S081-P008 Time: May 29 17:00-18:30

Voxel Finite Element Method for 3-D elastodynamic analysis (No.3)

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Modeling wave fields using numerical techniques such as finite difference methods and finite element methods is an important tool for the strong-motion prediction. The basic equation of finite difference method is differential equation and that of finite element method is weak form integral equation. These methods belong to the more general weighted residual method. The difference between the finite difference method and the finite element method depends on technique of discretization.

In this study, we develop the Voxel Finite Element Method (VFEM) for 3-D elastodynamic analysis and compares finite-difference and finite-element solutions of the 3-D elastic wave equation. The VFEM is a numerically economical version of the finite element method. Because conventional finite element method requires much larger size of memory than that of the VFEM, it is difficult to solve large size problems by using conventional finite element method.

Numerical dispersion, stability condition and numerical complexity of the VFEM are studied. Numerical dispersion of the VFEM is comparable to the second-order finite difference method. The stability condition of VFEM is 1.7 times longer than the staggered grid finite difference method. Numerical complexity of our code of the VFEM is about 4-7 times larger than the second-order finite difference method. It may be possible to reduce the numerical complexity of the VFEM by using the advanced techniques to construct stiffness matrix.