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Comparative Analysis of Conventional and self healing concrete

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ABSTRACT:

Due to the low durability, weak strength, and other characteristics of concrete buildings exposed to the environment, the service life of the structure has decreased in the modern construction industry. The bio- mineralization of calcium carbonate with the help of bacteria like Bacillus is a unique method for repairing or treating cracks that have developed in the structures. This study provides details on By adding bacterial cells and other nutrients needed for the process of biocalcification, which is where microorganisms secrete calcium precipitate, which when combined with carbonate ions forms calcium carbonate (calcite) layer and self-heals cracks, the durability of the concrete structure is increased. As a result, the concrete structure will be more durable, and a study using bacterially exposed concrete cubes has to be done.

Keywords :- Calcium Carbonate, Bacillus Pasteurii, Compressive Strength, and Water Absorption etc.

INTRODUCTION

The most common building material is concrete. Its benefit is that it can be easily moulded into any desired shape. It is a synthetic stone made by combining aggregates, cement, and water, then letting the mixture to cure and solidify. Cement and water, which react chemically to create another substance with usable strength, are its two primary components. The calibre of the ingredients, their proportional amounts, and the methods of mixing, compacting, and curing all affect how strong the concrete is. By properly changing the quantities of cement, aggregate, and water, it is possible to manufacture concrete that meets a variety of criteria for diverse applications.

The serviceability of the structures must be legal and legitimate. Minor structural cracks that might eventually lead to the structure deteriorating should be prevented in order to maintain its serviceability. There is no need to do any repairs because the structure's flaws may be repaired or sealed. The procedure of self-healing cracks can be used to allow the cracks to close on their own, avoiding the need for repair and rehabilitation.

MECHANISM OF SELF HEALING BACTERIAL CONCRETE

Self-healing concrete is produced by a biological reaction between unrelated limestone and a calcium-based nutrient with the assistance of bacteria to repair building cracks. Along with the calcium nutrient calcium lactate, specific bacteria known as Bacillus are used. When mixing is complete during the production of concrete, these materials are added to the wet concrete. The latent stage of this bacterium can last for almost 200 years. Water pours into the concrete fractures as soon as they develop. The bacteria's spores start to grow and begin to feed on the calcium lactate, which consumes oxygen. Limestone is created from the soluble calcium lactate. The insoluble limestone starts to become more solid. therefore naturally filling the fracture without additional assistance aide.

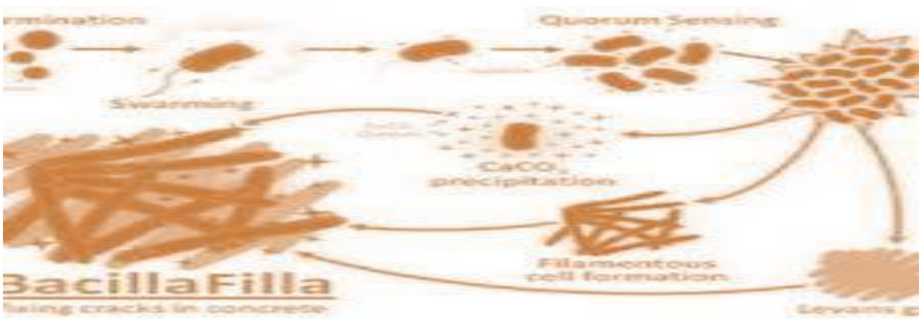

Figure 1 Process of self healing bacterial concrete

PREPARATION OF BACTERIAL CONCRETE

In the direct application approach, calcium lactate and bacterial spores are introduced directly to the concrete after mixing. The typical characteristics of concrete remain unchanged when this bacterium and calcium lactate are used. when a building has fractures for clear causes. Climate changes are exposed to the bacterium. This bacteria grows and feeds on calcium lactate to make limestone when it comes into touch with water. therefore filling in the gaps. Byusing the encapsulation method, clay pellets are treated, and then concrete is made with the bacterium and its food, calcium lactate. Clay pellets are added in the amount of 6% to create bacterial concrete. When bacterial concrete is used to create concrete structures, when cracks appear in the structure and clay pellets break, the bacteria grow, consume the calcium lactate, and generate limestone, which hardens and seals the crack. 0.5mm wide minor fractures can be repaired using bacterial concrete.

