Meshfree Methods for Modeling of Material Deformation Using Higher-Order Continuum Theories

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In this contribution, meshfree methods are applied for the modeling of gradient elasticity and hyperelasticity using higher-order theories based on only one microstructural parameter [1]. Both the Mixed Meshless Local Petrov-Galerkin (MLPG) approach [2] and the Optimal Transportation Method (OTM) [3] are considered. Firstly, the MLPG collocation method based on the staggered solution strategy [4] is utilized for structures undergoing small strain. Thereafter, the OTM [3] based on the weak-form of gradient continuum for finite strain is considered. Both methods are used for the modeling of homogeneous and heterogeneous structures. In the mixed collocation approach the fourth-order equilibrium equations are solved as an uncoupled sequence of two sets of second-order differential equations, while in the OTM method the weak-form of the original fourth-order equilibrium equations is employed. The independent variables in both approaches are approximated using meshless interpolating functions enabling the satisfaction of the boundary conditions in a simple and straightforward manner without the need for the calculation of additional parameters. The Interpolation Moving Least Squares (IMLS) [5] are utilized in the mixed MLPG methods and the Maximum-Entropy functions [6] are used in the OTM method. The analysis of accuracy and numerical performance of both approaches are demonstrated by a set of suitable numerical examples.

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