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A Virtual Element Discretization of a 3D Elastoplastic Problem

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In order to model mechanics of porous media, the elastoplastic behaviour of materials, such as rocks and soils, plays an important role. In this work, we study Virtual Element Methods for 3D elastoplastic simulations. We focus on the equations that characterize the elastoplastic 3D model in the framework of small deformations theory. We especially deal with the Mohr-Coulomb plasticity model, which is suited to describe the plasticity behaviour of materials in which we are interested. We apply its yield function and flow potential to define associative and non associative plasticity. Due to numerical problems of the model, we study and implement a 'smooth' version of the Mohr-Coulomb model, proposed by Abbo and Sloan (2011). This aspect requires the study of a suitable generalized Return Mapping Algorithm. Moreover, we have to tackle with a strong non-linearity involved in the model. This issue requires the study and the application of a proper globalization strategy for Newton method, for instance line search methods. Furthermore, as regards the variational discretization framework, we focus on the VEM formulation of the 3D primal elastoplastic equation, combined with the stress estimation through the Return Mapping Algorithm. We study a suitable stabilization for the problem with respect to the one introduced by Beirão da Veiga et al (2015). Finally, we present a 3D numerical experiment of limit analysis on slope stability, which is a classical benchmark problem for Mohr-Coulomb plasticity model, and other results in order to discuss numerical problems of the model and the strategies to deal with them.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

Abbo, A.J. and Lyamin, A.V. and Sloan, S.W. and Hambleton, J.P. 2011 A C2 continuous approximation to the Mohr-Coulomb yield surface. International Journal of Solids and Structures 48, 3001-3010
Beirão da Veiga, L. and Lovadina, C. and Mora, D. 2015 A Virtual Element Method for elastic and inelastic problems on polythope meshes. Comput. Methods Appl. Mech. Engrg. 295, 327-346

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