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EXPERIMENTAL INVESTIGATION ON CONCRETE WITH ALCCOFINE1203 AND BIO CEMENT

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Abstract:

This study presents an experimental investigation aimed at enhancing the properties of concrete through the incorporation of bio cement and Alccofine1203. Bio cement, derived from microbial-induced calcium carbonate precipitation, offers potential benefits such as self-healing properties and increased durability. Alccofine1203, a high-performance superplasticizer, is known for its ability to improve the workability and strength characteristics of concrete. In this research, various mixes of concrete incorporating different proportions of bio cement and Alccofine1203 are prepared and tested for compressive and split tensile strength. The experimental results are analyzed to assess the influence of bio cement and Alccofine1203 on the mechanical and durability properties of concrete at 28, 56, and 90 days. The findings of this study contribute to understanding the synergistic effects of bio cement and Alccofine1203 in enhancing concrete performance, providing valuable insights for sustainable and durable construction practices.

Key words: Bio cement, Alccofine 1203, Enhancing , Microbial-induced, Compressive strength and Split tensile strength

1. INTRODUCTION

Concrete is among the most extensively utilized construction materials worldwide; however, its production poses substantial environmental challenges, primarily due to the significant carbon emissions linked to the manufacturing of ordinary Portland cement (OPC). This study explores the use of bio-cement and Alccofine 1203 as supplementary cementitious materials to create a more sustainable and efficient concrete mix.

Bio-Cement:
Bio-cement, produced through microbial processes, is a groundbreaking material that employs microorganisms to precipitate calcium carbonate. This method, known as microbial-induced calcite precipitation (MICP), has the potential to lower the carbon footprint of concrete production while improving its mechanical and durability characteristics. Bio-cement has garnered interest for its capacity to enhance the binding properties of concrete and increase its resistance to environmental degradation.

Alccofine1203:
Alccofine 1203 is an ultrafine slag-based supplementary cementitious material that improves concrete performance by enhancing workability, strength, and durability. Its ultra-fine particles and distinctive size distribution promote better dispersion within the mix, leading to a denser concrete matrix and reduced permeability

2. OBJECTIVES

1. Evaluate the effects of incorporating bio-cement and Alccofine 1203 on the compressive and tensile strength of concrete, aiming to determine the optimal proportions of these materials for improved mechanical performance.

2.Investigate the durability properties, including resistance to sulfate attack, chloride penetration, and ater permeability, while assessing the environmental advantages, such as carbon footprint reduction and resource efficiency, associated with using bio-cement and Alccofine 1203 in concrete.

3. MATERIALS

3.1 Cement: Cement is a finely ground powder composed of clay, limestone, and other minerals that undergoes a chemical reaction called hydration when mixed with water, forming a solid binding material. As the key ingredient in concrete, it provides structural stability and strength. However, its production is highly energy-intensive and generates substantial carbon dioxide emissions, highlighting the need to explore sustainable

alternatives and additives to reduce its environmental impact.

3.2 Fine aggregate: Fine aggregate is a granular material typically consisting of natural sand, crushed stone, or crushed gravel, with particles fine enough to pass through a 4.75 mm (No. 4) sieve. It fills the voids between coarse aggregates, creating a dense and well-graded mixture in concrete or mortar. By enhancing the mixture's smoothness and cohesiveness, fine aggregate plays a vital role in improving workability, strength, and overall quality.

3.3 Coarse aggregate: Coarse aggregate comprises large, durable particles such as gravel, crushed stone, or slag, typically sized between 4.75 mm and 40 mm. Serving as the primary load-bearing element in concrete, it contributes structural strength, stability, and volume to the mix. Coarse aggregates are essential for forming a robust and dense concrete matrix, enhancing durability, minimizing shrinkage, and improving the concrete's overall mechanical properties.

3.4 Water: Water is a crucial component of concrete, triggering the hydration process that enables cement to harden and bond aggregate particles. The amount and quality of water in the mix play a significant role in determining the concrete's workability, setting time, strength, and durability. Managing the water-to-cement ratio is essential to achieving a balance between workability and strength; too much water increases porosity and weakens the concrete, while too little water impairs compaction and makes the mix challenging to handle.

3.5 Bio Cement: Bio-cement is an environmentally friendly material created through microbial-induced calcite precipitation (MICP), a process in which microorganisms facilitate the formation of calcium carbonate. This enhances the bonding properties of concrete and boosts its durability. As a sustainable alternative to traditional cement, bio-cement helps reduce carbon emissions and is gaining attention for its potential in green construction and environmental remediation.

