

Influence of pore fluid on shear wave transmissivity across discontinuities

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Abstract:

The shear motion within the pore-fluid, i.e., the fluid vorticity, may affect the macroscopic shear (S-) wave in the post Biot critical frequency (Ω_i) regime where viscous boundary layer (VBL) develops. The standard approach introduces dynamic permeability in the Biot theory² to capture the effect of VBL. This work analyzes a horizontally polarized plane S-wave normally incident upon a planar contact of solid and fluid-saturated porous half-spaces. The VBL causes the relative motion of phases, as fluid is coupled viscously to the frame only in the vicinity of the pore-wall. That is expected to reduce S-wave transmission across the interface, in the frequency regime above Ω_i , over the regime below. Figure 1 shows a contrary prediction for the Biot theory.

The slow S-wave, envisaged in the Biot theory's viscosity extended framework (de la Cruz and Spanos, in short dCS, theory)², is a candidate mechanism to capture the expected reduction in S-wave transmission. The dCS theory has two S-waves. The first or fast S-wave is akin to the Biot theory's S-wave. The second or slow S-wave is the fluid vorticity that emerges at the macroscale as an out-of-phase shear motion of the constituent phases. It is a highly diffusive wave that attenuates within half-a-wavelength of its point of excitation. Figure 1 shows the expected reduction in (fast) S-wave transmission in the high-frequency regime because of the partitioning into slow S-wave.

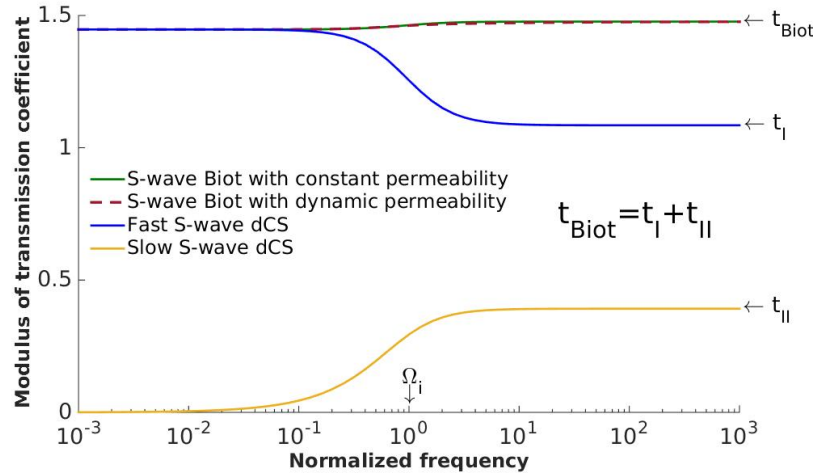


Figure 1: Transmissivity of S-wave across a solid/porous planar contact for a normal incident horizontally polarized plane S-wave from the solid half-space.

¹Johnson, D. L., Koplik, J., and Dashen, R. (1987). *Theory of dynamic permeability and tortuosity in fluid-saturated porous media*, JFM 176, 379-402.

²Sahay, P.N. (2008) *On the Biot Slow S-wave*, Geophysics 73(4), N19-N33.