Vol-08 Issue 03, March- 2024 Impact Factor: 7.936

ISSN: 2456-9348

iJETRM

International Journal of Engineering Technology Research & Management

www.ijetrm.com

MECHANICAL PROPERTIES OF BACTERIA SUBTILIS CONCRETE WITH DOLOMITE

[1] J.Sree Naga Chaitanya, [2] Dr.K.Chandramouli, [3]Sk.Sahera, [4] Mohammad Abdullah

[1&3] Assistant Professor, Department of Civil Engineering, NRI Institute of Technology, Visadala (V),Medikonduru(M),Guntur,AndhraPradesh,India. [2]Professor & HOD, Department of Civil Engineering, NRI Institute of Technology, Visadala (V), Medikonduru (M), Guntur, Andhra Pradesh, India.

[4]B.Tech Student, Department of Civil Engineering, NRI Institute of Technology, Visadala (V), Medikonduru (M), Guntur, Andhra Pradesh

Abstract:

Concrete, a fundamental material in construction, often faces durability challenges due to various factors including carbonation, chloride ingress, and microbial-induced deterioration. This study investigates the synergistic effects of incorporating dolomite and Bacillus subtilis bacteria in concrete to enhance its durability. Dolomite, a mineral rich in calcium and magnesium carbonates, serves as a supplementary cementitious material and offers potential benefits such as improved workability, reduced permeability, and increased resistance to acid attack. To assess compressive strength and split tensile strength for 7 and 28 days.

Keywords

Dolomite, Bacillus Subtilis, Workability, Compressive Strength and Split Tensile Strength.

1. INTRODUCTION

Concrete is the most widely used construction material globally due to its strength, durability, and versatility. However, despite its widespread application, concrete structures are susceptible to various forms of deterioration over time, including carbonation, chloride ingress, and microbial-induced corrosion. These challenges necessitate continuous efforts to enhance the durability and longevity of concrete structures.

Cement production is energy-intensive and contributes significantly to carbon dioxide emissions, making it imperative to explore alternative materials that can mitigate environmental impact. Dolomite, when finely ground and added to concrete mixes, acts as a supplementary cementitious material (SCM), effectively reducing the clinker content in cementitious blends. This not only conserves natural resources but also lowers the overall carbon footprint of concrete production.

Bacillus subtilis is a Gram-positive, rod-shaped bacterium known for its ability to thrive in various environmental conditions, including those present in concrete. This bacterium has been extensively studied for its role in biomineralization processes, particularly the precipitation of calcium carbonate (CaCO3). When provided with a suitable calcium source and carbon dioxide, Bacillus subtilis can enzymatically catalyze the formation of calcium carbonate crystals, a phenomenon known as microbial-induced carbonate precipitation (MICP).

2. OBJECTIVES

(a) Bacillus subtilis in concrete is to improve its durability.

(b) Dolomite's ability to reduce permeability and increase resistance to chemical attacks.

(c) To determine the Compressive strength and Split tensile Strength.

iJETRM
International Journal of Engineering Technology Research & Management
www.ijetrm.com

3. MATERIALS

1. Cement:- Cement is a binding material commonly used in construction that serves as the primary ingredient in concrete, mortar, and grout. It is a fine powder typically made from a mixture of limestone, clay, shale, iron ore, and other materials, which are heated in a kiln at high temperatures to form a clinker.
2. Fine aggregate:- Fine aggregate also known as sand, is a granular material typically composed of particles ranging in size from 0.075 millimeters (mm) to 4.75 mm in diameter. It is one of the primary components of concrete and mortar mixes, along with coarse aggregate (such as gravel or crushed stone) and cement.
3. Coarse aggregate:- Coarse aggregate refers to granular materials typically ranging in size from 4.75 millimeters (mm) to 75 mm in diameter, although the upper limit may vary depending on regional standards and specifications. It is one of the main constituents of concrete, alongside fine aggregate (sand) and cement.
4.Doloimie:- Due to its chemical composition, dolomite reacts with calcium hydroxide (a byproduct of cement hydration) to form additional calcium carbonate crystals. These crystals fill the pores and capillary voids within the concrete matrix, reducing permeability and enhancing durability.
5.Bacteria Subtilis:- Bacillus subtilis bacteria have the ability to induce biomineralization, particularly the precipitation of calcium carbonate ($CaCO_3$), when provided with a suitable calcium source and carbon dioxide. When incorporated into concrete mixes, these bacteria remain dormant until activated by moisture and nutrients present in the concrete matrix.
6. Water:- water plays a crucial role in concrete mixtures, influencing workability, strength, durability, and other properties of the hardened material. Proper water-cement ratio control, along with appropriate mix design and curing practices, is essential for producing high-quality and long-lasting concrete structures.

