

*A Peer Reviewed Refereed International Journal*

## EXPERIMENTAL INVESTIGATION OF CONCRETE INCORPORATING GROUNDNUT SHELL ASH, COCONUT SHELL, AND CRIMPED STEEL FIBRES

<sup>1</sup> DR.K.CHANDRAMOULI, <sup>2</sup> J.SREE NAGA CHAITANYA, <sup>3</sup>K.DIVYA,<sup>4</sup>PATAN HUSSEN

<sup>1</sup>Professor & HOD, <sup>2,3</sup> Assistant Professor, <sup>4</sup>B. Tech Student

<sup>1,2,3,4</sup> 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 examines the mechanical performance of concrete incorporating sustainable agricultural and industrial by-products. Fine aggregate was partially replaced with groundnut shell ash (GNSA), an agro-waste material with pozzolanic properties, to enhance strength and durability. Coarse aggregate was partially substituted with coconut shell (CS) to promote renewable waste utilization and reduce concrete density. In addition, crimped steel fibres were introduced to improve tensile strength, crack resistance, and overall toughness. Concrete cubes and cylinders were cast, cured, and tested for compressive and split tensile strengths at 28, 56, and 90 days. The results indicated that optimal replacement levels of GNSA and CS, combined with steel fibres, enhanced both compressive and split tensile strengths compared to conventional concrete. At 28 days, compressive strength exhibited a significant early gain, while higher ultimate strengths were achieved at 56 and 90 days. Split tensile strength also improved, demonstrating better crack resistance and load-carrying capacity. The findings highlight that the combined use of agricultural waste and steel fibres produces a durable, eco-friendly concrete mix suitable for structural applications. This approach reduces dependence on natural aggregates and cement, encourages waste valorization, and supports sustainable construction practices.*

**KEYWORDS:** Groundnut shell ash, Coconut shell, Steel fibres, Sustainable concrete, Compressive strength, Split tensile strength

## 1. INTRODUCTION

Concrete remains the most widely used construction material owing to its versatility, durability, and high compressive strength. It is typically composed of cement, fine aggregate, coarse aggregate, and water, which together form a composite capable of sustaining structural loads. However, rising demand for construction materials necessitates the adoption of sustainable alternatives that minimize environmental impact, optimize resource utilization, and improve mechanical performance.

Groundnut shell ash (GNSA), an agricultural by-product derived from the controlled combustion of groundnut shells, is rich in silica and other pozzolanic compounds. When used as a partial replacement for fine aggregate, GNSA enhances particle packing, contributes to long-term strength development, and promotes agro-waste utilization, thereby mitigating environmental pollution.

Coconut shell (CS), a renewable by-product of coconut processing, offers a lightweight alternative to natural coarse aggregates. Its incorporation as a partial replacement reduces concrete density, enhances toughness, and supports sustainable waste management while lowering reliance on natural stone aggregates.

Crimped steel fibres, short deformed strands of steel, are added to concrete to improve tensile strength, ductility, and crack resistance. By bridging cracks and enhancing energy absorption, they increase load-bearing capacity under tensile and flexural stresses. Their inclusion is particularly advantageous in concrete mixes utilizing lightweight or waste-derived aggregates, ensuring structural integrity without compromising performance.

## 2. OBJECTIVES

1. To evaluate the influence of groundnut shell ash (GNSA) as a partial replacement for fine aggregate on the properties of concrete.
2. To examine the effect of coconut shell (CS) as a partial replacement for coarse aggregate.
3. To assess the role of steel fibres in enhancing crack control and improving the overall performance of concrete.

## 3. MATERIALS

**3.1 Cement:** A finely ground powder produced from limestone and clay, cement acts as the primary binder in concrete. In the presence of water, it undergoes hydration and forms a hardened, stone-like mass that imparts strength to the concrete.

**3.2 Fine Aggregate :**Consisting of natural sand or crushed stone particles smaller than 4.75 mm, fine aggregate fills the voids between coarse aggregates and enhances the workability of fresh concrete.

**3.3 Coarse Aggregate:** Made up of gravel or crushed stone particles larger than 4.75 mm, coarse aggregate provides bulk, stability, and contributes significantly to the strength of the concrete mix.

**3.4 Water:** An essential ingredient that initiates the hydration process of cement, water provides workability to fresh concrete and supports proper curing for strength development.

**3.5 Groundnut Shell Ash (GNSA):** A pozzolanic material obtained through controlled burning of groundnut shells. GNSA can be used as a partial replacement for fine aggregate, enhancing strength development while promoting the utilization of agricultural waste.

**3.6 Coconut Shell (CS) :** A renewable agricultural by-product obtained after coconut processing. When used as a partial replacement for coarse aggregate, coconut shell reduces concrete density, improves toughness, and contributes to sustainable waste management.

