healing property & the enhancement in other aspects of the concrete would save environment & money because of predefined materials for evaluation in strength and durability are not good to environment and also more expensive than bacterial concrete and also they require regular maintenance. Strength and durability of structures will enhance through the MICCP process. .The MICCP depends on various factors like the presence of nucleation site, concentration of the calcium ions & dissolved inorganic carbon. By using bacteria in concrete it increases in strength, better resistance through freeze – thaw attack in reduction, low maintenance of structure, and it increase the resistance towards chloride attack but the bacterial concrete increases the cost up to 7% to 30% and also the bacteria in concrete should be used minimum because the used bacteria are not safe to the human health & there is no standard mix design for the bacterial concrete.

LITERATURE REVIEW

J.Harshali et al.: This paper investigates to evaluate strength in the comparision with that of conventional& bio concrete cubes. This project discusses about filling of the voids in the fresh concrete & plugging of the artificially cracked cement mortar using the bacillus sphaericus&proteusvulgarious bacteria that is combined with the sand & the filling material in the artificially made cuts in the cement mortar which were cured in the urea & cacl2 medium. The effect on compressive strength and the flexural strength due to mixing of the bacteria along with the effect of the water absorption &sorptivity on the concrete cubes is done.

M.Kishore et al.: This paper investigates with the development of a sustainable building material through the bacterial actions. The sustainability is achieved by the usage of the 0% cement. In this, we are going to make the different type of the earthen cubes by the bacteria action & then test them for the strength parameters. Sustainability is by word means that not only cost effective buildings but that also implies fact that it also have in concern about the environment aspect & also cares about our natural resources.

EXPERIMENTAL PROGRAM

In this experimental work the materials required for the concrete use in the present work are cement, fine aggregate, coarse aggregate, water and bacterial solution.

- **Cement:** The ordinary Portland cement (OPC), 53 grade conforming to IS:12269 – 1987 is used. Ordinary Portland cement, 53 grade was used for casting all the specimens.

Physical properties of cement

S.No	Properties	Test Results
1	Fineness test	6%
2	Specific Gravity	3.12
3	Normal Consistency	33%
4	Initial setting time	38 min
5	Final Setting Time	330 min

- **Fine aggregate:** Fine aggregate size less than 4.75mm size were used. The river sand was found to be zone-II as per IS: 10262 – 2009,IS: 383-1970.

Physical properties of fine aggregate

S. No	Properties	Test Results
1	Bulk density (g/cc)	1.52
2	Specific gravity	2.29
3	Fineness modulus	2.62

- **Coarse aggregate:** The material whose particles are of size are retained on IS sieve of size 4.75 mm is termed as coarse aggregate and containing only so much finer material as is permitted for the various types as per IS: 383-1970 is considered as coarse .

Physical properties of coarse aggregate

S. No	Properties of coarse aggregate	Test results
1	Bulk density	1.59 g/cc
2	Specific gravity	2.78
3	Fineness modulus	7.32

- **Water:** Locally available portable water confirming to IS 456 is used.
- **Bacterial Solution:** To prepare the bacterial solutionsome of the microorganisms are used namely Bacillus Sphaericus and Proteus Vulgarious.

Preparation of Bacterial solution

Primarily 5 grams of peptone, 5 grams of beef extract, 2.5 grams of Nacl added in 500ml conical flask containg distilled water. Then it is covered with the cotton plug and wrap it with aluminium foil. Then after sterilize it in autoclave for 15 min at 121 degree centigrade, under 15 lb pressure. Then microbial solution is added for culturing is 5 ml of bacillus sphaericus, 5 ml of proteus vulgarious to extract medium. The whole process was done under sterile condition. This culture was incubated at 37 degree centigrade on a shaker incubator at 120 rpm for 24 – 48 hours.

