Application of the Synthetic Rock Mass Discrete Element Approach for Fracture Behavior in Shale

Nicholas Thompson[1] and Rune M. Holt[1,2]
[1]*Department of Petroleum Engineering and Applied Geophysics, Norwegian University of Science and Technology,Trondheim, Norway*
[2]*SINTEF Petroleum Research, Trondheim, Norway*

Synthetic Rock Mass (SRM) discrete element modeling represents a relatively new numerical approach with the ability to capture both the behavior of an intact rock (e.g. elasticity/brittleness) as well as scale-dependent behavior of the rock *mass (*e.g. strength/stiffness reduction with increasing sample size) (Mas Ivars et al., 2007; Pierce et al, 2007). Furthermore, incorporation of the 'Smooth Joint' contact model allows slip and separation on planar discontinuities within rock mass in question; when sufficient slip occurs, these fractures may propagate as would be expected in real world scenarios. Interparticle bond breakages which occur as fractures propagate may also be tracked as microseismic events. Thus, the emergent behavior of the system as whole represents a powerful tool with which to investigate fracture processes within complex, larger scale rock masses.

The research-in-progress presented here concerns an investigation of SRM approach for the behavior of fractures in highly anisotropic materials such as shale. This investigation is focused sequentially on: 1) simulation of the mechanical behaviors of intact shale, honoring observations laboratory-scale test specimens (in particular anisotropy), and; 2) subsequent development of a meter- to tens-of-meter-scale analysis environment (i.e. potentially fractured rock mass). In this respect the lessons learned during development of the laboratory-scale models are applied to the rock mass model. The feasibility of various methods of creating mechanical anisotropy in laboratory-scale intact rock simulations is currently being explored by several approaches, including: 1) custom interparticle bonding algorithms, and; 2) use of the Smooth Joint contact model at an appropriately small scale. In regards to the meter-scale rock mass, the ability of the SRM to consider *in situ* fractures (e.g. as developed though discrete fracture networks) makes this an ideal approach for investigating the manner in which fractures may develop and/or evolve in highly anisotropic, naturally fractured rock masses such as shale.

References

Mas Ivars, D., Deisman, N., Pierce, M., Fairhurst, C., 2007, The synthetic rock mass approach – a step forward in the characterization of jointed rock masses. In: Ribeiro e Sousa et al. (eds.), Proceedings of the 11th Congress of the International Society for Rock Mechanics, Lisbon, Taylor and Francis, London, 1, 485-490.

Pierce, M., Mas Ivars, D., Cundall, P., Potyondy, D., 2007, A synthetic rock mass model for jointed rock. In: Eberhardt et al. (eds.), Proceedings of the 1st Canadian-US Rock Mechanics Symposium, Vancouver, Taylor and Francis, London, 341-349.