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Size dependent analysis of wave propagation in functionally graded composite cylindrical microshell reinforced by carbon nanotube

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Abstract:
In this study, wave propagation in functionally graded carbon nanotube reinforced composite (FG-CNTRC) cylindrical microshell is investigated by taking into consideration nonlocal constant and material length scale parameter. For this purpose, FG-CNTRC cylindrical microshell is modeled using shear deformable shell theory as well as nonlocal strain gradient theory. The classical governing equations are extracted using Hamilton's principle. Carbon nanotubes are distributed in UD and FG-X shapes in FG-CNTRC cylindrical microshells. The results demonstrate that the rigidity of FG-CNTRC cylindrical microshell is higher in the strain gradient theory and lower in the nonlocal theory compared to that in the classical theory. In addition, the effect of manner of distribution of carbon nanotubes in the FG-CNTRC cylindrical microshell as well as the effect of volume fraction of the carbon nanotubes on the phase velocity of the FG-CNTRC cylindrical microshell is investigated. The results demonstrate that the effects of nonlocal constant and material length scale parameter, thickness, and wavenumber on the phase velocity of FG-CNTRC cylindrical microshell are considerable.

Keywords: FG-CNTRC cylindrical microshell, shear deformation theory, nonlocal strain gradient theory, nonlocal constant, material length scale parameter.

1- Introduction

Distinctive mechanical, chemical, and electrical properties of carbon nanotubes have led to their extensive application in microcomposites. Examples of these applications include their use as reinforcement in microcomposites. Microcomposites reinforced with carbon nanotubes have light weight and high mechanical strength, hence their extensive application in aerospace and transportation industries. Due to the diminutive size of microcomposites, regular methods are not appropriate for studying these nanostructures; therefore, molecular dynamics (MD) simulation [1, 2]and continuum theories are used instead. Due to the fact that MD simulation is time-consuming and includes complex computation, researchers have recently been interested in the use of non-classical continuum theories.

Since micro/nanostructures are studied in minute dimensions, the classical theory is unable to accurately predict the mechanical properties and dynamic behavior of such structures;