Modeling of the displacement field of the Japanese islands using 3DFEM

Yoshiko Kotake[1], Teruyuki Kato[2]

[1] ERI, Univ. Tokyo, [2] Earthq. Res. Inst., Univ. Tokyo

The displacement field of the Japanese islands is clearly governed by the interactions between the surrounding plates such as Pacific, Philippine Sea and Amurian plates. In the present study, we employ the 3DFEM for modeling the displacement field obtained by the nationwide GPS array by putting observed plate motions as boundary conditions. As the first trial of modeling, we employed a rather crude model with about 3000 elements.

The displacement field of the Japanese islands is clearly governed by the interactions between the surrounding plates such as Pacific, Philippine Sea and Amurian plates. It is thus important to understand how such interactions are related to the earthquake generation in the islands from the standpoint of forecasting crustal activity. Relative motions between these plates have been precisely estimated by GPS observations.

In the present study, we employ the 3DFEM for modeling the displacement field obtained by the nationwide GPS array by putting observed plate motions as boundary conditions. Estimation of stress distribution in the crust of the Japanese islands would be possible if such modeling is successful. Since this is the first trial of modeling, we employed a rather crude model with only about 3000 elements in three dimensions. Each element has a shape of hexagon. The earth surface is divided by roughly 90 square kilometers. The area of modeling was limited to the upper part of the subducting plate interface. The MARC solver was used for a FEM analyzing program.

Simple elastic material is assumed in the modeling considering that the data used is short period of two years of GPS velocity. In such elastic body, rapid decrease of displacement toward the Japan Sea coast and the rigid displacement in the northwestern part of Japan would be problematical. The former one was, however, easily realized by applying shear displacement along the subducting plate surfaces to the depth of only about 40 to 60km. On the contrary, rigid-like displacements were only realized by putting reinforced displacements at the base of the crust for the whole area of the assumed Amurian plate. As a result, we were able to reconstruct very basic features of the displacement field of the Japanese islands, though fine adjustments are left for future modeling of large number of elements, which is now in process.