BOUNDARY ATTENUATION ANGLES OF INHOMOGENEOUS PLANE WAVES IN DISSIPATIVE MEDIA

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Plane waves are called inhomogeneous if the real part of the slowness vector, called propagation vector, makes a non-zero angle γ with the imaginary part of the slowness vector, called the attenuation vector. The angle γ between the propagation and attenuation vector is called the attenuation (inhomogeneity) angle. The attenuation angle γ always attains values from $<\gamma_1^*, \gamma_2^*>$, where γ_1^* and γ_2^* are *boundary attenuation angles*. They depend on the viscoelastic moduli, on the direction of propagation, and on some other parameters of the plane wave under consideration. In isotropic media, $\gamma_1^* = -90^0$ and $\gamma_2^* = 90^0$. In anisotropic media, $|\gamma_1^*|$ and $|\gamma_2^*|$ generally differ from 90^0.

Choice of the attenuation angle outside the allowed range $<\gamma_1^*, \gamma_2^*>$ leads to non-physical results like negative square of the phase velocity. This phenomenon is known in seismic literature as “forbidden directions” (Carcione, 2007). Since the attenuation angles may be significant in realistic media (Behura and Tsvankin, 2009), the danger that they may be chosen outside the allowed range is high. It is therefore either necessary to use alternative specification of the slowness vector or the boundary attenuation angles γ_1^* and γ_2^* must be a priori known in order to prevent selection of γ outside the allowed range.

The mixed specification of the slowness vector (Červený and Pšenčík, 2005) removes the above-mentioned problems. In the mixed specification, the attenuation angle γ is not chosen, it is computed. The relevant computations are based on the solution of a simple polynomial equation of the sixth degree (or less for special cases), with complex-valued coefficients. The mixed specification allows exact and simple computation of all quantities, including boundary attenuation angles, describing any inhomogeneous plane wave propagating in arbitrary isotropic or anisotropic, viscoelastic or perfectly elastic media (where it describes evanescent waves).

In this contribution, we investigate the behaviour of boundary attenuation angles, their dependence on the intrinsic attenuation, anisotropy, etc. Described phenomena are illustrated on numerical examples.

References

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