CULTIVATION OF BACTERIA

The pure culture of bacteria i.e., Bacillus Sphaericus and Proteus Vulgarious is preserved on nutrient agar slants. It forms irregular dry white colonies on nutrient agar slants. Two colonies of the bacteria are inoculated in to nutrient broth of 30 ml in 250ml conical flask and incubated at the temperature 37 degree Celsius and 120 rpm orbital shaker incubator. The medium composition used for growth of bacterial culture consists of peptone, NaCl, Beef extract.

SAFETY MEASURES FOR BACTERIAL SOLUTION

- The bacteria which is used are harmful to health and it may lead to the diseases so precautions must be taken.
- It is compulsory to use gloves while preparing the bacterial solution.
- The flask should be heated before pouring the bacterial solution.
- The bacteria preparation must be done between the two candles by that bacterial solution does not get contaminated.
- Nose mask should be used compulsory to avoid the bacteria smell.

PREPARATION OF SPECIMENS

The research is carried out to study the properties of M_{20} and M_{30} grade of concrete by using bacterial solution with various percentages of 0%, 20%, 40%, 60%, 80% and 100% with replacement water. The mix proportions for M_{20} grade is 1:1.76:3.49 with water cement ratio 0.55 and M_{30} grade is 1:1.6:2.66 and water cement ratio 0.44. The compressive strength, split-tensile strength and flexural strength tests are carried out for 7, 14 & 28 days curing. The experimental program is planned to cast around 36 cubes of size 150x150x150 mm, 36 cylinders of size 150x300 mm and 36 prisms of size 500x100x100 mm and they were tested in the laboratory.

RESULTS AND DISCUSSION

COMPRESSION STRENGTH

Compression test was conducted on 150mm×150mm×150mm cubes. Concrete specimens were removed from curing tank and cleaned. In testing machine, the prepared cube is placed with cast faces at right angles to that of the compressive faces, then the load is applied at constant rate of the 1.4 kg/cm^2/minute up to the failure &ultimate load is noted. The load is increased until specimen fails & maximum load is recorded. The compression tests were carried out at 7, 14, 28 days. For strength computation, load of each specimen is considered for each mix. Load of each specimen was noted as the cube compressive strength.

SPLIT TENSILE STRENGTH

The cylinder specimen is of the size 150 mm diameters and 300mm length. This test used is carried out by the placing an cylindrical specimen horizontally between loading surfaces of the compression testing machine &load is applied until the failure of cylinder, along its longitudinal direction. The cylinder specimens are tested at 7, 14, 28 days. The load of the each specimen was noted as split tensile strength.

FLEXURAL STRENGTH

In this test Prism is loaded with two-point loading method at the midpoints of the prism. For flexural test the size of the specimen is 500 mm × 100 mm × 100 mm. The load is applied to top of the surface as the cast in mould &loads are applied at distance of the one-third from the both of prism supports. The axis of specimen is carefully aligned with axis of loading device. The load is increased till specimen fails & maximum load applied to specimen during test is recorded. The appearance of fractured faces of the concrete & any unusual features in type of failure thus noted. The prism specimens are tested at the 7, 14, 28 days. The load of each specimen was noted as the flexural strength.

