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Effect of Alccofine on Engineering and Durability Properties of Bacterial Concrete

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Abstract:-

Concrete is cheap and easily available construction material in the world. So advancement in the concrete is to improve its compressive strength and durability of structures by using micro organisms carrying process of MICP. This project discusses the filling of voids in fresh concrete and plugging of artificially cracked cement mortar using Bacillus Sphaericus and Proteus Vulgarious bacteria combined with sand as a filling material in artificially made cuts in cement mortar which was cured in urea and $CaCl_2$ medium. The effect on the compressive strength, flexural strength due to the mixing of bacteria along with effect of water absorption and sorptivity on concrete cubes is also discussed in this project. The main aim of the project is to evaluate the strength in comparison with conventional and bio concrete cubes. The evaluated results suggest that there is significant increase in the strength of concrete.

Key words:- *: Microbiologically Induced Calcite Precipitation Bacterial Self Healing ,Bacillus pasteurii.*

1. Introduction

Bio concrete is the science of precipitation of minerals by living organisms. Bacteria have a remarkable ability to precipitate Calcite, Carbonate, Phosphate, Oxides, sulphite. In bio concrete bacterial species like, B.Sparicus Proteus Vulgarious etc. deposit calcium carbonate by their bacterial activity in this system. This result decreases in water absorption and permeability. Presence of layer of Calcium precipitation improves its strength and durability. New Researches and studies introduced Bio-concrete. In this the bacteria is already introduced in the concrete during casting process. It helps in reduction in the pores in concrete and hence reducing the chances of formation of cracks. This method is very useful in new constructions. Bacterially induced calcium carbonate precipitation has been proposed as an alternative and environmental friendly crack repair technique. In this process the bacteria species is maintained at an alkaline environment and ph value about 10. Along with the precursor compound the bacteria is filled in the cracks with an additive filler viz. clay or sand. After a period of time the bacteria precipitates calcite and hence heals the crack thus increasing the compressive strength and reducing the permeability of concrete. This method is very useful for already existing cracks.

1.1. Objective of the Study

i. To introduce bacteria in fresh concrete as a bioconcrete.
ii. To introduce bacteria in hardened concrete as a self healing agents .
iii. To check the effects of Alccofine on engineering properties of self healing concrete.
iv. To check the effects of Alccofine on durability properties of Bacterial concrete.
v. To check the self healing bacterial concrete in terms of compression test, RCPT, alkaline attack test, sorptivity test.

1.2. Scope of the Study

Bacterial concrete, as the name suggest is an improvisation provided to cement using living microbes which are capable of doing so. Using microbes such as Bacillus and some compound which has properties of bio calcification can secrete calcium carbonate as an extracellular product thus filling the pores and the cracks internally making the structure

more compact and resistive to seepage. As the texture becomes more compact the compressive strength is also considerably increased. Thus, this process can reduce the seepage permanently.

2. Experimental details

i. Cement

ISI marked OPC 53 cement used in this study Ordinary Portland cement that satisfies the requirements of Indian standards IS 12269:1987.

ii. Coarse Aggregate

The coarse aggregates obtained from the locally available quarries with maximum size of 20 mm and satisfying the grading requirements of BIS (IS: 383-1970) is use during this work.

iii. Fine Aggregate

The Size of aggregate 4.75 mm and smaller is called fine aggregate.IS:383-1970 has divided the fine aggregate in to four grading zones. The grading zones become progressively finer from grading zone I to grading zone IV. Zone III used during this work.

iv. Water

Portable drinking water having pH value of 7 and conforming to IS 456-2000 IS used for concreting as well as curing of specimens.

v. Alccofine

Alccofine 1203 is proprietary low calcium silicate based mineral additive. Controlled granulation process results in unique particle size distribution. Its latent hydraulic property and pozzolanic reactivity results in enhanced hydration process. Addition of Alccofine 1203 improves the packing density of paste component. This results in lowering water demand, admixture dosage and hence improving strength and durability parameters of concrete at all ages.

