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C1 natural element method for strain gradient linear elasticity and its application to microstructures

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Abstract C1 natural element method (C1 NEM) is applied to strain gradient linear elasticity and size effects on microstructures are analyzed. The shape functions in C1 NEM are built upon the natural neighbor interpolation (NNI), and realize the interpolation to nodal function and nodal gradient values, so that the essential boundary conditions (EBCs) can be imposed directly in a Galerkin scheme for the partial differential equations (PDEs). In the present paper, C1 NEM for strain gradient linear elasticity is constructed, and several typical examples which have analytical solutions are presented to illustrate the effectiveness of the constructed method. In the application to microstructures, size effects of the bending stiffness for microgripper and the stress concentration factor (SCF) for microspeciem are studied. It is observed that size effects are obvious strong when the width of spring for microgripper, the radius of circular perforation and the long axis of elliptical perforation for microspeciem, are close to the material characteristic length scales. For the U-shaped notch, with the increase of notch radius, size effects turn weak obviously; with the increase of the length of notch, size effects turn weak slightly.

Keywords: Strain gradient linear elasticity C1 natural element method Sibson interpolation Microstructures Size effects

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