IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Comparative Analysis of Conventional Concrete, Bacterial Concrete, And Bacterial Concrete with Fly Ash

[1] Santosh Shankrappa Rathod, [2] Pranay Satish Sabale, [3] Shaikh Adnan Saif Arif, [4] Shaikh Nusrat Nafiz Arif,

Project Guide - [5]Prof. Prashant Lalasaheb Jadhav

[1,2,3,4]Diploma Students and [5]Head of Department of Civil Engineering of Zeal Polytechnic, Pune, Maharashtra, India.

***Abstract**:* This study aims to completely equate conventional actual, bacterial factual, and bacterial concrete combining fly ash as an additional cementitious material. We will judge each material based on substance, stamina, and self-curative capabilities, referring to practices or policies that do not negatively affect environmental impact, and cost-influence. Concrete samples will be arranged using normal join designs, accompanying bacterial strains for calcium carbonate precipitation, and accompanying fly ash as a prejudiced substitute for cement. We will analyse compressive substances and evaluate self-healing through being able to be seen with eye notes and microscopy. Referring practices or policies that do not negatively affect environmental impact will be evaluated by resolving element emissions, strength devouring, and resource exercise, accompanying cost reasonings for economic practicability. The verdicts will inform tenable creation practices, providing insights into reinforcing actual performance and endurance while underrating material impact.

Index Terms - Concrete, Bacterial, Fly ash, Durability, Environmental impact

1. Introduction

Factual stands as a cornerstone in creation, prized for its changeability, strength, and resilience. Despite its allure and widespread use, the usual hardened is not impervious to imperfections like breaking, which can endanger fundamental integrity and make necessary valuable interventions. Current stalks in research have ushered in a new term of change, giving be even with bacterial factual, also known as self-restorative hardened. This groundbreaking electronics harnesses microbial powers capable of hurrying calcium carbonate inside fractures, enabling independent repair and helping the material's durability and endurance. Together, construction manufacturing has endorsed a surge in interest surrounding additional cementitious matters like fly ruins, a product of coal explosion. Gifted with pozzolanic features, fly ash reinforces hardened strength, grit, and practicability while mitigating material impact, so presenting an irresistible street for sustainable explanation practices.

This approximate analysis endeavours to analyse and place side by side the performance of unoriginal concrete, bacterial factual, and bacterial hardened integrated accompanying fly ash as additional cementitious material. Through a detailed examination of key attributes, containing substance, durability, self-restorative proficiencies, environmental footmarks, and cost influence, the study aims to illuminate the substances, restraints, and potential applications of each hardened variant in the building landscape. By fixture partners with inclusive intuitions, this endeavour seeks to support cognizant decision-making in explanation project preparation and material selection, throwing the manufacturing towards sustainable examples and supporting resilience in factual buildings for generations at hand.

2. Literature reviews

Concrete is the most important building material in the construction process. One disadvantage is because of the mass production of concrete causes adverse effects on nature such as an increase in the greenhouse effect, energy utilization & energy Environmental disfigurement. To reduce these effects self-healing concrete or bacterial concrete is the best option. bacterial concrete Also helps to heal the cracks.

According to S. A. Puranik, S. Jain, G. Shritem & S. Sandbhor, this article discusses the significant improvement in compressive strength achieved when treating concrete with Bacillus sphaericus, specifically M20 Mixture. This treatment also improves water quality and control of Bacillus subtilis. Bacteria stones can be used in areas that require knowledge of bacteria and culture by providing new solutions. It provides reliability, greater durability, and lower maintenance costs compared to methods of eliminating breakage and poor performance. The use of this technology can lead to sustainable and environmentally friendly construction.

According to the study of R. Khambenpur, this article discusses cracks that can affect the integrity and durability of concrete due to various factors such as improper application, environment, and loading. Traditional methods such as chemical and epoxy gel application require constant maintenance, resulting in high costs and environmental impacts. However, treating cracks using organic chemicals is a non-toxic solution that improves quality of life and reduces maintenance costs. This method is consistent with the increasing importance of security in buildings. Additionally, the development of self-healing processes is seen as a good idea to increase the reliability of the process, especially in complex areas where the remediation process is not normally used, such as soil or landfills. The Cost of construction using bacterial, concrete is around 3.2% higher than the cost of construction using conventional concrete.

