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Simulations of SH waves scattered by randomly oriented 2-D cracks

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Recently, several methods have been proposed about the rigorous synthesis of scattered wave fields by cracks (Murai et al., 1995; Murai and Yamashita, 1998; Kelner et al., 1999; Yomogida and Benites, 2002). Most of them, however, have been applied only to the scattering by cracks with specified orientations; there seems to be no applied example treating many cracks whose orientations are distributed uniformly and randomly, i.e., cracked media that are isotropic as a whole. In this study, we extended the method of Murai et al. (1995) for synthesizing SH waves scattered by 2-D parallel cracks, and thereby simulated the scattering by randomly oriented cracks. We then experimentally estimated the mean attenuation and phase velocity of the direct waves and compared them with the predictions by the single scattering theory (Kawahara and Yamashita, 1992).

The method of Murai et al. (1995) is a kind of the boundary integral equation method. The key is to solve the boundary conditions on the crack surfaces to evaluate the displacement discontinuity along them, and then to synthesize the scattered wave fields on the basis of the representation theorem. Here the surfaces are assumed to be stress-free, or a friction law of Newtonian type is assumed on them. Every crack is assumed to have the same length and boundary condition. The original method has been formulated under the assumption of parallel cracks for simplicity. Here we removed this restriction and allowed the individual cracks to be freely oriented. Next, we randomly distributed randomly oriented cracks within a rectangular area, let plain Ricker wavelets incident on the bottom end of the area, and synthesized the scattered waves. The model parameters in the experiment were chosen to coincide with those in the experiments of Ohno et al. (2001), who treated the scattering by 2-D circular cavities; here we made the crack length be equal to the cavity diameter in their experiments. We then expanded the observatory array along the top end of the area, and estimated the Q and the relative decreases of the phase velocity from the amplitudes and travel times of peaks of the band-pass filtered seismograms. This procedure was repeated for varying boundary conditions. For comparison with the experimental results thus obtained, we also evaluated the corresponding theoretical predictions. This was achieved by calculating the solutions of Kawahara and Yamashita's (1992) theory for parallel cracks with the orientation being changed by every one degree, and then averaging them. The obtained estimates are close to those for parallel cracks with the incident angle of about 45 degrees, and smaller for almost all frequencies than those for cavities whose diameter coincides with the crack length. It was shown that the experimental and theoretical estimates generally agreed with each other independently of the boundary conditions, suggesting the validity of the theory also in this case.

References

Kawahara and Yamashita, 1992, Pure Appl. Geophys., 139, 121-144.
Kelner, Bouchon and Coutant, 1999, Geophys. J. Int., 137, 197-203.
Murai, Kawahara and Yamashita, 1995, Geophys. J. Int., 122, 925-937.
Murai and Yamashita, 1998, Geophys. J. Int., 134, 677-688.
Ohno, Kawahara and Yomogida, 2001, JEPS 2001 Joint Meeting, Program, Sr-P002.
Yomogida and Benites, 2002, Pure Appl. Geophys., 159, 1771-1789.