PhD position

Multiscale analysis and inverse design of uncertain meso-structures

Description

The proposed PhD is framed within a collaborative project between the University of Stuttgart, the University of Liège and the Université libre de Bruxelles (ULB) entitled '*Multiscale analysis and inverse design of uncertain meso-structures*'. It will be co-supervised by Université libre de Bruxelles (Prof. Thierry J. Massart) and University of Stuttgart (Prof. Felix Fritzen).

The generation of complex architectured meso-structures has developed at a rapid over the past decade. However, the structures generated by such processes are subject to several variabilities: the processing conditions induce some scatter in the microstructure which, in turn, results in varying constitutive behavior; while the geometry is subject to stochastic variations. These can manifest, e.g., in variable strut diameters, variations in junction morphology, local waviness or random porosities. Therefore, a better understanding of their impact on the effective structural response is required. To address this problem, the project will work on three main topics that will later be merged: (1) modelling of such stochastic meso-structures and characterizing them using reasonable descriptors of the intrinsic stochasticity, (2) developing direct numerical simulations based on recent Fourier-Accelerated Nodal Solvers that will provide data for robust reduced order models (ROMs), (3) Using ROMs for the generation of quality data for feeding Deep Material Networks. The latter will incorporate not only variable constitutive parameters, but also an interpolation across the previously modeled, stochastic meso-structural geometries will be developed. Methods will be synthesized from these three building blocks in order to run forward simulations and analyze the stochastic response of the structures and its correlation to meso-structural features. Finally, a direct inverse model will be built to recommend combinations of uncertain geometry and uncertain constitutive parameters.

The proposed PhD will focus on the generation and analysis of non-periodic meso-structures with quantified variability with a view to optimization across scales. It will involve the generation of aperiodic metamaterials geometries at different levels of controlled variability, the extraction of meso-structure information representative of the homogenized response, and the use of Numerical Simulations using FFT-based solvers to feed the obtained data in the set up of Deep Material Networks.

The PhD is funded by FRS-FNRS (National Fund For Scientific Research) in the frame of a PDR-Weave funded project.

Skills and Qualifications

- Master Degree in Mechanical or Civil Engineering
- Strong background in Computational Mechanics
- Completion of a Nonlinear solid mechanics course at master level
- Knowledge on Machine Learning, Computational Geometry are a plus

Specific Requirements

The ideal candidate should demonstrate a strong interest in computational code development and programming. This research project involves extensive application of different computational techniques among which FFT-based solvers, Model Reduction techniques, Machine Learning tools, requiring the candidate to build significant expertise in this area.

Additionally, they should be prepared to rapidly gain proficiency in coding. A strong motivation to learn and apply advanced computational techniques is thus essential.

A proven sufficient proficiency in English is required.

Benefits

- Full time grant to support the candidate during 3 years + optional one year extension.
- Expected starting grant amount 2450 net euros per month, tax free.

Selection procedure

The position will remain open until a suitable candidate is recruited.

As part of their application, the candidates should send the following documents to the contact email **thierry.j.massart@ulb.be** :

- Motivation letter, including availability date for starting working on the project
- CV
- Transcript of bachelor and master grades
- Two reference letters

Shortlisted candidates will be interviewed (remotely) by the research supervisors, where further details about the research project will be discussed.

Application deadline: As soon as possible