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A new calculation method for seabed displacement due to fault slip by boundary integration

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In tsunami simulation, initial water level of tsunami is often considered to be equal to vertical displacement of seabed generated by a source fault slip. Exact solution for displacement due to rectangular fault slip in elastic half space (Okada, 1985) has been generally applied to calculate the seabed displacement.

In order to calculate the displacement due to the source fault which has irregular form using this solution, the source fault should be modeled by patching many rectangular small faults along the irregular surface. As a result, the source-fault model has portions in which the rectangular small faults are overlapped each other or not covered the fault surface. Then, calculated displacement from the fault model is overestimated near the overlapped area or underestimated near the uncovered area. This kind of displacement discontinuity is not negligible when the fault is located near the seabed, while it is negligible in the case that it is far from the seabed. Therefore, a new technique to take the irregular form into consideration accurately is required to solve the above problem.

Under such a background, we developed a new method to calculate displacement of seabed due to slip of the source fault using boundary integration. It is well known that deformation of the medium due to a fault slip is represented by the boundary integration for the medium surface and the fault surface by applying Green's theorem to the governing equation. Considering the seabed as an elastic half space, it can also be expressed only with the boundary integration for the fault surface. Calculating the boundary integration numerically, we introduce the linear element which is used by Boundary Element Method (BEM) into the proposed method to guarantee continuity of the displacement. However the numerical integration based on Gauss quadrature formulae at the point near the fault surface is broken down by the influence of singularity of Green's function. We apply the Projection and Angular & Radial Transformation (PART) method (Hayami and Brebbia, 1988) to the proposed method to evaluate the effect of the singularity accurately. We will present formulation, validation, verification and application of this method.

This research was carried out as part of Tsunami Hazard Assessment for Japan by National Research Institute for Earth Science and Disaster Prevention (NIED).

Reference

Okada, Y. (1985) Surface deformation due to shear and tensile faults in a half-space, Bull. Seism. Soc. Am., 75, 1435-1154.

Hayami, K. and Brebbia, C.A. (1988) Quadrature methods for singular and nearly singular integrals in 3-D boundary element method, (Invited paper), Proc. 10th Int. Conf. on Boundary Elements, Southampton, Computational Mechanics Publication with Springer-Verlag, Vol. 1, pp. 237-264.

Keywords: seabed displacement, fault slip, numerical calculation, boundary integration, singularity of Green's function, PART method