**3.7 Crimped Steel Fibres :** Short, deformed steel strands incorporated into concrete to improve tensile strength, toughness, and crack resistance. Their addition enhances load-bearing capacity, ductility, and durability of the mix.

#### 4. EXPERIMENTAL RESULTS

**4.1 Compressive strength:-** In this test, standard concrete cubes measuring 150 mm × 150 mm × 150 mm are cast and properly cured. After 28, 56 and 90 days of curing, the cubes are placed in a compression testing machine, and a gradually increasing load is applied until failure occurs. The maximum load at failure is then used to calculate the compressive strength of the concrete.

**Table 1: Compressive strength results of concrete ground nut shell ashes partial replacement of fine aggregate.**

Sl.no	% of ground nut shell ash	Compressive Strength Results, N/mm <sup>2</sup>		
		28 days	56 days	90 days
1	0%	49.07	52.98	56.86
2	5%	50.54	54.46	58.63
3	10%	51.96	56.12	60.27
4	15%	51.05	55.14	59.35

**Table 2: Compressive strength results of concrete coconut shell as partial replacement of coarse aggregate.**

Sl.no	% of coconut shell	Compressive Strength Results, N/mm <sup>2</sup>		
		28 days	56 days	90 days
1	0%	49.07	52.98	56.86
2	2.5%	64.84	70.21	75.35
3	5%	68.72	74.14	79.73
4	7.5%	63.17	68.36	73.64

**Table 3: Compressive strength results of concrete by addition of crimped steel fibres.**

Sl.no	% of crimped steel fibres	Compressive Strength Results, N/mm <sup>2</sup>		
		28 days	56 days	90 days
1	0%	49.07	52.98	56.86
2	1%	49.69	53.64	57.72
3	2%	50.38	54.42	58.57
4	3%	51.52	55.73	59.68
5	4%	50.91	54.89	59.05

**Table 4: Compressive strength results of Combined replacement of 10%GSA+5%CS+3%CSF in concrete.**

Sl.no	10%GSA+5%CS+3%CSF	Compressive Strength Results, N/mm <sup>2</sup>		
		28 days	56 days	90 days
1	0%	49.07	52.98	56.86
2	10%GSA+5%CS+3%CSF	71.42	77.13	82.92

4.2 Split tensile strength: - Split tensile strength is an indirect method used to assess the tensile capacity of concrete, as concrete is naturally weak in direct tension. In this test, a cylindrical specimen is placed horizontally, and a compressive load is applied along its diameter. The applied load generates tensile stresses within the cylinder, causing it to split along the line of loading. Tests are conducted at 28, 56 and 90 days of curing to evaluate the development of tensile strength and observe cracking behavior in the concrete.

**Table 5: Split tensile strength results of concrete ground nut shell ash as partial replacement of fine aggregate.**

Sl.no	% of ground nut shell ash	Split tensile Strength Results, N/mm <sup>2</sup>		
		28 days	56 days	90 days
1	0%	4.85	5.23	5.64
2	5%	5.04	5.48	5.82
3	10%	5.29	5.71	6.19
4	15%	4.98	5.34	5.78

**Table 6: Split tensile strength results of concrete coconut shell as partial replacement of coarse aggregate.**

Sl.no	% of coconut shell	Split tensile Strength Results, N/mm <sup>2</sup>		
		28 days	56 days	90 days
1	0%	4.85	5.23	5.64
2	2.5%	6.36	6.84	7.38
3	5%	6.94	7.49	8.05
4	7.5%	6.18	6.67	7.16

**Table 7: Split tensile strength results of concrete by addition of crimped steel fibres.**

Sl.no	% of crimped steel fibres	Split tensile Strength Results, N/mm <sup>2</sup>		
		28 days	56 days	90 days
1	0%	4.85	5.23	5.64
2	1%	4.91	5.34	5.82
3	2%	5.13	5.52	5.98
4	3%	5.25	5.67	6.09
5	4%	5.03	5.48	5.82

**Table 8: Split tensile strength results of combined replacement of 10%GSA+5%CS+3%CSF in concrete.**

Sl.no	10%GSA+5%CS+3%CSF	Compressive Strength Results, /mm <sup>2</sup>		
		28 days	56 days	90 days
1	0%	4.85	5.23	5.64
2	10%GSA+5%CS+3%CSF	7.38	7.96	8.59