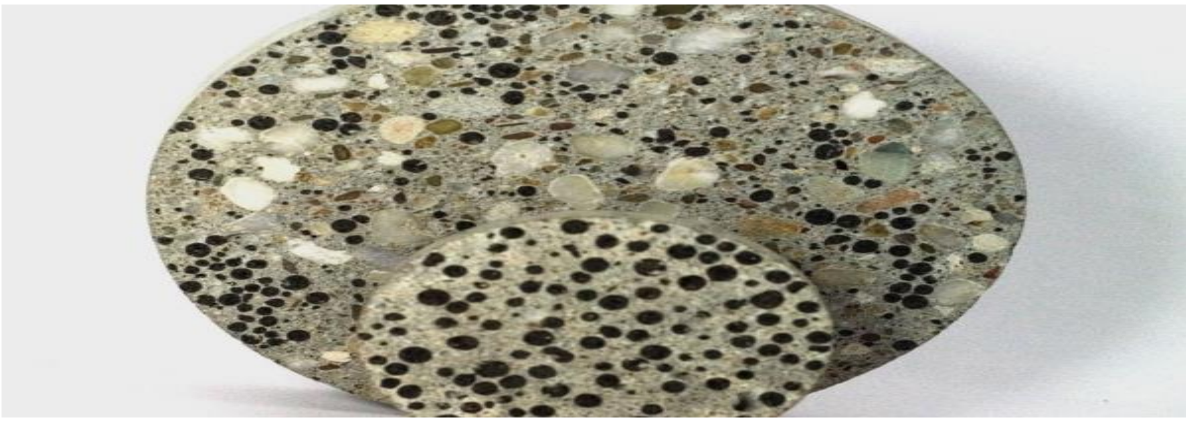

Figure 2 self healing Bacterial concrete

MODELLING

1. Material

Materials employed in this study include calcium lactate, Bacillus Pasteurii bacteria, river sand, coarse aggregate with a nominal size of 25 mm, and regular Portland cement of grade 43.

2. Specimen preparation

For the creation of specimens, concrete mix proportions of 1:2:4 are employed. Standard specimens were cast. Parallel casting is also done for bacterial specimens in which 18%, 28%, and 38% of the water is replaced by a bacterial solution. The samples were evaluated after 7, 14, and 28 days of curing in room temperature tap water.

3. Concrete tests

Compressive Strength Test- At 7, 14, and 28 days old, the 150mm x 150mm x 150mm cube-shaped cast specimensunderwent tests to ascertain their compressive strength.

Water Absorption Test- To estimate the water absorption % at the age of 28 days, 150mm x 150mm x 150mm cubesof various sizes were examined.

RESULT AND DISCUSSION

There was discussion and tabulation of the different data from the compressive strength test and the water absorption tests. The test findings' charts were also made available. The findings of the compressive strength of the conventional concrete cubes are shown in table 1, while those of the bacterial concrete cubes with 18%, 28%, and 38% of bacterial solution are shown in tables 2, 3, and 4, respectively. The findings of the water absorptionof both the conventional concrete and the bacterial concrete are shown in table 6. Tables 5 and 7 show the comparisons between the compressive strength and water absorption of bacterial and ordinary concrete cubes, respectively.

A. Compressive strength comparison

Here the comparison of Compressive strength results for Conventional Concrete Cubes for 7, 14 and 28 days is discussed. The Compressive strength values are shown below.