According to K. Keerthana, A. Ranjani, & N.K. Amudhavalli, Research studies use bacteria such as Bacillus globus and E. coli to increase the strength of concrete by producing calcium precipitates that fill cracks. H.M. Jonkers (2011) found that concrete bacteria can repair small cracks, especially in humid environments, thus reducing metal corrosion. Jagadish Kumar et al. (2013) supported the use of B. campylobacter in calcite precipitation. S. Maheswaran et al. (2014) found that the compressive strength of B. cereus was better than B. pasturelands, especially in the marine environment. In general, concrete systems are promising in improving the performance of concrete structures. They compare the properties of two bacteria bacillus Sphericus & Escherichia Coli. The compressive, split tensile, and Fletcher strength of bacterial concrete is more than that of conventional concrete.

K. Monica, Dr. K. Chandramouli, and N. Chetanya said that the addition of bacteria was found to increase the compressive strength, and this was mainly due to microbial-induced calcium carbonate accumulation on the microbial surface and in the pores of the mortar. It is worth noting that in ordinary mortar, the increase in bacterial cell concentration is associated with greater compressive strength.

According to B. Pawar, A. Magdum, M. Bhosale, & S. Pol, the progress made in improving the properties of cement and concrete, such as increasing compressive strength, reducing permeability, reducing water absorption, and increasing corrosion resistance. These advances are achieved through a simple cementation method that promises to be profitable and environmentally safe. However, more research is needed to increase the economy and effectiveness of this technology. Most importantly, the most significant improvement in compressive strength occurred at a cell concentration of 105 cells/ml; This resulted in a 25% increase in the 28-day compressive strength of the cement mortar.

Therefore, according to various studies bacterial concretes can be used in the construction industry.

3. Problem Statement: Despite the growing interest in bacterial concrete for its potential durability and self-healing properties, there remains a significant gap in research regarding its comparison with conventional concrete and bacterial concrete supplemented with fly ash. This lack of comparative analysis hinders informed decision-making in construction projects, where material selection is crucial.

4. Aim: This study aims to fill this gap by systematically evaluating the mechanical, physical, and durability properties, as well as environmental impacts, of conventional concrete, bacterial concrete, and bacterial concrete with fly ash.

5. Objectives:

1. Compare mechanical properties (e.g., compressive strength, flexural strength) of conventional concrete, bacterial concrete, and bacterial concrete with fly ash.

2. Assess physical properties (e.g., density, porosity) of conventional concrete, bacterial concrete, and bacterial concrete with fly ash.

3. Investigate durability properties (e.g., resistance to chemical attack, freeze-thaw resistance) of conventional concrete, bacterial concrete, and bacterial concrete with fly ash.

4. Provide a comprehensive comparative analysis to facilitate informed decision-making in construction projects regarding material selection, considering the mechanical, physical, and durability properties of the three types of concrete.

6. Methodology:

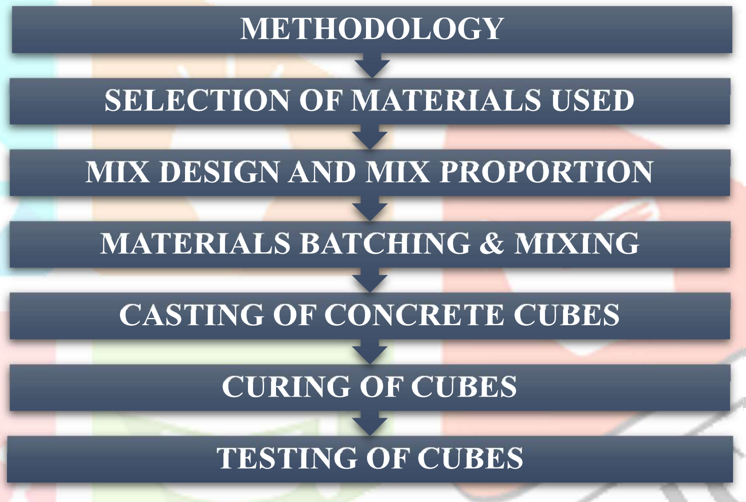

Fig No. 1 – Methodology

6.1 Material Selection:

1. Portland cement: standard OPC with microbial additives and fly ash. Performance: concentration, degree of coagulation, specific gravity, fineness, compressive strength, speed.
2. Fine Aggregate: Sand is essential for performance, strength, and durability. Performance: specific gravity, fineness modulus, water absorption.
3. Coarse Aggregate: Determines the quality of stone concrete. It is available in 10mm and 20mm sizes, taking into account factors such as gravity and water absorbency.
4. Water: The mixture should be drinkable, sodium/potassium-free, neutral pH and chemical-free.
5. Bacteria: Bacillus helps heal stones. BactaHeal-PR produces calcium carbonate, which fills cracks with strength.
6. Fly ash: It is a product formed as a result of the combustion of coal, rich in silica and alumina. Partial replacement of Portland cement, increasing strength, durability, and sustainability. Properties: specific gravity (2.25) and density (1100-1200 Kg/m3).