3.6 Alccofine1203: Alccofine 1203 is an ultrafine supplementary cementitious material produced from slag-based industrial by-products. Renowned for its high fineness and distinctive particle size distribution, it enhances the workability, strength, and durability of concrete. By reducing porosity and increasing density, Alccofine 1203 strengthens the concrete matrix, making it well-suited for high-performance applications such as bridges, dams, and marine structures.

4. EXPERIMENTAL RESULTS

4.1 Compressive strength

The compressive strength of a concrete cube is the maximum load it can withstand before failing under compression. It is measured by crushing the cube in a compression testing machine, typically after 28,56 and 90 days of curing. This value indicates the concrete's load-bearing capacity and overall durability.

Table 1: Compressive Strength of concrete with Bio cement as partial replacement for cement.

S.No	% of Bio Cement	Compressive Strength Results, N/mm²		
		28 days	56 days	90 days
1	0	27.68	29.96	32.18
2	0.5	31.16	33.94	36.41
3	1	31.84	34.72	37.27
4	1.5	29.83	32.53	34.96

Table 2: Compressive Strength of concrete with Alccofine1203 as partial replacement for Cement

S.No	% of Alccofine 1203	Compressive Strength Results, N/mm²		
		28 days	56 days	90 days
1	0	27.68	29.96	32.18
2	5	30.31	33.01	35.42
3	10	32.05	34.92	37.48
4	15	29.93	32.87	35.45

Table-3: Combined replacement of Compressive strength results

S.No	% of Bio cement + Alccofine 1203	Compressive Strength Results, N/mm²		
		28 days	56 days	90 days
1	0	27.68	29.96	32.18
2	1% of bio cemnt + 10% AF	33.79	37.08	39.87

4.2 Split tensile strength

The split tensile strength of a concrete cylinder indicates its ability to withstand tensile stress and is measured by applying a load horizontally across its diameter.

Table 4: Split tensile Strength of concrete with Bio cement as partial replacement for cement.

S.No	% of Bio Cement	Split tensile Strength Results, N/mm²		
		28 days	56 days	90 days
1	0	2.81	3.06	3.28
2	0.5	3.08	3.35	3.61
3	1	3.24	3.59	3.83
4	1.5	2.95	3.24	3.56

Table 5: Split tensile Strength of concrete with Alccofine1203 as partial replacement for Cement

S.No	% of Alccofine 1203	Split tensile Strength Results, N/mm²		
		28 days	56 days	90 days
1	0	2.81	3.06	3.28
2	5	2.99	3.27	3.53
3	10	3.23	3.54	3.86
4	15	2.96	3.25	3.51

Table-6: Combined replacement of Split tensile strength results

S.No	% of Bio cement + Alccofine 1203	Split tensile Strength Results, N/mm²		
		28 days	56 days	90 days
1	0	2.81	3.06	3.28
2	1% of bio cemnt + 10% AF	3.41	3.72	4.02

5. CONCLUSION

1. The normal concrete compressive strength results for 28, 56 and 90 days are given are 27.68, 29.96 and 32.18 N/mm².
2. At optimum of 1.0% bio cement is partial replacement with cement. The compressive strength results is 31.84,34.72 and 37.27N/mm² at 28, 56 and 90 days.
3. At optimum of 10% Alccofine1203 is partial replacement with cement. The compressive strength results is 32.05, 34.92 and 37.58 N/mm² at 28, 56 and 90 days.
4. Combination of 1.0% bio cement with cement + 10% Alccofine1203 with cement. The compressive strength results is 33.79 37.08 and 39.87 N/mm² at 28, 56 and 90 days.
5. The normal concrete split tensile strength results for 28, 56 and 90 days are given as 2.81,3.06 and 3.28 N/mm².
6. At optimum of 1.0% replacement of the cement with bio cement which gives split tensile strength results for 28, 56 and 90 days are given as 3.24, 3.59 and 3.83 N/mm².
7. At optimum of 10% replacement of the cement with Alccofine1203 which gives split tensile strength results for 28, 56 and 90 days are given as 3.23, 3.54 and 3.86 N/mm².
8. Combination of 1.0% bio cement with cement + 10% Alccofine1203 with cement. The split tensile strength results is 3.41,3.72 and 4.02 N/mm² at 28, 56 and 90 days .

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