Some novel numerical applications of Cosserat continua

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Abstract

Cosserat continua demonstrated to have peculiar mechanical properties, with respect to classic Cauchy continua, due to the fact that they are able to more accurately model heterogeneous materials, as particle composites, masonry-like materials and others, taking into account, besides the disposition, the size and the orientation of the heterogeneities [1-2]. On the contrary, classical Cauchy elasticity fails in the modeling of problems in which the characteristic internal length is comparable with the structural length (e.g. [3]). For this reason, many studies are devoted to the numerical implementation of the Cosserat model for practical engineering purposes.

Due to the complexity of real physical systems, generally it is not convenient to use semi-analytical approaches for solving such problems, due to limitations related to the boundary conditions and constitutive material models. Thus, numerical approaches are considered as a better choice in these studies. In particular, the authors in the present paper are studying some reference benchmarks, well known from the literature of Cosserat continua, by comparing the solution provided by strong and weak formulations. On one hand, the high accuracy of the so-called Strong Formulation Finite Element Method (SFEM) [4-6] is compared to the numerical models provided by a Finite Element (FE) modeling given by COMSOL® Multiphysics. Convergence, stability and reliability of both modelling will be discussed. The aim is to investigate the more convenient numerical strategies for solving the Cosserat elastic problem. Moreover, differences between classical (Cauchy) and micropolar (Cosserat) model will be discussed in order to emphasize the capabilities of the Cosserat continua in modelling the aforementioned class of problems.

Keywords: Cosserat continua, Differential quadrature method, Strong formulation finite element method.

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