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On the effect of coupled solid-fluid deformation on natural frequencies of fluid saturated porous plates

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Abstract

This paper is concerned with the effect of deformation coupling between solid and fluid on the free vibration characteristics of isotropic rigid porous rectangular plates under undrained condition. Mindlin plate theory is employed to model the moderately thick porous plate. The problem addressed is formulated by using Hamilton's principle, which leads to a set of partial differential equations dealing with frequency response of the plate. The governing equations of motion are solved analytically for Levy-type porous plates by introducing some auxiliary functions. The fluid viscosity is assumed to be very low so that it cannot cause energy dissipation in system. Numerical results are obtained in non-dimensional form. The accuracy of the solution is confirmed by making some comparisons of the obtained frequencies with those available in literature. It is found that the effect of coupled solid-fluid deformation cannot be neglected when the Biot-Willis constants are considerable compared to mechanical properties of solid skeleton of the plate. It is also observed that plate gets stiffer as fluid is trapped in pore network of the porous medium.

Keywords: *Coupled Solid-Fluid Deformation; Porous Materials; Free Vibration; Rectangular Plate; Analytical Solution; Fluid Saturated.*

1. Introduction

Lightweight materials have always been interesting because they can be considered as a good alternative in structures which are constrained by their own weight. Considering porous plates as a lightweight material, they can be used vastly in engineering applications. In order to predict the mechanical behavior of plates and shells, several types of theories have been developed. Free

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