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Finite element analysis of earthquake cycles with the effect of inertia and rate- and state-dependent friction.

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There have been many numerical models of earthquake cycles using frictional constitutive laws. Recently, Lapusta et al. (2000) and Lapusta and Liu (2009) developed 2D and 3D boundary integral models of earthquake cycles considering elastodynamic response. They found that the effect of inertia is important in the model of earthquake cycles. However, in case of boundary integral models, it is difficult to include crustal structure. Therefore, we develop a finite element method (FEM) for modeling earthquake cycles that can consider the effect of inertia term and crustal structure.
Our FEM method is formulated with tetra elements, prism elements and 8-node elements. We introduce joint elements in which a fault plane exists. We consider friction force between 2-node in the joint element. Friction force is considered in the tangential direction and spring force is considered in the vertical direction. We had formulated elastodynamic analysis with rate-and state-dependent friction laws on 3D space. Time depended equation is solved by Newton-Raphson method. We introduce adaptive time step control in which time step becomes enough small when slip velocity is high. As an example, we analyze earthquake cycles on a 2D thrust fault. We report the results of numerical simulation.

Keywords: Finite element Method, Earthquake cycle, Fault, Frictional constitutive law, Elastodynamic analysis