Solitary waves in longitudinally wrinkled and creased helicoids

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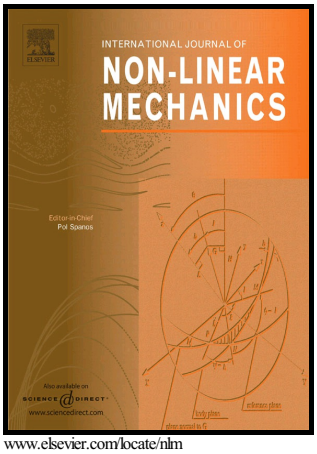

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Solitary waves in longitudinally wrinkled and creased helicoids

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Abstract

Elastic ribbons subjected to twist and stretch handle multiple morphological instabilities, amongst others, the longitudinally wrinkled and creased helicoids are investigated in the present paper as promising periodic nonlinear waveguides. Modeling the ribbon by isogeometric Kirchhoff-Love shells, the first longitudinal buckling mode is recovered numerically and used into the Bloch-Floquet method to obtain dispersion curves. After analyzing the effects of the buckling pattern on the different wavemodes, it is shown that classical linear axial waves interact with bending ones and become dispersive. Additionally, as buckling involves geometrical nonlinearities, the structure is expected to host stable nonlinear waves. Indeed, clear supersonic rarefaction trains are observed experimentally and their characteristics are found in agreement with the weakly-nonlinear Boussinesq model.

Keywords: longitudinally wrinkled and creased helicoids, supersonic rarefaction train, experiment, Boussinesq model

1. Introduction

Periodic-buckled structures possess geometrically (physically) nonlinear deformations and intrinsic length scales responsible for dispersion effects, such that the two required conditions for the structure to host solitary waves are present. In recent works [1, 2], it has been shown analytically, numerically and experimentally that solitary waves can propagate in periodic-buckled

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