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UNIFIED THEORY OF STRUCTURES BASED ON MICROPOLAR ELASTICITY

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Classical theory of linear elasticity is the common practice in engineering. It assumes that the rotations within the continuum are a direct consequence of displacements and the interaction between adjacent points occur only by means of translational forces. The classical theory of linear elasticity has produced acceptable results for various applications. However, when large stress gradients or significant microstructure contributions occur within the structure (e.g., in the proximity of holes and cracks), classical theories may fail. In fact, recent experiments have shown that materials will display strong scale effects as the deformations are small compared to a characteristic length. Moreover, the trend of miniaturization in engineering, such as micro-electro-mechanical systems (MEMS) and electronic materials, requires a comprehensive understanding of microstructural effects on the macroscopic response of the structure. In this framework, micropolar elasticity was developed to overcome these issues. This theory considers the structure as a continuous distribution of particles. Each particle can make not only translations but also microrotations. As a consequence, the solid can bear not only stresses, but also couple stresses.

This paper intends to establish a unified theory of structure based on the micropolar elasticity. The solution proposed is developed in the domain of the Carrera Unified Formulation (CUF), according to which theories of structures can degenerate into a generalized kinematics that makes use of an arbitrary expansion of the generalized variables. CUF is a hierarchical formulation that considers the order of the structural model as an input of the analysis, so that no specific formulations are needed to obtain any refined model.

Different types of structures have been analyzed and the results are compared and validated with examples found in the literature.