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Title: Numerical evaluation of two-dimensional micromechanical structures of anisotropic cellular materials: case study for polyurethane rigid foams

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Abstract: This paper deals with evaluating the elastic response of several micromechanical structures used for simulating cellular materials under compression. For this study polyurethane rigid foams were investigated, having three relative densities: 0.085, 0.124 and 0.256. Their microstructure was analysed using SEM images, determining four types of cells that were consequently designed using specialized CAD software: square cells with circular, quadratic and/or hexagonal orifices and hexagonal cells. An interdependent variation of the cells' geometrical parameters of the proposed structures was determined to obtain geometrical variations at a required relative density. Finite element analysis simulations were performed on the designed microstructural models using a linear elastic material model for the cell struts, resulting in the variation of the elastic modulus of the structure with the variation in cell geometry parameters. The final objective of this work was to determine anisotropic bi-dimensional micromechanical models for the studied cellular material that provides accurate results in compression on both loading directions. The anisotropic models for the proposed cell structures were obtained by generating irregular geometries which provided extra variables for the cell geometry parameters. It was determined that some cell geometries are suitable for simulating lower relative density materials while other cell geometries provide good accordance with experimental data for higher relative density materials.

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