3. Mix Design of M-40 Concrete

Table 1: Mix design

Proportion	Water	Cement	Fine aggregate	Coarse aggregate
By weight (kg/m^3)	157.6	415	771.9	1157.8
Weight	0.40	1	1.86	2.78

4. Results and Discussion

4.1. Compressive Strength Test Results.

Table 2: Result of Compressive Strength for Replacement of Cement with Alccofine

Type of Concrete	7 Days		28 Days	
	Compressive Strength N/mm^2	Average Compressive Strength N/mm^2	Compressive Strength N/mm^2	Average Compressive Strength N/mm^2
Conventional Concrete(M_{40})	29.01	29.07	38.45	40.12
	30.45		40.69	
	27.77		41.23	
bacterial concrete	25.06	26.09	39.16	39.78
	27.01		38.93	
	26.20		41.25	
bacterial concrete with 4%, Alccofine	29.29	29.26	42.03	42.03
	29.57		40.96	
	28.93		43.10	
bacterial concrete with 6% Alccofine	34.04	33.52	45.86	44.56
	33.12		43.69	
	33.40		44.13	

bacterial concrete with 8%, Alccofine	35.12	34.80	48.07	47.71
	34.48		45.98	
	34.80		49.08	

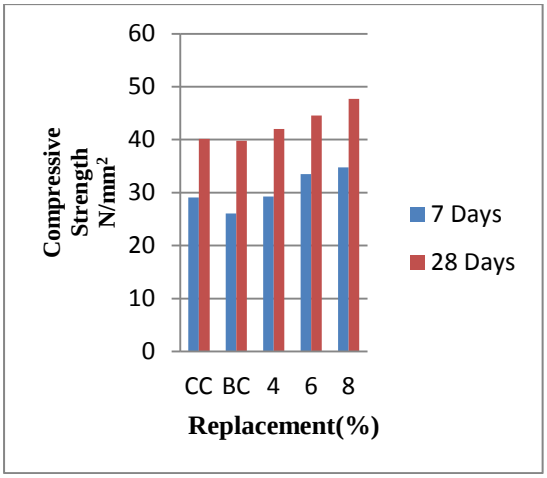

Fig. 1: Graph 1 Compressive Strength for Replacement of Cement with Alccofine for 7 & 28 days

4.2. Sorptivity Test Results.

Calculations: Sorptivity is measured
S= (I/√t) Where;
S= sorptivity in mm,
t= elapsed time in minute.
I=Δw/Ad
Δw= change in weight = W2 ─ W1
W1 = Oven dry weight of cube after coating in grams
W2 = Weight of cube after60 minutes capillary suction of water in grams.
A= surface area of the bottom side through which water penetrated.
d= density of water

Sample Calculation:

Δw = change in weight = W2 ─ W1 = 8230 – 8190 = 40 gm
W1 = Oven dry weight of cube after coating in grams = 8190gm
W2 = Weight of cube after60 minutes capillary suction of water in grams = 8230gm
A= surface area of the bottom side through which water penetrated = 0.0225 m
d=density of water = 1 gm/cm3
t= time in minutes = 60 min
I=Δw/Ad = 40/ (0.0225 × 102 × 1) = 17.77 m
Hence, S = I/√t = 17.77 /√60 = 2.29

Table 3: Result of sorptivity test for Replacement of Cement with Alccofine

Type of conctrete	Dry wt. in grams	Wet wt. in grams	Change in wt in grams	Sorptivity value in m.s-1/2	Average Sorptivity Value in m.s-1/2
Conventional Concrete(M_{40})	8227	8266	39	2.24	2.25
	8233.31	8270.31	37.12	2.12	
	8229.96	8271.96	42.03	2.41	
bacterial concrete	8235.17	8271.29	36.12	2.07	2.12
	8239.06	8278.18	39.12	2.24	
	8237.12	8273.09	35.96	2.06	
bacterial concrete with 4%, Alccofine	8230	8266.04	36.04	2.06	2.01
	8242	8283	41	2.1	
	8247	8279.37	32.37	1.86	
bacterial	8238	8267.13	29.37	1.47	

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concrete with 6% Alccofine	8241	8272.09	31.09	1.78	1.54
	8225	8249.21	24.21	1.38	
bacterial concrete with 8%, Alccofine	8240	8261.21	21.03	1.2	1.21
	8234	8257.21	23.21	1.33	
	8228	8247.18	19.18	1.10	

Discussion on Compressive Strength

1. In conventional as well as Replacement Accofine the compressive strength at 7 days and 28 days are found out and results are tabulated.
2. The maximum value of compressive strength obtained is 47.71 N/mm^2 for M40 grades of concrete respectively when the cement is replaced by 8% Alccofine.
3. The required strength of M40 concrete is achieved for 4%, 6%, 8% replacement in the case of M40 grade concrete.

Discussion on Sorptivity Test

1. Durability of bacterial concrete is high compare to convetional concrete.
2. Durability is increase with the 4%, 6%, 8% replacement in the case of M40 grade concrete.

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