6.2 Mix design and mix proportion:

Test data for materials for both M20 & M30 Grade:

Sr. No	Test Performed	Result
1.	Specific Gravity of Cement	3.15
2.	Specific Gravity of Fly ash	2.25
3.	Specific Gravity of Admixture	1.12
4.	Specific Gravity of Water	1
5.	Specific Gravity of Coarse Aggregate- I	2.89
6.	Specific Gravity Coarse Aggregate- II	2.88
7.	Specific Gravity Fine Aggregate	2.85
8.	Water Absorption- Coarse Aggregate- I	1.05%
9.	Water Absorption- Coarse Aggregate- II	1.05%
10.	Water Absorption- Fine Aggregate	2.72%

Concrete mixing proportion of M20 grade:

a) Stipulations for proportioning

1.	Grade Of Concrete	M20
2.	Type Of Cement to be used	OPC 53 Grade Conforming to IS 12269:2013
3.	Fly ash	Confirming to IS 3812:1981 Part I & Part II
4.	Maximum Size of Aggregate	20mm
5.	Maximum Water/Cement Ratio	0.55
6.	Minimum Cementitious Content	300 kg/m³
7.	Workability	130mm Slump
8.	Exposure Condition	Mild (For Reinforced Concrete)
9.	Degree of Quality Control	Good
10.	Method of Concrete Placing	Pumping
11.	Type of Aggregate	Crushed Angular Aggregate
12.	Maximum Cement Content	450 kg/m³
13.	Chemical Admixture Type	PCE

1. Calculation of target strength:

f'ck = fck + 1.65 x S ……... (S = Standard Deviation)

f'ck = 20 + 1.65 x 4 ……... (S = 4 N/mm^2 – IS-10262-2019, Table- 1 P. no. 3)

f'ck = 26.6 N/mm^2

2. Water Cement Ratio:

Exposure – Mild ……... (IS-456-2000, Table- 3 & 5, P. No. 20)

Water Cement Ratio = 0.46 ……... (Assumed)

3. Calculation of Water Content:

20mm Aggregate – 186 kg (for 50mm slump) …... (IS- 10262, Table- 4, P. No. 5)

100mm slump – for every 25mm – add 3% …... (IS- 10262- cl.5.3)

186 + 6% of 186 = 197 kg

For super plasticizer reduce 21.5% (197 – (21.5% of 197)) = 155 kg

Water Content = 155 kg

4. Calculation of Cement Content:

Cement Content = Water Content / Water Cement Ratio

Cement Content = 155 / 0.46

Cement Content = 336 kg

5. Aggregates proportion between C.A. & F.A.

Zone – II – 0.62 (w/c – 0.5) ……. (IS- 10262, Table- 5, P. No. 6, cl.5.5.1)

0.62 – 0.01 = 0.61 …….. (Every 0.05 increase reduce 0.01)

For pumpable concrete C.A can reduced up to 10% (IS- 10262, cl.5.5.2)

Vol. of Course Aggregates = 0.61- (10% of 0.61) = 0.549

6. Mix Calculation:

- Volume of Concrete – 1m^3
- Volume of Cement

  (Mass / Sp. Gravity) X (1 / 1000) = 336 / (3.15 X 1000) = 0.106 m^3
- Volume of Water

  (Mass / Sp. Gravity) X (1 / 1000) = 155 / (1 X 1000) = 0.155 m^3
- Volume of Admixture

  Mass – 1.1% of Cement = 1.1% of 336 = 3.696 kg

  (Mass / Sp. Gravity) X (1 / 1000) = 3.696 / (1.12 X 1000) = 0.0033 m^3
- Volume of all in Aggregate

  a – (b+c+d) = 1- (0.106 + 0.155 + 0.0033) = 0.735
- Mass of Coarse Aggregates

  Vol. of all in Aggregate X Vol. of C.A X Sp. Gravity of C.A X 1000

  0.735 X 0.549 X 2.88 X 1000 = 1160 kg
- Mass of Fine Aggregate

  Vol. of all in Aggregate X Vol. of F.A X Sp. Gravity of F.A X 1000

  0.735 X 0.451 X 2.85 X 1000 = 945 kg

1) Concrete mixing proportion of M30 grade:

a) Stipulations for proportioning

1.	Grade Of Concrete	M30
2.	Type Of Cement to be used	OPC 53 Grade Conforming to IS 12269:2013
3.	Fly ash	Confirming to IS 3812:1981 Part I & Part II
4.	Maximum Size of Aggregate	20mm
5.	Maximum Water/Cement Ratio	0.50
6.	Minimum Cementitious Content	300 kg/m^3

