Hydraulic Fractures in Layered media

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In this study, the propagation of a hydraulic fracture in a three-layer medium is investigated using a robust finite element method. The top and bottom layers have similar properties, while the soft middle layer has variable thickness and stiffness. Both two-dimensional plane-strain and three-dimensional models are used to evaluate the vertical and lateral growth of the fracture, initiated from the bottom layer. In 2D model, the competition between the gravity forces and the stress concentration at the layer boundary dictates whether the fracture grows upward or downward, while in the 3D model, the lateral growth of the fracture is also captured. Results from the 2D model show that in majority of cases (6 out of 9) the fracture reaches to the middle layer, and due to the lower minimum principal stress in this layer, an extensive propagation occurs in this layer. When the lateral growth is considered utilising the 3D model, depending on the stress concentration and the position of the fracture in the bottom layer, the downward or lateral growth may become dominant. Thus, the geometry of the fracture can vary between a long and narrow shape towards a round shape. The lateral growth of fractures in the 3D model undermines the suitability of 2D plane-strain model results.