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Morphological optimization of tensegrity-type metamaterials

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Abstract

We analyze the problem of morphological optimization for metamaterials with tensegrity-type cells. Our mass and morphological optimization scheme is based on both local and global instability analyses. As a meaningful prototypical example we tassellate a slab, subjected to a compression macro-stress orthogonal to its middle plane, into periodic patterns of triangular, square and hexagonal cells.

Keywords: Metamaterials, Morphological Optimization, Tensegrities, Global Stability

1. Introduction

Metamaterials are engineered materials, which may exhibit resistance and lightness properties unobserved in natural materials [2], [3]. Strong and lightweight materials are increasingly needed for several advanced applications as those in aerospace and automotive fields. The new proposed materials are typically obtained as periodically patterned low scale structures, whose macroscopic response depends primarily on their topology rather than chemical composition. Thus understanding how the topology of the structured material influences the macroscopic properties is a key-point to propose design criteria for new artificial materials. The interest in this field is also due to other physical properties of the new designed materials, such as optical properties [4], negative material moduli [7] and vanishing macroscopic shear modulus [8].

The present study is based on previous results on the mass optimality of tensegrity structures for compressive load transfer [9], [10]. Here we ana-