

Stability of various free surface boundary conditions for time-domain finite-difference operators

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The question of how to include free surface boundary condition in finite difference (FD) schemes continues to be controversial (e.g. Stacey, 1994). We develop and apply methods for systematically analyzing various proposed FD schemes. We write the stiffness matrix and mass matrix for each of the schemes, and then analyze the eigenvalues to see whether unstable modes exist. The three schemes considered in this study are (1) a weak-form based FD operator (Takeuchi and Geller, 2000), (2) a strong-form based FD operator called the "single-sided pseudonode" scheme (Alterman and Karal, 1968), and (3) a strong-form based, implicit FD operator (Vidale and Clayton, 1986). The last two schemes have unstable modes, while the first does not.