A Virtual Element approach for micropolar continua

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ABSTRACT

A wide range of microstructured materials, commonly adopted in different engineering applications, is strongly characterized by nonlocal constitutive response. The overall behaviour is, thus, influenced by scale parameters, directly related to the dimension of heterogeneities, that are typically non negligible with respect to the characteristic structural size [1].

In this context, the micropolar continuum [2], that belongs to the class of generalized continua, is able to retain memory of an inherent microstructure, providing an enriched constitutive behaviour, with respect to the classical Cauchy continuum. Each material point is, indeed, provided with displacement and rotation degrees of freedom, thus resulting in additional strains and stresses: besides the classical components, micropolar ones include curvatures (work conjugate to couple stresses) and skew-symmetric strains (work conjugate to skew-symmetric stresses).

In this work, we propose a virtual element approach for solving boundary value problems in 2D linear isotropic micropolar elasticity. The recently proposed virtual element method [3], represents an extension of mimetic finite difference approaches to deal with very general polygonal elements with generic number of nodes. Following the basic idea of the method, here, the displacement and rotation fields are decomposed into a polynomial space, either linear or quadratic, and a remaining space that is kept virtual in the formulation. Generalized consistency and stabilization terms are consistently derived.

Different applications are proposed [4], ranging from a patch test, properly conceived for micropolar continua, to various engineering applications. The obtained results are in good agreement with reference solutions, confirming the capability of the proposed elements in modelling the expected responses.

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