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RESEARCH ARTICLE

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DURABILITY STUDIES OF M20 GRADE BACTERIAL CONCRETE

SHAIK NASREEN[1], Dr.T.SURESH BABU[2]

[1]Student, M.Tech, Department of Civil Engineering, Visvodaya, College of Engineering, Kavali

[2]Professor, Head of Department of Civil Engineering, Visvodaya, College of Engineering, Kavali

SHAIK NASREEN

ABSTRACT

Cracks in concrete are inevitable and are one of the inherent weaknesses of concrete. Water and other salts seep through these cracks, corrosion initiates, and thus reduces the life of concrete. Concrete structures usually show some self-healing capacity, i.e. the ability to heal or seal freshly formed micro-cracks. This property is mainly due to the presence of non-hydrated excess cement particles in the materials matrix, which undergo delayed or secondary hydration upon reaction with water. Scientists have developed a new type of self-healing concrete in which bacteria mediate the production of minerals which rapidly seal freshly formed cracks, a process that concomitantly decreases concrete permeability, and thus better protects embedded steel reinforcement from corrosion. Bacterial concrete is a material, which can successfully remediate cracks in concrete. This technique is highly desirable because the mineral precipitation induced as a result of microbial activities is pollution free and natural. As the cell wall of bacteria is negatively charged, metal accumulation (calcite) on the surface of the wall is substantial, thus the entire cell becomes crystalline and they eventually plug the pores and cracks in concrete. It was found that use of bacteria improves the stiffness and compressive strength of concrete.

KEY WORDS: Bacterial concrete, Self-Healing Capacity, Crack Formation, Durability, compressive strength

1.INTRODUCTION

1.1GENERAL

Concrete is one of the most widely used construction materials in the world today. It is made by mixing small pieces of natural stone (called aggregate) together with a mortar of sand, water, Portland cement and possibly other cementations materials. Properly designed and constructed, concrete structures compare favorably with regard to economy, durability and functionality with structures made from other structural materials, such as steel and timber. It is the second most widely consumed substance on earth, after water. Micro cracks are the main cause to structural failure. One way to circumvent costly manual maintenance and repair is to incorporate an autonomous self-healing mechanism in concrete.

1.2 ABOUT BACTERIA (PSEUDONOMAS AEROGINOSA)

Pseudomonas aeruginosa is a common bacterium found in soil like peat and humus. such bacteria can sometimes cause diseases when touched direct to human skin. such bacteria can be used in concrete in some concentrations to increase compressive strength and remediating cracks in concrete.it has to be used with proper care only. Very less concentration of it shall be added to water, diluting it properly with high concentration of water and thus mixed to cement under certain design mixes.

2 Methodology :

1.12 flexural beams or prisms were cast ,out of which 3 are of conventional concrete,3 of 5ml bacterial concrete,3 of 10ml bacterial concrete, 3 of 15ml bacterial concrete. All were casted and removed from casts after 24 hours and then submerged in water tanks containing 2 % of HCl for 14 days.

2. 12 flexural beams or prisms were cast ,out of which 3 are of conventional concrete,3 of 5ml bacterial concrete,3 of 10ml bacterial concrete, 3 of 15ml bacterial concrete. All were casted and removed from casts after 24 hours and then submerged in water tanks containing NAOH(BASE) for 14 days.

3.Finally, durability tests were conducted for 14days flexural beams ,in acid and base ,and values were taken.

3.MIX DESIGN OF CONCRETE :

Cement: Fine aggregates : coarse aggregates : water

290: 696: 1429 : 145

1: 2.4 : 4.93 : 0.5

3.1 5ML BACTERIAL MIX:

5ml of bacteria (Pseudomonas aeruginosa) was added to every 500 ml of water while mixing concrete, so a total of 65ml of bacteria was added to 6.5 litres of water used for mixing cement of 14kgs.

3.2. 10 ML BACTERIAL MIX:

10ML of bacteria (Pseudomonas aeruginosa) was added to every 500 ml of water while mixing concrete, so a total of 126ml of bacteria was added to 6.5 litres of water used for mixing cement of 14kgs.

