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Characteristic Study On Self-Healing Concrete Using Calcium Lactate And Silica Fumes

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Abstract - *In this paper, an overview is given of new developments obtained on self healing on cracks in cement based materials. In this project of bacterial concrete, in which bacteria are mixed in concrete, that can precipitate calcite in cracks and with that make concrete structures water tight and enhances durability. The agents consists of bacteria and organic mineral precursor compound. Whenever cracks occurs and water is present, the bacteria become active and convert the incorporate organic compounds into calcium carbonate, which precipitates and is able to seal and block the cracks. This project aims to review the development of bacteria based self healing concrete, introducing the proposed healing system. These results were observed and studied. With this study, an attempt was made to produce Bio concrete. Thus in a nut shell the project shows the development of bio concrete and to how this new technology must have come into existence.*

***Key Words*: Bio Concrete, Calcium Lactate, Silica Fumes, Concrete, Compressive Strength, Split Tensile Strength, Flexural Strength.**

1.INTRODUCTION

Concrete is the most widely used man made construction material in civil engineering. Therefore both strength and durability have to be considered at the design stage in construction especially to produce a more durable structure. Some of major forms of environmental attack are chloride and sulphate attack that would lead to corrosion of reinforced steel and subsequent reduction in strength, serviceability and aesthetics of the structure. This scenario may lead to early repair of the structure in order to prolong service life of concrete structure. Recent development, a stronger and more durable concrete has been invented incorporating a biological approach namely bacteria. This new approach is called a bio-concrete which utilizing bacteria mineral precipitation to increase the strength and durability of concrete. Furthermore, this crossbreed leads to more durable concrete and last longer. Therefore, the maintenance cost can be reduced. Microorganisms play an important role in promoting deterioration in porous materials, improve sand properties, repair of limestone monuments and sealing of concrete cracks to highly durable material and finally enhance the durability of building materials. Self-healing concrete could solve the problem of concrete structures deteriorating well before the end of their service life. The technique can be used to improve the compressive strength and stiffness of cracked concrete specimens. Research leading to microbial Calcium lactate precipitation and its ability to heal cracks of construction materials has led to many applications like crack remediation of concrete, sand consolidation, restoration of historical monuments and other suchapplications.so it can be define as "The process can occur inside or outside the microbial cell or even some distance away within the concrete. Often bacterial activities simply trigger a change in solution chemistry that leads to over saturation and mineral precipitation. Use of these Bio mineralogy concepts in concrete leads to potential invention of new material called — Bio- Concrete OR Self-Healing Concrete".

2. MATERIALS AND METHODS

2.1. Materials

2.1.1 Cement: OPC 43 grade confirming to Indian Standards is used in the present study and the test is conducted to determine specific gravity. The specific gravity of cement was found to be 3.15 by proper experimentation.

2.1.2 Fine aggregates: Locally available river sand passing through 4.75 mm sieve was used. The specific gravity was found as 2.4.

2.1.3 Coarse aggregates: Aggregates bigger than 12.5mm but passing through 20mm sieve was used. The specific gravity was found as 2.6.

2.1.4 Calcuim lactate: Calcium lactate is a medicine prevent low blood pressure and provide calcium in the diet. It also repairs weak bones and decrease the activity of parathyroid gland and a certain muscle disease. Same it also repairs the concrete and increase its efficiency.

2.1.5 Silica fumes: Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. Because of its chemical and physical properties, it is a very reactive pozzolana. Concrete containing silica fume can have very high strength and can be very durable.

2.1.6 Water: Fresh water available in the local sources was used for the mixing and curing.

Table -2.1: Significant properties of materials used

Materials	Specific gravity
Cement	3.12
Fine aggregates	2.4
Coarse aggregates	2.6
Calcium lactate density	1.494 g/cm^3

Table -2.2: properties of calcium lactate

Properties	
Molecular formula	$C_6H_{10}CaO_6$
Molar mass	218.22 g/mol
Appearance	white or off-white powder
Odor	slightly efflorescent
Density	1.494 g/cm^3
Melting point	240 °C (anhydrous) 120 °C (pentahydrate)
Solubility in water	7.9 g/100 mL (30 °C)
Solubility	very soluble in ethanol
Acidity (pK_a)	6.0-8.5
Refractive index (n_D)	1.470

2.2 Methods

2.2.1 Chemical reaction

Chemical reaction occurs and calcium lactate turns calcium carbonate.

$$2Ca(CHO_2)_2 + 2\,O_2 \longrightarrow 2\,CaCO_3 + 2\,CO_2 + 2\,H_2O$$

(Calcium Lactate) (Calcium Carbonate)

When cracks appears on surface of concrete calcium lactate reacts with oxygen present in atmosphere and fill the cracks with calcium carbonate and liberates a small amount of CO_2 and H_2O.

2.2.2 Mix design (M25)

materials	amount	proportion
cement	438.13 kg/m^3	1
Fine aggregate	694.17 kg/m^3	1.5
Coarse aggregate	962.53 kg/m^3	2.2
water	208.42 lit.	0.5

3. EXPERIMENTAL PROGRAM

3.1 Specimen

These experiments consisted of casting and testing of specimens of cubes (150X150X150mm), cylinders (150 X 300 mm) and beams of size 100 X 100 X 500 mm.

3.2 Compressive strength

Three numbers of cubes were cast for each mix and tested using 200T capacity Compression Testing Machine (CTM).

3.3 Split Tensile strength

Three numbers of cylinders were cast and tested using 200T capacity Compression Testing Machine (CTM).