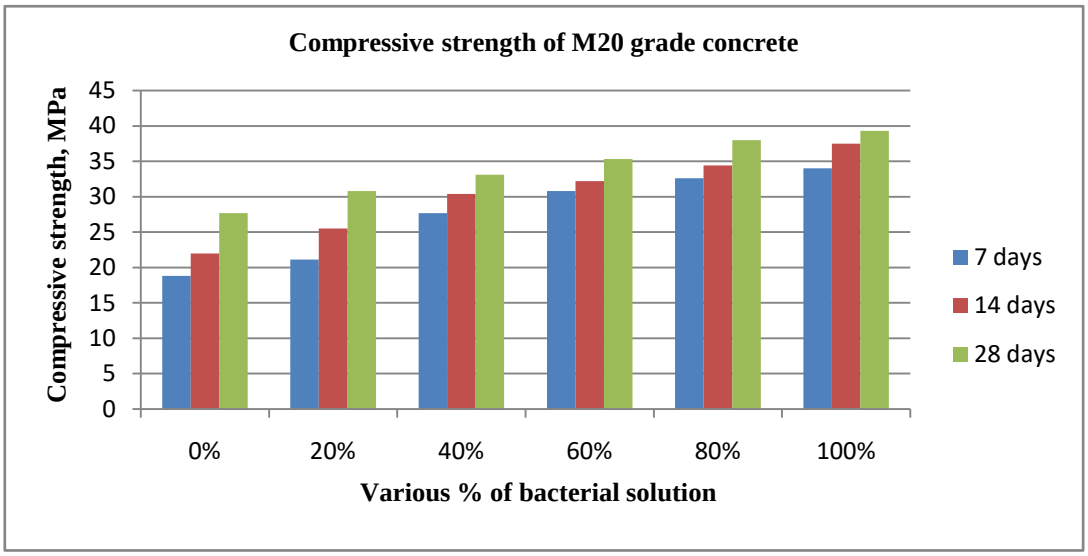

Fig.1 Compressive strength of cubes for M20 grade concrete.

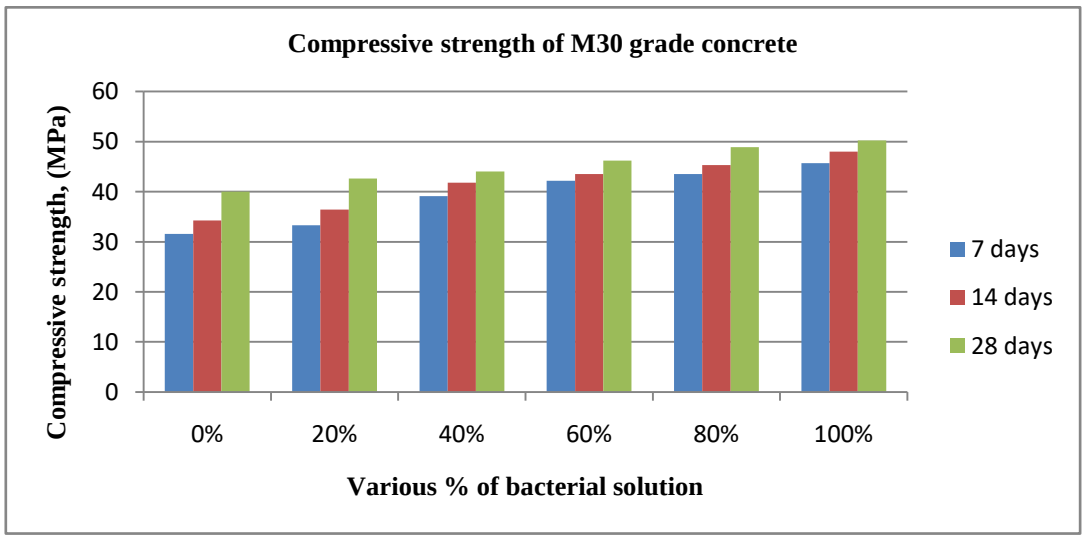

Fig.2 Compressive strength of cubes for M30 grade concrete.