3.3 15ML BACTERIAL MIX:

15ML of bacteria (Pseudomonas aeruginosa) was added to every 500 ml of water while mixing concrete, so a total of 195ml of bacteria was added to 6.5 liters of water used for mixing cement of 14kgs.

4.EXPERIMENTAL RESULTS:

4. 1 WORKABILITY TEST RESULTS:

- CONVENTIONAL CONCRETE:
  compaction factor =0.88
  vee-bee value= 8 sec
  slump loss=5mm
- 5ML BACTERIAL COCNCRETE:
  compaction factor =0.89
  vee-bee value= 4 sec
  slump loss=13mm
- 10ML BACTERIAL COCNCRETE:
  compaction factor =0.94
  vee-bee value= 4 sec
  slump loss=15mm
- 15ML BACTERIAL COCNCRETE:
  compaction factor =0.95
  vee-bee value= 3 sec
  slump loss=17mm

4.2 FINAL TEST RESULTS:

4.2.1 DURABILITY TESTS:

4.2.1.1 COMPRESSIVE STRENGTH: 8.4.2 COMPRESSIVE STRENGTH

Table 4.2.1.1 compressive strength of concrete immersed 28days in HCl Acidic Solution

Type of Concrete	Mix Designation	ml of bacterial Addition in water	Average compressive Strength of 3 cubes(Mpa) @ 28days
Conventional Concrete	T0	0	24
Bacterial Concrete	T1	5	22.2
Bacterial Concrete	T2	10	22.1
Bacterial Concrete	T3	15	20.1

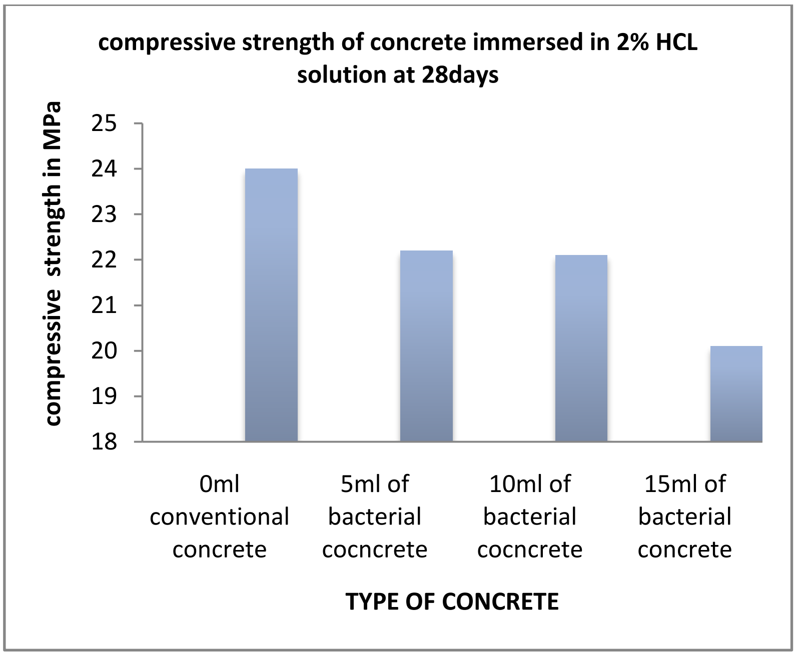

Fig 4.2.1.1 Showing Comparison of Compressive strengths of Conventional concrete & bacterial concrete immersed 28 days in 2% HCl solution.

Table 4.2.1.2 Compressive strength of concrete immersed 28days in NaOH Solution

Type of Concrete	Mix Designation	ml of bacterial Addition in water	Average compressive Strength of 3 cubes(Mpa) @ 28days
Conventional Concrete	T0	0	25
Bacterial Concrete	T1	5	24
Bacterial Concrete	T2	10	20
Bacterial Concrete	T3	15	20