3.4 Flexural strength

Three numbers of beams were cast and tested using 200T capacity Universal Testing Machine (UTM).

4. RESULTS AND DISCUSSIONS

4.1 Compressive strength: The compressive strength was determined after normal 28 days. The results are presented in Table 4.1

Table- 4.1 compressive strength of Bio concrete

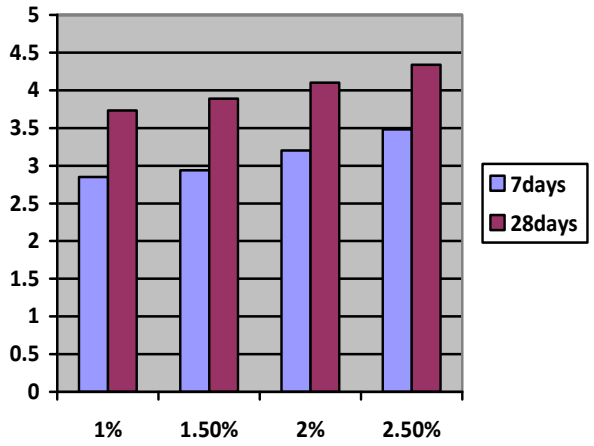
% Conc.	7 days (N/mm²)		28 days (N/mm²)	
1%	27.91	27.15	34.17	35.06
	27.11		33.86	
	26.11		37.15	
1.5%	31.02	30.85	36.66	37.27
	29.37		39.81	
	32.17		35.33	
2%	34.17	35.06	44.26	43.9
	33.86		42.48	
	37.15		44.96	
2.5%	34.76	35.90	44.56	43.75
	35.01		44.26	
	37.93		42.48	

4.2 Split Tensile strength: The split tensile strength was determined after normal curing for 7 days and 28 days. The results are presented in Table 4.2.

Table- 4.2 Split tensile strength of Bio concrete

% Conc.	7 days (N/mm²)	28 days (N/mm²)
1%	2.85	3.73
1.5%	2.94	3.89
2%	3.20	4.12
2.5%	3.48	4.34

Chart-4.1 Split Tensile Strength

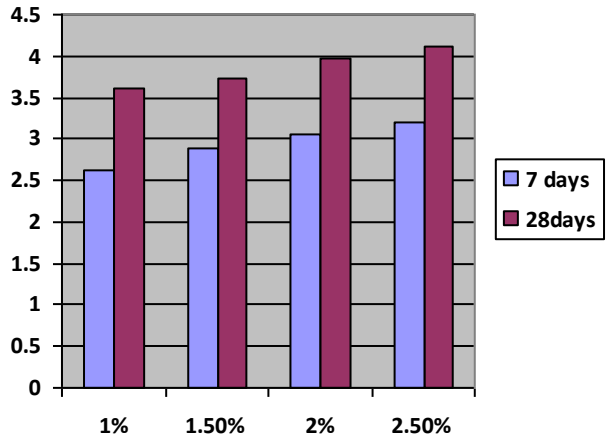


4.3 Flexural strength: The Flexural strength was determined after normal curing for 7 days and 28 days. The results are presented in Table 4.3. & chart 4.2.

Table- 4.3 Flexural strength of Bio concrete

% Conc.	7 days (N/mm²)	28 days (N/mm²)
1%	2.63	3.60
1.5%	2.89	3.72
2%	3.05	3.98
2.5%	3.20	4.12

Chart-4.2 Flexural Strength



5. CONCLUSION

1. The development of a new type of chemical-based self-healing concrete appears promising.
2. In this project we have shown the proof-of-principle, i.e. those concrete-incorporated using chemical and bacteria can produce copious amounts of minerals which can potentially seal freshly formed cracks.
3. The crack-sealing capacity and concomitant reduced material permeability will be quantified in our on-going research project.
4. We have concluded that bio concrete repairs surface micro cracks only and prevent disintegration of concrete.

REFERENCES:

[1] Edvardsen C. (1999). Water permeability and autogenous healing of cracks in concrete. ACI Materials Journal 96(4): 448–454.

[2] Hans-Wolf Reinhardt, Martin Jooss (2002). Permeability and self-healing of cracked concrete as a function of temperature and crack width.

[3] Henk M Jonkers, Erik Schlangen (2017). Bio-based self-healing mortar: An experimental and numerical Study. Journal of Advanced Concrete Technology, volume 1 5, pp. 536-543

[4] Jagadeesha Kumar B G (2013). Effect of Bacterial Calcite Precipitation on Compressive Strength of Mortar Cube. International Journal of Engineering and Advanced Technology (IJEAT), ISSN: 2249 – 8958, Volume-2, Issue-3, pp 486-491.

[5] Likhit M L, Kishan N, Pooja M, Sanath B, Ujwal Pinto R(2018). International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE) Vol 3. Issue 6.

[6] Manikandan A.T, Padmavathi V. (2015). An Experimental Investigation on Improvement of Concrete Serviceability by using Bacterial Mineral Precipitation. Volume II, Issue III, March 2015

[7] Meera C. M., Dr. Subha V (2016). Strength and Durability assessment Of Bacteria Based Self-Healing Concrete. IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE).

[8] Dr. Siddiraju S. and N.Ganesh Babu (2016). An Experimental Study on Strength And Fracture Properties Of Self-Healing Concrete. International Journal Of Civil Engineering And Technology (Ijciet) Volume 7, Issue 3, May–June 2016, Pp. 398–406, Article Id: Ijciet_07_03_041.

[9] Shetty M.S. Concrete Technology (Revised Edition).