Trabelssi, M.; El-Borgi, S.
A novel formulation for the weak quadrature element method for solving vibration of strain
gradient graded nonlinear nanobeams. (English) Zbl 07612099
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Summary: A novel formulation of the weak form quadrature element method, referred to as the locally
adaptive weak quadrature element method, is proposed to develop elements for nonlinear graded strain
gradient Timoshenko and Euler-Bernoulli nanobeams. The equations of motion are obtained based on
Hamilton principle while accounting for the position of the physical neutral axis. The proposed elements
use Gauss quadrature points to ensure full integration of the variational statement. The proposed for-
mulation develops matrices based on the differential quadrature method which employs Lagrange-based
polynomials. These matrices can be modified to accommodate any number of extra derivative degrees
of freedom including third-order beams and higher-order strain gradient beams without requiring an en-
tirely new formulation. The performance of the proposed method is evaluated based on the free vibration
response of the linear and nonlinear strain gradient Timoshenko and Euler-Bernoulli nanobeams. Both
linear and nonlinear frequencies are evaluated for a large number of configurations and boundary condi-
tions. It is shown that the proposed formulation results in good accuracy and an improved convergence
speed as compared to the locally adaptive quadrature element method and other weak quadrature element
methods available in the literature.

MSC:
74Kxx Thin bodies, structures
74Sxx Numerical and other methods in solid mechanics
74Hxx Dynamical problems in solid mechanics

Full Text: DOI

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