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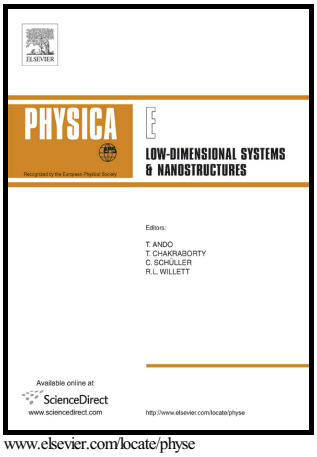
Akbar Jafari, Meysam Ezzati



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Investigating the non-classical boundary conditions relevant to strain gradient theories

Akbar Jafari* **and Meysam Ezzati**

Department of Mechanical Engineering, Sirjan University of Technology, Sirjan, Iran, P.O. Box: 7813733385

Abstract

In the present study, two classes of non-classical constitutive equations consisting of the first and the second order strain gradients theories (FSG and SSG) were applied in order to develop the governing equations of static and free vibrational behavior of beam structures. The governing equations in orders of six and eight were constructed for FSG and SSG theories, respectively. Therefore, higher order or in other words non-classical boundary conditions (HOBCs or NCBCs) came into play in addition to the classical ones (CBCs). Some explanations were presented about the concept of the non-classical boundary conditions. Analytical and finite element (FE) approaches were employed to solve the governing equations. The analytical solutions were utilized in validation and convergence study of FE results. Comparisons were made with the relevant data reported in the open literature; however, to the best of the authors' knowledge, few references have been published on SSG theory and HOBCs. In the numerical studies, the effects of applying different combinations of CBCs and HOBCs to the static and free vibration behaviors of the beam were investigated. Moreover, the impacts of non-classical elastic constants and the beam size on its behavior were also studied.

Keywords: Strain gradient; Non-classical, Higher order; Boundary conditions; FEM; Beam.