7.	Workability	130mm Slump
8.	Exposure Condition	Mild (For Reinforced Concrete)
9.	Degree of Quality Control	Good
10.	Method of Concrete Placing	Pumping
11.	Type of Aggregate	Crushed Angular Aggregate
12.	Maximum Cement Content	450 kg/m³
13.	Chemical Admixture Type	PCE

1. **Calculation of target strength:**

f'ck = fck + 1.65 x S ……... (S = Standard Deviation)

f'ck = 30 + 1.65 x 5 ……... (S = 5 N/mm^2 – IS-10262-2019, Table- 1 P. no. 3)

f'ck = 38.25 N/mm^2

2. **Water Cement Ratio:**

Exposure – Severe ……... (IS-456-2000, Table- 3 & 5, P. No. 20)

Water Cement Ratio = 0.39 ……... (Assumed)

3. **Calculation of Water Content:**

20mm Aggregate – 186 kg (for 50mm slump) …... (IS- 10262, Table- 4, P. No. 5)

100mm slump – for every 25mm – add 3% …... (IS- 10262- cl.5.3)

186 + 6% of 186 = 197 kg

For super plasticizer reduce 21.5% (197 – (21.5% of 197)) = 154.5 kg

Water Content = 154.5 kg

4. **Calculation of Cement Content:**

Cement Content = Water Content / Water Cement Ratio

Cement Content = 154.5 / 0.39

Cement Content = 396 kg

5. **Aggregates proportion between C.A. & F.A.**

Zone – II – 0.62 (w/c – 0.5) ……. (IS- 10262, Table- 5, P. No. 6, cl.5.5.1)

0.62 + 0.01 = 0.63 ……... (Every 0.05 decrease increase 0.01)

For pumpable concrete C.A can reduced up to 10% (IS- 10262, cl.5.5.2)

Vol. of Course Aggregates = 0.63- (10% of 0.63) = 0.567

6. **Mix Calculation:**

- Volume of Concrete – 1m^3
- Volume of Cement

  (Mass / Sp. Gravity) X (1 / 1000) = 396 / (3.15 X 1000) = 0.125 m^3
- Volume of Water

  (Mass / Sp. Gravity) X (1 / 1000) = 154.5 / (1 X 1000) = 0.1545 m^3
- Volume of Admixture

  Mass – 1.1% of Cement = 1.1% of 396 = 4.356 kg

  (Mass / Sp. Gravity) X (1 / 1000) = 4.356 / (1.12 X 1000) = 0.0038 m^3

- Volume of all in Aggregate

  a – (b+c+d) = 1- (0.125 + 0.154.5 + 0.0038) = 0.716

- Mass of Coarse Aggregates

  Vol. of all in Aggregate X Vol. of C.A X Sp. Gravity of C.A X 1000

  0.716 X 0.567 X 2.88 X 1000 = 1169 kg

- Mass of Fine Aggregate

  Vol. of all in Aggregate X Vol. of F.A X Sp. Gravity of F.A X 1000

  0.716 X 0.433 X 2.85 X 1000 = 883 kg

Moisture correction:

1. Measure Moisture Content: Determine the moisture content of fine and coarse mixes to ensure they dry properly or for SSD.

2. Adjust the water-cement ratio: Adjust the water-cement ratio according to the moisture content of the Aggregate to maintain the consistency of the mixture.

By treating moisture, the difference can be reduced and the comparative value of mixed concrete can be increased. Formula: Moisture purification value = good quality × (water absorption rate × moisture) %.

Moisture Correction for M20 & M30 mix:

Material	M20		M30	
	Moisture	Water Absorption	Moisture	Water Absorption
F.A - Sand	0.0	2.72%	0.2	2.72%
C.A – 10 mm	0.0	1.05%	0.2	1.05%
C.A – 20 mm	0.0	1.05%	0.0	1.05%

6.3 Mix proportion:

A. Mix proportion of M20 & M30 conventional concrete for 1m^3:

Sr. No.	Ingredient	M20		M30	
		Percentage	Kg/m^3	Percentage	Kg/m^3
1.	Total cementitious	-	336	-	396
2.	Portland cement	100%	336	100%	396
3.	Portland fly ash	-	-	-	-
4.	Free water	0.46	192.88	0.39	188.15
5.	Total coarse Aggregates	54.9%	1160	56.7%	1169
6.	Total fine Aggregates	45.1%	945	43.3%	883
7.	Coarse Aggregates - I	37%	424.69	37%	428.86
8.	Coarse Aggregates - II	63%	723.13	63%	728.74
9.	Fine Aggregates - I	0%	0	0%	0
10.	Fine Aggregates - II	100%	919.3	100%	860.75
11.	Admixture	1.10%	3.696	1.10%	4.356

