RÉPUBLIQUE FRANÇAISE
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Cerema
CLIMAT & TERRITOIRES DE DEMAIN

Phd proposal in seismic risk

" Non-linear soil behavior effects on earthquake recordings: Application to the French mainland sismo-tectonic context"

3 years (CDD)

Deadline to candidate: 15 of april 2022

Beginning of Phd: autumn 2022

1. Description of the Phd

The seismic ground motion at the surface results from the propagation of seismic waves from an earthquake occurring at depth. The motion tends to be attenuated with distance from the hypocentral zone. However, in the few hundred meters of soil close to the surface, the seismic waves can be trapped in the subsurface soft soil layers lying on a more rigid bedrock. In these cases, strong amplifications, compared to close by rock sites, can occurred. These amplifications are site dependent and are characterized by the seismic site responses. For strong ground motions, the non-linear soil behavior can modify the site response and consequently the surface ground motion. In 2011, The recordings of the Tohoku earthquake demonstrate the significant impact of non-linear soil behavior on site response. However, the thresholds from which those impacts need to be considered in the evaluation of seismic hazard are still not constrained. The consideration of these effects in the seismic hazard evaluation for moderate earthquakes, characteristics of the French mainland seismic context, is still under question.

The objective of this thesis is to analyze the earthquake records of these boundary events that can generate strong and weak seismic motions. The objective is to refine the thresholds from which motion aggravation/modulation factors due to non-linear soil behaviour will have to be calculated to correct the response spectra defined in EC8. For this, it will be necessary to (1) discriminate the mechanisms at the origin of the non-linear behavior in the earthquake recordings (2) define the relevant indicators characterizing the intensity of the seismic motions, and those characterizing the impact of the non-linear behavior of the soil as a function of these mechanisms (3) propose thresholds to define the domains of validity of the linear or non-linear behaviour to be used in the calculations of the seismic site response (4) define correction factors for the EC8 response spectra.

The different mechanisms at the origin of the non-linear behavior and their impact on a soil samples and on the in-situ seismological data will be analyzed through a detailed literature review. Then, a methodology for the analysis of seismic signals allowing to discriminate the type of non-linear behavior involved will be developed using seismological data from sites densely instrumented with seismological and water pressure sensors (two potential sites Widlife refuge and Garner Valley (US) have been identified)

Then, the developed methodology will be applied to the Japanese seismological database Kik-net in order to discriminate the sites according to their dominant mechanisms at the origin of the non-linear behavior. First, it will be necessary to update the database. This will allow to specify the seismic motion intensity parameters to characterize the non-linear behaviour potential of the sites and to refine the thresholds.

Finally, moderate earthquakes in near fields will be more finely analyzed by including time and frequency analysis methods on a selection of events from the Kik-net database and on the accelerometric database of the French Permanent Accelerometric Network (RAP-RESIF). The objective is to define possible aggravation factors according to the relevant parameters proposed and the thresholds to be applied to the EC8 spectra.

2. Required skills

The student will have completed a geoscience background during which he/she will have taken courses in seismic hazard. Strong engineering seismology skills are required. These include knowledge of:

- Seismic wave propagation in different soil layers,

- Soil mechanics and dynamic behavior of soils in saturated and unsaturated soils.

- Signal processing.

- Statistics

The student should be familiar with programming languages such as Matlab or Python.

3. hosting conditions for the thesis project

- The doctoral student will be employed by Cerema on a doctoral contract from fall 2022 to fall 2025 (exact dates to be determined with the doctoral student)
- The remuneration will be about 1500€ the first two years and 1700€ the third
- The project will take place mainly in Cerema in Sophia-Antipolis

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- the doctoral student will benefit from the training of the doctoral school of registration.

4. Supervision team of the thesis project

- The PhD student will be hosted in the REPSODY team of Cerema, whose leader is Luca Lenti.
- The project will be supervised by Luca Lenti du REPSODY/Laboratoire Geoazur
- The project will be co-supervised by Julie Régnier, researcher in the Cerema team

5. How to apply ?

The interested candidate is invited to contact as soon as possible the Cerema supervisor of this project:

A Julie Régnier, CEREMA Méditerranée
500 route des Lucioles
CS 80125 Valbonne
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Tel .04 97 28 86 44

Content of the application :

- The candidate's CV
- A copy of his/her identity card or passport
- The marks of the master (at least the master 1 if the marks of the master 2 are not available)
- A copy of the last diploma (master's degree, engineering degree, research master's degree if already defended)
- A letter of motivation from the candidate explaining his or her interest in the subject (maximum 1 double-sided page)
- A letter of recommendation

The candidate will send a complete file (above elements gathered in a single .pdf file), by e-mail, 15 April 2022.