

# Study of the Effect of Graphene on the Mechanical Behaviour of Cementitious Materials

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## Abstract

Improving the mechanical properties of cementitious materials is crucial for the construction sector, not least to meet the growing demands for infrastructure durability and strength while minimizing environmental impact. The cement industry is indeed responsible for a significant share of CO<sub>2</sub> emissions, motivating the search for more sustainable solutions. In this context, the incorporation of nanomaterials such as graphene and its derivatives is attracting considerable interest due to their exceptional properties, including enhanced mechanical strength and microstructural improvement of cementitious composites. This study aims to compare the mechanical behavior of raw concrete with that of concrete reinforced with different forms of graphene, including graphene nanoplatelets, focusing on compressive and flexural strength. Concrete samples with various graphene contents were experimentally tested to assess their mechanical performance. In parallel, numerical simulations were carried out using finite element analysis (FEA) with ANSYS to analyze the flexural behavior of the samples. The results show that incorporating graphene significantly enhances compressive strength, ductility, and flexural performance compared with conventional concrete. Simulations confirm these findings, revealing a more uniform stress distribution and reduced cracking in the reinforced specimens. This study underscores the potential of graphene to optimize the mechanical properties of cementitious materials, opening up new avenues for the development of stronger and more durable structures. These discoveries pave the way for a new generation of cementitious materials, capable of extending the lifespan of structures while reducing maintenance costs and the carbon footprint of construction, thereby promoting a more sustainable built environment.

## Keywords

Cementitious Materials, Nanomaterials, Graphene Reinforcement, ANSYS Numerical Simulation, Finite Element Analysis, Mechanical Properties, Performance in Construction, Sustainable Construction