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Vibration and instability analysis of closed-cell poroelastic pipes conveying fluid

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Abstract

Dynamic analysis and design of light-weight structures subject to different types of applied forces is of considerable practical interest in engineering applications. Porous structures are a novel class of weight-efficient engineering materials with optimized mechanical properties and improved structural performance. Porous materials with functionally graded porosity are achieved by tailoring the size and density of the internal pores in one or more directions that leads the desired mechanical properties. In this paper, the dynamic response of poroelastic pipes made of a closed–cell porous material with functionally graded porosity subjected to influences induced by fluid flow is investigated. Three different porosity distributions through the pipe thickness are introduced. The finite element formulation of dynamic equations of pipeline conveying fluid are presented based on Timoshenko theory by considering the fluid‑structure interaction and the effect of shear deformation. The complex modal analysis is employed to estimate the natural frequencies of a clamped-clamped pipe with different velocities. Finally, the effects of fluid velocity on the dynamic response of a poroelastic pipe are studied.

Keywords: Porous pipe, closed-cell porosity, Vibration, Functionally graded, instability

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