12.	Volume of all in Aggregate in m^3	-	0.735	-	0.716
13.	Total density of fresh concrete	-	2550	-	2550

C. Mix proportion of M20 & M30 bacterial concrete for 1m³:

Sr. No.	Ingredient	M20		M30	
		Percentage	Kg/m³	Percentage	Kg/m³
1.	Total cementitious	-	336	-	396
2.	Portland cement	100%	336	100%	396
3.	Portland fly ash	-	-	-	-
4.	Bacteria	1.35%	4.5	1.35%	5.3
5.	Free water	0.46	192.88	0.39	188.15
6.	Total coarse Aggregates	54.9%	1160	56.7%	1169
7.	Total fine Aggregates	45.1%	945	43.3%	883
8.	Coarse Aggregates - I	37%	424.69	37%	428.86
9.	Coarse Aggregates - II	63%	723.13	63%	728.74
10.	Fine Aggregates - I	0%	0	0%	0
11.	Fine Aggregates - II	100%	919.3	100%	860.75
12.	Admixture	1.10%	3.696	1.10%	4.356
13.	Volume of all in Aggregate in m^3	-	0.735	-	0.716
14.	Total density of fresh concrete	-	2550	-	2550

E. Mix proportion of M20 & M30 bacterial concrete with Fly Ash for 1m³:

Sr. No.	Ingredient	M20		M30	
		Percentage	Kg/m³	Percentage	Kg/m³
1.	Total cementitious	-	336	-	396
2.	Portland cement	81.55%	274	83.34%	330
3.	Portland fly ash	18.45%	62	16.66%	66
4.	Bacteria	1.35%	4.5	1.35%	5.3
5.	Free water	0.46	192.88	0.39	188.15
6.	Total coarse Aggregates	54.9%	1160	56.7%	1169
7.	Total fine Aggregates	45.1%	945	43.3%	883
8.	Coarse Aggregates - I	37%	424.69	37%	428.86
9.	Coarse Aggregates - II	63%	723.13	63%	728.74

10.	Fine Aggregates - I	0%	0	0%	0
11.	Fine Aggregates - II	100%	919.3	100%	860.75
12.	Admixture	1.10%	3.696	1.10%	4.356
13.	Volume of all in Aggregate in m^3	-	0.735	-	0.716
14.	Total density of fresh concrete	-	2550	-	2550

6.4 Material batching & mixing:

Material batching for M20 & M30 conventional concrete:

Sr. No.	Ingredients	M20 Batching			M30 Batching		
		1 m^3 (kg)	0.026 m^3 (kg)	0.003375 m^3 (gm)	1 m^3 (kg)	0.026 m^3 (kg)	0.003375 m^3 (gm)
1.	Cement	336	8.73	1134	396	10.29	1336.5
2.	Water	192.88	5.01	650.97	188.15	4.89	635.00
3.	F.A- sand	919.3	23.90	3102.63	860.75	22.37	2905.03
4.	C.A- 10 mm	424.69	11.04	1433.32	428.86	11.15	1447.40
5.	C.A- 20 mm	723.13	18.80	2441.13	728.74	18.94	2459.49
6.	Admixture	3.696	0.096	12.47	4.356	0.113	14.70

Material batching for M20 & M30 bacterial concrete:

Sr. No.	Ingredients	M20 Batching			M30 Batching		
		1 m^3 (kg)	0.026 m^3 (kg)	0.003375 m^3 (gm)	1 m^3 (kg)	0.026 m^3 (kg)	0.003375 m^3 (gm)
1.	Cement	336	8.73	1134	396	10.29	1336.5
2.	Water	192.88	5.01	650.97	188.15	4.89	635.00
3.	F.A- sand	919.3	23.90	3102.63	860.75	22.37	2905.03
4.	C.A- 10 mm	424.69	11.04	1433.32	428.86	11.15	1447.40
5.	C.A- 20 mm	723.13	18.80	2441.13	728.74	18.94	2459.49
6.	Admixture	3.696	0.096	12.47	4.356	0.113	14.70
7.	Bacteria	4.5	0.117	15.18	5.3	0.137	17.88

