Field Application of Fungus Concrete for Self-Healing Of Marine Structure

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Abstract: Concrete is very important material in construction point of view. Concrete is a material consists of cement; sand and aggregate in some define proportion. The fault in concrete is that it is weak in tension therefore probability of formation of crack is more. It may affect the durability, strength and reinforcement. It is expensive to repair this type of cracks by traditional method. As a self-healing agent fungi is consider as new concept used in concrete. To improve precipitation of calcium mineral filling the fungi is used in concrete. The isolation of fungi using, Pour plate Technique with Yeast Extract Rose Bengal Broth Plus Agar(2.93 gm. plus 2.5 gm. with distilled water of 100ml) as nutrient in microbiology laboratory. Wooden waste is taken as source of fungi. Yeast Extract Rose Bengal Broth Base (2.93 gm. with distilled water of 100 ml) was used for the multiplication of isolated fungi. SEM Test was performed for confirming the growth of fungi. Various experiments were performed to check the properties such as compressive strength of self-healing concrete and the results were compared with normal concrete.

Index Terms **– Self-Healing Concrete, SEM Test.**

I. INTRODUCTION

Concrete is very important, strong and flexible material used for construction. Concrete is material consists of cement, sand and aggregate in some definite proportion. The initial hardening reaction normally occurs within a few hours. It takes a few weeks for concrete to reach full strength and hardness. Concrete can continue to harden and gain strength over many years. Due to change in volume and dry shrinkage micro crack occurs before any application of load. When the load is imminent on the structure, the micro cracks expose up and in this cracks water, CO2, and other chemicals are easily enter. Due to this durability, strength and corrosion of reinforcement is affected. The reason behind the inelastic deformation is expansion of micro crack. In concrete infrastructure crack formation is very common. Cracking is caused by a measure of internal or external of volume change. It is also a combination of different factors such as contracting of hardens concrete, contraction due to change in temperature, settlement of the soil and due to applied load crack may occur.

II. OBJECTIVES

- To check the compressive strength of concrete using fungi in concrete.
- To check the compressive strength of concrete cured in marine water.
- To check the growth of fungi in concrete using SEM (Scanning Electron Microscopic) test.

III. LITERATURE REVIEW

[1]The author has selected bacillus bacteria to improve the structural properties like compressive strength, water permeability, tensile strength and durability.

[2]The author has suggested the calcium carbonate precipitating bacteria to repair or heal micro cracks.

[3]The author has concluded to optimum strength is obtained at 10^5 cells per milliliter of water and polyethylene fiber kept at constant as 0.4% concentration, also increase the compressive strength by 13.2%, split tensile by 21.4% and flexural strength by 16.04%.

[4]The author is mostly focused on the developing biological self healing concrete by using the bacillus bacteria capable of precipitating calcite carbonate.

[5]The author has concluded that rise in concentration of marine water used for concrete mixes after 28 days increase in strength when compared with normal water.

IV. MATERIAL AND METHODOLOGY

Materials list: (1) Cement, (2) Fine Aggregate, (3) Coarse Aggregate (4) Fungi

Cement: Ultratech Cement (OPC 53 Grade) as per confirming IS12269:2013

Fine Aggregate**:** The properties of sand were determined by tests as per IS 2386 (Part- I)

Table 1 Properties of Fine Aggregate

Properties	Sand
Source	Rampar (Bachau)
Sieve Analysis	Zone III
Fineness modulus	2.23
Specific Gravity	2.67
Water Absorption	0.2
Bulk Density	1.74 (Loose) 1.794 (Compacted)

Coarse Aggregate: Coarse Aggregate of 10 and 20 mm were used. Coarse aggregate conforming to IS 383-1987 was used.

Table 2 Physical Properties of Coarse Aggregate

Properties	Natural Coarse Aggregate
Fineness Modulus	7.11
Flakiness Index	29.278
Elongation Index	23.980
Impact Value	17.095
Crushing Value	11.765
Specific Gravity	3.08
Water Absorption	1.70

Fungi: There are two stage of fungi production in micro-biology laboratory Fungi Isolation and Fungi Multiplication.

