

Annex IV – Short public report. Conference grants

Title of the conference presentation

Name of the Applicant: Saeedeh Qaderi (passport format: Saeideh Ghaderi)

Reference: E-COST-GRANT-CA21155-11011b6e

Relevant Working Groups: WG4 (Novel simulation Methods and best practices)

Conference Details

Conference title: Material Science and Engineering congress (MSE 2026)

Conference web-page: <https://dgm.de/mse/2026/>

Conference venue: Technical University of Darmstadt, Germany

Conference start and end date: 29/09/2026 to 01/10/2026

Accepted contribution details

Title of the presentation: How Can AI-Driven Models Accelerate Finite Element-Based Design and Inverse Identification of Composite Materials?

Type of the presentation: Oral

Co-authors and their affiliations: Professor Nicholas Fantuzzi, University of Bologna, Italy

Abstract

The computational analysis of advanced composite and lattice structures at the nanoscale can become extremely demanding when large numbers of design configurations and loading conditions need to be investigated. This study addresses this challenge by combining physics-based finite element modelling with machine learning (ML) surrogate models to enable rapid prediction of the dynamic behavior of composite lattice nanostructures. A physics-informed finite element framework based on strain gradient elasticity was first used to model the vibration behavior of nanoscale beam and lattice structures. The framework was then applied to epoxy/graphene nanoplatelet composite lattice nanostructures to generate a comprehensive numerical dataset through systematic parametric simulations. This dataset was used to train and evaluate five different ML approaches: CatBoost, Extra Trees, TabPFN, XGBoost, and neural networks. The models use key design and physical parameters including beam thickness, nonlocal parameter, number of lattice units, and boundary conditions, to predict the resulting frequency response. The results demonstrate that ML surrogate models can reproduce the FEM-based predictions with high accuracy while requiring only a fraction of the computational effort needed for repeated numerical simulations. The proposed approach provides a practical computational tool for rapidly exploring large design spaces, performing parametric studies, and supporting the optimization of composite lattice structures with tailored dynamic properties. More broadly, the study demonstrates how AI-assisted surrogate modelling can complement high-fidelity physics-based simulations and contribute to more efficient virtual testing and computational analysis of advanced composite structures.

The figures show the lattice structure under analysis and also the graph with the first three natural frequencies for one of the cases (cantilevered lattice structure).

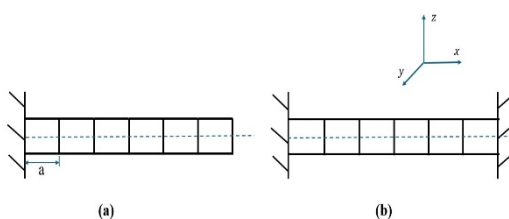


Figure 1: Nanolattice: (a) Cantilevered, (b) Doubly-clamped

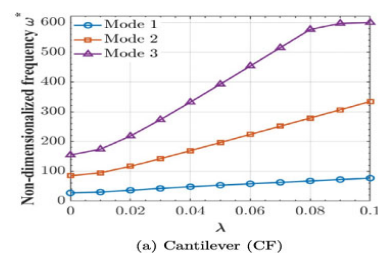


Figure 2: Natural frequencies for the first three modes of the Cantilevered lattice