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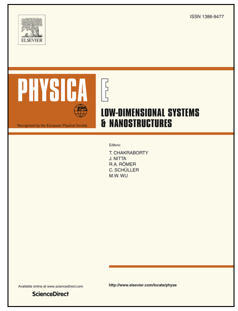

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Seismic response of functionally graded-carbon nanotubes-reinforced submerged viscoelastic cylindrical shell in hygrothermal environment

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Abstract

The current work suggests mathematical model for the seismic response of submerged cylindrical shells subjected to hygrothermal load. The structural damping effects are considered based on Kelvin-Voigt model. The cylindrical shell is reinforced by functionally graded (FG)-carbon nanotubes (CNTs) and carbon fibers where the Halpin-Tsai model is used for calculating the effective material properties of the structure. The acoustic wave equation is utilized for the effect of the fluid around the structure. The problem is framed combining shell motion equations with the acoustic wave equation where the fluid-loaded terms are considered with Hankel function of second kind. The equations of motion are derived based on Reddy shear deformation theory (RSDT) in conjunction with energy method and Hamilton's principle. The dynamic deflection of the structure is obtained using differential quadrature method (DQM) and Newmark approach. The effects of fluid, boundary condition, thermal load, moisture changes, structural damping parameter, length to thickness ratio of shell, CNTs volume percent and distribution type are shown on the dynamic deflection of the structure. The results show that with increasing the CNTs volume percent, the dynamic deflection decreases. In addition, the FG-X type (FGX) distribution of CNTs for the submerged cylindrical shell is the best choice among the FG-O type (FGO), FG-V type (FGV) and uniform distributions. Furthermore, the maximum dynamic deflection of the structure increases where the structure is in the hygrothermal environment.

Keywords: Seismic response; Submerged cylindrical shells, Earthquake load; Hygrothermal load; FG-CNT; Viscoelastic.

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