https://doi.org/10.46335/IJIES.2025.10.6.17 **e-ISSN: 2456-3463**
Vol. 10, No. 6, 2025, PP. 86-89

International Journal of Innovations in Engineering and Science, www.ijies.net

Partial Addition of Carbon Nano tubes and Glass Fibers in Concrete

Shaikh Muddasir Ahmed [1], Prof. K. G. Patwari [2]

[1]PG Student, M.E. Structural Engineering
DIEMS, Chh. Sambhajinagar (Aurangabad), Maharashtra, India (431005)
[2]Assistant Professor, Civil Engineering Department, 0009-0008-8633-922X
DIEMS, Chh. Sambhajinagar (Aurangabad), Maharashtra, India (431005)

Email of Corresponding Author: ***kavish.patwarii@gmail.com***

***Received on**: 05 May,2025* ***Revised on**: 04 June,2025* ***Published on**: 07 June,2025*

Abstract – *New carbon nanotubes have drawn the attention of those studying concrete because of their great strength, electrical conductivity, heat transfer, and chemical behavior. These tiny threads could be useful in making better cement composites. This study looked at how adding nanotubes affects concrete's bending strength, ability to stretch, how easily liquids pass through it, and its inner structure. Concrete mixes were made with different amounts of nanotubes: 0, 0.01, 0.02, and 0.03 percent by weight. A big problem for concrete bridges is tiny cracks that form early on, which makes them wear out faster. Adding fibers to concrete has worked well to make it stronger and reduce these early cracks. Concrete with a lot of cement gets very strong, but this can also cause early cracking. Weak tensile strength also leads to early cracking. Other things that cause these cracks are rising temperatures, how much water is present, and shrinkage. Using materials other than cement to increase compressive and tensile strength in a cost-effective way can help lessen early cracking. Concrete mixes were made with varying amounts of glass fibers: 0, 1%, 2%, and 3% by weight. This paper investigates how adding glass fibers and carbon nanotubes affects how well the concrete withstands pressure.*

Keywords- *Carbon Nano Tubes, Glass Fibers, Cement, Fine & Course Aggregate, Compressive Strength*

INTRODUCTION

Because the building field has grown so much these days, with many buildings, roads, and bridges being built, a lot of concrete is being used. Cement, the main part of concrete, needs to be cheap and not hurt the environment. However, making cement releases carbon dioxide and is expensive. So, we need to find something else to use in concrete. Adding tiny materials can make concrete better. Using these materials, like Carbon Nano Tubes (CNTs), thanks to new technology, creates a better type of concrete. CNTs can change how strong concrete is. They are now the strongest thing we know of and are great for making concrete stronger.

Carbon nanotubes were found in Japan in 1991 and come from making fullerenes. CNTs are like hollow tubes made of graphite, where carbon atoms are joined in different shapes. These tubes can be single-walled or multi-walled. CNTs fill in gaps and help form the structure of concrete. Cement is good at making concrete stronger. Lately, more people are using fibers instead of the usual materials to fix or make concrete buildings stronger.

The ACI says that fiber-reinforced concrete is made with cement and small rocks, plus fibers. Glass fiber is a popular choice because its light, doesn't soak up much water, and is strong. Glass fibers can make concrete better at handling weight and movement. Studies show that adding glass fiber to concrete can improve its ability to bend and handle pressure. With glass fiber, concrete can be about 20% stronger when squeezed.

1.1 Glass Fibre reinforced concrete

Glass fiber reinforced concrete (GFRC) was once a novel building method, but now it's commonly used. Glass fibers are now used in many parts of the

https://doi.org/10.46335/IJIES.2025.10.6.17 e-ISSN: 2456-3463
Vol. 10, No. 6, 2025, PP. 86-89

construction business, such as tunnels, airports, and warehouses. Glass fibers are better than other materials mainly because they save time and are safer to use. Glass fiber reinforced shotcrete (GFRS) is concrete with small, separate glass fibers sprayed onto a surface at high speed.

The glass fibers make the concrete less likely to crack, more flexible, and better at handling impacts and absorbing energy. The shape, amount, and length of the glass fibers are the most important things that affect how well they work in shotcrete (and concrete).

