Experimental Investigation of Concrete Using Bacteria in Fusion with Different Percentage of Flyash

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Abstract— Building material, concrete is extremely prone to developing cracks. A reduction in strength, ductility, durability, and reinforcement are all results of the chemicals reactions, coupled with water and CO2. Without urgent action, the fissures might worsen and lead to more serious issues. This work intends to explore the self-healing potential and the mechanisms associated with the process while considering the economy into account. This paper presents experimental investigation of concrete using bacteria in fusion with different percentage of flyash. Project work discusses the technique and analysis of preparing bacterial concrete mix proportions, materials utilized, and different test findings of qualities at 7 and 28 days for concrete acceptance.

Keywords: Self-Healing, Cracks, Concrete, Bacteria, Flyash, Concrete, Carbonate Precipitate

I. INTRODUCTION

Concrete Concrete is a well-balanced combination of cement, water, sand, and other materials. Also including several sorts of admixtures that are utilized to offer certain improve qualities of concrete. To enhance the physical attributes of the wet mix or final material, mixes or reagents which includes pozzolans or Plasticizers, superplasticizers, Accelarators, Air entertainers etc. are added to the mixture.

Concrete is commonly utilized in two kinds of structures: plain concrete construction and reinforced concrete construction. PCC is filled and cast without the need of reinforcement. This is done when the structural part is merely subjected to compressive stresses and not bending forces. When a structural part is bent, reinforcements are induced to counteract tension stresses since the structural member is very prone to cracking compared to compression. Under general, the compressive strength of the concrete in tension is only approximate 10% that of concrete in compression.

It has a high compressive strength and can successfully endure a wide variety of environmental changes. Where the environment influences the system's behavior various physiological and environmental conditions can cause irreversible structural damage, reducing structural durability and finally causing fractures and micro-cavity in the structure. Environmental factors like temperature variations, moisture content changes, and intrinsic drying shrinkage can all cause cracking in concrete. This spontaneous fracture initiation is an issue for brittle concrete because when cracks may easily propagate, the material's ductility does not increase, implying that cracking might compromise structural strength and hence safety.

Fly ash is defined as "the finely split residue arising from the burning of ground or powdery coal, which is conveyed from the firebox to the boiler by flue gases". Flyash is a byproduct of coal-fired power generation plants. Fly ash was formerly dispersed into the atmosphere, but new air pollution control guidelines mandate that it be trapped prior to release using pollution control technology.

Flyash not only benefits the environment, but it also enhances the performance and quality of concrete. Flyash enhances the plastic properties of concrete by increasing workability, decreasing water consumption, lessening segregation and bleeding, and decreasing heat of hydration. Flyash boosts strength, decreases permeability, lowers reinforcing steel corrosion, boosts sulphate resistance, and decreases alkali-aggregate reaction. Flyash concrete achieves its ultimate strength relatively slowly than Portland cement concrete. Pozzolanaassist in the setting of concrete and plaster and protects concrete against moist conditions and chemical assault.

Some bacteria, like the one that causes botulism, Clostridium botulinum, may be quite dangerous. The neurotoxin botulinum, which is produced by C. botulinum, is what causes the manifestations of botulism. Vision blurring, nausea, breathing difficulties, postural instability, and paralysis are some of the symptoms. The whole human species might be wiped out with just one kilogramme of the most lethal toxin known to science, botulinum.

II. SELECTION & MECHANISM OF BACTERIA

The following are the basic procedures for isolating microorganisms from sample:-

- First and foremost, gather samples in glass bottles or test tubes & Combine all of these samples with some water and aggressively shake it.
- Place 1ml of mixed sample in a test tube and add 9ml of distilled water.
- After combining 1ml of bacterial water with 9ml of pure water, the solution concentration becomes 10-1. This solution must be stored in a test tube.
- After that, transfer 1ml of the solution from the first test tube to the second test tube and add 9ml of distilled water to the second test tube.
- Repeat the first three steps 5 to 6 times more. Till the solution concentration ranges from 10-4 to 10-6.
- Following all of these methods, prepare Patrick plates with appropriate selective medium for the bacterium.
- After that, disseminate the aforesaid test tube solution at concentrations ranging from 10-4 to 10-6 on the Patrick plate containing medium. Also, after 24-48 hours, inspect the plate.
- Check the sort of colony development in the Patrick plate after 24-48 hours. In addition, I created some additional Patrick plates using the same medium and sample at various concentrations.