Table 1 Compressive strength comparison for Conventional Concrete Cubes

S. NO.	Compressive Strength N/mm^2		
	7 days	14 days	28 days
1	14.02	20.19	22.66
2	12.35	17.85	20.05
3	11.52	17.05	19.20

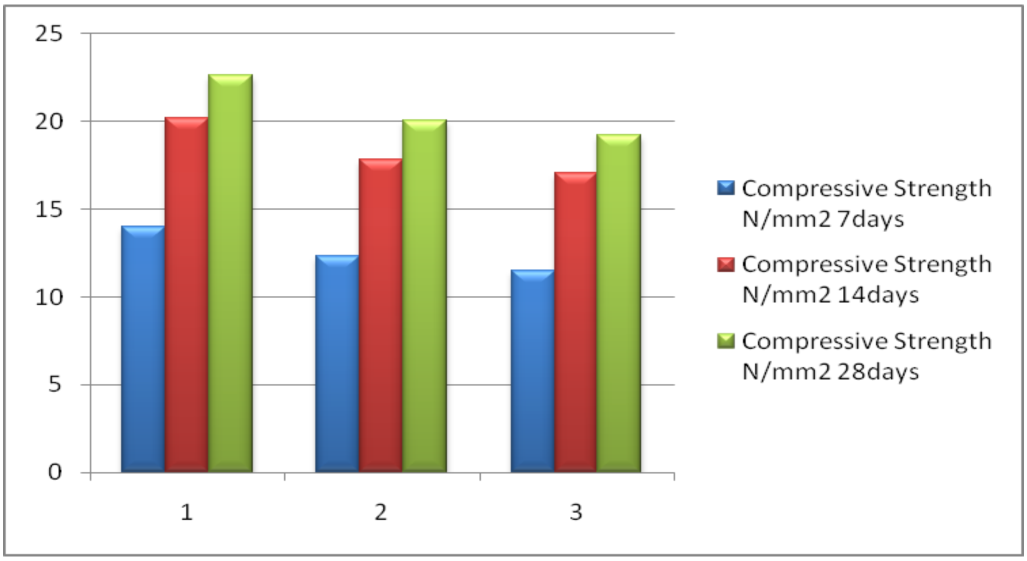

Figure 3 Compressive strength comparison for Conventional Concrete Cubes

Table 2 Compressive strength comparison for Bacterial Concrete cubes with 18% of bacteria

Sample	Compressive Strength N/mm^2		
	7days	14days	28days
1	12.59	18.21	20.45
2	13.08	18.88	21.21
3	11.38	16.53	20.74

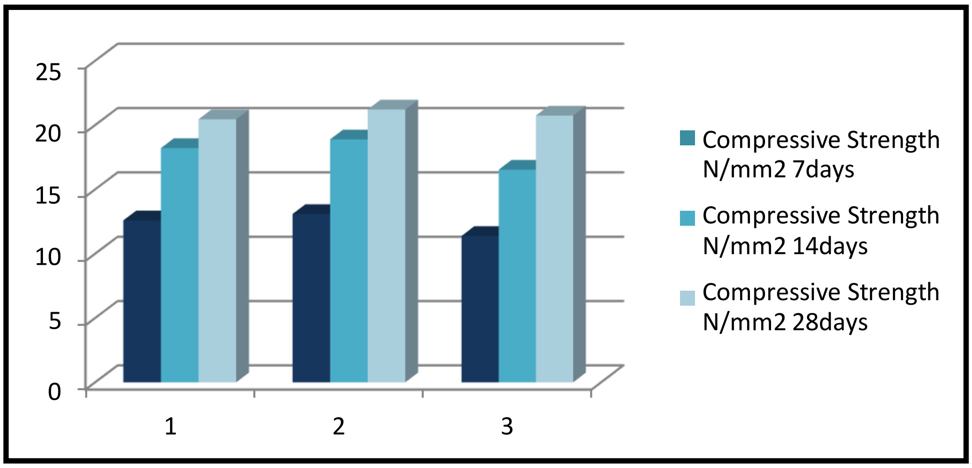

Figure 4 Compressive strength comparison for Bacterial Concrete cubes with 18% of bacteria

Table 3 Compressive strength comparison for Bacterial Concrete cubes with 28% of bacteria

sample	Compressive Strength N/mm^2		
	7days	14days	28days
1	12.41	17.25	19.32
2	13.21	19.23	22.47
3	12.58	17.52	20.13

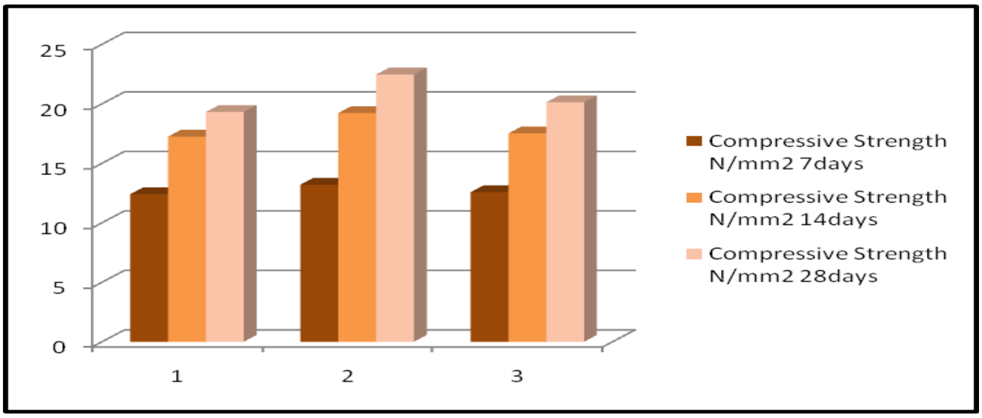

Figure 5 Compressive strength comparison for Bacterial Concrete cubes with 28% of bacteria

Table 4 Compressive strength comparison for Bacterial Concrete cubes with 38% of bacteria

sample	Compressive Strength N/mm^2		
	7days	14days	28days
1	11.21	16.89	20.14
2	12.12	17.45	20.48
3	13.25	19.27	21.02