Material batching for M20 & M30 bacterial concrete with Fly ash

Sr. No.	Ingredients	M20 Batching			M30 Batching		
		1 m^3 (kg)	0.026 m^3 (kg)	0.003375 m^3 (gm)	1 m^3 (kg)	0.026 m^3 (kg)	0.003375 m^3 (gm)
1.	Cement	336	8.73	1134	396	10.29	1336.5

2.	Water	192.88	5.01	650.97	188.15	4.89	635.00
3.	F.A- sand	919.3	23.90	3102.63	860.75	22.37	2905.03
4.	C.A- 10 mm	424.69	11.04	1433.32	428.86	11.15	1447.40
5.	C.A- 20 mm	723.13	18.80	2441.13	728.74	18.94	2459.49
6.	Admixture	3.696	0.096	12.47	4.356	0.113	14.70
7.	Bacteria	4.5	0.117	15.18	5.3	0.137	17.88
8.	Fly ash	62	1.612	209.25	66	1.716	222.46

Casting of concrete cubes:

1. Prepare Cube Molds: Ensure clean Molds, apply form release agent.
2. Mix Concrete: Prepare mixtures per predetermined designs.
3. Fill Molds: Place Molds, transfer concrete, compact layers.
4. Finishing: Remove excess concrete, label Molds.

We Observe that while preparing the bacterial concrete and bacterial concrete with fly ash when we add bacterial agent it is difficult to get required slump value.

Curing of Cubes:

Cube curing is a controlled process that allows concrete to harden and gain strength after it has been poured. It involves placing the concrete in a tank or curing chamber for a specified period (usually 7 or 28 days) to ensure adequate hydration of the cement particles and strength development. This helps prevent cracking and ensures the concrete achieves its strength and durability. The curing process of a cube also helps in the heat of hydration of cement. For the first week, we used the sprinkling method of curing bacterial concrete cubes and after that, we dipped the blocks in the water tank for the curing.

Testing of Blocks:

Evaluation of concrete involves the concrete process, treatment according to control, and compressive properties are made using the testing machine,

- This test determines the compressive strength of concrete, which is a measure of its ability to withstand axial loads.
- Concrete is placed in the pressure testing machine and gradually increasing pressure force is used until it breaks.

- The maximum failure rate is recorded and the compressive strength is calculated by dividing this factor by the cross-sectional area of the cube.

7. Observation:

1. Conventional concrete

Block No.	M20			M30		
	Compressive Strength 7 Days	Compressive Strength 14 Days	Compressive Strength 28 Days	Compressive Strength 7 Days	Compressive Strength 14 Days	Compressive Strength 28 Days
1.	19.82	26.22	30.53	27.02	37.15	38.26
2.	17.73	25.51	30.71	26.71	36.48	39.82
3.	18.53	25.06	30.26	29.82	37.95	36.35
Avg.	18.69	25.59	30.50	27.85	37.19	38.14

2. Bacterial Concrete

Block No.	M20			M30		
	Compressive Strength 7 Days	Compressive Strength 14 Days	Compressive Strength 28 Days	Compressive Strength 7 Days	Compressive Strength 14 Days	Compressive Strength 28 Days
1.	16.4	22.00	27.06	27.11	35.51	36.04
2.	15.15	22.35	26.53	26.53	34.80	36.66
3.	17.06	21.51	26.17	26.71	35.64	36.35
Avg.	16.20	21.95	26.58	26.78	35.31	36.35

3. Bacterial Concrete With fly Ash

Block No.	M20			M30		
	Compressive Strength 7 Days	Compressive Strength 14 Days	Compressive Strength 28 Days	Compressive Strength 7 Days	Compressive Strength 14 Days	Compressive Strength 28 Days
1.	18.44	25.73	30.84	27.15	36.04	38.75
2.	19.51	25.20	30.44	26.71	37.20	38.53
3.	17.82	24.48	31.06	26.88	36.66	38.00
Avg.	18.59	25.13	30.78	26.91	36.63	38.42

8. Results:

Final Result of 7, 14 & 28 Days Compressive Strength of M20 & M30 Grade Concrete:

Sr. No.	Type of Concrete	M20 Compressive Strength			M30 Compressive Strength		
		7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
1.	Conventional Concrete	18.69	25.59	30.50	27.85	37.19	38.14
2.	Bacterial Concrete	16.20	21.95	26.58	26.78	35.31	36.35
3.	Bacterial Concrete with Fly Ash	18.59	25.13	30.78	26.91	36.63	38.42

