Nonlinear vibrations and energy conservation of Single-Walled Carbon Nanotubes

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The nonlinear vibrations of Single-Walled Carbon Nanotubes are analysed. The Sanders-Koiter elastic shell theory is applied in order to obtain the elastic strain energy and kinetic energy. The carbon nanotube deformation is described in terms of longitudinal, circumferential and radial displacement fields. The theory considers geometric nonlinearities due to large amplitude of vibration. The displacement fields are expanded by means of a double series based on harmonic functions for the circumferential variable and Chebyshev polynomials for the longitudinal variable. The Rayleigh-Ritz method is applied in order to obtain approximate natural frequencies and mode shapes. Free boundary conditions are analysed. In the nonlinear analysis, the three displacement fields are re-expanded by using approximate eigenfunctions; an energy approach based on the Lagrange equations is considered in order to reduce the nonlinear partial differential equations to a set of nonlinear ordinary differential equations. Nondimensional parameters are considered. The total energy conservation of the system is verified by considering the combinations of different vibration modes. The effect of the companion mode participation on the nonlinear vibrations of the carbon nanotube is analysed.

References

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