1.2 Carbon Nanotubes (cnts)

Carbon nanotubes are tiny particles, measuring 12-15 nm in diameter and 0.5-5 μm long, with 8-15 layers. There are two main kinds: single-wall and multi-wall carbon nanotubes. Because they are very strong, they are useful for this study. Their good mechanical and electrical qualities help mortar cubes become stronger and conduct electricity better. Due to their small size, it's hard to mix carbon nanotubes well with cement. To solve this, we can use physical or chemical methods to mix them properly. Physical methods, like sonication, and chemical methods help carbon nanotubes dissolve in water better. In this study, we will use sonication, a physical method, to mix the carbon nanotubes well. Carbon nanotubes conduct electricity, creating a network for current to flow. Changes in this network can be detected. Electrodes, like pairs or wire meshes, are used to pass the electricity.

1.3 Objectives of study

1. To enhance concrete tensile strength through the partial incorporation of carbon nanotubes.
2. To investigate the impact of glass fibers on concrete durability and resilience.
3. To assess the synergistic effects of combined carbon nanotubes and glass fibers.

LITERATURE REVIEW

Abeer Hassan et.al (2022) explores the incorporation of carbon nanotubes (CNTs) and steel fibers (SFs) in concrete mixtures to enhance mechanical performance. Experiments with varying CNT percentages (0%, 0.025%, 0.050% and 0.075 %) identified 0.05% as the optimal content, providing maximum compressive, tensile, and flexural strength. The addition of SFs further improved mechanical properties, increasing compressive, tensile, and flexural strength by 22.7%, 29.3%, and 70.8%, respectively, compared to traditional pavements. This combined approach presents a promising solution for constructing stronger and more resilient rigid pavements.

Mahyar Ramezani et.al (2022) explores the incorporation of carbon nanotubes (CNTs) as reinforcement in cementitious composites, aiming for multifunctional properties. Over the past decade, researchers have grappled with elucidating the mechanisms through which CNTs influence the fresh and hardened states of cementitious materials. Conflicting experimental results, attributed to dispersion variations and fabrication inconsistencies, underscore the challenges faced. Addressing these, some researchers have proposed analytical equations to predict final properties. The review covers CNT multifunctional properties, production methodologies, dispersion strategies, surface treatment impacts, microstructure, fresh properties, and statistical analysis for optimal parameters, prediction models, and CNT effects on dimensional stability, durability, and smart applications. This synthesis offers a comprehensive understanding of the current state of CNT-reinforced cementitious composites research, highlighting potential applications and avenues for further investigation.

Purshottam Singh suman et.al (2022) explores sustainable alternatives by incorporating waste glass and fly ash as partial replacements for cement in glass fiber-reinforced concrete. Waste glass, when finely ground, exhibits pozzolanic properties, contributing to strength development. Glass fibers, in varying volume fractions (20%, 30%, and 40%) with fly ash replacement, were investigated for their impact on compressive and split tensile strength. Results indicate that 20% glass fiber, along with fly ash, maximizes concrete strength. Beyond this threshold, strength diminishes. Glass fibers, with their balanced properties, demonstrate resilience in aggressive environments. The study highlights the potential of incorporating waste materials for enhanced concrete performance and environmental sustainability.

A. M. Hunashyal et.al (2011) this study looked at how round bars made of cement mortar mixed with multiwalled carbon nanotubes (MWCNTs) and carbon fibers (CFs) act. The amount of CFs was always 2.25% of the cement's weight, and the amount of MWCNTs was always 0.5% of the cement's weight. To mix the MWCNTs and CFs well, they used a method involving ultrasonic energy. The round bars were pulled directly to see how strong they were, looking at things like how much weight they could hold, how much they bent, and how they stretched under pressure. The results were

https://doi.org/10.46335/IJIES.2025.10.6.17 **e-ISSN: 2456-3463**
Vol. 10, No. 6, 2025, PP. 86-89

International Journal of Innovations in Engineering and Science, www.ijies.net

compared to round bars made of just plain cement. The study showed that the bars with the added materials could hold much more weight when pulled than the plain cement bars.

Abeer Hassan et.al (2022) explores the incorporation of carbon nanotubes (CNTs) and steel fibers (SFs) in concrete mixtures to enhance mechanical performance. Experiments with varying CNT percentages (0%, 0.025%, 0.050% and 0.075 %) identified 0.05% as the optimal content, providing maximum compressive, tensile, and flexural strength. The addition of SFs further improved mechanical properties, increasing compressive, tensile, and flexural strength by 22.7%, 29.3%, and 70.8%, respectively, compared to traditional pavements. This combined approach presents a promising solution for constructing stronger and more resilient rigid pavements.

