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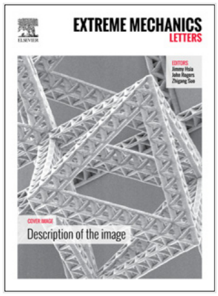

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Bending and Torsional Reconfiguration of Chiral Rods Under Wind and Gravity

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Abstract

We seek to understand the effect of chirality on the reconfiguration and the self-buckling strength of chiral plants subjected to wind and gravity by experimental and theoretical modeling of their large deformation. Chiral rod and ribbon specimens are made of polyurethane foam reinforced with nylon fibers and ABS plastic. Wind tunnel tests are performed to evaluate the effect of chirality on flow-induced reconfiguration. A theoretical model is developed by coupling the Kirchhoff rod theory with a semi-empirical formulation for aerodynamic loading evaluation. A range of geometrical, material and flow parameters are studied in the experimental and theoretical model. It is shown that for rods, chirality decreases the maximum root bending moment. For ribbons, chirality leads to a trade-off with higher self-buckling strength but also higher root bending moment. Moreover, chirality reduces the effect of the loading direction on deformation. Chirality plays an important structural role in the interaction of slender structures with fluid flow and gravity loading.

Key words: Reconfiguration, Drag reduction, Torsion, Large deformation, Buckling, Root bending moment, Kirchhoff rod.

1. Introduction

In general, plants and vegetation are flexible and are prone to significant deformation under fluid loading, their own weight or precipitation load. The deformation of plants which usually leads to a drag reduction, is termed reconfiguration [1]. The reconfiguration of plants has been studied fundamentally by modeling them as simple mechanical structures such as bending beams [2], fibers [3, 4] and plates [5, 6, 7]. Although these aforementioned models can simplify the two-dimensional deformation of plants, they are not representative for all forms of reconfiguration. For

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