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STRENGTH STUDIES ON BAMBOO FIBER CONCRETE WITH DOLOMITE AND GROUNDNUT SHELL ASH

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ABSTRACT

This study explores sustainable concrete by partially replacing fine aggregate with groundnut shell ash. Dolomite powder is used as a partial substitute for cement to reduce carbon emissions. Bamboo fibers are added to enhance the tensile resistance of the concrete matrix. Concrete mixes are prepared with varying proportions of GSA, dolomite, and bamboo fibers. Compressive strength tests are conducted on specimens at 7 and 28 days to assess load-bearing capacity. Split tensile strength is also evaluated at the same intervals to determine cracking resistance. The results show that appropriate replacement levels improve mechanical performance. Early-age strength is influenced by material reactivity and fiber dispersion. At 28 days, significant gains in both strength parameters are observed in optimized mixes. The findings support the use of agro-waste and natural fibers in eco-efficient concrete production.

KEYWORDS: ***Bamboo fibers,Dolomite, Ground Shell Ash,agro-waste, Compressive strength and Split tensile strength***

1. INTRODUCTION

Concrete is the most widely used construction material globally due to its versatility and durability. It is composed primarily of cement, fine and coarse aggregates, and water. The material gains strength through the chemical process of hydration, forming a hard, rock-like mass. Its adaptability allows it to be molded into various shapes before setting. Modern construction relies on concrete for buildings, roads, bridges, and dams. However, traditional concrete production has significant environmental impacts, particularly from cement manufacturing. Innovations in concrete aim to improve sustainability without compromising strength and performance. Alternative materials and admixtures are being explored to enhance mechanical and structural properties.

The increasing demand for concrete has led to the overuse of natural fine aggregates, raising concerns about environmental degradation. Groundnut shell, an agricultural waste, is often discarded or burned, causing pollution. Converting groundnut shell into ash offers a sustainable solution by repurposing waste into construction material.

Groundnut shell ash (GSA) possesses pozzolanic properties and fine particle size suitable for partial replacement of sand. Utilizing GSA in concrete helps conserve natural resources and reduces landfill burden. Studies have shown that proper proportions of GSA can enhance concrete's strength. It also contributes to improved bonding within the cement matrix. This approach supports eco-friendly construction practices by integrating agro-waste into building materials.

This study examines the potential of dolomite powder as a partial replacement for cement in concrete. Dolomite, a naturally occurring carbonate mineral, is rich in calcium and magnesium, contributing to cementitious behavior. The objective is to reduce cement consumption and environmental impact while maintaining concrete strength. Concrete mixes were prepared with varying percentages of dolomite replacing cement. Compressive and split tensile strength tests were conducted to evaluate performance. Results indicate that optimum replacement levels improve strength and durability. The use of dolomite also enhances the sustainability and cost-efficiency of concrete. This research promotes alternative binders for greener construction practices.

Bamboo fibers are gaining attention as a natural reinforcement material in concrete due to their high tensile strength and sustainability. As an eco-friendly alternative, bamboo fibers help reduce reliance on synthetic fibers and improve the mechanical behavior of concrete. When added by weight to the mix, these fibers enhance crack resistance and post-cracking performance. They contribute to better energy absorption and toughness under tensile loads. The biodegradable nature of bamboo makes it a suitable choice for green construction practices. Its lightweight properties do not significantly affect the density of concrete. Proper fiber dosage ensures uniform dispersion and effective bonding within the cement matrix. The use of bamboo fibers aligns with sustainable development goals in modern construction.

2. OBJECTIVES

1. To evaluate the effect of partial replacement of fine aggregate with groundnut shell ash on the compressive and split tensile strength of concrete.
2. To investigate the performance of concrete when cement is partially replaced with dolomite powder, focusing on strength development and durability.
3. To assess the influence of bamboo fiber addition by weight on the mechanical behavior and crack resistance of modified concrete mixes.

