North Asian International Research Journal of Sciences, Engineering & I.T.

IRJIF. I.F. : 3.821

ISSN: 2454-7514 Vol. 8, Issue-8, August-2022

Index Copernicus Value: 52.88 Indian Citation Index Thomson Reuters ID: S-8304-2016

A Peer Reviewed Refereed International Journal

STRENGTH STUDIES ON CONCRETE WITH BAGASSE ASH, CHEBULLA POWDER, AND GRAPHENE OXIDE AS PARTIAL REPLACEMENT

[1]DR.K.CHANDRAMOULI, [2]J.SREE NAGA CHAITANYA, [3]K.DIVYA,[4]M ARUN KUMAR

[1]Professor & HOD,[2,3] Assistant Professor,[4]B. Tech Student
[1,2,3,4] Department of Civil Engineering, NRI Institute of Technology, Visadala (V), Medikonduru (M), Guntur, Andhra Pradesh, INDIA .
Email:jarugumillichaitanya1989@gmail.com, koduru_mouli@yahoo.com

ABSTRACT

This study explores the effects of incorporating Chebulla powder, bagasse ash, and graphene oxide in concrete as partial replacements for fine aggregate and cement. Concrete, composed primarily of cement, aggregates, and water, can be enhanced with supplementary materials to improve performance and sustainability. Chebulla powder, derived from the fruit of Terminalia chebula, is introduced as a partial fine aggregate replacement to enhance mechanical properties. Bagasse ash, an agricultural byproduct from sugarcane processing, is also utilized as a fine aggregate substitute, contributing to eco-friendly waste management. Graphene oxide (GO) is employed as a partial cement replacement, aimed at improving strength, durability, and microstructural characteristics. The investigation evaluates compressive and split tensile strength at 28, 56, and 90 days of curing to identify optimal replacement levels for maximum mechanical performance. Comparative analysis with conventional concrete highlights the improvements achieved. Chebulla powder and bagasse ash reduce environmental impact through the recycling of agricultural waste, while graphene oxide enhances bonding, reduces porosity, and increases load-bearing capacity. The findings demonstrate the potential of combining agricultural byproducts with advanced nanomaterials to produce sustainable, durable, and high-strength concrete suitable for modern structural applications.

***KEYWORDS:* Graphene Oxide,Chebulla powder,Bagasse ash,sustainability,Compressive strength and Split tensile strength**

1. INTRODUCTION

Concrete is one of the most widely used construction materials worldwide, valued for its versatility, durability, and high compressive strength. It is a composite made of cement, water, fine aggregate, and coarse aggregate that, when properly mixed and cured, forms a solid structure capable of sustaining heavy loads. To further enhance its mechanical and durability properties, supplementary materials, as well as industrial and agricultural by-products, can be incorporated into the mix.

Bagasse ash, a by-product of burning sugarcane bagasse the fibrous residue left after juice extraction is rich in silica and exhibits pozzolanic properties. When partially replacing fine aggregate, it can improve workability, strength, and durability while supporting sustainable use of agricultural waste.

Chebulla powder, obtained from the dried fruit of Terminalia chebula, is another natural material with potential as a fine aggregate replacement. Its bioactive compounds can refine the concrete microstructure, enhance bonding within the matrix, and improve mechanical performance, while promoting environmentally friendly construction practices.

Graphene oxide (GO), a two-dimensional nanomaterial, possesses outstanding mechanical, thermal, and chemical characteristics. When incorporated as a partial cement replacement, GO enhances the cement matrix, reduces porosity, and improves both compressive and tensile strength. Its addition also increases durability, crack resistance, and load-bearing capacity, making it a promising component in the development of high-performance concrete.

2. OBJECTIVES

1. To investigate the influence of bagasse ash, chebulla powder, and graphene oxide on the strength of concrete at 28, 56, and 90 days of curing.

2. To assess the effects of these materials on the overall strength and durability characteristics of concrete.

3. To identify the optimal replacement levels of bagasse ash, chebulla powder, and graphene oxide that yield maximum mechanical performance in concrete.

3. MATERIALS

3.1 Cement: Cement is a primary binding material in construction, produced mainly from limestone and clay. It reacts with water through hydration to form a hardened matrix that binds aggregates together.

3.2 Fine Aggregate: Fine aggregate consists of natural sand or crushed stone particles that pass through a 4.75 mm sieve. It fills voids between coarse aggregates and contributes to the strength, density, and workability of concrete.

3.3 Coarse Aggregate: Coarse aggregate includes gravel or crushed stone retained on a 4.75 mm sieve. It provides bulk, stability, and load-bearing capacity to concrete.