- Following this streak, the various types of colonies on different plates. Also, monitor the development after 24-48 hours.
- Then, using the gramme staining procedure, examine the morphology of various colonies. Also, perform several biochemical activities to properly identify microorganisms.
- Then, produce another liquid broth with selective medium and streak the detected bacteria in it. Examine the development after 24-48 hours. The turbidity in the media will demonstrate the proliferation of bacteria after a given time period.
- Here after adopting all this steps, the bacterium that was ultimately isolated. This bacterial solution is then tested for the production of calcite.

III. METHODOLOGY

This section provides the details methodology of this experimental work. Finalise the materials like cement, water, Bacteria, fly ash. Then apply the material testing-Material quality tests are carried out as part of the quality assurance of structural concrete. Each quality test performed on materials determines the concrete's quality result. It is therefore basically worthless to carry out each test need to look at the various parameters of the material. We must select the standard tests that could be providing an adequate evaluation of the concrete's quality. The priority quality test report the difference b/w the requisite and nominal concrete parameters to be use in the site. The quality tests assuring that the highest high standard grade of concrete is utilized on the job site, resulting in concrete structural members of the desired strength.

A. Experimental Setup:

1) Constituents:-

- Cement:-Ordinary Portland cement of grade 53 is available in the local market and meets IS: 12269-1987 specifications. Having sp. gravity of 3.15.
- Fine Aggregate:-Locally available clean, well-graded natural river sand that meets IS 383-1970 specifications and has a specific gravity of 2.50 is used.
- Course Aggregate:-Crushed granite angular aggregate of nominal size 20 mm from a local source is used, with a specific gravity of 2.65.
- Water:-Locally available potable water that meets IS 456 standards is used.
- Fly Ash:-Fly ash of class 'F' with a specific gravity of 2.32 is used at 15%, 20%, 25% as replacement of cement by weight.
- Microorganisms:-Bacteria subtilis, a soil bacterium cultured and grown in the Biotechnology Department's laboratory, is used in concentrations of 10^5 and 10^6cells/ml.
- Calcium lactate is added at 1% of the cement's mass.
- Concrete grade designation: M25 specified as per IS 456:2000

We use mix of concrete of grade 25 having ratio of 1:1:2. Adding to this 15%, 20%, 25% of Flyash in different samples with bacteria subtilis in different proportions which is nonpathogenic and not harmful to the human species. After proper batching, Mix of grade M25 is prepare with the standard specification specified in Indian standard Code IS 456:2000. After 7 & 28 days of curing from the day of casting the cube and cylindrical sample are ready for testing in respective equipment.

2) Preparation of Sample

- Firstly select the material of concrete after proper testing of them in the laboratory as per standard procedure mention in IS 456:2000.
- Bacteria and Flyash are selected after the standard procedure adopted in above mentioned methods.
  - According to IS Code IS 10262:2009, concrete elements such as bacteria and fly ash are combined to create M25 Mix.
  - Different physical qualities of the materials, like specific gravity, water absorption capacity, standard size, etc., are considered to be in accordance with IS 456:2000 at the time of batching and batching of M25 grade of concrete.
- At the time of preparation of sample other condition such as exposure condition, temperature, pressure etc. are also assumed to be in accordance of IS 456:2000.
- Various test mention in IS Code 1199-1959 for workability of concrete are performed to its workability at fresh stage of mix.
- After preparation of mix take standard mould of size 150mm*150mm*150mm with clean and oiled surface
- Mix is poured in the mould in 3 layer with compaction of having 25 blows in each layer by temping rod.
- After 24 hours, concrete cubes are unbolted from moulds and named with water resistant paint and placed in the curing tank filled with normal water at 27+ 2 ^{0}c, for period of 28 days.
- At the end of 7 and 28 days curing it's time to test those cubes as per Indian standard code of different material and final specimen which gives actual strength of concrete and other different parameter which is an objective to be observed from this test.
- After perform all the test make a proper test report and list all the test performed at green as well as hardened stage.

