OFFRE DE THÈSE

Mechanisms analysis and numerical modeling of stability of abandoned cavities under complex environmental conditions

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Type de contrat : Doctorant
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Context

Mining and quarry activities have created a high number of abandoned cavities in many regions of France, in particular in the East region. Some of them are located in porous chalk layers. Due to climatic changes, in particular heavy rainfall and related flooding, several catastrophic events occurred causing important material damage. Among many factors leading to mechanical instability and collapse of those cavities, the degradation of mechanical properties of rocks due to cyclic wetting and drying still remain an essential issue. In the case of cavities in chalks, it is known that the mechanical behaviour of most chalks is strongly sensitive to the water saturation degree and to the chemical composition of water. In spite of a number of previous studies devoted to the characterization and modelling of the mechanical behaviour of chalks, there are still gaps in the understanding of mechanisms related to time-dependent chalk behaviour, cracking onset and failure of chalks, under complex hydromechanical and chemical conditions. These mechanisms have to be taken into account in numerical modelling of short and long term stability of cavities. On the other hand, recent advances in monitoring techniques allow to better capture and analyse in-situ deformation and structure evolutions of cavities. Numerical modelling and in-situ monitoring should be performed in coordinated way and mutually enriched.

Objective and content of the thesis

The scientific objective of the thesis is twofold: to improve our knowledge of mechanisms related to the time-dependent behaviour and failure process of chalk and to develop relevant numerical modeling approach for long term stability analysis of cavities, under complex environmental conditions. To this end, some complementary laboratory tests will be performed in order to better characterize short and long deformation of chalks under different mechanical loading paths, different hydric conditions and chemical environments. Based on identified mechanisms, a constitutive model will be developed in order to describe the deformation and failure process of chalks in the required conditions. The proposed model will be implemented into a robust computer code being able to solve nonlinear boundary values problems with hydromechanical and chemical coupling. 2D and 3D numerical simulations will be carried out on a selected abandoned underground chalk mine by considering in-situ environmental conditions. One important issue will be to establish a strong interaction between in-situ monitoring and numerical modeling. The in-situ measurement should enrich the numerical modeling which in turn will help to improve the analyze of in situ behaviour.

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Laboratory : LaMcube, UMR9013 CNRS, Cité Scientifique, 59655 Villeneuve d'Ascq (50 %) and Ineris Ecole des Mines Campus Artem Nancy (50%)
Keywords: Abandoned cavity, quarry, chalk, hydromechanical coupling, numerical modeling

Profil

Master in geomechanics, solid mechanics, numerical modeling
The candidate must have a solid background on mechanics of porous materials, numerical methods for engineering problems in particular finite element method, elastoplasticity theory, damage and failure mechanics.

How to apply

- Application deadline: July 30, 2020
- To be submitted to: jian-fu.shao@polytech-lille.fr and nathalie.conil@ineris.fr
- The application should include: a detailed CV, a cover letter, transcripts of the master degree, if possible, recommendation letters.

References:
Xie S.Y. and Shao J. F. (2006). Elastoplastic deformation of a porous rock and water interaction. International Journal of Plasticity 22, 2195-2225
Pietruszczak S., Lydzba D. and Shao J.F. (2006). Modeling of deformation response and chemo-mechanical coupling in chalk. Int. J. for numerical and analytical methods in geomechanics 30, 997-1018
Lydzba D., S. Pietruszczak and J.F. Shao (2007). Intergranular pressure solution in chalk; a multiscale approach. Computers & Geotechnics 34, 291-305
Shen WQ, Shao JF (2018), A micro-mechanics based elastic-plastic model for porous rocks: Applications to sandstone and chalk, Acta Geotechnica 13: 329-340
Lafrance Noémie (2016), Étude des effets de l'eau sur les phénomènes de rupture et de déformation affectant les carrières souterraines de craie, thèse de doctorat, Université de Lorraine.

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