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On Nonlocal and Strain Gradient Models in Structural Mechanics

J.N. Reddy
Advanced Computational Mechanics Laboratory
Department of Mechanical Engineering
Texas A & M University, College Station, TX 77843-3123
jnreddy@tamu.edu

ABSTRACT

In this paper, an overview of the authors' recent research on Eringen's nonlocal elasticity [1], gradient elasticity of Srinivasa and Reddy, and couple stress theories in formulating the governing equations of beams and plates is presented. Three different nonlocal models that account for microstructure-dependent size effects are revisited to establish the connection between them. The first one is based on modified couple stress theory of Mindlin, Koiter, Toupin, Green, Naghdi, and Rivlin [2] and the second one is based on Srinivasa-Reddy gradient elasticity theory [3]. The third nonlocal model discussed here is a unified integral model developed by Khodabakhshi and Reddy [4]. The three nonlocal models are used to derive the governing equations of beams and plates. In addition, a discrete peridynamics idea as an alternative to the conventional peridynamics idea of Silling [5] is also discussed briefly [6]. Thus, the three major results discussed herein are: (1) establishing the relationship between the strain gradient theory and the modified couple stress theory, (2) an introduction of unified integro-differential nonlocal elasticity model and its use in the bending analysis of Euler-Bernoulli beams, and (3) a discrete peridynamics model. An overview of Eringen's nonlocal model, Mindlin's modified couple stress theory, the gradient elasticity theory of Srinivasa-Reddy, and a unified integro-differential model that includes Eringen model as a special case is presented.

References

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