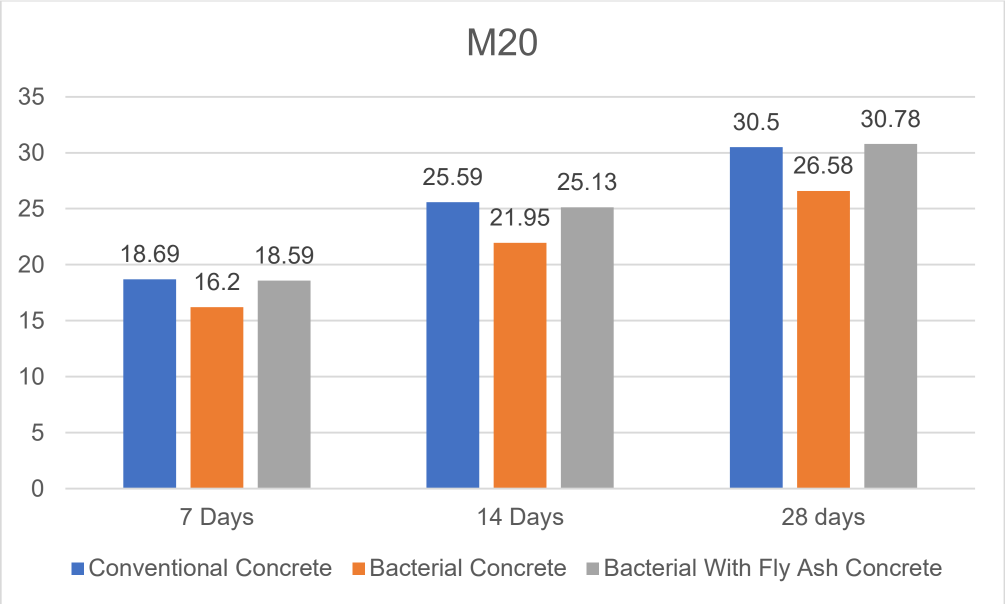

Fig. No. 2 – Compressive Strength of M20 Grade Concrete

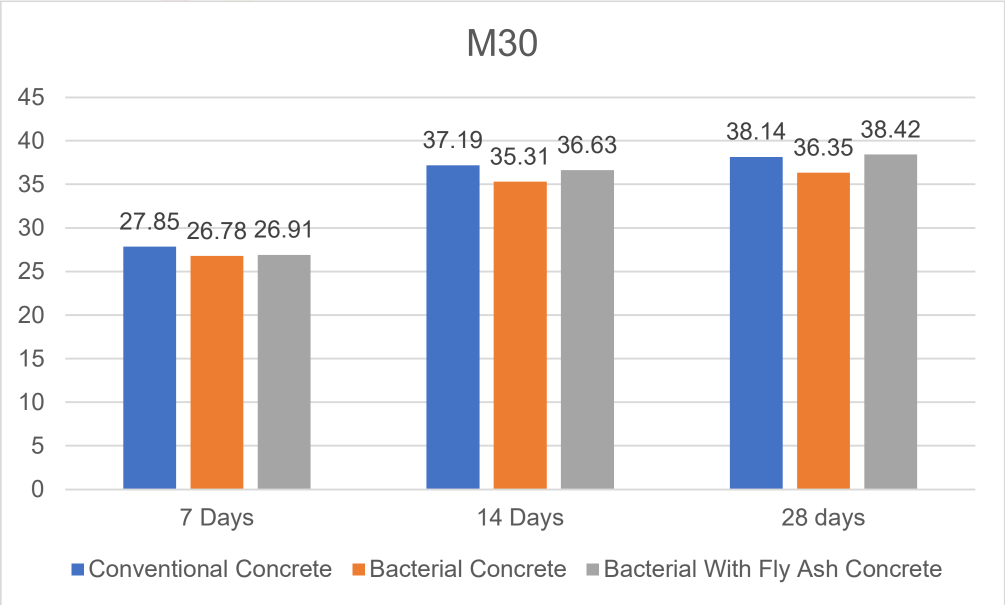

Fig. No. 3 – Compressive Strength of M30 Grade Concrete

8. Conclusion:

- Concrete with fly ash exhibits superior properties and durability compared to traditional concrete.
- Incorporating fly ash enhances the strength and longevity of concrete structures.
- Despite higher initial costs, the long-term treatment expenses are reduced due to the self-healing capabilities of fly ash-added concrete.
- The utilization of fly ash in concrete offers sustainable solutions for construction projects.
- Bacterial concrete presents a promising avenue for developing stronger and more environmentally friendly buildings.
- The reinforcement of concrete structures through bacterial concrete leads to enhanced durability and resilience.
- Overall, the adoption of fly ash and bacterial concrete contributes to sustainable and cost-effective construction practices.