## 5. CONCLUSION

1. The **Normal concrete** without any replacement achieved a compressive strength of **49.07, 52.98 and 56.86 N/mm<sup>2</sup> at 28, 56 and 90 days**.
2. The use of **groundnut shell ash (GNSA)** as a partial replacement of fine aggregate showed optimum compressive strength at **10% replacement**, reaching **51.96, 56.12 and 60.27 N/mm<sup>2</sup> at 28, 56 and 90 days**.
3. The use of **coconut shell (CS)** as a partial replacement of coarse aggregate yielded the best compressive strength at **5% replacement**, achieving **68.72, 74.14 and 79.73 N/mm<sup>2</sup> at 28, 56 and 90 days**.
4. The addition of **crimped steel fibres (CSF)** improved compressive strength maximally at **3% addition**, with values of **51.52, 55.73 and 59.68 N/mm<sup>2</sup> at 28, 56 and 90 days**.
5. The **combined replacement** of **10% GNSA + 5% CS + 3% CSF** resulted in the highest compressive strength, reaching **71.42, 77.13 and 82.92 N/mm<sup>2</sup> at 28, 56 and 90 days**, significantly higher than normal concrete.
6. The Normal concrete without any replacement achieved a **split tensile strength of 4.85, 5.23 and 5.64 N/mm<sup>2</sup> at 28, 56 and 90 days**.
7. **Groundnut shell ash (GNSA)** as partial replacement of fine aggregate showed optimum split tensile strength at **10% replacement**, reaching **5.29, 5.71 and 6.19 N/mm<sup>2</sup> at 28, 56 and 90 days**.
8. **Coconut shell (CS)** as partial replacement of coarse aggregate yielded the best split tensile strength at **5% replacement**, with values of **6.94, 7.49 and 8.05 N/mm<sup>2</sup> at 28, 56 and 90 days**.
9. **Crimped steel fibres (CSF)** addition improved split tensile strength maximally at **3%**, achieving **5.25, 5.67 and 6.09 N/mm<sup>2</sup> at 28,56 and 90 days**.

10. The **combined replacement** of **10% GNSA + 5% CS + 3% CSF** gave the highest split tensile strength, reaching **7.38, 7.96 and 8.59 N/mm<sup>2</sup>** at **28, 56 and 90 days**, which is significantly higher than normal concrete.

## REFERENCES:

1. Synergistic and sustainable utilization of coconut shell ash and groundnut shell ash in ternary blended concrete. This study investigates concrete with both CSA (coconut shell ash) and GSA (groundnut shell ash) as ternary cementitious materials, assessing strength at 7, 28, 90 days etc.
2. 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.
3. Effect of Steel Fiber on the Strength and Flexural Characteristics of Coconut Shell Concrete Partially Blended with Fly Ash. Prakash, R., Divyah, N., Srividhya, S., Avudaiappan, S., Amran, M., Naidu Raman, S., Guindos, P., Vatin, N. I., & Fediuk, R. (2022). *Materials*, 15(12): 4272. Examines use of coconut shell aggregate, fly ash, and steel fibres; includes compressive and flexural strength results.
4. R Jagadheeswari. Experimental Study to Reduce Cracks and Enhance Strength & Durability by Appending Recron 3S Fibre. *Elsevier Article* (2022).
5. J. SREE NAGACHAITANYA,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 INCONCRETE,North Asian International Research Journal of Sciences, Engineering & I.T,9(5),May-2023.
6. Experimental Investigation on the Mechanical and Microstructural Properties of Concrete with Agro-Waste. Godwin I. A., Nancy Deborah S., Julius Ponraj I., Vinslin Blessho R., Stephen C. (2018). *International Journal of Engineering and Technology*, 7(3.12), 33-37. This looks at using a combination of several agro-wastes including coconut shell powder, areca nut shell, etc., and studying mechanical & durability properties.
7. J. Sree Naga Chaitanya, Dr. K. Chandramouli, Dr. D. Vijaya Kumar, P. Dileep.Strength studyon Comparative of Banana FibreReinforced Concrete with NormalConcrete,International Journal for Research in Applied Science & EngineeringTechnology (IJRASET),10(8),Aug 2022.
8. An Investigation on Compressive Strength of Concrete Blended With Groundnut Shell Ash. Abro, A. W., Kumar, A., Keerio, M. A., Shaikh, Z. H., Bheel, N., & Dayo, A. A. (2021). *Neutron*, 20(2), 123-127. Effect of replacing cement with GNSA on workability and compressive strength.
9. K.Chandramouli , N.Pannirselvam ,J.Sree Naga Chaitanya, andG.Hymavathi.Experimental Investigation on Self Compacting Concrete with SilicaFume,International Conference on Smart Materials and Structures( ICSMS),2810(1),June 22 2023.
10. J. Sree Naga Chaitanya; Dr. K. Chandramouli; Dr. D. Vijaya Kumar; N. Varalakshmi, Investigation on Concrete by Using Carbon Fibers and Partial Replacement of Sand with Copperslag and Cement with Metakaolin, *Gis Science Journal*, Volume 9, Issue 7, 2022, Pages: 1308–1310.