Mechanical and Industrial Engineering Department-College of Engineering-Sultan Qaboos University

Finite Element Analysis of Mechanical Behavior of Cellular Structures

Isra Sadiq AL-Muscati

Abstract

Cellular solids have been widely used in many applications due to their enhanced properties compared to metals, polymers and composites. Researchers have devoted their time and effort to study the various properties of cellular solids. This study focuses on determining the effective mechanical properties of cellular solids, namely the modulus of elasticity and the Poisson's ratio, and the way they are affected by a few parameters.

These parameters include: relative density, aspect ratio of the structure, cellular shape, cross-section, and material of the cell walls. The shapes of cellular structure considered are: regular hexagon, equilateral triangle, and square cells.

Two commercial software programs, MATLAB and ANSYS, are used for modeling and analysis. It is found that the finite element solution of the equilateral triangle and square cellular solids are in good agreement with the analytical solution, whereas the differences are up to 82% for regular hexagonal cellular solids.

Cellular solids having a solid square cross-section are found to be much stiffer than the ones with a hollow square cross-section. No significant difference is found in mechanical properties of cellular solids having different cell wall materials; rather it is a strong function of relative density. Square cellular solids are the stiffest among the three cellular structures considered in this research.