4. TEST RESULTS

(a) Compressive Strength: Compressive strength is a measure of the maximum load or force that a material can withstand under compression (pushing or squeezing) before it fails or fractures. To determine for 7 and 28 days.

Table 1 : Compressive Strength Results of Bacillus Subtilis

Sl.no	Bacillus subtilis	Compressive Strength Results,(N/mm^2)	
		7 days	28 days
1	0%	26.73	39.37
2	10^4 Cells/ml	31.67	45.29
3	10^5 Cells/ml	32.35	46.85
4	10^6 Cells/ml	29.23	41.89

Table 2: Compressive Strength Results of Partial Replacement of Cement With Dolomite Powder

Sl.no	% of Dolomite Powder	Compressive Strength Results,(N/mm^2)	
		7 days	28 days
1	0%	26.73	39.37
2	5%	27.62	40.92
3	10%	30.04	42.98

iJETRM

International Journal of Engineering Technology Research & Management

www.ijetrm.com

4	15%	31.76	45.29
5	20%	29.32	42.81

Table 3: Combined Replacements of Compressive Strength Results of Bacillus Subtilis and Dolomite powder

Sl.no	% of BS+ DOL	Compressive Strength Results,(N/mm^2)	
		7 days	28 days
1	0%	26.73	39.37
2	**10^5 Cells/ml** BS+15%Dol	34.38	49.91

Split Tensile Strength: Split tensile strength is an important property of concrete, as it provides insight into the material's resistance to cracking and tensile stresses. It is particularly relevant in applications where tensile forces are expected to be exerted on the concrete. To determine for 7 and 28 days.

Table 4 : Split Tensile Strength Results of Bacillus Subtilis

Sl.no	Bacillus subtilis	Split tensile Strength Results(N/mm^2)	
		7 days	28 days
1	0%	2.65	3.93
2	10^4 Cells/ml	3.09	4.43
3	10^5 Cells/ml	3.34	4.76
4	10^6 Cells/ml	2.87	4.14

Table 5: Split Tensile Strength Results of Partial Replacement of Cement With Dolomite Powder

Sl.no	% of Dolomite Powder	Split tensile Strength Results(N/mm^2)	
		7 days	28 days
1	0%	2.65	3.93
2	5%	2.72	4.04
3	10%	2.95	4.23
4	15%	3.24	4.63
5	20%	2.86	4.18

Table 6: Combined Replacements of Split Tensile Strength Results of Bacillus Subtilis and Dolomite powder

Sl.no	% of BS+ DOL	Split tensile Strength Results(N/mm^2)	
		7 days	28 days
1	0%	2.65	3.93

iJETRM
International Journal of Engineering Technology Research & Management
www.ijetrm.com

2	10^5 Cells/ml BS+15%Dol	3.44	4.93

5. CONCLUSIONS

1. The combined use of Bacillus subtilis bacteria and dolomite in concrete holds promise for improving durability, sustainability, and resilience in construction.
2. The Normal Concrete of Compressive Strength results for 7 and 28 days is 26.73 and 39.37 N/mm^2.
3. The Normal Concrete of Split tensile Strength results for 7 and 28 days is 2.65 and 3.93 N/mm^2.
4. By 10^5 Cells/ml of bacteria subtilis added in concrete the Compressive Strength results for 7 and 28 days is 32.35 and 46.85 N/mm^2.
5. By 10^5 Cells/ml of bacteria subtilis added in concrete the Split tensile Strength results for 7 and 28 days is 3.34and 4.76 N/mm^2.
6. By 15% of dolomite as partial replacement with cement the Compressive Strength results for 7 and 28 days is 31.76 and 45.29 N/mm^2.
7. By 15% of dolomite as partial replacement with cement the Split tensile Strength results for 7 and 28 days is 3.24 and 4.63 N/mm^2
8. By the combination of 10^5 Cells/ml BS+15%Dol the Compressive Strength results for 7 and 28 days is 34.38 and 49.91 N/mm^2.
9. By the combination of 10^5 Cells/ml BS+15%Dol the Split tensile Strength results for 7 and 28 days is 3.44 and 4.93 N/mm^2.