IV. RESULTS AND DISCUSSION

Some test is performed, which results is followings-

A. Consistency of Concrete by Slump Cone Test:-

Type of Concrete	Fly ash	Cell concentration (cells / ml)	Consistency (mm)
Conventional	-	-	77mm
Concrete with bacterial subtilis	-	10^5	74 mm
Bacterial concrete with flyash	15%	10^5	62mm
	20%	10^5	59mm
	25%	10^5	60 mm

Table 1: Consistency Test

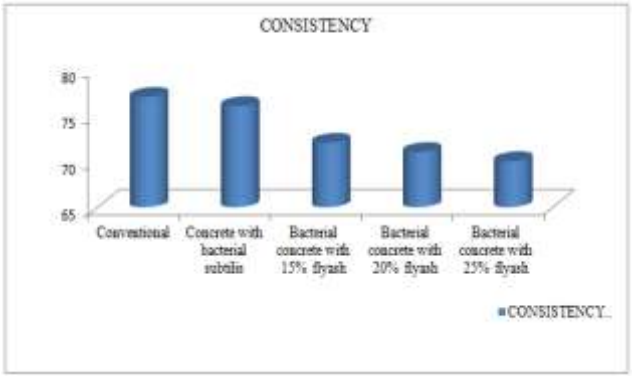

Fig. 1: Scatter Plotting Of Consistency Test Result

B. Workability of Concrete by Compaction Factor test:-

Type of Concrete	Fly ash	Cell concentration (cells / ml)	Workability
Conventional	-	-	0.86
Concrete with bacterial subtilis	-	10^5	0.82
Bacterial concrete with flyash	15%	10^5	0.79
	20%	10^5	0.81
	25%	10^5	0.79

Table 2: Workability Test Result Obtained From Compaction Factor Test

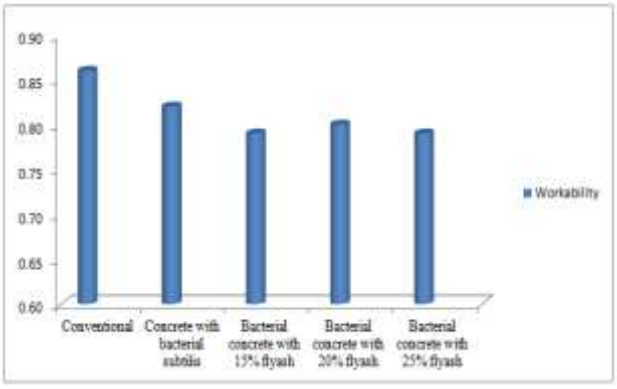

Fig. 2: Scatter Plotting of Workability Test Result from Compaction Factor Test

C. Compressive Strength of Concrete -Cube Test-

Type of Concrete	Fly ash	Cell concentration (cells / ml)	Compressive strength of concrete after 28 days (N/mm^2)			
			Sample 1	Sample2	Sample 3	Average value
Conventional	-	-	26.89	27.23	24.61	26.23
Concrete with Bacillus subtilis	-	10^5	27.18	29.23	25.39	27.26
Bacterial concrete with fly ash	15%	10^5	29.65	25.37	23.26	26.09
	20%	10^5	28.56	25.42	27.89	27.29
	25%	10^5	24.76	29.67	29.29	27.90