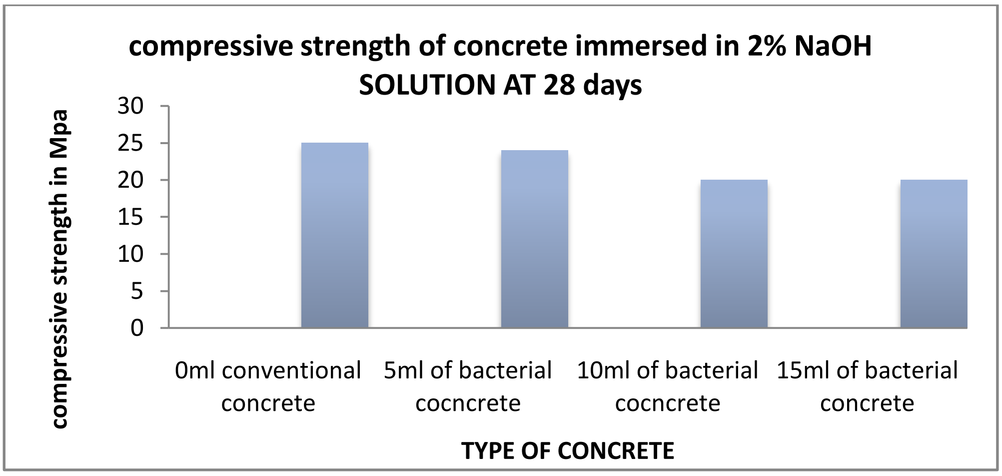

Fig 4.2.1.2 Showing Comparison of Compressive strengths of Conventional concrete & bacterial concrete immersed 28 days in 2% NaOH solution

Table 4.2.1.3 comparison of compressive Strength of Concrete immersed in NaOH and HCl solutions

Type of Concrete	Mix Designation	ml of bacterial Addition in water	Average compressive Strength of 3 cubes(Mpa)	
			28days (HCL)	28days (NaOH)
Conventional Concrete	T0	0	24	25
Bacterial Concrete	T1	5	22.2	24
Bacterial Concrete	T2	10	22.1	20
Bacterial Concrete	T3	15	20.1	20

4.2.2 FORMATION OF A CRACK AND TEST RESULTS TAKEN FOR 14DAYS IN A CUBE WITH AND WITHOUT BACTERIA:

Fig (a): conventional cocncrete cube still with cracks after curing for 14days

- A crack of 10mm was formed in between the 15ml bacterial cube and cured in water for 14days and rechecked, it was found that the crack filled up healing approximately upto 5mm.This shows the crack healing capacity due to calcite release by bacterial cells which act as a property to cover up the crack and this calcite possesses cementitious properties.

5.DISCUSSION OF TEST RESULTS:

1. With the addition of 5ml,10ml,15ml bacteria into concrete, the average compressive strength decreased by 7.5%,7.9%,16.25% in HCL respectively at 28 Days

2. With the addition of 5ml,10ml,15ml bacteria into concrete, the average compressive strength decreased by 4%,20%,20% in NaOH respectively at 28 Days

3. The above mentioned reduction in strength may be due to the interaction of bacteria with concrete forming a precipitate which furthers helps in providing a bond between cement molecules.

6.CONCLUSION

From the tests conducted on bacterial and Conventional Concrete Specimens, the following conclusion have been drawn

- The above addition in strength is because of adding bacterial liquid to concrete, which generates calcite precipitate in concrete matrix.
- Therefore, due to addition of small amount, there was seen lesser decrease in durability of bacterial concrete to the conventional concrete, and a great addition of 15ml caused drastic decrease in compressive strength of bacterial concrete. This is mainly due to production of calcite precipitate in concrete(hardened0 when it is cured properly with water, thus the calcite acts as a cement agent and recovers the whole cracked area to the inner side of concrete surface.
- These bacterial concrete is a self-healing concrete which heals cracks for effective duration of initial 5 hours upto as long as possible and the bacterial cell life is 200years.
- These bacterial usage can save the cement and the construction of a building can be made economical ,as we know cement production

gives rise to production of carbon dioxide to the higher levels, so further controlling is made very effective.

- These bacterial concrete usage can be made common in next few decades heading towards victory of civil engineering structures as per the scientific view of highly authorized laboratories .

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