



20th International Conference on Advanced
Computational Engineering and Experimenting
27 JUNE – 1 JULY 2027 | PARIS, FRANCE

ABSTRACT:

Auxetic Metamaterials from Unit Cells to Structural Components: Adaptive Simulation and Experimental Dynamics

T. Ricken¹, N. Grünfelder¹, S. M. Seyedpour¹, M. Brodbeck¹, B. Dieckgraeff¹, K. Madhikarmi¹,
N. Waschinsky¹

¹University of Stuttgart, Institute of Structural Mechanics and Dynamics in Aerospace Engineering,
Pfaffenwaldring 27, 70569 Stuttgart, Germany

The mechanical response of auxetic metamaterials depends on unit-cell geometry and its interaction with the surrounding structure. This contribution addresses the transition from individual cells to structural components through advances in adaptive numerical simulation and the experimental characterisation of modular lattice architectures.

In a experimental study, three-dimensional auxetic lattices are assembled from two repeatable planar component types connected by interlocking dovetail joints [1]. This modular architecture enables disassembly and replacement of individual components. Impact-hammer testing, accelerometers and laser vibrometry reveal repeatable low-frequency global resonances, strongly direction-dependent modal participation and additional modal groups up to approximately 1 kHz. The identified damping depends on frequency and estimation method, indicating that a single constant damping ratio is insufficient to describe the tested assembly. These findings provide experimental targets for subsequent modelling of joint compliance, contact and frictional dissipation.

[1] N. Grünfelder, M. Brodbeck, N. Waschinsky, T. Ricken, S. M. Seyedpour: Puzzle-like auxetic lattice architectures employing dovetail joints: Experimental investigation of the structural dynamic behaviour. *Materials & Design*, 268 (2026), 116408. DOI: 10.1016/j.matdes.2026.116408.