Table 3: Compressive Strength Test Result at 28 Days

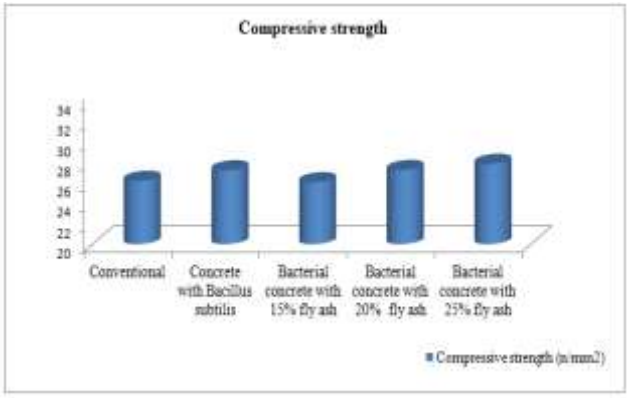

Fig. 3: Scatter Plotting of Compressive Strength Test Result at 28 Days

D. Tensile Strength of Concrete – Split Cylinder Test

Type of Concrete	Fly Ash	Cell Concentration (cell/ml)	Testing of sample at 28 Days (MPa)			
			Sample 1	Sample 2	Sample 3	Average Value
Conventional	-		3.09	4.11	3.68	3.62
Concrete with Bacillus subtilis	-	10^5	3.59	3.97	3.81	3.79
Bacterial concrete with fly ash	15%	10^5	4.19	4.57	4.02	4.26
	20%	10^5	4.01	4.28	5.26	4.51
	25%	10^5	5.09	4.34	5.27	4.60

Table 4: Tensile Strength Test Result at 28 Days

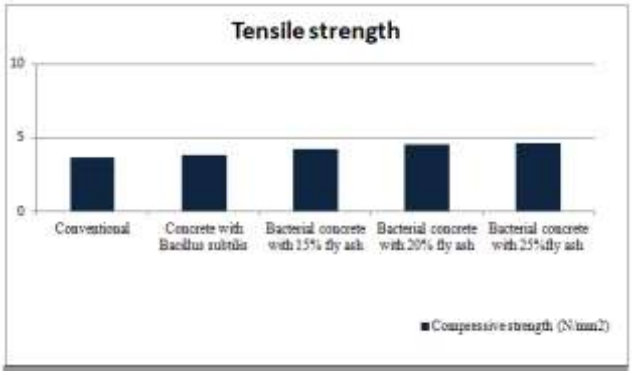

Fig. 4: Scatter Plotting Of Tensile Strength Test Result at 28 Days

E. Durability Test of Concrete – Chemical Test

Type of Concrete	Fly Ash	Cell Concentration (cell/ml)	Percentage strength change after immersion in 5% H_2SO_4 AT 28 Days			
			Sample 1	Sample 2	Sample 3	Average value
Conventional	-		7.63	6.38	8.65	7.55
Concrete with Bacillus subtilis	-	10^5	7.25	7.08	5.29	6.54
Bacterial concrete with fly ash	15%	10^5	7.81	7.32	8.58	7.90
	20%	10^5	7.49	6.69	6.15	6.77
	25%	10^5	6.79	8.39	7.88	7.68

Table 5: Percentage Strength Change Test Result at 28 Days

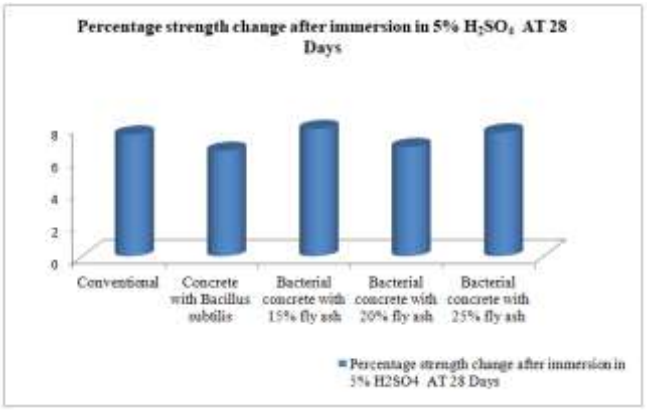

Fig. 5: Scatter Plotting of Percentage Strength Change Test Result at 28 Days

The durability of the mix having 25% flyash with concentration of 10^5 cell/ml shows that in short duration 7 days is increase up to 24.49% and in later stage after testing at 28 days the durability increases up to 17.21% at 15% addition of flyash.