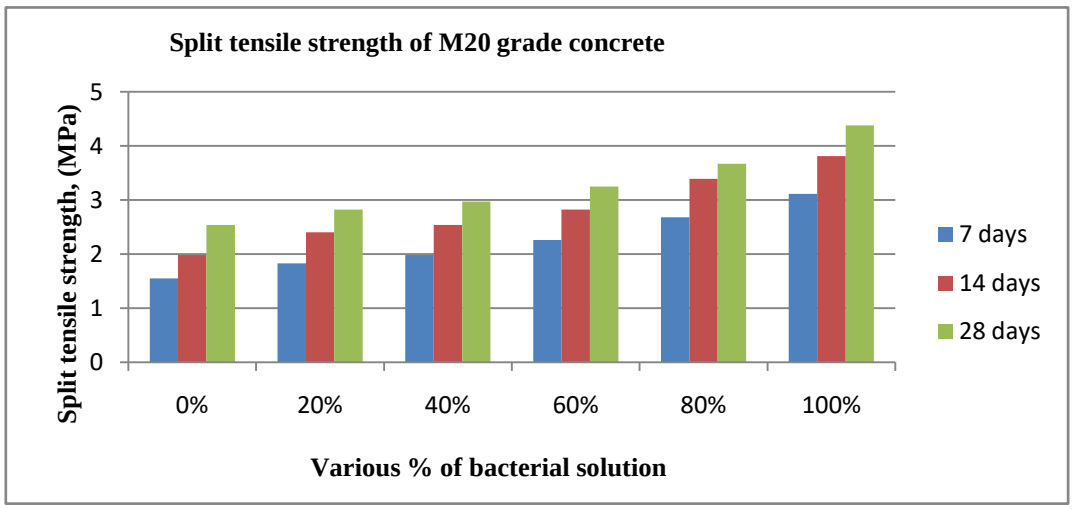

Fig.3 Split tensile strength of cylinders for M20 grade concrete.

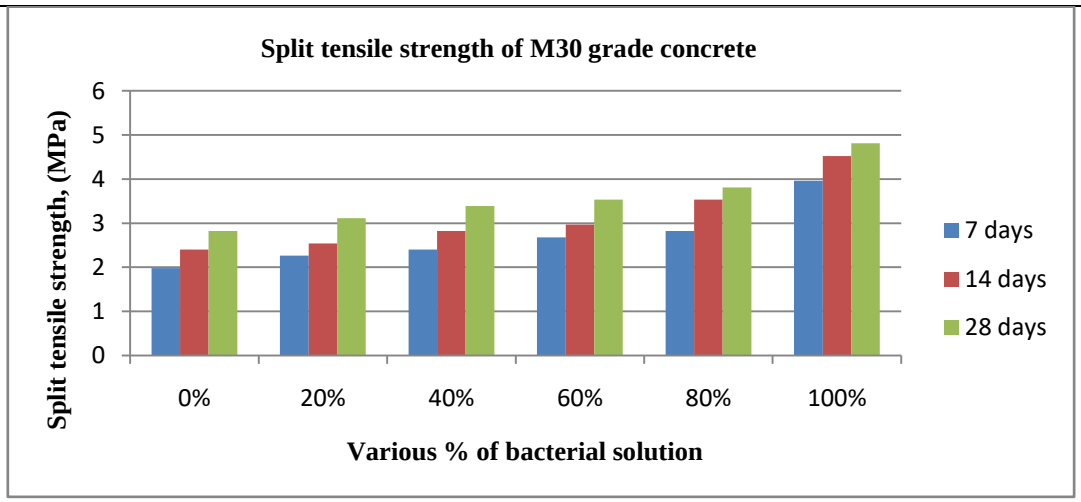

Fig.4 Split tensile strength of cylinders for M30 grade concrete.

