Post-doctoral fellowship proposal

at the Laboratoire de Mécanique des Sols, Structures et Matériaux (MSSMat)
CentraleSupélec, CNRS

Coupling of numerical solvers for large-scale wave propagation from source to structure

Scientific context and objectives

The Spectral Element Method (SEM) is currently very popular for large-scale wave propagation in geophysics, while the Finite Element Method (FEM) is much more widely used for vibration of structures in the context of Earthquake Engineering. This implies in particular that the two communities have developed efficient and validated solvers based on these two methods for their respective cases of interest. These cases of interest consider in particular non-linearities in the mechanical behavior (both for the soil and the structure) and uncertainties in the mechanical parameters. When aiming at computing the full seismic wave propagation path, from the fault to the structure, a natural approach would consist in coupling a SEM solver for the ground and a FEM solver for the structure. However, the space discretization is different for the two methods (larger elements for high order methods). Likewise, the classical time discretization for the SEM is explicit with very small time steps, while it is implicit for the FEM, with larger time steps. These issues must be mitigated by appropriate numerical treatment at the interface or through a coupling volume. When considering wave propagation over large numbers of processing cores, the questions of synchronous computation and load balancing are essential, and will be of constant concern. The post-doctoral candidate will propose novel approaches for the coupling between SEM and FEM solvers (here SEM3D and Code_Aster), and implement them in a High Performance Computing environment.

This post-doctoral fellowship is funded within project SINAPS@ ("Earthquake & Nuclear Plant : Ensure and Sustain Safety"), which aims to explore the uncertainties inherent in databases, knowledge of the physical processes and methods used at each step of the evaluation of the seismic hazard and the vulnerability of structures and nuclear components, in the context of a safety approach. The main objective is to identify or quantify the seismic margins resulting from assumptions or when selecting the level of seismic design, i.e. taking into account the uncertainties in the conservative choice, or design strategy. SINAPS@ is coordinated by CEA and brings together a multidisciplinary community of scientists and engineers from university teams and organizations associated with nuclear issues (designer of the operator by providing technical support to the regulator). The project partners are the CEA, EDF, École Normale Supérieure de Cachan, CentraleSupélec, Institute for Radiological Protection and Nuclear Safety, laboratory Soil-Solids-Structures and Risks (Institut Polytechnique de Grenoble), École Centrale de Nantes, EGIS-industry, AREVA, ISTerre, IFSTTAR and CEREMA. Within this project, an important research effort aims at developing a integrated numerical tool for the wave propagation from the fault to the structure, incorporating uncertainties and non-linearities.

Research position

— **Duration :** 1 year, plus possible renewal for 1 year.
— **Location :** The applicant will join the MSSMat laboratory (http://www.mssmat.ecp.fr), located on the campus of CentraleSupélec, in Châtenay-Malabry, France.
— **Net Salary :** 2200 euros net per month (possibilities for cheap housing close to campus available upon request).

Qualifications

We seek for candidates with excellent skills in numerical methods and computational science. An experience in mechanics or wave propagation would be appreciated, but not compulsory.

Application

Applicants should send their curriculum vitae and statement of interest, or questions, to

Régis Cottereau
regis.cottereau@centralesupelec.fr
Fernando Lopez-Caballero
fernando.lopez-caballero@centralesupelec.fr