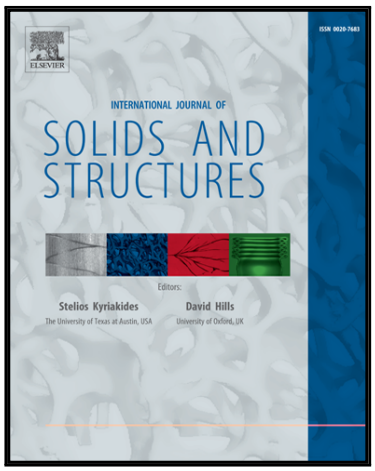

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Closed-form approximations to borehole stresses for weakly triclinic elastic media

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Abstract

We have derived new closed-form approximations to borehole stresses for triclinic elastic media, with arbitrary borehole and principal stress orientations. By introducing Green's three anisotropic parameters, ω_1, ω_2, and ω_3, into Lekhnitskii's formalism to calculate stresses around boreholes subjected to internal pressure and in situ stress, we have recast the general borehole stresses into more symmetric expressions that are useful to highlight explicitly the impact of the anisotropy. In this general case, the in-plane and anti-plane borehole stresses are not decoupled, all borehole stresses depend on all far-field stresses. By linearizing the expressions for weak anisotropy degree, i.e. $\mid \omega_i \mid \ll 1$, we have shown that the borehole stresses are the sum of the Kirsch isotropic solution and additional terms that depend on the elastic constants and azimuthal/radial functional dependence of high orders, i.e. series of $(\cos 4\theta, \sin 4\theta)$ and $(1/r^2, 1/r^4, 1/r^6)$ for in-plane components, and, series of $(\cos 3\theta, \sin 3\theta)$ and $(1/r^2, 1/r^4)$ for anti-plane components. The elasticity contribution is expressed through a series of complex coefficients that depends on the anisotropic parameters ω_1, ω_2, and ω_3. Our verification examples, for three borehole orientations in transverse-isotropic, orthorhombic, and monoclinic media, show that these closed-form approximations provide good approximations for weak anisotropy conditions.

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