3D analysis of H-M coupled problem with zero-thickness interface elements applied to Geomechanics.

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ABSTRACT

Advanced Geo-mechanical modelling involves the treatment of geological discontinuities. In the approach described in this paper, zero-thickness interface elements of the Goodman type [1] are considered for this purpose. Those elements can also be used for representing the fluid flow and the coupled hydro-mechanical problem [2]. The technique consists in inserting interface elements in between standard elements to allow jumps in the solution fields. For the mechanical problem, their kinematic constitutive ("strain-type") variables are relative displacements, and the corresponding static ("stress-type") variables are stress tractions. The relationship between variables is controlled via a fracture-based constitutive law with elasto-plastic structure [3]. Concerning the hydraulic problem, the interface formulation includes both the longitudinal flow (with a longitudinal conductivity parameter strongly dependent on the fracture aperture, cubic law), as well as and the transversal flow across the element (and an associated localized pressure drop, with the corresponding transversal conductivity parameter).

The formulation presented in this paper is the 3D extension of recent work presented by the authors [4] which was verified first by comparison to existing analytical and numerical solutions for the propagation of a single hydraulic fracture [5]. The current implementation is compared to two examples: the first one consists of a horizontal layer of 1m of thickness with a line-like distributed flow injection, with the purpose of simulating as close as possible the standard GDK conditions model. The second case consists of a cubic block of 80m side composed of the same horizontal thin layer surrounded by thick overburden and underburden layers and contact interfaces, the results of which are compared with the classical PKN solution. General good agreement is observed in both cases between the numerical results and both analytical solutions. The comparisons also motivates a discussion on the boundary conditions implicit in those classical solutions.

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