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EXPERIMENTAL STUDY ON CONCRETE WITH CHEBULLA POWDER, BAGASSE ASH, AND GRAPHENE OXIDE AS PARTIAL REPLACEMENT WITH FINE AGGREGATE AND CEMENT

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ABSTRACT

This study investigates the effects of incorporating chebulla powder, bagasse ash, and graphene oxide in concrete as partial replacements for fine aggregate and cement. Concrete is a widely used construction material composed of cement, aggregates, and water, which can be enhanced by supplementary materials. Chebulla powder, derived from the fruit of **Terminalia chebula*****, is used as a partial replacement for fine aggregate to improve mechanical properties and sustainability. Bagasse ash, obtained from sugarcane processing, serves as another partial replacement for fine aggregate, offering eco-friendly utilization of agricultural waste. Graphene oxide*** *(GO)* ***is employed as a partial replacement of cement to enhance the strength, durability, and microstructural properties of concrete. The study focuses on evaluating compressive strength and split tensile strength of the modified concrete at 7 and 28 days of curing. Optimal replacement percentages are determined for maximum mechanical performance. The combined use of these materials aims to produce sustainable and high-performance concrete. Test results are compared with normal concrete to assess improvements in strength and durability. Chebulla powder and bagasse ash help reduce environmental impact by recycling agricultural waste. Graphene oxide improves bonding, reduces porosity, and enhances load-bearing capacity. The findings provide insight into sustainable construction materials that maintain or improve concrete performance. This research contributes to the development of eco-friendly, durable, and high-strength concretesuitable 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 in the world due to its versatility, durability, and high compressive strength. It is a composite material made of cement, water, fine aggregate, and coarse aggregate.

When properly mixed and cured, concrete forms a solid, durable structure capable of bearing heavy loads. To improve its mechanical and durability properties, supplementary materials and industrial or agricultural wastes can be incorporated into the mix.

Bagasse ash is a by-product obtained from burning sugarcane bagasse, the fibrous residue left after extracting juice from sugarcane. It is rich in silica and can act as a pozzolanic material in concrete. When used as a partial replacement for fine aggregate, bagasse ash can improve the workability, strength, and durability of concrete while promoting sustainable utilization of agricultural waste.

Chebulla powder is derived from the dried fruit of *Terminalia chebula*, a natural plant material with potential as a partial replacement for fine aggregate in concrete. It contains bioactive compounds that can contribute to improved microstructure and bonding within the concrete matrix. The use of chebulla powder not only enhances mechanical performance but also provides an environmentally friendly alternative by recycling natural resources.

Graphene oxide is a two-dimensional nanomaterial with exceptional mechanical, thermal, and chemical properties. When added to concrete as a partial replacement for cement, GO enhances the microstructure of the cement matrix, reduces porosity, and increases both compressive and tensile strength. Its incorporation in concrete improves durability, crack resistance, and overall load-bearing capacity, making it a promising additive for high-performance construction materials.

2. OBJECTIVES

1. To investigate the effect of **bagasse ash, chebulla powder, and graphene oxide** on the **strength**of concrete at 7 and 28 days of curing.
2. To evaluate the impact of these materials on the **strength** and overall durability of concrete.
3. To determine the **optimal replacement percentages** of bagasse ash, chebulla powder, and graphene oxide for achieving maximum mechanical performance in concrete.

3. MATERIALS

3.1 Cement:-Cement is a binding material used in construction, made from limestone and clay.

3.2 Fine Aggregate:-Fine aggregate refers to naturally occurring sand or crushed stone passing through a 4.75 mm sieve

3.3 Coarse Aggregate:-Coarse aggregate consists of gravel or crushed stone retained on a 4.75 mm sieve.

3.4 Water:-Water is an essential component of concrete, required for the hydration of cement. It ensures proper workability and setting of concrete mix. The quality and quantity of water directly affect concrete strength.

3.5 Bagasse ash:- A by-product from burning sugarcane bagasse, rich in silica. It serves as a pozzolanic material that improves concrete strength, durability, and sustainability.

3.6 Chebulla powder:- A natural material derived from the dried fruit of *Terminalia chebula*. Used as a partial replacement for fine aggregate, it enhances bonding and mechanical properties in concrete.

