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Pressurized Cells: From Self-Buckling of Cylinders to Pressurized Cellular Solids

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Abstract

Pressurized cellular structures are ubiquitous in nature and inspire the design of soft robotics and shape-morphing structures. These structures have recently garnered significant attention and inspired the field of biomimetic materials. Motivated by the internal cells of leaves, the mesophyll, and its internal turgor pressure, we seek to understand how the internal pressure of cylinders can enhance or compromise the structural stability in these slender structures under their own weight. Via dimensionless structural analysis utilizing both Saint Venant-Kirchhoff and Neo-Hookean material models, we rationalize the influence of the applied internal pressure on self-weight buckling via numerical simulations, scaling analysis, and experiments, obtaining results that highlight the coupling between geometric properties and the structural response of the system. These insights may inform the design of pressure-stabilized structures. This work was supported by a Research Grant from HFSP (Ref.-No: RGP010/2023)

Keywords:

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