

# TWIN WAVEFRONT CONSTRUCTION APPROACH TO SIMULATION OF SHEAR WAVES IN TRANSVERSELY ISOTROPIC LAYERED MEDIA

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We present a novel approach to simulation of shear (S) waves in transversely isotropic layered media, based on the wavefront construction method. The model of the medium consists of heterogeneous elastic layers (blocks) separated by generally shaped interfaces. Inside layers the type of elasticity is either isotropic or transversely isotropic. The symmetry axis of transverse isotropy may have arbitrary orientation and is allowed to change direction smoothly inside the layers. Heterogeneities in layers and curvatures of interfaces must be processed such that the model is suited for ray tracing.

The wavefront construction method consists of two main ingredients: ray tracing and interpolation. Rays are traced a short time step, that means, from one wavefront to the next. Whenever necessary, ray points are filled in by interpolation along the new wavefront, in order to guaranty a fairly uniform density of points. Data for events (arrivals) in receivers are computed using interpolation within ray cells. A ray cell is made up of three nearby ray segments connecting two triangular wavefront patches. Over many years the wavefront construction method has proven its ability in efficient computing of accurate ray-tracing data in a huge number of receiver points.

In the new approach, each ray code containing a specification of S-wave simulation will give rise to two runs of the wavefront construction process, one run for each elementary (twin) S wave. For one S-wave twin the polarization, in local anisotropy coordinates, is assumed to be mainly of type SV; for the other twin the polarization is mainly SH. The computation of the effective polarization direction depends on a given prevailing frequency. If the twin waves are separated by at least one prevailing half cycle the polarizations of each wave are determined entirely from the eigenvectors of the Christoffel matrix. On the other hand, in the singularity situation, the polarization is considered independent of these eigenvectors. In between these two extremes we use interpolation to compute the degree of attraction of polarization to the eigenvectors of the Christoffel matrix.

Some important features of the method: 1) The polarization direction is continuous in a region around a singularity. 2) In the case of a heterogeneous anisotropic layer, there are different options to coupling ray theory, by which one can perform continuation of amplitude along the rays. 3) Rays are traced using standard ray theory for transversely isotropic media (not an average type of ray computation). This ensures accurate traveltimes also in situations of strong anisotropy. 4) The approach treats the transition from isotropy to anisotropy in a continuous fashion. As a consequence, if the degree of anisotropy is gradually reduced to zero the resulting computed ray tracing data (traveltimes, amplitudes, polarization directions,...) will comply with those obtained using isotropic ray theory.