Δ Ι Α Λ Ε Ξ Η Γ Ε Ω Τ Ε Χ Ν Ι Κ Η Σ Μ Η Χ Α Ν Ι Κ Η Σ

Τρίτη, 18 Οκτωβρίου 2016, 3:30μμ (ΝΕΑ ΩΡΑ)

Αίθουσα Εκδηλώσεων Πολιτικών Μηχανικών Ε.Μ.Π. (Ζωγράφου)

FROM DISCRETE TO CONTINUUM APPROACH OF BVP IN GEOMECHANICS: FEM-DEM INTEGRATED APPROACH

By Jacques J. M. Desrues

Laboratoire 3S, CNRS – Université Grenoble-Alpes, France

ABSTRACT: Recently, multi-scale analysis using a numerical approach of the homogenization of the microstructural behavior of materials to derive the constitutive response at the macro scale has become a new trend in numerical modelling in geomechanics. Considering rocks and soils as granular media with cohesion between grains, a two-scale fully coupled approach can be defined using FEM at the macroscale, together with DEM at the microscale. In this approach, the micro-scale DEM boundary value problem attached to every Gauss point in the FEM mesh, can be seen as a constitutive model, the answer of which is used by the FEM method in the usual way. In this presentation, we illustrate several remarkable features of the FEM-DEM approach :

- it allows one to perform real-grain-size micro-structure modelling on real-structure-size macroscopic problems, without facing the intractable problem of dealing with trillions of grains in a fully DEM mapped full-field problem
- using this approach, microscale related features such as the inherent and induced anisotropy of the material, and material softening/hardening with strain, naturally flow from the microscale DEM model to the macroscale FEM model
- the intrinsic variability of the local micro structure of granular matter deposits can be easily taken into account
- the Continuum Mechanics advanced methods like e.g. second gradient or Multiphysics coupling , can be used directly together with this kind of DEM-based numerical homogenized law for the granular skeleton
- Future developments of DEM-based approaches, for improved modelling of grain shape, roughness, grain crushing etc that today's multi-scale experimental methods put in the foreground, can be readily implemented.

BIOSKETCH : Jacques Jean Marie **Desrues**, born November 16th, 1951 in Pornichet, France, received the Engineer diploma in Civil Engineering from the Institut National de Sciences Appliquées of Rennes (INSA) in 1974, the DEA (Master) of Solid Mechanics, the Doctor-Ingenieur degree in 1977 and the PhD in Physics Science (Doctorat es Science) at Grenoble University in 1984. He holds a CNRS researcher position since 1978, with the grade of *Directeur de Recherche* (Research Professor) since 1992. His major research field has been advanced soil and rock mechanics, both from the experimental and theoretical viewpoint. With a special interest to strain localization phenomena in soils and rocks, he developed early in the 1980' experimental full-field measurement techniques (time lapse stereophotogrammetry, then DIC - Digital Image Correlation) to characterize deformation processes in laboratory specimens subjected to as-homogeneous-as-possible deformation, up to localization. He started to use X-ray tomography for this purpose as soon as 1984. On the other hand, he worked on the theoretical side of strain localization studies, combining bifurcation theory with advanced constitutive equations for soils and rocks. In recent years, he focused on the multiscale analysis of deformation processes in granular media, experimentally using microtomography and DIC, and numerically by developing *integrated* two-scale analysis using FEM at the macro scale and DEM at the microscale.

He is the recipient of the Ernest Déchelle Prize of the French Science Academy, in *2010*, for his contribution to the development of tomography for deformable solids experimental studies. He has been the head of 3SR laboratory of Grenoble from 2008 to 2013, member on the French CNRS national evaluation committee and French academic evaluation agency for 10 years. He was the advisor of 20 phD thesis, and scientific manager of a number of industrial and academic research projects over the years. His publications can be found here.

Acknowledgment: this Lecture was supported by ERC FP7 IDEAS Advanced Grant No 290963_SOMEF