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Numerical research on a three-dimensional solid element based on generalized elasticity theory. (English) Zbl 1435.74011

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Summary: A finite element equation is established based on generalized elasticity theory by applying a virtual work principle. Then, a penalty function term is added to the virtual work equation by imposing rotation and displacement as independent variables. An 8-node element with full integration, an 8-node element with reduced integration, and a 20-node element with full integration are constructed using difference integration schemes and shape functions. The influences of structural degrees of freedom and the penalty parameter on convergence are analyzed via the three elements. It is shown that the 8-node element with reduction integration and the 20-node element with full integration are convergent, whereas the 8-node element with full integration is divergent. The scale effects of a slender beam, a short beam, a thin plate, and a medium-thick plate are numerically analyzed. Lastly, the scale effects of the frequencies that correspond to the bending mode, torsion mode, and tension-compression mode for a pretwisted plate are studied. It is found that the frequencies that correspond to the bending mode and torsion mode exert a scale effect, whereas the frequency that corresponds to the tension-compression mode does not. The essence of the scale effect is that the rotational deformation of the microstructure is amplified.

MSC:

74B05 Classical linear elasticity
74S05 Finite element methods applied to problems in solid mechanics

Software:

FEAPpv

Full Text: DOI

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