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Exploring the Influence of High-Frequency Acoustic Parameters on Wave Behavior in Porous Bilayer Materials: An Equivalent Fluid Theory Approach

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Abstract : This study investigates the sensitivity of high-frequency acoustic parameters in a rigid air-saturated porous bilayer material within the framework of the equivalent fluid theory, a specific case of the Biot model. The study specifically focuses on the sensitivity analysis in the frequency domain. The interaction between the fluid and solid phases of the porous medium incorporates visco-inertial and thermal exchange, characterized by two functions: the dynamic tortuosity $\alpha(\omega)$ proposed by Johnson et al. and the dynamic compressibility $\beta(\omega)$ proposed by Allard, refined by Sadouki for the low-frequency domain of ultrasound. The parameters under investigation encompass porosity, tortuosity, viscous characteristic length, thermal characteristic length, as well as viscous and thermal shape factors. A +30% variation in these parameters is considered to assess their impact on the transmitted wave amplitudes. By employing this larger variation, a more comprehensive understanding of the sensitivity of these parameters is obtained. The outcomes of this study contribute to a better comprehension of the high-frequency wave behavior in porous bilayer materials, providing valuable insights for the design and optimization of such materials across various applications.

Keywords : bilayer materials, ultrasound, sensitivity analysis, equivalent fluid theory, dynamic tortuosity., porous material
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