Post-doctoral position
Cracking of concrete structures under cyclic loadings

Scientific context

New questions concerning seismic risk have arisen after the Fukushima nuclear accident. Hence, the SINAPS@ research project has been launched by the SEISM institute – a French scientific interest group created by CEA, EDF, Ecole Centrale Paris, Ecole Normale Supérieure de Cachan and CNRS. A post-doctoral position is open to work on the cracking of concrete structures under cyclic loadings.

Indeed, it is well-known that the prediction of the durability of reinforced concrete structures is strongly correlated to the prediction of the degradations caused by cracking. But cracks have different impacts at different observation scales. At the microscopic scale, permeability is directly correlated to the cracks' characteristics such as their spacing, length, opening or tortuosity. At the macroscopic scale, the degradation of concrete influences the stiffness, the load distribution and the bearing capacity. Therefore, it is crucial to use models adapted to the observation scale in order to correctly represent the cracking of concrete.

Recently, some major advances have been made in the development of a beam-particle approach. Non-linear mechanisms due to concrete degradation – such as cracking and frictional sliding – have been introduced. Thus, this beam-particle model allows us to simulate the behaviour of quasi-brittle materials under multi-axial and cyclic loadings. This microscopic model has been validated as a virtual testing tool and used to establish equations of a macroscopic model, on the basis of damage and plasticity theories. The macroscopic model has finally been calibrated, entirely with the microscopic model, and employed to simulate the response of large reinforced concrete structures under monotonic and cyclic loadings. These simulations have served to showcase the numerical robustness of the proposed macroscopic model as well as its representativeness.

The microscopic model can also be used as post-treatment tool to obtain a fine description of cracking. A structural zoom is performed on the damage fields obtained through a macroscopic computation. This zoom introduces a weak coupling between the two scales. Several studies under monotonic loadings have been performed and showed the capacity of the approach to finely describe the crack propagation in reinforced concrete structures.

Objectives

First, the aim of the post-doctoral researcher is to pursue the aforementioned developments in order to realise a complete simulation of a reinforced concrete structure under cyclic loading. The phases are:

- Getting familiar with the elasto-plastic damage model CONCYC developed in the Cast3m FEM code and the beam-particle model developed in C++;
- Studying the key points of the structural zoom for cycling loadings;
- Computing the global behaviour of a reinforced concrete structures under cyclic loading and characterising the evolution of its cracking pattern.

The second objective is to extend the beam-particle model to 3D. The extension of the lattice part has already been performed but important developments remain to handle 3D frictional contacts.

The final objective could be to introduce thermo-hydro-mechanical effects in the beam-particle model.

Ideal candidate

- PhD in computational mechanics and/or non-linear analysis of materials and structures.
- Thorough knowledge of continuum mechanics, finite element methods
- Familiarity with discrete element methods would be a plus.
- Experience of object-oriented programming (C++).

Practical information

Location : LMT / ENS Cachan
Net salary : 2000 € euros/month
Duration : 12 months

Contact

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