When M25 grade mix concrete mixed with bacillus subtilisat a concentration of 10^5 cell/ml & the addition of 15%, 20%, 25% flyash, The consistency of concrete mix is obtained its peak value in the conventional mix having ratio 1:1:2 is about 77mm and also the workability is highest in the conventional mix which having value of about 0.86. It is due to the density increased by mixing of flyash which reduces the pores and make more compact concrete.

This concrete is compared to conventional concrete, increase in the compressive strength is about 6.3 % as well as flexural strength increases with 27.07% at 25% addition of flyash with bacillus subtilisat a concentration of 10^5 cell/ml because flyash addition provide high density rich mix which reduces shrinkage, bleeding, segregation etc. also fly ash has the property of gaining strength over a longer period of time and it is observed that when fly ash content increases in a feasible limit the results are much more favorable also it reduces the cost up to some extent by replacing the cement in the concrete mix.

V. CONCLUSION

The paper describes the betterment of the proposed techniques rather than the traditional technology because to its self-healing powers, eco-friendliness, increased durability, and so on. It significantly improves the strength and durability of concrete. It also has greater drying shrinkage resistance, acid attack resistance, and sulphate resistance. Bacterial concrete with admixtures such as silica fume, fly ash, and others has higher strength and toughness The results of numerous research institutions described above suggest that these materials have a lot of potential. Each novel or modified bacterial and additive conformation leads to improved results. Therefore experimental results show that the proposed work gives significant better performance than previous.

REFERENCES

[1] Z.P.Bhathena & NamrataGadkar (2014) "Bacteri-based Concrete: A Novel approach for increasing its durability" International Journal of Biosciences.
[2] Vijeth N Kashyap & Radhakrishna (2013) "A Study on effect of bacteria on Cement composites" International Journal of Research in Engineering and Technology.
[3] L.Soundari, C.S.Maneesh Kumar, S.Anthoniraj & E.Karthikeyan (2015) "An Experimental study on strengthening of concrete by using Bacterial Mineral Precipitation" International Journal of Core Engineering & Management.
[4] HenkM.Jonkers & Erik Schlangen (2008) "Development of a bacteria-based self healing concrete"
[5] B.Naveen & S.Sivakamasundari (2016) "Study of strength parameters of bacterial concrete with controlled concrete and structural elements made with concrete enriched with bacteria" International Conference on engineering innovations and solutions.
[6] ChintalapudiKarthik & Rama Mohan Rao.P (2016) "Properties of Bacterial-based Self-healing Concrete" International Journal of Chem Tech Research.
[7] Chithra P, BaiShibi Varghese. An experimental investigation on the strength properties of fly ash based bacterial concrete International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2763 Issue 08, Volume 3 (August 2016)
[8] V Srinivasa Reddy, M V SeshagiriRao, S Sushma. Feasibility Study on Bacterial Concrete as an innovative self crack healing system. International Journal of Modern Trends in Engineering and Research, e-ISSN No.:2349-9745, Volume 2, Issue 7, [July-2015] Special Issue of ICRTET'2015, Date: 2-4 July, 2015, PP 642-647.
[9] Ashish Babarao Gawande, Yash Suneel Khandekar and Ojas Pravin Rahate, Applicability of Concrete Treated with Self-Healing Bacterial Agents. International Journal of Civil Engineering and Technology, 7(5), 2016, pp.275–283.
[10] Abhishek Thakur, Akshay Phogat and Khushpreet Singh, Bacterial Concrete and Effect of Different Bacteria on the Strength and Water Absorption Characteristics of Concrete: A Review. International Journal of Civil Engineering and Technology, 7(5), 2016, pp.43–56.
[11] MohitGoyal, P. Krishna Chaitanya. Behaviour of Bacterial Concrete as Self Healing Material, International Journal of Emerging Technology and Advanced Engineering ,ISSN 2250-2459, Volume 5, Issue 1, January 2015,PP 100-103
[12] N.GaneshBabu. 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.