Process of Fungi Isolation:

- Take one flask with 100ml distilled water add Yeast Extract Rose Bengal Broth Base 2.93 gm. add Agar 2.5 gm. and plug with cotton cap.
- Plug the flask and cover the petri dish with paper and put flask and petri dish in autoclave machine for sterilization of material at pressure up to 1.0 kg/cm^2 for 5 minutes.
- Pour approximately 20 ml the media in to petric dish and allow it to solidify then put 2 drop of culture taken our from test tube and spread properly and put in incubate at temperature 30° C for 6 days.

Process of Fungi Multiplication:

- Collect 100 ml distilled water in flask and add 2.93 gm. Yeast Extract Rose Bengal Broth Base in it and plug with cotton cap, put in autoclave for 5 minute.
- Collect one nichrome wire loop sample of fungi from petri dish and add it into flask and plug with cotton cap.
- Put prepared solution in shake table for 48 hours at roomtemperature.

Table 3 Mix Proportion for M20 Grade of Concrete

Cement	FA	CA	Water
394.32 Kg	570.23 Kg	1430.40 Kg	197.16 Kg
1	1.45	3.62	0.50

V. RESULTS

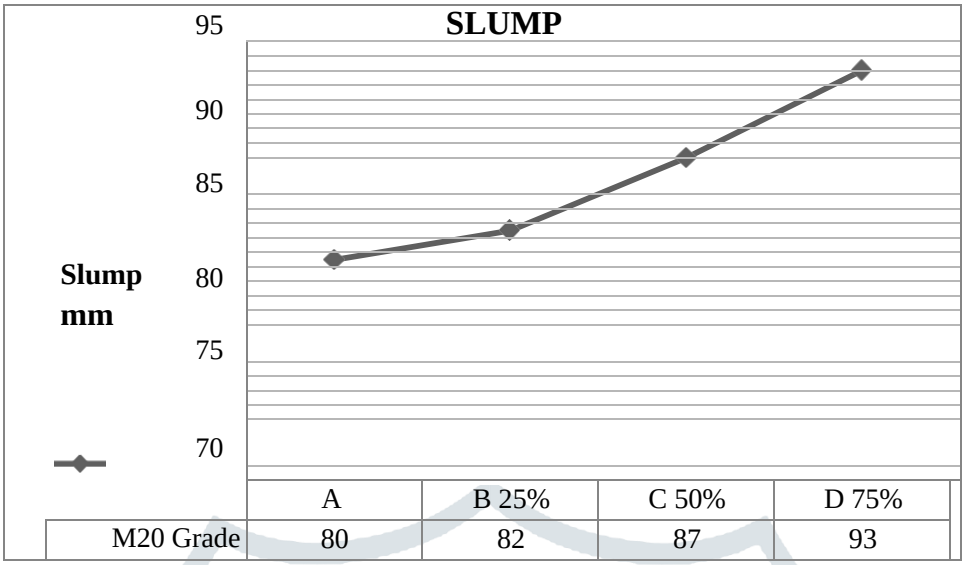
Workability:

- The measurement of a properties of fresh concrete as per IS: 1199 - 1959

Table 4 Slump test results

Variations	Slump Value (in mm)
	M20 GRADE
A (Normal)	80
B (**25%** replacement of water with Fungus water)	82
C (**50%** replacement of water with Fungus water)	87
D (**75%** replacement of water with Fungus water)	93

Figure 1 Slump Value Comparison



Compressive Strength Test:

- Compressive strength is determine by using cube where size of cube specimen is 150×150×150 mm and this test was performed on 2000 KN capacity compressive testing machine.
- To determine properties of concrete is evaluated at age of 3 days, 7 days and 28 days.
- The compressive strength of cube specimen is calculated using the following formula:

$$\sigma = P/A$$

Where, P = failure load

A = cross sectional area of cube in mm

Table 5 Compressive strength test results

MIX	Fungus Water %	Grade	Compressive Strength N/mm^2 Days		
			3	7	28
A	0	M20	13.05	18.48	28.36
B	**25**	**M20**	**14.15**	**19.92**	**29.72**
C	50	M20	14.11	17.68	27.73
D	75	M20	13.24	16.70	27.23

