MECHANICAL ENGINEERING MSc SEMINAR (30 min.)

Thursday, August 28 2025 at 13:30-14:00, D. Dan and Betty Kahn Building, Room 217

Also online: https://technion.zoom.us/j/93367962364

Soft orthotropic hyperelastic lattice structures: numerical homogenization and experimental validation

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Lattice structures have become increasingly popular in various applications due to their lightweight and wide range of effective properties that can be locally tailored by adjusting their geometric features. Finite element (FE) simulations are commonly used to predict their mechanical response and inform inverse design algorithms. However, these simulations pose significant computational demands due to the large number of elements needed for meshing lattice geometries. This challenge can be addressed by replacing lattice geometries with a homogeneous solid of equivalent mechanical properties, a process known as homogenization. However, determining a suitable constitutive model and parameters is difficult, particularly when the response is nonlinear and anisotropic. To this end, this study presents a method for numerically homogenizing orthotropic lattice structures subjected to large elastic deformations. FE simulations of lattice unit cells are employed to quantify their nonlinear elastic response to finite deformations in uniaxial tension, compression, and simple shear. The simulation results are then used to fit the constitutive model parameters for the effective behavior of the unit cells, employing a Fung orthotropic hyperelastic formulation. The proposed homogenization method is validated through comparisons with simulations of the full geometry of the lattice structures, as well as with compression experiments on beam-based cubic lattice structures manufactured from thermoplastic polyurethane using selective laser sintering. Furthermore, we compare the response of a beam with orthotropic unit cells subjected to bending, which activates multiple deformation modes. The results demonstrate the feasibility and computational efficiency of the proposed homogenization method, highlighting the potential of this approach for efficient modeling and design of lattice structures in various engineering applications.

Note: the seminar will be given in Hebrew

Seminars Coordinator: Assoc. Prof. Shmuel Gal.