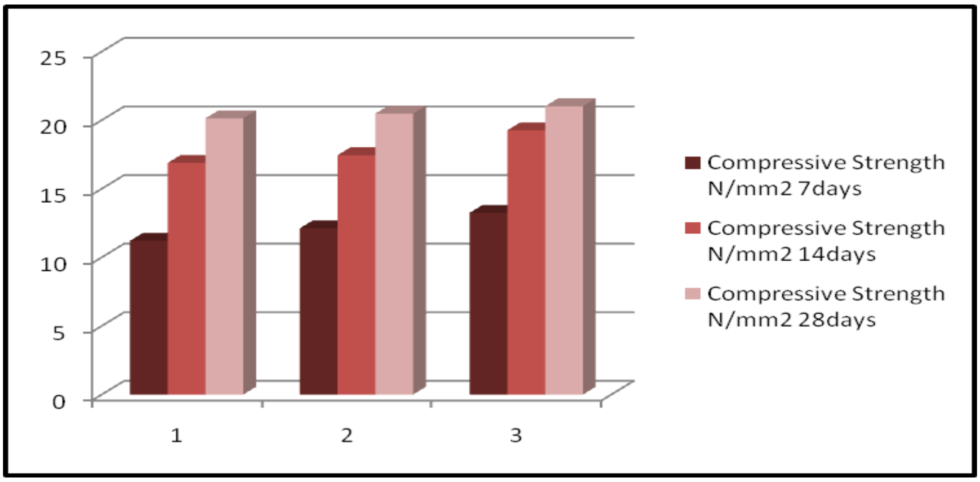

Figure 6 Compressive strength comparison for Bacterial Concrete cubes with 38% of bacteria

Table 5 Compressive Strength results Comparison

Sample	**Average Compressive StrengthN/mm²**			
	Conventional concrete	**Bacterial concrete**		
		18%	**28%**	**38%**
1	**20.63**	**20.80**	**20.77**	**20.69**

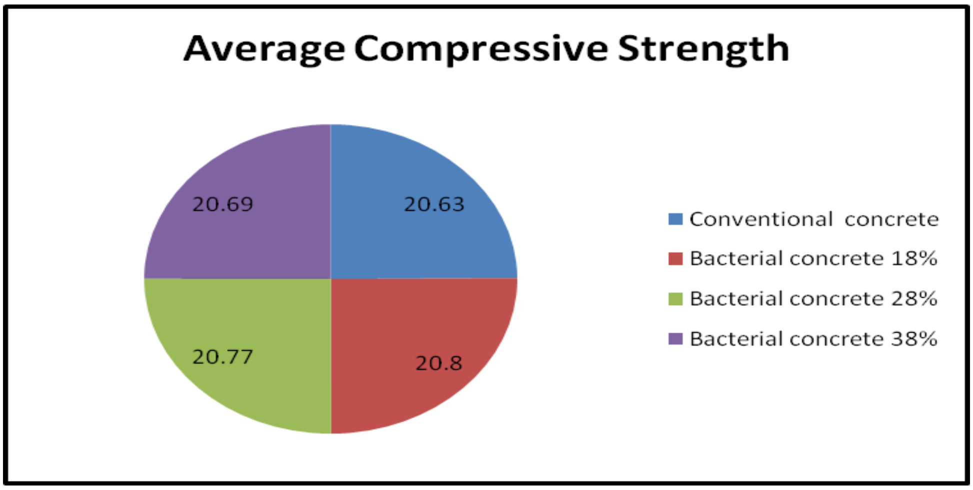

Figure 7 Compressive Strength results Comparison

A. Water absorption comparison

Here the comparison of Water absorption results for Conventional Concrete Cubes and for Bacterial Concrete cubesis discussed. The Water absorption values are shown below.

Table 6 Water absorption values of concrete cubes

Sample	**Water Absorption in %**			
	ConventionalConcrete	**Bacterial concrete**		
		18%	**28%**	**38%**
1	**2.16**	**1.12**	**0.79**	**1.06**
2	**2.19**	**0.65**	**0.77**	**1.18**
3	**2.13**	**1.28**	**1.01**	**0.99**