3.7 Graphene oxide:- A two-dimensional nanomaterial with excellent mechanical and chemical properties. When added to concrete as a partial cement replacement, it enhances strength, durability, and crack resistance.

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 7 or 28 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 offine aggregate.

Sl.no	% of bagasse ash	Compressive Strength Results, N/mm^2	
		7 days	28 days
1	0%	27.32	39.06
2	5%	27.38	40.23
3	10%	27.79	40.58
4	15%	29.35	42.16
5	20%	28.17	40.83

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	
		7 days	28 days
1	0%	27.32	39.06
2	0.25%	33.85	49.54
3	0.5%	34.85	50.74
4	0.75%	36.09	51.57
5	1%	33.91	48.78

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	
		7 days	28 days
1	0%	27.32	39.06
2	0.06%	37.05	54.25
3	0.12%	41.02	58.59
4	0.18%	38.05	54.95

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	
		7 days	28 days
1	0%	27.32	39.06
2	15%BSH+0.75%CP+0.12%GO	46.53	66.38

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 7 and 28 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	
		7 days	28 days
1	0%	2.61	3.82
2	5%	2.73	3.94
3	10%	2.79	4.01
4	15%	2.92	4.25
5	20%	2.84	4.06

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	
		7 days	28 days
1	0%	2.61	3.82
2	0.25%	3.34	4.84
3	0.5%	3.45	4.99
4	0.75%	3.58	5.21
5	1%	3.83	4.87

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

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Sl.no	% of graphene oxide	Split tensile Strength Results, N/mm^2	
		7 days	28 days
1	0%	2.61	3.82
2	0.06%	3.67	5.31
3	0.12%	4.07	5.93
4	0.18%	3.79	5.48

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	
		7 days	28 days
1	0%	2.61	3.82
2	15%BSH+0.75%CP+0.12%GO	4.82	6.83

5. CONCLUSION

1. **Normal concrete** without any replacement achieved a compressive strength of **27.32 N/mm^2 at 7 days** and **39.06 N/mm^2 at 28 days**.
2. The use of **bagasse ash (BSH)** as a partial replacement of fine aggregate showed optimum compressive strength at **15% replacement**, reaching **29.35 N/mm^2 at 7 days** and **42.16 N/mm^2 at 28 days**.
3. The use of **chebulla powder (CP)** as a partial replacement of fine aggregate showed maximum compressive strength at **0.75% replacement**, achieving **36.09 N/mm^2 at 7 days** and **51.57 N/mm^2 at 28 days**.
4. The use of **graphene oxide (GO)** as a partial replacement of cement showed the highest compressive strength at **0.12% replacement**, reaching **41.02 N/mm^2 at 7 days** and **58.59 N/mm^2 at 28 days**.
5. The **combined replacement** of **15% BSH + 0.75% CP + 0.12% GO** resulted in the maximum compressive strength of **46.53 N/mm^2 at 7 days** and **66.38 N/mm^2 at 28 days**, significantly higher than normal concrete.
6. Normal concrete without any replacement achieved a **split tensile strength of 2.61 N/mm^2 at 7 days** and **3.82 N/mm^2 at 28 days**.
7. **Bagasse ash (BSH)** as partial replacement of fine aggregate showed optimum split tensile strength at **15% replacement**, reaching **2.92 N/mm^2 at 7 days** and **4.25 N/mm^2 at 28 days**.
8. **Chebulla powder (CP)** as partial replacement of fine aggregate showed maximum split tensile strength at **0.75% replacement**, achieving **3.58 N/mm^2 at 7 days** and **5.21 N/mm^2 at 28 days**.
9. **Graphene oxide (GO)** as partial replacement of cement showed the highest split tensile strength at **0.12% replacement**, reaching **4.07 N/mm^2 at 7 days** and **5.93 N/mm^2 at 28 days**.
10. The **combined replacement** of **15% BSH + 0.75% CP + 0.12% GO** gave the highest split tensile strength, reaching **4.82 N/mm^2 at 7 days** and **6.83 N/mm^2 at 28 days**, demonstrating a significant improvement over normal concrete

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