Three-node zero-thickness hydro-mechanical interface finite element for geotechnical applications

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ABSTRACT

An interface is a surface between two distinct materials or two phases of a given material. In many fields of geomechanics, interfaces are crucial for numerical modelling. For instance, the modelling of soil structure interaction may involve sliding and loss of contact between the foundation and the soil [1]. Then the bodies in contact must be represented by two independent finite element meshes and their mechanical interaction is ruled by a so-called interface element.

In rock mechanics, fractures inside the rock mass are a special case of interfaces [2]. The altered material or the open fracture creates a preferential path for fluid flow, coupled with its mechanical behaviour. Thence, the interface element must be also characterised by hydraulic properties.

In the finite element code LAGAMINE, a classic mortar formulation is adopted to rule the mechanical behaviour [3]. The contact constraint is regularised using the penalty method, meaning that interpenetration of two solids in contact is allowed. Sliding and loss of contact between two solids is then reproduced [4].

Different frameworks exist to describe the hydro-mechanical coupling of the interface [5]. In this paper, the hydraulic behaviour of the interface is described by a three-node formulation. Additional hydraulic degrees of freedom (fluid pressures) discretise the longitudinal flow within the interface. The two gradients of pressure between inner nodes and nodes of the edges are used to compute transversal fluid flows.

The main objective of this paper is to fully describe the formulation of the hydro-mechanical interface, to list the main hypotheses and to highlights its limitations. Its mains features are illustrated by simple examples.

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