



## STRAIN GRADIENT CONTINUUM MODELS FOR LINEAR PANTOGRAPHIC STRUCTURES: A CLASSIFICATION BASED ON MATERIAL SYMMETRIES

YOSRA RAHALI, JEAN-FRANÇOIS GANGHOFFER, FREJ CHAOUACHI AND ALI ZGHAL

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**Abstract.** We analyze the mechanics of planar networks of extensible fibers, for which we derive the general form of the mechanical energy. We consider especially networks made of two sets of non orthogonal and non equivalent fibers, called the parallelogram structure, with variants obtained as specific patterns called the square, rectangular, and rhombic structures. The fibers of the network are assumed to obey Bernoulli kinematics. A second order gradient continuum is obtained. The arguments of the energy of these four patterns are obtained based on the material symmetry group of the considered structures.

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### 1. Introduction

Network materials made of a repetitive set of beams continue to attract the interest of many researchers (see for instance [4, 14, 16]), due to their low weight and interesting mechanical performances in comparison to bulk materials. The relationship between the material microstructure and the resulting properties is the key to optimization and design of lightweight, strong, and tough materials and structures [7]. Examples include artificial textile materials, soft biological structures like skin or the arterial wall, for which open problems in this field are related to the development of suitable constitutive models accounting for the anisotropy induced by the fibers, and the presence of large strains. Despite the availability of powerful machines, it may be cumbersome to compute the mechanical response of such discrete structures, thus there is a need for suitable continuum constitutive models that can be used at the macroscale for the purpose of structural computations.

The objective of this work is the derivation of the energy of a set of two inequivalent fibers, a situation representative of a planar network of extensible and flexible