DEM-SJM combined 2D-hydraulic fracturing simulation for consideration of the influence of differential stress

*Hayate Ohtani[1], Hitoshi Mikada[1], Junichi Takekawa[1]

1. kyoto university

For improving the production of shale oil and gas, hydraulic fracturing has been conducted for many years. In addition, hydraulic fracturing is used for the development of geothermal energy known as HDR (Hot Dry Rock geothermal power), and EGS (Enhanced Geothermal System), and for measuring of the rock failure strength and the orientation of principal stress direction, etc. On the other hand, hydraulic fracturing has some environmental impacts, such as pollution caused by chemical substances in injected proppants or fluid, induced seismicity, etc. Since it is necessary to minimize the environmental impacts, techniques to predict propagating directions and distances of fractures to be generated hydraulically, which are known still very difficult, have been waited for. The causes for the difficulty in the prediction are the strong anisotropy of rock strength, in-situ stress around the borehole, natural fractures in the media surrounding the borehole, unknown differential stress, etc. Among these causes, little study has been done to examine the influence of differential stress. In this paper, we would like to demonstrate the influence of differential stress and the anisotropy using DEM (Distinct Element Method) combined with SJM (Smooth Joint Model). Hydraulic fractures in general propagate in the direction of maximum principal stress on large differential stress conditions. As the differential stress decreases, the propagating direction of hydraulic fractures curves to the direction of bedding plane, i.e., anisotropic direction of weak rock strength, and sometimes fractures branch to plural directions. These results suggest that the behavior and propagating direction of hydraulic fractures are strongly influenced by both the differential stress and the rock strength anisotropy in the underground shallow layer.

Keywords: Distinct Element Method, Smooth Joint Model, 2D-hydraulic fracturing simulation, underground shallow layer

