PhD Position in Industrial Manufacturing Processes group: "Enhanced Concrete Additive Manufacturing technologies for building and construction" (VAC-2021-30)

Title of the PhD project: Enhanced Concrete Additive Manufacturing technologies for building and construction

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 Industrial Manufacturing Processes.

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 three 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.

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

DESCRIPTION OF THE PHD PROJECT:

This project aims to the development of concrete **AM technologies**, namely **D-shape** and **Contour-crafting**, suitable for building and construction.

D-shape is a novel powder-bed technique for Additive Manufacturing (AM) using cement-based materials and polymeric fibres which has proved to be a promising construction technology, still under development. D-Shape is a method of digital construction making use of a binder jetting 3D printer for civil and architectural applications. D-Shape materializes building or architectural components directly from the CAD design by spreading a sequence of layers of granular material. A selective binder jetting allows for turning the granular material into the expected shape.

Contour Crafting (**CC**) additive manufacturing (AM) technology uses specially designed robotic systems to build self-resistant structural components (capable of resisting their own weight at fresh state) making use of data from 3D computer-aided design (CAD) systems. This AM system allows minimizing construction times and the avoidance of formworks and labour-force, while reducing the cross-section material consumption and guaranteeing sustainable (economic, environmental and social) solutions versus those traditionally used in building and construction.

This goal will be achieved by means of the following prospective outcomes:

1) Development of a D-Shape AM-design framework for: a) the **numerical analysis** and simulation of the **D-shape AM construction process**, and b) the analysis of the built structure **under in-service operations**. The software platform will be able to reproduce the whole construction process and to predict and monitor the performance of 3D-printed structures computing the mechanical properties (stiffness and strength) during the whole duration of the D-shape process and at any point of the built structure. It will also useful for optimizing the amount of material needed for the construction process, as well as for predicting the behaviour of the D-Shape AM structure under service load conditions.
2) Development of a CC/AM-design framework for the **numerical simulation of the CC/AM construction process** and the **in-service operations**. The CC/AM software platform will reproduce the AM construction process and will also predict and monitor the performance of the AM structures, computing the mechanical properties (stiffness and strength) during the duration of the CC/AM process at any point of the built structure.

References

Applications of additive manufacturing in the construction industry – A forward-looking review. Daniel Delgado Camachoa, Patricia Claytona, William J. O'Brien, Carolyn Seepersadb, Maria Juengera, Raissa Ferrona, Salvatore Salamonea, Automation in Construction 89, 110–119, 2018.

Experimental characterization and numerical modelling of 3D printed concrete. Controlling structural behaviour in the fresh and hardened state. Robert Johannes Maria Wolfs. PhD Thesis, Technische Universiteit Eindhoven, 2019.

Additive Manufacturing of Reinforced Concrete - Development of a 3D Printing Technology for Cementitious Composites with Metallic Reinforcement. Martin Classen, Jan Ungermannand Rahul Sharma. Appl. Sci. 10, 3791, 2020.

REQUIREMENTS

1. The position is aimed at students (Spanish nationals, EU and non EU citizens) who have completed one of the following options:

a) The studies that lead to an official Spanish, or European Higher Education Area, 1st cycle university degree (BSc) in Structural, Civil or Mechanical Engineering and that have 180 credits (ECTS) of an official university degree.

b) A degree from a non-European Higher Education Area university that gives access to MSc studies in Structural, Civil or Mechanical Engineering.

2. Excellent academic record.
3. Advanced knowledge of Continuum and Computational Mechanics (master level).
4. High working knowledge of English (Minimum B2).
5. Programming skills: Fortran 2008 Object Oriented, Python
6. Windows and Linux OS
7. Previous research or academic experience in the field of the position
8. Language skills: Spanish

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.

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