Table 6 Compressive strength test result curing in marine water

Mix ID	Curing Process	Fungus water %	Grade	3 Days	7 Days	28 Days
A	Fresh water	0%	M20	13.05	18.48	28.36
B	Marine water	0%	M20	13.02	16.37	30.14
C	Fresh water	25%	M20	14.15	19.92	29.72
D	Marine water	25%	M20	14.11	18.58	27.68

Figure 2 Compressive Strength Test Results 3-Days

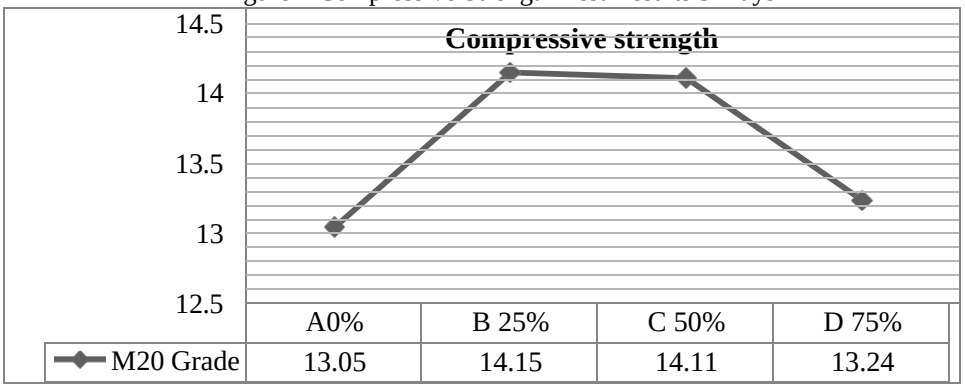


Figure 3 Compressive Strength Test Results 7-Days

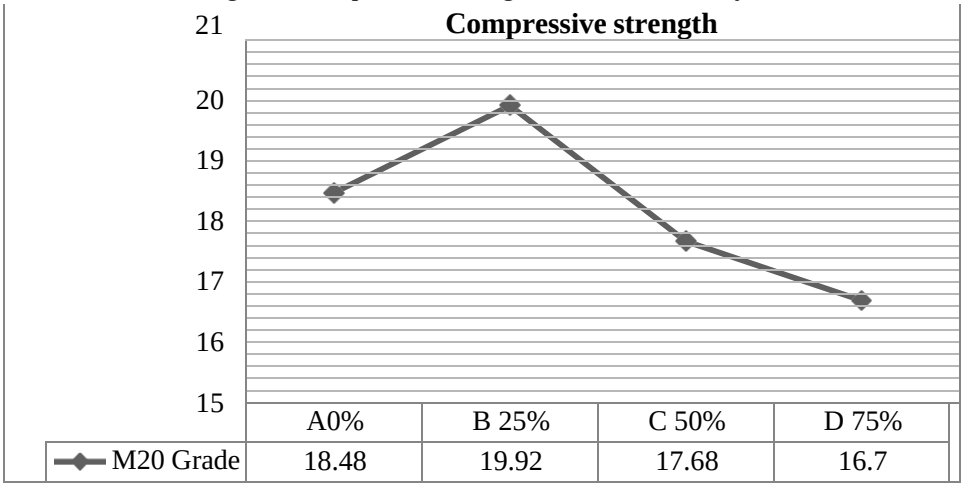
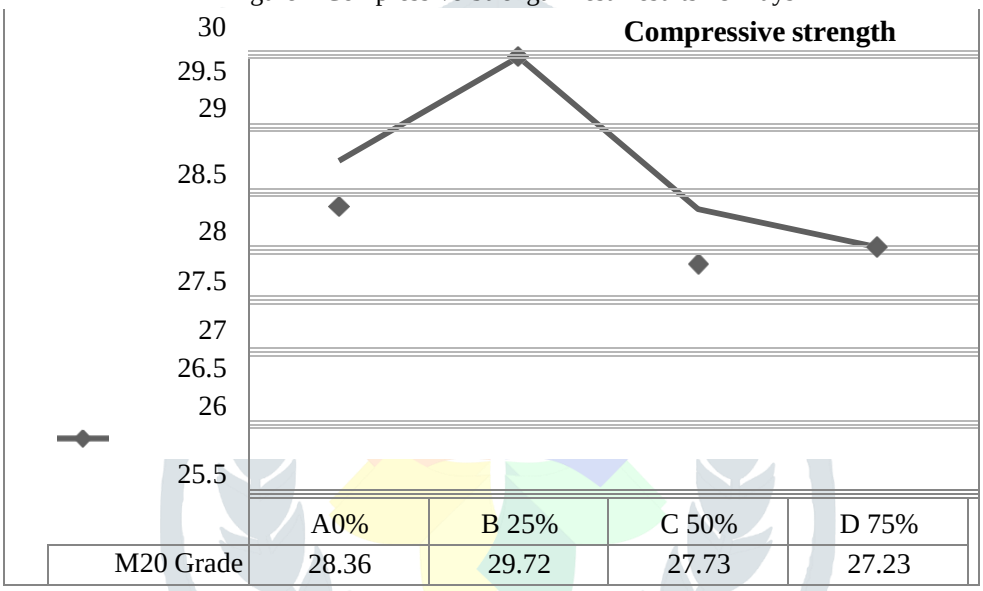


