The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

Reduced Dimension Fracture Flow – Deformable fractures coupled with inertial and transient fluid behaviour

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Key Words: *Fracture flow, Aperture variation, Fluid-structure interaction*

Large amplitude and high-rate fluid pressure pulses have been shown to be an effective means of stimulating a wellbore [1]. While hydraulic fracture simulation has become a well-developed topic, nearly all models have assumed quasi-static conditions for the rock mass and fluid. The assumption of a quasi-static rock mass is well-suited for traditional hydraulic fracturing operations; however, this assumption is not valid for dynamic stimulation. Dynamic stimulation with high-rate loading introduces inertial effects in both the rock mass and the fluids and can trigger fracture patterns which are different from the normal patterns observed in regular hydraulic fracturing.

In this paper, we present and explore the challenges of coupling of a new fluid flow model, the Reduced Dimension Fracture Flow (RDFF) model, with a deformable dynamic rock mass. Most existing models of fluid flow through fractures are almost exclusively based on the Poiseuille flow model, also known as the cubic law. The RDFF model captures the transient and inertial fluid behaviour, which the quasi-steady Poiseuille flow model cannot. However, the ability to capture more complex physical phenomena comes with increased model complexity. The fluid phase is discretized using an explicit finite volume method, while a finite element method is used for the rock mass. In this presentation, we explore the behaviour and challenges of both planar and axisymmetric deformable fractures to dynamic stimulation via pressure pulses, and present novel phenomena which cannot be captured by quasi-steady models.

REFERENCES

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