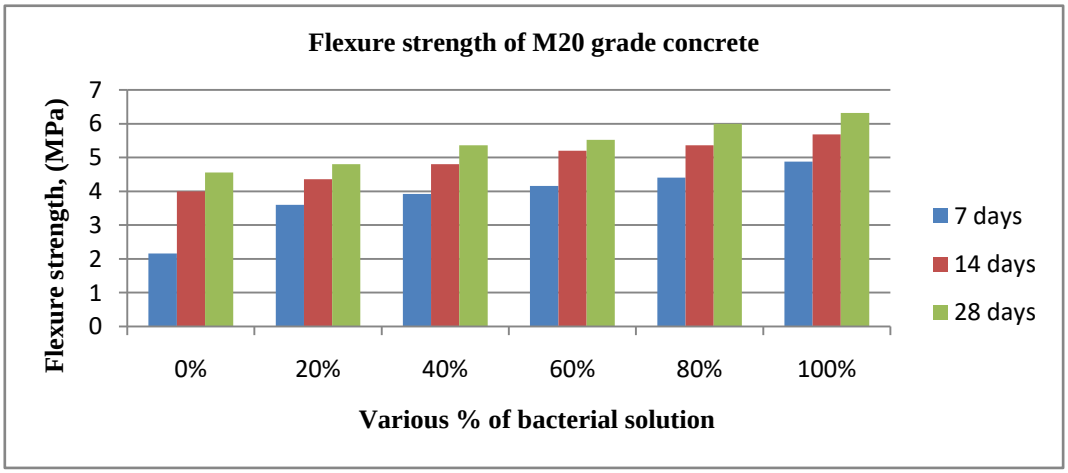

Fig.5 Flexure strength of prisms for M20 grade concrete

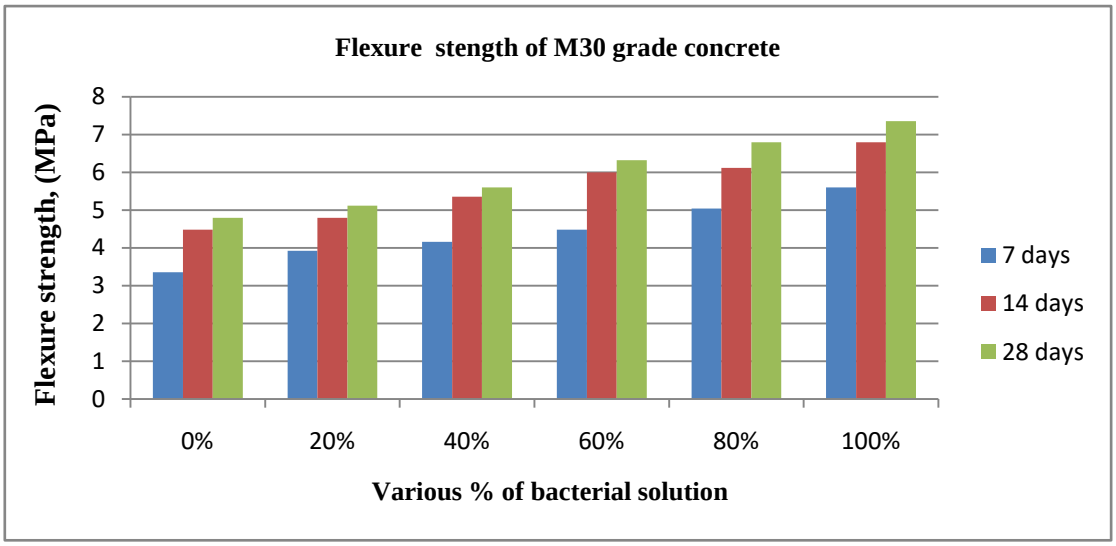

Fig.6 Flexure strength of prisms for M30 grade concrete.

CONCLUSION

The following conclusions are drawn based on the experimental study on Bacterial concrete:

- In bacterial concrete it has been found that the use of bacteria can enhance the strength aspects of concrete. It has been found that the maximum increase in the compressive, flexure, split tensile strength is achieved by the addition of Bacillus Sphaericus, Proteus vulgarious than the conventional concrete after the 28 days curing time period.The life of bacterial concrete is more than conventional concrete.
- In this project, bacterial solution used in the concrete is replaced with 0%, 20%, 40%, 60%, 80%, 100%.
- From the above replacements, the strength of concrete increases at 100% in compression, split tensile, flexural strength tests for M20 and M30 grade concrete.
- The strength of concrete decreases at 0% in compression, split tensile, flexural strength tests for M20 and M30 grade concrete.
- The test results of compressive strength test, split tensile strength test, flexure strength test of bacterial concrete is higher than conventional concrete and M30 grade concrete results are higher than M20 grade concrete.

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