Three-dimensional, finite-difference, viscoelastic seismic modeling

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We have developed a three-dimensional viscoelastic finite-difference modeling method. The effect of viscoelastic attenuation should be considered in the realistic modeling of seismic wave propagation in the near surface region. We use a velocity-stress staggered grid and employ an O(2,4) accurate finite-difference scheme. Viscoelastic modeling is based on the Standard Linear Solid. Memory variables are introduced to eliminate the convolution in the viscoelastic constitutive relation. Numerical test was performed and the finite-difference solution agreed with the waveforms calculated by the Discrete Wave-number Integral method. The method enables us to calculate three-dimensional viscoelastic wave propagation using inexpensive computers.

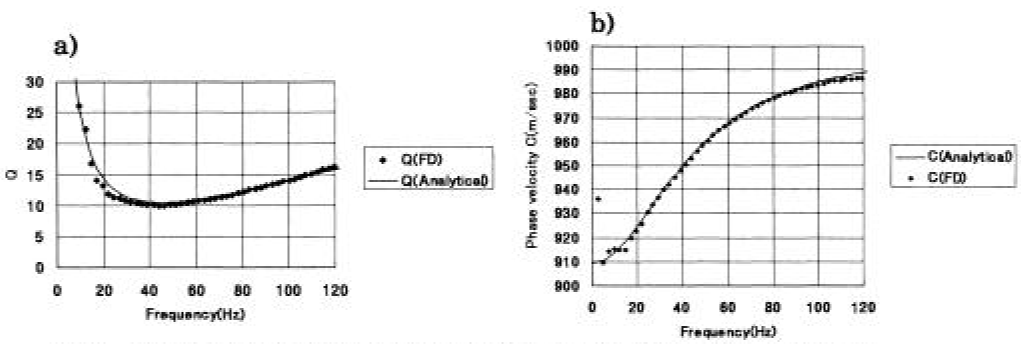

Fig.1. Q(ω) and phase velocity C(ω) obtained from finite-difference solution in comparison to an analytical solution. Dots : finite-difference solution. Solid line : analytical solution.

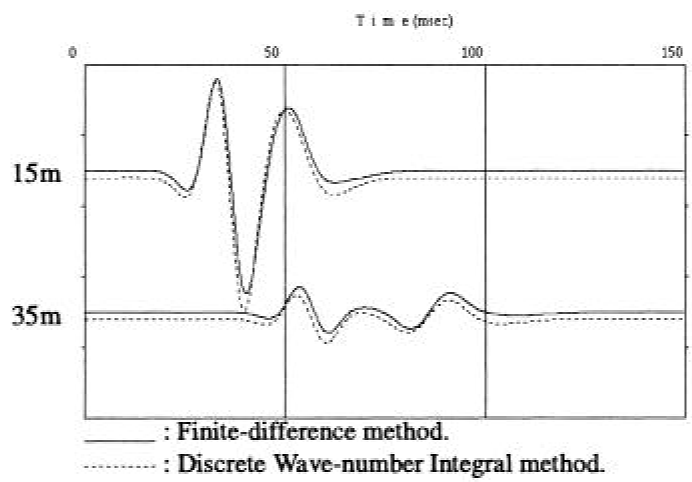

Fig.2. The comparison of finite-difference method and Discrete Wave-number Integral method. Solid line : finite-difference method. Dashed line: discrete wave-number integral method. Particle velocity (vertical component) collected at the receivers located at 15m and 35m from the source are plotted.