METHOLOGY

Selection of Materials and specimen size.

A. Mix Design (Determination Of Proportion Of Materials) (**IS 10262:2009)**
B. Determination Of Compressive Strength Of Concrete With Glass Fibers and Carbon nano tubes And Without Glass Fibers and Carbon nano tubes At 7 days .(Specimen size-cube of 150 x 150 x 150 mm size)
C. To Compare The Results And Conclusion.

Following proportions are used for all the tests

A. Only PPC, Fine Aggregate, Coarse Aggregate (MD1)
B. 0.01% Multi wall carbon nano tubes and 1 % of Glass fibers. (MD2)
C. 0.02% Multi wall carbon nano tubes and 2 % of Glass fibers. (MD2)
D. 0.03% Multi wall carbon nano tubes and 3 % of Glass fibers. (MD2)

MORPHOLOGICAL STUDIES ON GFRP COMPOSITES INCORPORATED WITH CNTs

The microstructural features on epoxy GFRP composites incorporated with CNTs were studied using images of Scanning Electron Microscopy. The mechanical properties of GFRP composites depend on the effective dispersion of Nano fillers into the epoxy resin matrix. The dispersion of CNTs epoxy was analyzed using Finite element – Scanning Electron Microscope (FE-SEM). The samples were cut with dimensions 5 x 5 x 5 mm as composite cube to place in epoxy holder of FE-SEM zeiss machine by polishing its surface to flatness through several steps. The method of obtaining optical FE-SEM images is a qualitative method as it is accurate and reliable technique to evaluate the nano filler dispersion and distribution in epoxy matrix.

RESULT & DISCUSSION

Table 1- Test & Result on cement, FA and CA

Fineness of Cement: 9%
Standard Consistency of Cement: 32%
Initial and Final Setting Time: 30min and 600 Min
Specific Gravity of Cement: 3.15
Fineness Modulus of Fine Aggregate: 2.88
Fineness Modulus of Sand: 3.34
Specific Gravity and Moisture Content of Fine Aggregate: 2.32 and 1.8%
Specific Gravity and Moisture Content of Sand: 2.55 and 2.39%
Fineness Modulus of Coarse Aggregate: 3.55
Specific Gravity and Moisture Content of Coarse Aggregate: 2.68 and 2.79%

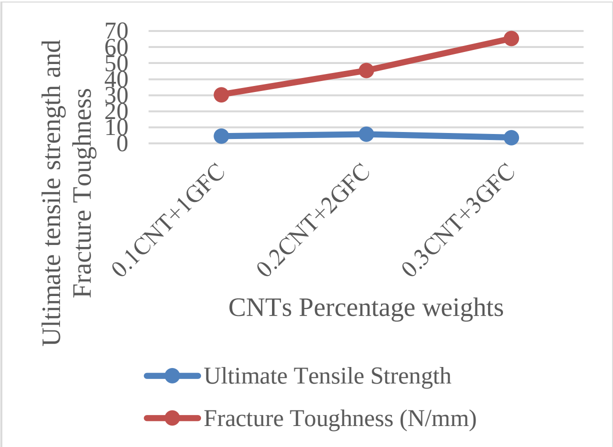

Fig 1 Properties of Ultimate tensile strength and Fracture Toughness for Glass Fiber composites at various CNTs Percentage weight

FLEXURAL BEHAVIOUR OF CNTs ENHANCED GFRP COMPOSITES

https://doi.org/10.46335/IJIES.2025.10.6.17 **e-ISSN: 2456-3463**
Vol. 10, No. 6, 2025, PP. 86-89