3.4 Water: Water is an essential ingredient in concrete, enabling cement hydration and ensuring workability, setting, and compaction. Both the quality and quantity of water significantly influence the strength and durability of concrete.

3.5 Bagasse Ash: Bagasse ash is a by-product obtained from burning sugarcane bagasse, a fibrous residue left after juice extraction. Rich in silica, it acts as a pozzolanic material, improving strength, durability, and sustainability when used in concrete.

3.6 Chebulla Powder: Chebulla powder is derived from the dried fruit of Terminalia chebula. When used as a partial replacement for fine aggregate, it enhances bonding within the matrix and improves mechanical performance.

3.7 Graphene Oxide: Graphene oxide (GO) is a two-dimensional nanomaterial with outstanding mechanical and chemical properties. As a partial cement replacement, it improves concrete's strength, durability, and crack resistance by refining the microstructure.

4. EXPERIMENTAL RESULTS

4.1 Compressive strength:-In this test, concrete cubes of standard size (usually 150 mm × 150 mm × 150 mm) are cast and cured. After 28, 56 and 90 days, the cubes are placed in a compression testing machine. Load is applied gradually until failure, and the maximum load is used to calculate compressive strength.

Table 1: Compressive strength results of concrete bagasse ash as partial replacement of fine aggregate.

Sl.no	% of bagasse ash	Compressive Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	39.06	42.18	45.32
2	5%	40.23	43.45	46.68
3	10%	40.58	43.83	47.07
4	15%	42.16	45.59	48.92
5	20%	40.83	44.07	47.36

Table 2: Compressive strength results of concrete chebulla powderas partial replacement of fine aggregate .

Sl.no	% of chebulla powder	Compressive Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	39.06	42.18	45.32
2	0.25%	49.54	53.51	57.46
3	0.5%	50.74	54.79	58.85
4	0.75%	51.57	55.64	59.98
5	1%	48.78	52.53	56.62

Table 3: Compressive strength results of concrete grapheme oxide as partial replacement of cement.

Sl.no	% of graphene oxide	Compressive Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	39.06	42.18	45.32
2	0.06%	54.25	58.59	62.93
3	0.12%	58.59	63.27	67.98
4	0.18%	54.95	59.34	63.72

Table 4: Compressive strength results of Combined replacement of 15%BSH+0.75%CP+0.12%GOin concrete.

Sl.no	15%BSH+0.75%CP+0.12%GO	Compressive Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	39.06	42.18	45.32
2	15%BSH+0.75%CP+0.12%GO	66.38	71.69	77.04

4.2 Split tensile strength: - **Split tensile strength** is an indirect method to evaluate the tensile resistance of concrete, since concrete is inherently weak in direct tension. In this test, a cylindrical specimen is placed horizontally and a compressive load is applied along its diameter. This loading induces tensile stresses inside the cylinder, causing it to split along the loaded diameter. The test is carried out at 28, 56 and 90 days of curing to study the cracking behavior and tensile strength development of concrete.

Table 5: Split tensile strength results of concrete bagasse ash as partial replacement of fine aggregate.

Sl.no	% of bagasse ash	Split tensile Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	3.82	4.13	4.48
2	5%	3.94	4.25	4.57
3	10%	4.01	4.38	4.64
4	15%	4.25	4.59	4.93
5	20%	4.06	4.46	4.84

Table 6: Split tensile strength results of concrete chebulla powder as partial replacement of fine aggregate .

Sl.no	% of chebulla powder	Split tensile Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	3.82	4.13	4.48
2	0.25%	4.84	5.24	5.61
3	0.5%	4.99	5.38	5.76
4	0.75%	5.21	5.62	6.04
5	1%	4.87	5.25	5.68

Table 7: Split tensile strength results of concrete grapheme oxide as partial replacement of cement.

Sl.no	% of graphene oxide	Split tensile Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	3.82	4.13	4.48
2	0.06%	5.31	5.73	6.15
3	0.12%	5.93	6.41	6.87
4	0.18%	5.48	5.97	6.34

Table 8: Compressive strength results of Split tensile replacement of 15%BSH+0.75%CP+0.12%GO in concrete.

