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Influence of saturation on the reflection and refraction at the interface between two semi-infinite poroelastic media

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Based on the theoretical model derived by Yeh et al. (2010), this study simulates and analyzes reflection and refraction of incident elastic waves on a plane interface between two semi-infinite poroelastic half-spaces saturated by two different fluid mixtures. The amplitude and energy ratios of reflected and refracted waves considering the effect of motional modes, inertial and viscous couplings are determined for the first time with respect to water saturation of an incident P1 wave (the first dilatational wave). A plot of amplitude and energy ratios of reflected and refracted waves as a function of water saturation using an illustrative example with Lincoln sand containing an air-water mixture in the lower half-space and Columbia fine sandy loam bearing an oil-water mixture in the upper half-space. Analytical results indicate that the amplitude and energy ratios have the same magnitude order as phase speed, and the ratios of refracted and reflected waves are markedly affected by different physical parameters. This study further elucidates the difference in reflection and refraction between the oblique (30°) and normal (0°) incidences at the interface. The normal incident case have similar trend with the oblique case but no reflected and refracted SV waves exist. The sum of the energy ratio under each degree of water saturation equals unity. Additionally, amplitude and energy ratios of reflected and refracted waves are affected significantly by degree of saturation.