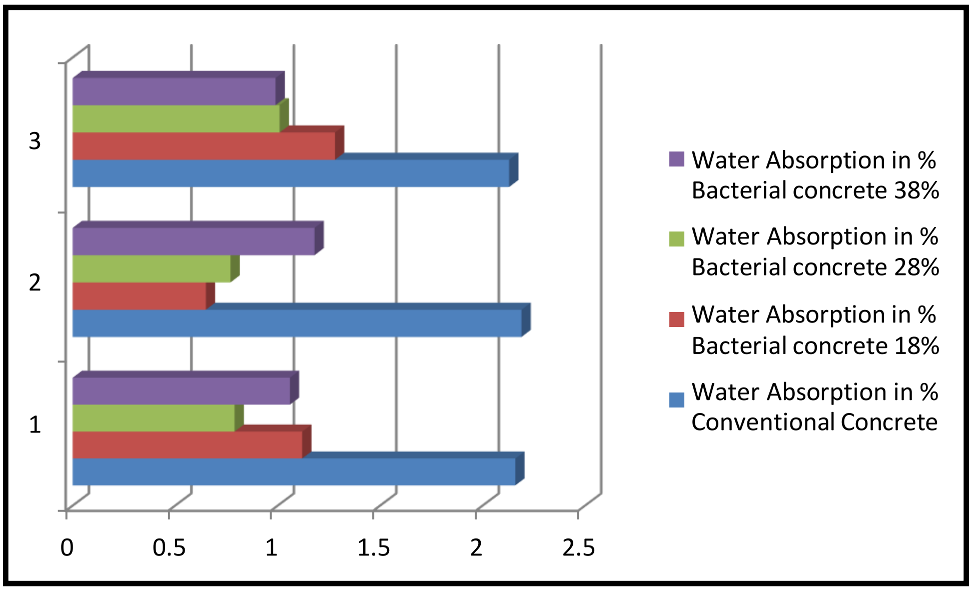

Figure 8 Water absorption values of concrete cubes

Table 7 Water absorption results Comparison

S.No	Average Water Absorption in %			
	Conventional concrete	Bacterial concrete		
		18%	28%	38%
1	2.17	1.18	1.00	1.14

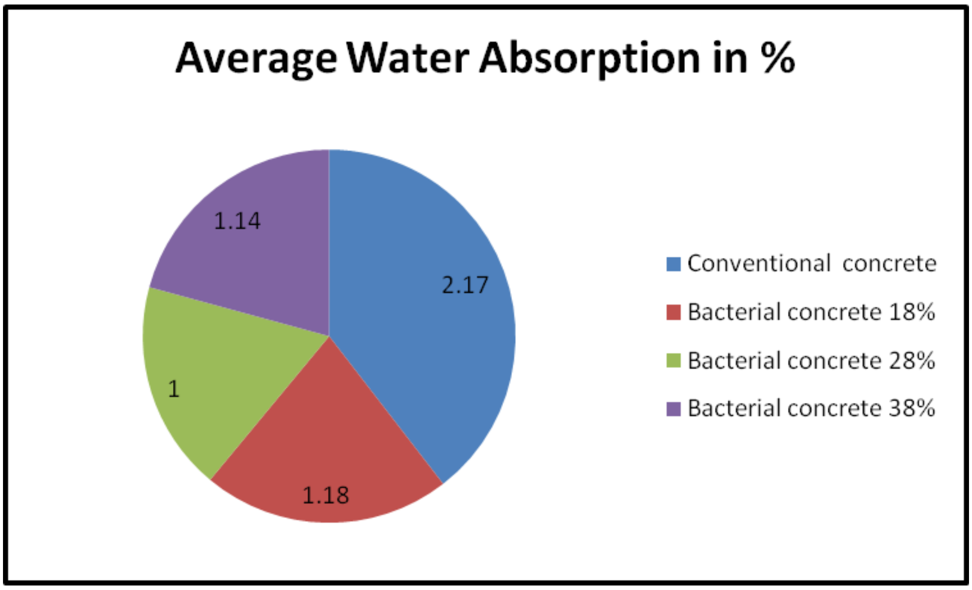

Figure 9 Water absorption results Comparison

CONCLUSION

The debate leads to the conclusion that, due to its numerous unique properties, Sporosarcina Pasteurii may be used as the best alternative in concrete for microbially induced calcite precipitation. The method of self-healing by introducing bacteria into the concrete has the larger advantage of reducing the need for human inspection and repair, saving time and money, and also enhancing the durability of the building. The constructions' slight flaws may be repaired, and it was discovered that the concrete's compressive strength is equivalent to that of regular concrete. The durability of the bacteria-infused concrete will be higher since it absorbs less water. As only 18%, 28%, and 38% of bacterial solutions were employed in this study, more research must be done to ascertain the restriction on percentage replacement of bacterial solution. The study showed that diverse healing agents have benefits and even drawbacks, thus additional research must be conducted as a follow-up study.

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