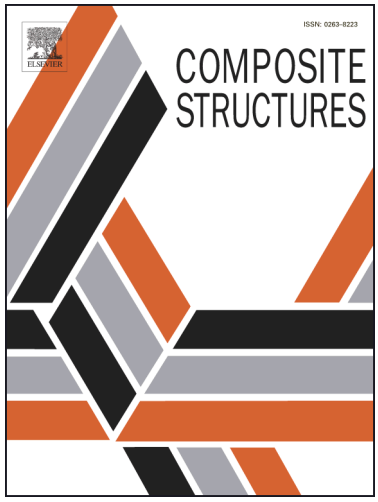

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Large deformation of an auxetic structure in tension: experiments and finite element analysis

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Abstract:

The present paper reports on the post-yield behaviors of an auxetic structure, honeycomb with representative re-entrant topology. Specimens were made of stainless steel and polymer, respectively. Quasi-static uniaxial tensile tests were conducted in the two principal directions, followed by simulations using the commercial code - ABAQUS 6.11-2. The deformation, tensile stress-strain curves and Poisson's ratio were of interest. A good agreement was observed between the numerical simulations and the experimental results. Subsequently, the effect of cell wall thickness and initial cell angle was studied by means of finite element analysis. An analytical equation was also given for the yield stress of such materials under tension.

Keywords: Re-entrant hexagonal honeycomb; Polymer and stainless steel; Image correlation; Poisson's ratio; Finite element analysis

1. Introduction

Over the past several decades, developments in structural engineering design and technology in aircraft industry as well as automotive, sports, and leisure sectors have demanded novel materials to meet higher engineering specifications [1]. Such materials are to possess a combination of high stiffness and strength with significant weight savings. Structural material with negative Poisson's ratio was explored [1, 2], known as auxetic materials [3, 4].

Lakes [5] first discovered this negative Poisson's ratio effect in polyurethane (PU) foam with re-entrant structures and responded to a comment in Ref. [6] on this negative trait. The key to the

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