S040-022 Room: C417 Time: May 31 16:00-16:15

Development of Earthquake Cycle Simulation Program (ECSP)

Hidekuni Kuroki[1], Hidemi Ito[2], Akio Yoshida[3]

[1] Seismology and Volcanology Res. Dep. of M.R.I.,J.M.A., [2] Seismology and Volcanology Research Dep., M.R.I., [3] MRI

We have reported short-, intermediate- and long-term changes of crustal movement, stress field and Coulomn stress function before the hypothetical Tokai earthquake, as well as of effects of large earthquakes around Tokai area that are expected from simulation analysis on subduction process (Kuroki et al., 2001).

Since simulation study in seismology is still in early stage of development, we need to conduct simulation with different physical models and conditions. We have developed a program package ECSP suitable for this purpose.

(1) Calculation of elastic stiffness

We divide plate boundary to triangular elements, and calculate shear stress and normal stress at the center of each element induced by unit dislocations at other elements. Green's function method is used in case of homogenous media, and finite element method (FEM) in case of inhomogenous media. Mindlin (1975) and Mura (1987) gave Green's functions. We use the node splitting method by Melosh and Raefsky (1981) in the FEM. We transform a viscoelastic problem to an elastic problem by Laplace transformation in homogenous media, while we use Yamada's (1980) direct method in the FEM analysis for the inhomogenous media.

(2) Equation of motion

In quasi-static approximation, equation of motion is derived by a balance of frictional force and stress at each element on the plate boundary with the use of elastic stiffness in (1). The equation of motion involves shear stress, normal stress, relative displacement, and relative velocity of the elements on the plate boundary. Types of the equation of motion are ordinary differential equation for elastic media, Volterra type integro-differential equation containing time dependent stiffness for viscoelastic media, and stochastic differential equation when a fluctuation is given to the plate velocity. This stochastic model is dynamical extension of the random Brownian Passage time model used in long-term assessment of hazardous earthquakes by Earthquake Research Committee.

(3) Integration of equation of motion

Ordinary differential equation is integrated by 6 step 5th order Runge-Kutta method, Volterra type integro-differential equation by 5 step 4th order Runge-Kutta method, and stochastic differential equation by Milstein method.

(4) Frictional constitutive law

Rate- and state-dependent friction laws and a slip dependent friction law are supported in our program. Rate- and state-dependent friction laws include slip version and slowness version (Linker and Dieterich, 1992), as well as a composite law which combined the two versions (Kato and Tullis, 2001). It is not possible to discuss earthquake cycles basing on the slip dependent friction law because the present package includes only Matsu'ura et al. (1992) version which does not incorporate healing process on the plate boundary.

(5) Graphics

1. Spatial and temporal changes are shown concerning relative displacement, velocity, shear stress on the plate boundary
2. Strain and displacement on the earth's surface
3. Focal mechanism and Coulomn failure function in the media

As a basic tool of graphics, we used GMT.

(6) Miscellaneous

Effects of neighborhood earthquakes on the occurrence of the Tokai earthquake have been so far discussed only qualitatively using Coulomn failure function. We can now estimate the effects quantitatively by using the present program package.