Further developments in stress initialization in Geomechanics via FEM and a two-step procedure involving Airy functions

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ABSTRACT

Geological materials are inevitably subject to an in situ stress field which is crucial for the evaluation of the geomechanical response of the rock mass in a variety of fields of Engineering [1,2]. However, in-situ measurement procedures are complex and expensive, and their accuracy strongly depends of every type of situation. Additionally, although in situ measurements are certainly essential, stress fields are also subject to some constraints due to physical laws such as equilibrium and limit behaviour of material laws. For this reason, it is nowadays accepted that a sound procedure to reconstruct an accurate picture of the in situ stress field requires the combination of measurements with numerical calculations [3].

In previous papers [4,5], a two-step method to generate in-situ stress states was presented which was based on Airy functions and the Finite Element method. In the first step, a first estimate of the stress state or "guess" at each Gauss point is proposed using vertical stresses due to gravity and horizontal due to K_0, and in a second step global equilibrium is verified and re-balanced nodal forces are applied as needed. In this paper, further developments accomplished in this procedure are described. Among them, we include the implementation of a Mohr's circle-based criterion for two-dimensional cases using an iterative process, and making use of isoparametric geometries with internal "local coordinates" and numerical integration for the subdomains, instead of the limiting closed-form trigonometric formulation originally proposed [4]. As the result of these developments, the method can make adjustments to more complex geometries and situations, and also these changes are crucial for the application to the extension of the method to 3D. The procedures described are illustrated with examples of application to both academic and real field cases.

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