

A PARTITION OF UNITY BASED COHESIVE ZONE MODEL FOR HYDRAULIC FRACTURING

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Hydraulic fracturing is the process that is applied to stimulate oil and gas reservoirs by pumping a high viscous fluid into the underground formation. Numerical modeling can help to obtain more insight in the hydraulic fracturing process. In this contribution we present two numerical models for hydraulic fracturing. In both models a fracture is modeled as a jump in the displacement field by using the eXtended Finite Element Method (X-FEM) [1]. Bulk poroelasticity is based on Biot Theory. The Camacho Ortiz fracture criterion is used with a cohesive zone formulation to model fracture propagation in arbitrary directions [2]. Fluid flow in the fracture is based on a local mass balance, meaning there is an equilibrium between the opening of the fracture, the leakage of fluid from the fracture to the formation, and the tangential fluid flow. The tangential fluid flow depends on the fluid viscosity, the pressure gradient along the fracture, and the fracture opening according to the cubic law.

The distinction between the two models is based on the manner of modeling the pressure in the fracture. The first numerical model is a regular X-FEM model, with the previous explained features, and is explained in more detail in e.g. [1, 3]. In this type of model the pressure over the fracture is continuous. In the second model, we add an additional degree of freedom to describe the pressure in the fracture. By doing this we change the pressure over the fracture in a discontinuous function. The fluid leakage from the fracture to the formation is calculated based on Terzaghi's Consolidation Theory. The advantage of this model over the regular X-FEM model is that we can now force the fluid inflow to go completely through the fracture inlet. This may be a desirable feature for hydraulic fracturing situations. We will refer to this model as the Enhanced Local Pressure (ELP) model.

The two numerical models are compared with an analytical solution for a propagating hydraulic fracture in a KGD geometry, Figure 1a [4]. The evolution of the fracture aperture and the location of the fracture tip during time are shown in figure 1. There is a small difference between the two numerical models. However, both models are consistent

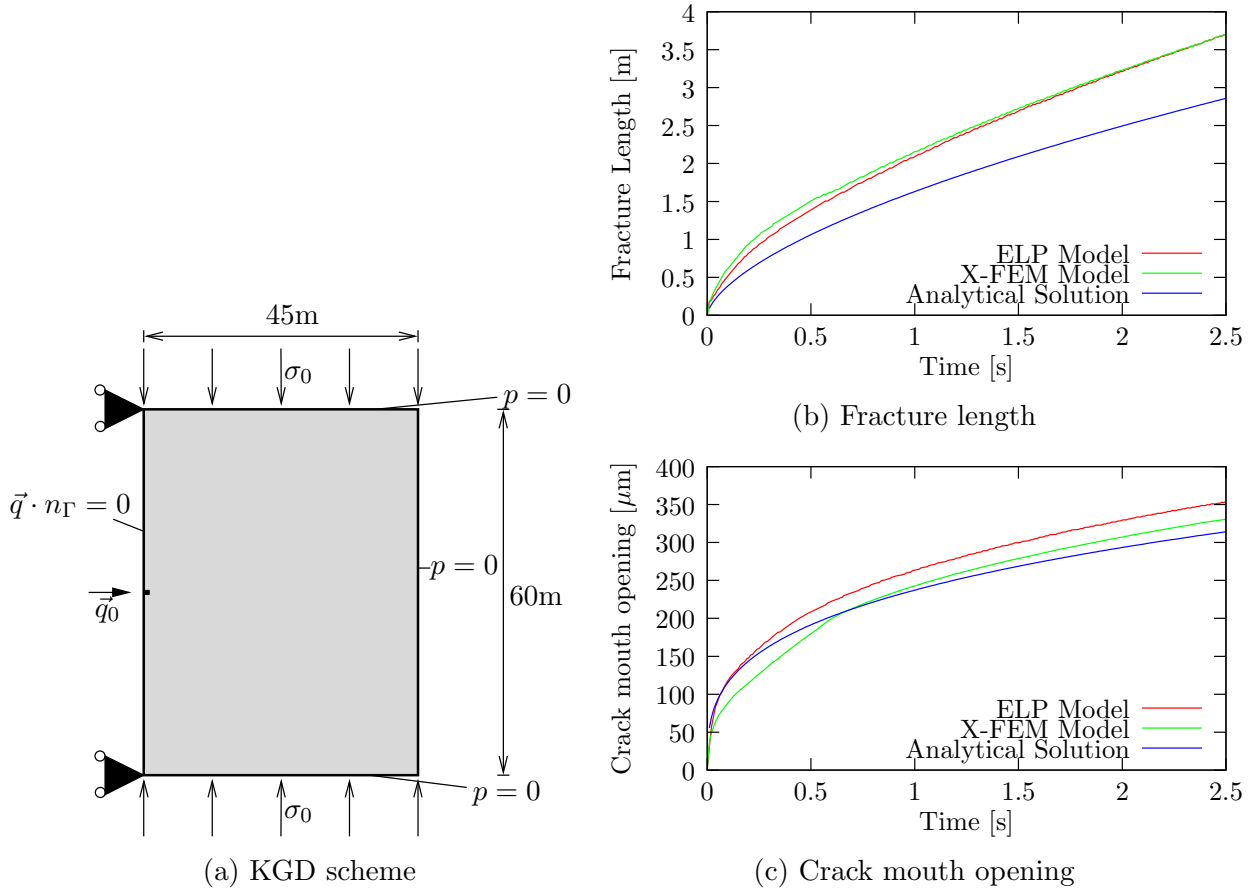


Figure 1: The scheme and the results of the KGD fracture problem

with the analytical solution. In this presentation we will apply both models to investigate realistic hydraulic fracturing situations.

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