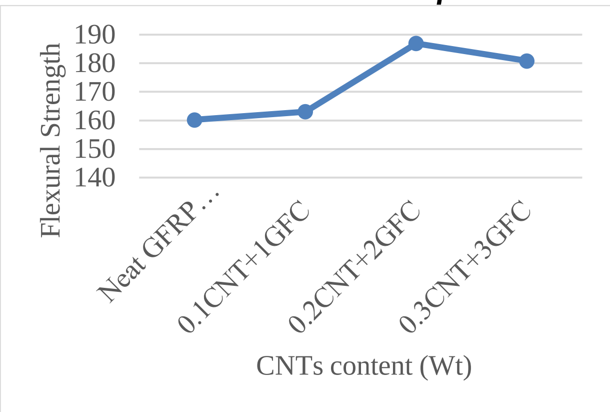

Fig 2 Flexural Strength Disparities of Glass Fiber Composites with CNTs content

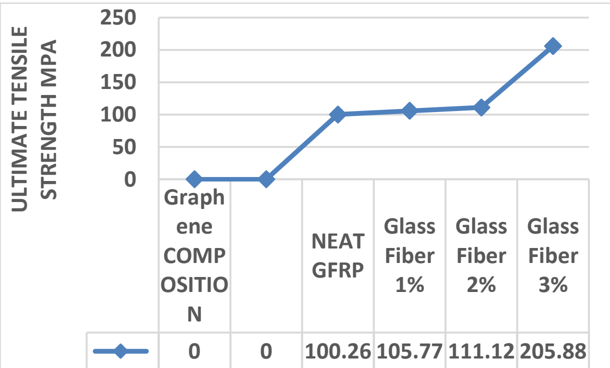

Fig 4. Curve of Ultimate tensile strength for Glass Fiber composites reinforced with different Graphene

CONCLUSION

In conclusion, this study aimed to investigate and enhance the strength properties of conventional concrete through the partial addition of Carbon Nanotubes (CNTs) and Glass Fibre (GF). While previous research has explored the individual reinforcing effects of GF and CNTs, their combined impact remained largely unexplored. Through varying concentrations of CNTs and volumes of GF, the study comprehensively examined their synergistic influence on compressive strength, split tensile strength, and flexural strength of concrete. By adhering to established testing protocols and durations, the research provided valuable insights into the optimal proportions and synergies between CNTs and GF for achieving enhanced concrete strength. The findings contribute to the advancement of construction materials, facilitating the development of high-performance concrete with superior mechanical properties and durability. Ultimately, this research informs future practices in the construction industry, guiding the utilization of novel materials for sustainable and resilient infrastructure.

REFERENCES

[1] *Mohammadyan-Yasouj, S. E., & Ghaderi, A. (2020). Experimental investigation of waste glass powder, basalt fibre , and carbon nanotube on the mechanical properties of concrete. Construction and Building Materials, 252, 119115. https://doi.org/10.1016/j.conbuildmat.2020.119115*

[2] *Ramezani, M., Dehghani, A., & Sherif, M. M. (2022). Carbon nanotube reinforced cementitious composites : A comprehensive review. Construction and Building Materials, 315, 125100. https://doi.org/10.1016/j.conbuildmat.2021.125100*

[3] *Pitroda, J. (2016). A Critical Review on Carbon Nanotubes. 2(5), 36–42.*

[4] *Hunashyal, A. M., Tippa, S. V, Quadri, S. S., & Banapurmath, N. R. (2011). Experimental Investigation on Effect of Carbon Nanotubes and Carbon Fibres on the Behavior of Plain Cement Mortar Composite Round Bars under Direct Tension. 2011. https://doi.org/10.5402/2011/856849*

[5] *Murali, G., Abid, S. R., Amran, M., Fediuk, R., Vatin, N., & Karelina, M. (2021). Combined Effect of Multi-Walled Carbon Nanotubes, Steel Fibre and Glass Fibre Mesh on Novel Two-Stage Expanded Clay Aggregate Concrete against Impact Loading.*

[6] *Cui, K., Chang, J., Feo, L., Chow, C. L., & Lau, D. (2022). Developments and Applications of Carbon Nanotube Reinforced Cement-Based Composites as Functional Building Materials. 9(March), 1–14. https://doi.org/10.3389/fmats.2022.861646*

[7] *Suman, P. S., & Khan, Z. (2022). Glass fiber reinforced concrete with partial replacement of. 10(6).*

[8] *Vidivelli, B., & Ashwini, B. (2018). A study on carbon nanotube (cnts) in concrete. 481–489.*

[9] *Hassan, A., Galal, S., Hassan, A., & Salman, A. (2022). Utilization of carbon nanotubes and steel fibers to improve the mechanical properties of concrete pavement. Beni-Suef University Journal of Basic and Applied Sciences. https://doi.org/10.1186/s43088-022-00300-5*

[10] *Alurkar, T. S. (2021). Effects of addition of Carbon Nanotubes on the properties of concrete. 7(3), 888–890*