8. Reference:

1) Shubham A. Puranik, Siddharth Jain, G. Sitaram, Sayali Sandbhor (September 2019), "Bacterial Concrete-A Sustainable Solution for Concrete Maintenance", IJITEE, ISSN: 2278-3075, Volume-8, Issue-11S, September 2019.

2) Bhagyashree Pawar, Archana Magdum, Megh Bhosale, Sayali Pol (2017), "Bacterial Concrete", JIKRCE, ISSN: 0975-6744, Volume-4, Issue-2, Nov 16 to Oct 17.

3) Chaitanya B. Ghatol, L. G. Kalurkar, (2020), "Bacteria-Based Self-Healing Concrete Incorporated with Industrial Waste (Fly Ash) for the Development of Sustainable concrete", JETIR, ISSN: 2349-5162, Volume-7, Issue-8, August 2020.

4) Ishraq Mohammad Ali Khattab, Hazhar Shekha1, Mohammed Abukar Abdi1, (2019), "Study on Self-healing concrete Types", SSM (E-Journal), ISSN: 76-87, Volume- 2, Issue-1, 2019.

5) Md Montaseer Meraz, Nusrat Jahan Mim, Md Tanjid Mehedi, Badhon Bhattacharya, Md. Reduan Aftab, Md. Mustakim Billah, Md. Musfike Meraz, (2023), "Self-healing concrete: Fabrication, advancement, and effectiveness for long-term integrity of concrete infrastructures", AEJ, ISSN: 665-694, Volume-73, 2023.

6) El ˙zbieta Stanaszek-Tomal, (2020), "Bacterial Concrete as a Sustainable Building Material?", 12, 696; doi:10.3390/su12020696, 2020.

7) Sandip Chandra, Dr. Sulagno Banerjee, (2023), "Bacterial Concrete - A Review Paper", IJIRT, ISSN: 2349-6002, Volume 9, Issue 10, march 2023.

8) Mounika, scree naga Chaitanya, dr.k. chandramouli, (2018), "Experimental study on bacterial concrete", SSRG International journal of Civil engineering, ISSN – 2348-8352, Special Issue ICITSET, Sept 2018.

9) Er. Sumit Sharma, Shishupal Singh, (2021), "Study of Behaviour of Bacterial Concrete", IJAEM, ISSN: 2395-5252, Volume 3, Issue 12, Dec 2021.

10) Yasmeena Javeed, Yingxin Goh, Kim Hung Mo, Soon Poh Yap, Bey Fen Leo, (2024), "Microbial self-healing in concrete: A comprehensive exploration of bacterial viability, implementation techniques, and mechanical properties", Journal of Materials Research and Technology, ISSN - 2376–2395, Feb 2024.

11) Rashmi Khambenour, Dr Ashwini L K, Mallikarjun S D, Dr Shivaprasad H, (2023), "A Comparative Analysis Between Self-healing Bio Concrete and Conventional Concrete", Eur. Chem. Bull., ISSN - 2953-2960, Volume 12, Issue 10, 2023.

12) k. Keerthana, a. Ranjani, n. K. Amudhavalli, (2016), "comparative study on bacterial Concrete using bacillus sphaericus and escherichia coli", IJIRT, ISSN: 2349-6002, Volume 2, Issue 10, March 2016.

13) Ruchika Dhole, Pragati Zalke, Nitesh Sakhare, Avinash Madankar, Vedika Deshbhratar, Gopal Dhanjode, (2020), "Comparative Study of Bacterial Concrete Over Normal Concrete", IRJET, e-ISSN: 2395-0056, p-ISSN: 2395-0072, Volume: 07, Issue: 09, Sept 2020.

14) Chithra P Bai, Shibi Varghese, (2016), "An experimental investigation on the strength properties of fly ash based bacterial concrete", IJIRAE, ISSN: 2349-2763, Volume 3, Issue 08, Aug 2016.

15) Santosh Ashok Kadapure, Girish S. Kulkarni, K. B. Prakash, (2019), "Study on properties of bacteria-embedded fly ash concrete", Asian Journal of Civil Engineering, ISSN - 627–636, 2019.

16) Santosh A. Kadapure, Girish Kulkarni, K.B Prakash and Poonam S. Kadapure, (2020), "Mechanical and durability performance of sustainable bacteria blended fly ash concrete: an experimental study", International Journal of Sustainable Engineering, ISSN – 45 – 53, Volume 13, 2020.