3. MATERIALS

3.1 Cement: Cement is a fine, gray powder that acts as a binder in concrete and mortar.When mixed with water, it forms a paste that hardens through hydration.It provides strength and cohesion to construction materials.

3.2 Fineaggregate: Fine aggregate consists of small particles such as natural sand or crushed stone. It fills the voids between coarse aggregates and improves workability.Typically, it passes through a 4.75 mm sieve.

3.3 Coarse aggregate: Coarse aggregate includes larger particles like gravel or crushed stone.It provides volume, strength, and stability to concrete mixtures.Generally, it is retained on a 4.75 mm sieve.

3.4 Water: Water is a vital component in concrete, as it triggers the hydration reaction with cement that allows the mixture to harden and gain strength. In addition to hydration, water acts as a lubricant, improving the mix's workability for proper placement, compaction, and finishing.

3.5Groundnut shell ash : Groundnut shell ash is produced by burning groundnut (peanut) shells.It is used as a pozzolanic material, partially replacing cement in concrete.GSA enhances sustainability and reduces construction costs.

3.6 Dolomite: Dolomite is a sedimentary rock composed primarily of calcium magnesium carbonate. It is ground into powder and used as a filler or cement substitute in concrete. Dolomite improves durability and reduces thermal cracking.

3.7 Bamboo Fiber: Bamboo fiber is a natural, eco-friendly reinforcement material extracted from bamboo. It is added to concrete to improve tensile strength and crack resistance.Its lightweight and biodegradable nature makes it suitable for green construction.

4. EXPERIMENTAL RESULTS

4.1 Compressive strength:-Compressive strength evaluates a material's ability to resist crushing or compressive forces. It is typically measured by applying a gradually increasing load to a standardized cube specimen using a testing machine, with tests commonly conducted at 7 and 28 days.

Table 1: Compressive strength results of concrete with different percentages of Groundnut shell ash used as a partial replacement of fine aggregate.

Sl.no	% of Groundnut Shell Ash	Compressive Strength Results, N/mm^2	
		7 days	28 days
1	0%	34.06	49.59
2	5%	39.92	51.59
3	10%	41.53	52.64
4	15%	35.59	51.66

Table 2: Compressive strength results of concrete with different percentages of Dolomite used as a partial replacement of Cement.

Sl.no	% Of Dolomite	Compressive Strength Results, N/mm^2	
		7 days	28 days
1	0%	34.06	49.59
2	5%	36.09	52.01
3	10%	38.27	54.63
4	15%	38.69	56.16
5	20%	39.85	53.65

Table 3: Compressive strength results of Bamboo fiber concrete.

Sl.no	% Of Bamboo fiber	Compressive Strength Results, N/mm^2	
		7 days	28 days
1	0%	34.06	49.59
2	0.5%	39.01	57.53
3	1%	44.04	62.21
4	1.5%	40.63	58.14

Table 4: Compressive strength results of combined replacement of 10%GSA+15%DOL+1%BFin concrete.

Sl.no	10%GSA+15%DOL+1%BF	Compressive Strength Results, N/mm^2	
		7 days	28 days
1	0%	34.06	49.59
2	10%GSA+15%DOL+1%BF	46.53	67.05

4.2 Split tensile strength

Split tensile strength is an indirect measure of concrete's resistance to tensile forces, as concrete is weak in direct tension. It involves placing a cylindrical specimen horizontally and applying a compressive load diametrically along its length, causing the cylinder to split along the loaded diameter due to induced tensile stresses. To cracking in concrete constructions for 7 and 28 days.

Table 5: Split tensile strength results of concrete with different percentages of Groundnut shell ash used as a partial replacement of fine aggregate.

Sl.no	% of Groundnut Shell Ash	Split tensile Strength Results, N/mm^2	
		7 days	28 days
1	0%	3.34	4.85
2	5%	3.25	4.69
3	10%	4.01	5.08
4	15%	3.45	5.01

Table 6: Split tensile strength results of concrete with different percentages of Dolomite used as a partial replacement of Cement.