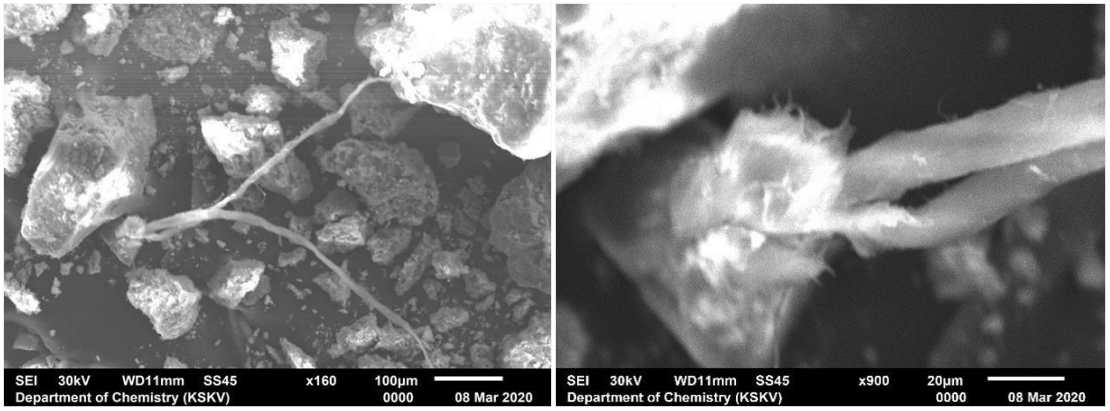
Figure 4 Compressive Strength Test Results 28-Days



Scanning Electron Microscopy Test:

- Compressive strength of fungi used in concrete found to be 25%,50%,and 75% is 14.15,19.92 and 29.72 N/mm^2 compared to the normal concrete compressive strength found to be 13.05, 18.48, and 28.36 N/mm^2 respectively for 3 , 7, 28 days and it is higher than compressive strength of normal concrete.
- According to SEM Test 25% Replacement of Fungus water with marine water. As per figure 4.7 and 4.8 it was found that there was functional growth of fungi in concrete which is confirm by SEM Test which help to filling the crack in concrete.

Figure 5 Fungi observed in magnification of X90 and X900



VI. CONCLUSION

- For 25% replacement of water with Fungus water the slump value increased by 2.50%.
- For 25% replacement of water with Fungus water the Compressive Strength increased by 4.79%
- For 50% replacement of water with Fungus water the Compressive Strength decreased by 2.22%
- For 75% replacement of water with Fungus water the Compressive Strength decreased by 3.98%
- It was observe that there was increase compressive strength by 25% replacement of water with fungus water but more than 25% replacement of water decrease the compressive strength of concrete.

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