Sl.no	15%BSH+0.75%CP+0.12%GO	Split tensile Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	3.82	4.13	4.48
2	15%BSH+0.75%CP+0.12%GO	6.83	7.38	7.92

5. CONCLUSION

1. Normal concrete without any replacement achieved a compressive strength of 39.06, 42.18 and 45.32 N/mm² at 28,56 and 90 days.
2. The use of bagasse ash (BSH) as a partial replacement of fine aggregate showed optimum compressive strength at 15% replacement, reaching 42.16, 45.59 and 48.92 N/mm² at 28,56 and 90 days.
3. The use of chebulla powder (CP) as a partial replacement of fine aggregate showed maximum compressive strength at 0.75% replacement, achieving 51.57, 55.64 and 59.98 N/mm² at 28,56 and 90 days.
4. The use of graphene oxide (GO) as a partial replacement of cement showed the highest compressive strength at 0.12% replacement, reaching 58.59, 63.27 and 67.98 N/mm² at 28,56 and 90 days.
5. The combined replacement of 15% BSH + 0.75% CP + 0.12% GO resulted in the maximum compressive strength of 66.38, 71.69 and 77.04 N/mm² at 28,56 and 90 days.significantly higher than normal concrete.
6. Normal concrete without any replacement achieved a split tensile strength of 3.82, 4.13 and 4.48 N/mm² at 28,56 and 90 days.
7. Bagasse ash (BSH) as partial replacement of fine aggregate showed optimum split tensile strength at 15% replacement, reaching 4.25, 4.59 and 4.93 N/mm² at 28,56 and 90 days.
8. Chebulla powder (CP) as partial replacement of fine aggregate showed maximum split tensile strength at 0.75% replacement, achieving 5.21, 5.62 and 6.04 N/mm² at 28,56 and 90 days.
9. Graphene oxide (GO) as partial replacement of cement showed the highest split tensile strength at 0.12% replacement, reaching 5.93, 6.41 and 6.87 N/mm² at 28,56 and 90 days.
10. The combined replacement of 15% BSH + 0.75% CP + 0.12% GO gave the highest split tensile strength, reaching 6.83, 7.38 and 7.92 N/mm² at 28,56 and 90days.demonstrating a significant improvement over normal concrete.

6. REFERENCES

1. Jagadesh, P., *et al.* (2023). Effect of processed sugarcane bagasse ash on concrete compressive strength improvements reported for various W/B ratios.
2. J. SREE NAGA CHAITANYA, DR.K. CHANDRAMOULI, SK.SAHERA,DR.D.VIJAYAKUMAR,5M. SIREESHA.STRENGTH STUDIES ON GRAPHENE OXIDEAND METAKAOLIN AS PARTIALREPLACEMENT OF CEMENT ANDQUARRY DUST AS PARTIAL REPALCEMENT OFFINEAGGREGATE IN CONCRETE,North Asian International Research Journal of Sciences, Engineering & I.T,9(5),May-2023.

3. Sobuz, M. H. R., *et al.* (2024). Assessing the influence of sugarcane bagasse ash for concrete compressive strength increased up to ~30% substitution in some mixes.
4. DR.K.CHANDRAMOULI, J.SREE NAGA CHAITANYA, .M.CHAITANYANAVA KUMAR AND Y.PREM NIKHIL.An Experimental Investigation on Concrete by Zeolite Powder as Partial Replacement of Fine Aggregate and Coarse Aggregate With Bamboo Chips.North Asian International Research Journal of Sciences, Engineering & I.T,9(10),October-2023.
5. Elawadly, N., *et al.* (2025). Sustainable concrete incorporating Sugarcane Bagasse Ash — workability, strength, and microstructure analysis.
6. J. Sree Naga Chaitanya, Dr. K. Chandramouli, Dr. D. Vijaya Kumar, P. Dileep.Strength study on Comparative of Banana FibreReinforced Concrete with Normal Concrerte,International Journal for Research in Applied Science & Engineering Technology (IJRASET),10(8),Aug 2022.
7. Khan, M. A., *et al.* (2025). Optimizing concrete sustainability with bagasse ash experimental program including compressive & split tensile tests.
8. Thirumalini, S., Ravi, R., Rajesh, M. (2019–2022). Study on engineering properties of concrete using Kadukkai (Terminalia chebula) reports improved workability and compressive strength in mortar/concrete mixes.
9. IJCRT / IJTimes project reports on chebulla powder additions experimental compressive strength results at 28, 56, 90 days for small percentage additions (e.g., 0.5–1%).
10. Chintalapudi, K., et al. (2021). Strength properties of graphene oxide cement composites reported average compressive strength increases at optimum GO dosages.
11. Alateah, A. H., et al. (2023). Graphene concrete: Recent advances reviews reported large improvements (tensile/compressive) at optimized GO concentrations.
12. ResearchGate review (2023) — Graphene Oxide in Construction: A Comprehensive Review challenges (dispersion, scale-up) and performance benefits summarized.
13. Benavente, C., et al. (2025). The Influence of Graphene Oxide on the Performance of Cementitious Materials recent experimental and literature synthesis.