Sl.no	% Of Dolomite	Split tensile Strength Results, N/mm^2	
		7 days	28 days
1	0%	3.34	4.85
2	5%	3.51	5.05
3	10%	3.78	5.38
4	15%	3.85	5.59
5	20%	3.62	5.32

Table 7: Split tensile strength results of Bamboo fiber concrete.

Sl.no	% Of Bamboo fiber	Split tensile Strength Results, N/mm^2	
		7 days	28 days
1	0%	3.34	4.85
2	0.5%	3.89	5.74
3	1%	4.32	6.11
4	1.5%	3.55	5.08

Table 8: Split tensile results of combined replacement of 30% QD+10% HS+0.5% AF in concrete.

Sl.no	10%GSA+15%DOL+1%BF	Split tensile Strength Results, N/mm^2	
		7 days	28 days
1	0%	3.34	4.85
2	10%GSA+15%DOL+1%BF	4.61	6.63

5. CONCLUSION

1. The compressive strength of concrete increased with the addition of groundnut shell ash up to 10%, achieving **41.53 N/mm² at 7 days** and **52.64 N/mm² at 28 days**, compared to **34.06 N/mm² and 49.59 N/mm²** respectively in normal concrete. Beyond 10%, strength decreased, indicating **10% GSA** as the optimum replacement level.
2. Replacing cement with dolomite showed a consistent improvement in strength up to 15%, where the compressive strength reached **38.69 N/mm² at 7 days** and **56.16 N/mm² at 28 days**, against **34.06 N/mm² and 49.59 N/mm²** in the control mix. The optimum replacement level was **15% dolomite**, beyond which strength declined slightly.
3. Incorporating bamboo fibers significantly improved compressive strength, with the best result observed at **1% fiber content**, yielding **44.04 N/mm² at 7 days** and **62.21 N/mm² at 28 days**, outperforming normal concrete by a margin of **10 N/mm² at 28 days**. The optimum fiber content was **1%**, as strength reduced slightly at 1.5%.
4. The combination of all three additives led to the highest strength gain, reaching **46.53 N/mm² at 7 days** and **67.05 N/mm² at 28 days**, compared to **34.06 N/mm² and 49.59 N/mm²** in the reference mix. This combination achieved a **35% increase in 28-day compressive strength**, making it the **optimum mix configuration**.
5. Concrete with 10% GSA showed the highest compressive strength of **41.53 N/mm² at 7 days** and **52.64 N/mm² at 28 days**, compared to **34.06 N/mm² and 49.59 N/mm²** for normal concrete. This indicates a **22% increase at 7 days** and a **6.1% increase at 28 days**, making **10% GSA** the **optimum replacement level**. Strength declined at 15%, confirming a performance peak at 10%.
6. Partial replacement of cement with dolomite showed a consistent improvement in tensile strength, peaking at **15% replacement**, with **3.85 N/mm² at 7 days** and **5.59 N/mm² at 28 days**. Compared to the control mix (**3.34 N/mm² and 4.85 N/mm²**), this represents a **15.3% increase at 7 days** and **15.2% at 28 days**, identifying **15% dolomite** as the **optimum replacement level**. A slight drop in performance was observed at 20%.
7. Partial replacement of cement with dolomite showed a consistent improvement in tensile strength, peaking at **15% replacement**, with **3.85 N/mm² at 7 days** and **5.59 N/mm² at 28 days**. Compared to the control mix (**3.34 N/mm² and 4.85 N/mm²**), this represents a **15.3% increase at 7 days** and **15.2% at 28 days**, identifying **15% dolomite** as the **optimum replacement level**. A slight drop in performance was observed at 20%.
8. The combined mix achieved the highest tensile strength, with **4.61 N/mm² at 7 days** and **6.63 N/mm² at 28 days**, compared to **3.34 N/mm² and 4.85 N/mm²** in the control mix. This results in a **38% increase at 7 days** and a **36.6% increase at 28 days**, establishing this **hybrid combination** as the **most effective formulation** for enhancing tensile properties.

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