PhD Position in Structural Mechanics Group: "A Discrete Element Method for modelling sandstones under regular and extreme loads" (VAC-2021-31)

Title of the PhD project: A Discrete Element Method for modelling sandstones under regular and extreme loads

INTRODUCTION:

The International Centre for Numerical Methods in Engineering (CIMNE, www.cimne.com) is a research centre, created in 1987 by consortium between the Catalan Government and the Universitat Politècnica de Catalunya (UPC-BarcelonaTech), devoted to the development and application of numerical methods to a wide range of areas in engineering. CIMNE has been selected as a Severo Ochoa Centre of Excellence for the period 2019-2023, the highest level of recognition of excellence and leadership awarded to a research centre in Spain.

POSITION DETAILS

Number of vacancies: 1
Category: PhD (PHD2)
Location: Barcelona
Yearly salary (gross): 17.563,14 EUR
Working hours: Full time
Duration: 3 years
Starting date: No later than Sept 2021

FUNCTIONS TO BE DEVELOPED BY THE APPLICANT

CIMNE is looking for a **PhD Researcher** to be part of the Research and Technical Development (RTD) Group on Structural Mechanics.

The functions assigned to the candidate will be:

- Complete a PhD on Structural Analysis at Universitat Politècnica de Catalunya – Barcelona Tech. The candidate is expected to complete the PhD thesis in a maximum of three years.
- Collaborate with various research groups within CIMNE and worldwide.
- To publish a minimum of two papers in JCR journals during the PhD period, author and co-author articles in high-impact international journals
- Carry out quality research, training and management.

cimne@cimne.upc.edu
+34 93 401 74 95
CIMNE - Edifici C1 Campus Nord
UPC C/ Gran Capità, S/N 08034
Barcelona, Spain

- Participate on the dissemination and outreach activities associated with the project
- Participate in international conferences presenting her/his work

DESCRIPTION OF THE PHD PROJECT:

The term ‘sandstones’ covers a wide range of rocks, from very soft to moderately strong, slightly permeable to very permeable and unconsolidated to overconsolidated. They have a wide variety of uses and also present a relatively high permeability, which makes them an attractive scenario for extracting water, oil and gas. They are also useful for injecting these same substances, for instance in the case of atmospheric CO2 sequestration.

The detailed behaviour of sandstones at certain depths is largely unknown due to the difficulty in reproducing the same conditions in experimental laboratories. Thus, a good, reliable model of the sandstone behaviour can bring valuable insight on the processes occurring at high depths, or those which might occur, but also valuable information about the stiffness and strength of the same material when it is located at surface level, along with more detailed processes like grain detachment or crack propagation. This knowledge can increase safety levels not only for neighbouring communities, but to the environment as well, preventing filtrations or induced seismicity.

Some of the best attempts to reproduce the behaviour of sandstones as based on the Parallel Bond Method (PBM, [1]), consisting on a dual force between Discrete Element Method (DEM) particles: one modelling the unbonded phase and the other modelling the bonded, also called cementitious, phase. However, the current models fail to cover the full range of properties of the sandstones. They are not, for example, capable of dealing with pre-stressed sandstones (extracted from high depth), or rarely deal with the cataclasis phenomenon (breakage of sand grains).

The PhD project will consist in developing a general numerical model for sandstones, including the major driving characteristics of its microscopic behaviour when the size of each particle of the model is that of an actual sand grain. The work must try to cover the widest possible range of rock types and load types. The Kratos Multiphysics DEM [2, 3] will be used as a starting point, as it already features a PBM implementation.

References

[1] Cao, R. H., Cao, P., Lin, H., Pu, C. Z., & Ou, K. (2016). Mechanical behavior of brittle rock-like specimens with pre-existing fissures under uniaxial loading: experimental studies and particle mechanics approach. Rock Mechanics and Rock Engineering, 49(3), 763-783.

[2] Celigueta, M. A., Latorre, S., Arrufat, F., & Oñate, E. (2017). Accurate modelling of the elastic behavior of a continuum with the discrete element method. Computational Mechanics, 60(6), 997-1010.

[3] Onate, E., Zárate, F., Miquel, J., Santasusana, M., Celigueta, M. A., Arrufat, F., ... & Ring, L. (2015). A local constitutive model for the discrete element method. Application to geomaterials and concrete. Computational particle mechanics, 2(2), 139-160.

REQUIREMENTS

1. The candidates must have a background in engineering: civil, geotechnical, mechanical engineering or similar.
2. Programming vocation is crucial.
3. Python and C++ experience will be valued.
4. A good command of English.

EVALUATION OF CANDIDATES

The requirements and merits will be evaluated with a maximum mark of 100 points. Such maximum mark will be obtained by adding up the points obtained in the following items:

- Academic record (60%)
- Previous research and academic experience in the field of the position (20%)
- Programming skills (10%)
- Language skills (10%)

HOW TO APPLY

Candidates must complete the "Application Form" form on our website, indicating the reference of the vacancy and attaching the following documents **in English**:

- Curriculum vitae
- A motivation letter
- Academic transcripts from all Undergraduate and MSc degrees
- Name and institutional contact information of two possible referees

The deadline for registration to the offer ends on 31st May, 2021 at 12 noon.

The shortlisted candidates may be called for an interview. They may also be required to provide further supporting documentation.

CIMNE is an equal opportunity employer committed to diversity and inclusion. We are pleased to consider all qualified applicants for employment without regard to race, colour, religion, sex, sexual orientation, gender identity, national origin, age, disability or any other basis protected by applicable state or local law. CIMNE has been awarded the HRS4R label.

cimne@cimne.upc.edu
+34 93 401 74 95
CIMNE - Edifici C1 Campus Nord
UPC C/ Gran Capità, S/N 08034
Barcelona, Spain