Design+Analysis
VISITING LECTURE

"Numerical modelling of quasi-brittle materials with polygonal finite elements"

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Thursday the 2nd of May 2019 at 2 pm
Lecture hall R2, Rakentajanaukio 4 A, Otaniemi, Espoo

Visitor. Dr. Saksala obtained his Ph.D. (2010) in Mechanical Engineering from Tampere University of Technology (TUT). Dr. Saksala's research interests include numerical modeling of brittle materials in general and percussive drilling of rock in particular. He has published some 55 scientific articles in international journals and conference proceedings. He is also a member of ISRM Commission on Rock Dynamics. Presently, Dr. Saksala works as an Academy (of Finland) Research Fellow and as a Docent (Adjunct Professor) at the Laboratory of Civil Engineering at Tampere University. For more on Dr. Saksala's research, see https://www.researchgate.net/profile/Timo_Saksala.

Abstract.
Numerical modelling of rock fracture is an important task in many fields of engineering, such as geotechnical, mining, and earthquake engineering, as well as in mechanical engineering related to research and development of excavation technologies. From the material modelling point of view, rocks are challenging materials as they are highly heterogeneous, brittle, asymmetric with respect to tension and compression, and display a pronounced rate-sensitivity. In the present lecture, an overview on modelling rock fracture with polygonal elements is given.

Polygonal finite elements have been drawing increasing attention during the last 15 years because these elements offer some benefits over the classical triangular and rectangular elements. These include greater flexibility in meshing arbitrary geometries, better accuracy in the numerical solution, better description of certain materials, and less locking-prone behavior under volume-preserving deformation. On the other hand, the disadvantages of the polygonal finite element method include less sparse system matrix and the need for a higher order numerical integration quadrature to achieve high-accuracy.

In the present lecture, some results on a project of modelling rock materials with polygonal finite elements based on the Voronoi tessellation are presented. Namely, the method to describe the rock microstructure based on the Voronoi tessellation and randomly mapped clusters of polygonal elements representing the mineral texture is equipped here with a rock constitutive model. This model is based on the Hoek-Brown viscoplasticity model and a bi-variable scalar damage model. The aim of the project is to model rock fracture under dynamic applications involving contact/impact. For this reason, the equations of motions are solved by explicit time marching. In the numerical examples, the performance of the present approach is demonstrated with uniaxial tension and compression test simulations as well as in dynamic Brazilian disc test simulations.

The structure and the contents of the lecture are modified to be more suitable for students (the lecture is a part of course CIV-E4080 Material Modelling in Civil Engineering). This means that short educational excursions are made into the subtopics, such as computational plasticity and damage mechanics, while carrying on the story on the main topic.

We wish you welcome – coffee at 2 pm sharp, the presentation a quarter after the first dose!

Jarkko Niiranen, Assistant Professor
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Design+Analysis VISITING LECTURES target for presenting and discussing a diverse collection of topics related to C*omputational Structural Engineering* and *Structural Mechanics* from the perspective of *Structural Analysis* and in the context of *Architectural, Industrial and Structural Design,* with a special emphasis on *Theoretical and Applied Mechanics of Solids and Structures.* Accordingly, term *design* – besides architectural, industrial and structural design – refers to designing models and methods, whereas term *analysis* refers to analyzing models and methods – besides structural analysis.