Numerical simulation of Riedel shear in surface earthquake faults

***Sayako Hirobe[1], and †Kenji Oguni[1]**

[1]Department of System Design Engineering, Keio University, Japan.

*Presenting author: s.hirobe@keio.jp
†Corresponding author: oguni@sd.keio.ac.jp

Abstract

Riedel shear is a commonly observed echelon type fault pattern on the top surface of the embedded soil of the strike slip earthquake faults. This echelon pattern on the top surface of a layer subject to shear at the bottom can be observed regardless of the materials and scales. Since the sudden appearance of the specific length scale in the mechanical problems without typical length scale is counter-intuitive, complete explanation for the mechanics behind Riedel shear has not been provided.

The periodical pattern formation observed in Riedel shear implies the importance of bifurcation in the governing mechanism of this phenomenon. Therefore, numerical analysis method with the capacity of the fracture-induced bifurcation analysis is required. For this purpose, the authors carried out numerical analysis of Riedel shear using PDS-FEM (Particle Discretization Scheme Finite Element Method). PDS-FEM employs discretization of the displacement and stress field using characteristic functions on conjugate geometries. This results in a rigorous mass-spring model for solid continuum and thus, discontinuities in the displacement field due to failure can be easily yet rigorously treated. Elasto-dynamic analysis of a plate of homogeneous elasticity subject to strike-slip at the bottom surface has been carried out as the simplest model of the Riedel shear.

This numerical simulation shows the growth of the cracks starting from the strike-slip at the bottom with the twist of the crack surface toward the top surface, and the alternative pattern of the growth of the crack surface, which results in the periodical echelon fault pattern (Riedel shear) on the top surface of the plate.

These results from numerical simulation imply that Riedel shear is the consequence of the consecutive choice of the bifurcation solutions. Mass-spring model for solid continuum given from PDS-FEM and explicit time integration in PDS-FEM enable us to capture the bifurcated solutions and to show sudden appearance of periodic solution in the problems without specific length scale.

Keywords: **Bifurcation, Riedel shear, Strike slip, Pattern formation, PDS-FEM**