6.REFERENCES

1. Achal, V., Mukherjee, A., Reddy, M. S., & Chattopadhyay, D. (2011). Biogenic treatment improves the durability and remediates the cracks of concrete structures. Construction and Building Materials, 25(8), 4113-4125.
2. Jonkers, H. M., Thijssen, A., Muyzer, G., Copuroglu, O., & Schlangen, E. (2010). Application of bacteria as self-healing agent for the development of sustainable concrete. Ecological Engineering, 36(2), 230-235.
3. Dr.K. Chandramouli, Dr.N. Pannirselvam, J. Sree Naga Chaitanya, D. Venkateswara. A Partial Replacement of Natural Sand by M Sand in Bacterial Concrete, International Journal Of Innovative Research In Technology ,8(5),(2021),30-35.
4. Edalatmanesh, M. A., & Ranjbar, M. M. (2018). Incorporating Bacillus subtilis in concrete to induce calcite precipitation. Construction and Building Materials, 187, 624-631.
5. Sunil pratap Reddy, SeshagiriRao M V, Aparnac P, sasikalac(2010) "Performance of standard grade bacterial concrete." Asian journal of civil engineering (building and housing) Vol 11.
6. De Belie, N., Wang, J., & Verstraete, W. (2015). Biogenic calcium carbonate precipitation for limestone and dolomite repair. Cement and Concrete Composites, 56, 59-72.
7. J.Sree Naga Chaitanya,Dr.K.Chandramouli, Dr.N.Pannirselvam. Strength Studies On Concrete With Recron 3s Fiber By Partial Replacement Of The Fine Aggregates With Marble Powder And Cement With Dolomite, International Journal For Research & Development In Technology,16(2),(2021),1-6.
8. Jia, Z., Li, W., Yang, M., Xu, D., Chen, H., & Chen, H. (2020). Development of bacterial concrete using Bacillus subtilis and Micrococcus luteus. Construction and Building Materials, 262, 120236.
9. PROF.MAHESH YELBAR-Experimental study of performance of concrete with partial replacement of cement by dolomite//vol.6//issue.3//2020.

ISSN: 2456-9348

iJETRM

International Journal of Engineering Technology Research & Management

www.ijetrm.com

10. Achal, V., Mukherjee, A., Basu, P. C., & Reddy, M. S. (2011). Limestone and dolomite flux and their use in iron and steel plant. Journal of Mines, Metals and Fuels, 59(1-2), 1-8.
11. ATHULYA SUGATHAN-Experimental investigation on partial replacement of cement with dolomite powder//vol:6//issue:7,july2017.
12. P.Anantha Naga Sai, Dr.K.Chandramouli, J.Sree Naga Chaitanya, Dr.N.Pannirselvam . Strength Studies in Concrete with M-Sand and Silica Fume, International Advanced Research Journal in Science, Engineering and Technology,8(7),(2021),372-375.
13. Chandramouli,K, Pannirselvam,N, Vijayakumar,D, (2019), Strength Studies on Pine Apple Fibre Concrete with Nano Silica, International Journal of Innovative Technology and Exploring Engineering, 8(7), pp. 3063-3065.
14. J.SATHEESH KUMAR,G.PALANISELVAN,D.JAYGANESH AND J.VIJAYARAGHAVAN-Physical and chemical characteristics of dolomite for partial replacement of cement in M20 concrete //vol.1;5December2016 .
15. Pannirselvam,N, Chandramouli,K, Anitha,V, (2018), Pulse Velocity Test on Banana Fibre Concrete with Nano Silica, International Journal of Civil Engineering and Technology, 9(11), pp. 2853-58.