Finite Deformations in Geomechanics

Luís-André Todo-Bom
Ecole Centrale de Paris

Résumé :

Mechanical Formulation

Infinitesimal theories can be adopted to model the behaviour of inelastic solids as long as the strains and rotations remain sufficiently small. However, the deformations of solids under loading or imposed displacements can also be large in cases such as soil mechanics. The expression finite deformations (or large deformations) is usually associated with problems where differences between the undeformed and deformed state (important geometrical changes) cannot be neglected when considering the behaviour law of the material under analysis. Since most theories of material behaviour (relationship between deformation and stress) are written considering the infinitesimal deformation hypothesis most of the effort concerning the finite deformation range has been the extension of these theories. This extension is not, however, straightforward and it has lead to different opinions, approaches and heated debates in the scientific community. The extension of these theories encounters issues with the stress and strain measures, decomposition of strain in elastic and plastic, the stress rate, observer independent yield function and rotation of material texture.

Constitutive Model

The ECP's constitutive model (also known as 'Hujeux's model') is an elastoplastic multimechanism model. However, The ECP model is part of the most commonly used constitutive models which were developed under the framework of small strain and therefore limited in their scope. Taking into account the laboratory results of large deformations tests, one cannot fail to notice the inability of the standard models, which consider a critical state at a relatively small strain for example, to replicate the behaviour of the specimens. Therefore, the constitutive model is altered in order to cope with the behaviour of the soil specimens when subjected to very high volumetric and shear strains. This adaptation is validated by comparing the numerical results with the laboratory data.