UNSTABLE STRUCTURES FOR THE DESIGN OF SOLIDS BREAKING THE CONCEPT OF ELASTIC POTENTIAL

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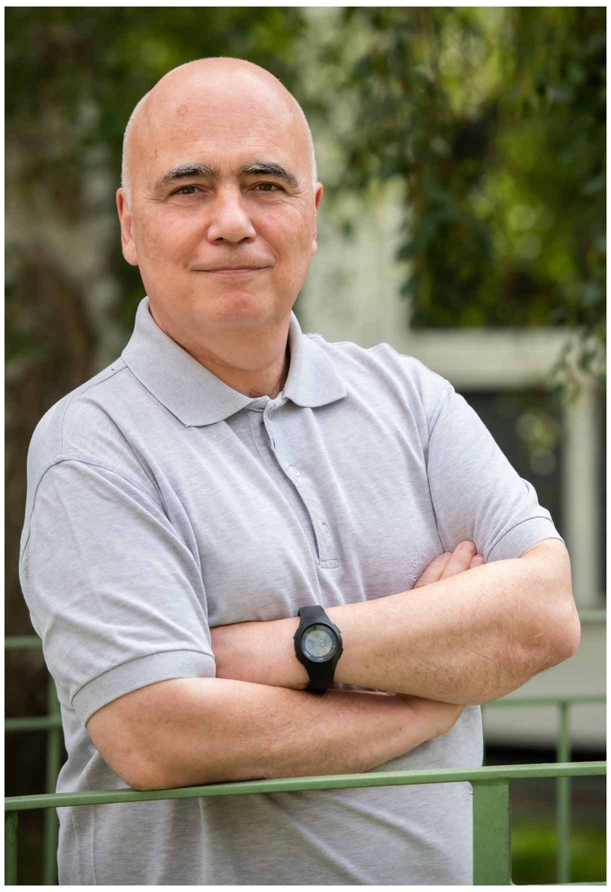

Abstract

Several "unusual" structural instabilities are presented, including effects of configurational forces [1], snaking of a rod, tensile buckling, and flutter [2]. Then the problem is addressed of implementing these structural behaviours into a metamaterial, via homogenization theory. In particular, elastic grids of axially prestressed rods are considered, to be deformed incrementally and thus involving incremental bending moment, and axial and shear forces. It is shown that tunable material instabilities can be designed, as well as the achievement of dynamical properties for wave localization and filtering. The emergence of material instabilities such as shear band formation is demonstrated both for compressive [3] and tensile axial forces [4]. Moreover, the architecture of the considered structures leads to the emergence of multiple band gaps, flat bands, and Dirac cones [5]. The experience gained on structural flutter [2, 6] is exploited to implement a new concept, namely, the possibility of implementing a Hopf bifurcation in a continuous medium. This possibility is proven through a rigorous application of Floquet-Bloch wave asymptotics, which yields an unsymmetric acoustic tensor governing the incremental dynamics of the effective material [7]. The latter represents the incremental response of a hypo-elastic solid, which does not follow from a strain potential and thus apparently breaks the wall of hyperelasticity, leading to non-Hermitian mechanics. The discovery of elastic materials capable of collecting or releasing energy in closed strain cycles through interactions with the environment introduces new micro and nano technologies and finds definite applications, for example, in the field of energy harvesting.

Keywords: Flutter instability; Non-Hermitian mechanics; Homogenization

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Biography

Since 2001, Professor Bigoni has held a Full Professor position at the University of Trento, where he leads a dynamic research group specializing in Solid and Structural Mechanics. His recognitions include being elected a Euromech Fellow by the European Mechanics Society in 2009, receiving the Ceramic Technology Transfer Day Award in 2012, and being awarded a Doctor Honoris Causa by Ovidius University of Constanta in 2014. Additionally, he has been honored with the Panetti and Ferrari Award for Applied Mechanics by the Accademia delle Scienze di Torino. His contributions extend globally: he was the Guest Lecturer for the Midwest Mechanics Seminars in 2018, elected a Fellow of the Istituto Lombardo, Accademia di Scienze e Lettere in 2019, and featured in a 60th Anniversary Issue of the Journal of the Mechanics and Physics of Solids. In 2024, he was inducted as a Fellow of the Italian Academy of Engineering. Professor Bigoni's research is prominently featured on the covers of nine international journals. He has played a key role in fostering academia-industry collaboration, coordinating three European grants and a Marie Curie Fellowship. He is the recipient of two prestigious ERC Advanced Grants from the European Research Council (2013, 2021).

More details can be found at https://bigoni.dicam.unitn.it/

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