Offre de thèse / Thesis offer

MSCA Cofund - MISCEA

Template EURAXESS

Note for laboratories/potential supervisors : only fill in the *green and italic parts*

Job Information

Organisation/Company : **Ecole nationale des ponts et chaussées (ENPC)**

Department : *Laboratoire Navier*
Research Field : *Civil engineering, materials science*

Researcher Profile : **First Stage Researcher (R1)**

Country : **France**

Type of Contract : **Temporary**

Job Status : Full-time

Is the job funded through the EU Research Framework Programme? : **Horizon Europe (HE) / Marie Skłodowska-Curie Actions COFUND**

Is the Job related to staff position within a Research Infrastructure? : **No**

This project is co-funded by the European Union as part of the **HorizonEurope programme, Marie Sklodowska-Curie Actions, call COFUND-2022** and under grant agreement number 101126720

Offer Description

Thesis offer :

Creep of low-carbon concretes: experimental study and modelling

1 - Please describe the doctoral thesis project that you are proposing.

Two complementary strategies are being mobilized to address climate change: **mitigation**, which seeks to reduce greenhouse gas emissions, and **adaptation**, which prepares infrastructure and society for the consequences of a changing climate. The construction sector plays a major role in mitigation, accounting for nearly **8% of global CO_2 emissions**, most of which stem from cement production. Reducing the carbon footprint of cement and concrete is therefore an urgent priority for sustainable development.

The adoption of **low-carbon concretes (LCCs)**—through the use of alternative binders, supplementary cementitious materials (SCMs), and optimized mix designs—represents one of the most promising approaches to lowering embodied carbon while maintaining the required mechanical and functional properties. However, the large-scale deployment of these materials requires not only demonstrating adequate strength and durability but also a solid understanding of their **long-term behavior** and **durability**. Increasing the service life of concrete structures reduces the frequency of repairs and reconstructions, thereby minimizing lifecycle emissions. Combining durability enhancement with carbon reduction is thus a key strategy for sustainable construction.

Among the most critical factors influencing both durability and serviceability is **creep**, the time-dependent deformation of concrete under sustained load. Creep governs long-term deflections, prestress losses, and cracking risk in structural members. Despite decades of research, its underlying mechanisms remain only partly understood. At the material scale, creep is linked to moisture transport, viscous rearrangements of the C–S–H gel, and microstructural evolution; at the structural scale, it controls long-term deflections, redistributions of stresses, and ultimately the reliability of design. While conventional concretes have been extensively studied, far less is known about creep in **low-clinker and alternative binder systems**, where changes in hydrate assemblage, pore structure, and chemistry may alter both the magnitude and mechanisms of creep. The methods currently used for creep evaluation in structural design—such as those included in **FIB Model Code 2020**, **Eurocode 2 (EN 1992-1-1 & EN 1992-2), ACI 209R** — are mainly based on empirical and semi-empirical formulations calibrated primarily on ordinary Portland cement (OPC) concretes and historical datasets. These models describe the evolution of the creep coefficient as a function of loading age, strength, humidity, and temperature, and they remain the reference tools for serviceability design.

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However, the **direct application of these formulations to low-carbon concretes is not guaranteed to be valid**. Recent experimental studies have reported significant variability in creep behavior depending on binder chemistry and microstructure. For example, concretes incorporating high volumes of slag, fly ash, or calcined clays may exhibit creep evolutions similar to OPC at later ages, but alkali-activated binders or hybrid cements often display different magnitudes and temporal developments, reflecting changes in gel chemistry, pore structure, and moisture transport mechanisms. In such cases, standard models may either under- or over-estimate creep, highlighting the need for validation and potential recalibration when applied to LCCs. There is therefore a **clear need for industry**: to verify, adapt, or extend normative methods so that safe and reliable serviceability assessments can be made for structures built with LCCs.

The present project, entitled **"Creep of Low-Carbon Concretes: Experimental Study and Modelling,"** seeks to address this need by combining systematic laboratory investigations with micromechanical and macroscopic modeling. The objectives are twofold: (i) to experimentally characterize the creep of representative families of low-carbon concretes under controlled hygro-thermal and loading conditions; and (ii) to evaluate and calibrate existing prediction models and, where necessary, to propose mechanistic models that incorporate the chemistry and microstructure of novel binders. The results will provide scientific insights and practical tools to support the safe integration of low-carbon concretes into modern design codes and sustainable infrastructure development.

The study will be based on three combined approaches:

1- experimental study at laboratory scale, including macro-scale creep and relaxation experiments under various stress states, microstruture analysis, nanoindentation creep tests

2- Theoretical analysis including macro-scale constitutive model development, and micromechancial modelling

3- numerical simulation at both sample and structural scale and comparison with available measurements

The conclusion of this study will help to propose some modifications of the formulations of creep effects in codes and standards, to make them applicable to low-carbon concretes, in order to deal with this long-term phenomenon in design of low carbon concrete structures.

2. Please provide the name of the thesis supervisor and their email address. Prospective candidates should contact you to discuss their research topic and obtain your approval for their application.

Thesis supervisor : Siavash Ghabezloo (siavash.ghabezloo@enpc.fr), Directeur de recherche
Co-supervisors : Maxime Pierre (ENPC), Jean-Michel Pereira (ENPC), Romain Ragouin (Tractebel)

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3. Please offer a description of the working environment that will be available to candidates (laboratory with a link to its website, research facilities, etc.).

This work will be carried out as part of a collaboration between the Navier laboratory and Traceebel.

The Navier laboratory (https://navier-lab.fr), located in Champs-sur-Marne, France, is a joint research unit of the Ecole Nationale des Ponts et Chaussées (ENPC), the Gustave Eiffel University and the Centre National de la Recherche Scientifique (CNRS). The staff (nearly 180 people) carry out research into the mechanics and physics of materials, structures and geomaterials, and their applications to geotechnics, civil engineering, transport, geophysics and energy. Societal challenges include sustainable construction, natural hazards, the environment and energy. In developing the mechanical and physical laws relating to these themes, the studies undertaken are both experimental and theoretical. They are based on a wide range of equipment, some of which is unique.

Tractebel (part of the ENGIE Group) is a global engineering and consulting firm delivering multidisciplinary expertise across energy, water and infrastructure. Backed by more than 150 years of experience, Tractebel brings together around 5,600 experts and operates in over 40 countries, providing sustainable, innovative and resilient solutions to technically demanding projects. Tractebel's track record spans major international projects in nuclear (new builds and lifetime-extension studies), hydropower and dams, offshore and onshore renewables, rail and metro infrastructures, tunnels and large hydraulic and civil works — demonstrating its capacity to deliver complex, high-technology projects while advancing sustainability goals.

Kindly specify whether the doctoral offer is co-developed with an associated project partner (co-funding).

This work will be carried in the framework of a collaboration between Navier laboratory and Tractebel ENGIE company.

5 - Please clarify if there are any secondments planned:
- time spent with the associated partner
- secondment at international partner (e.g.: laboratory outside France, if so, which discipline and interest for the thesis) or intersectoral (e.g.: company, association, local authority, specifying the interest for the thesis, etc.)
- participation in EELISA activities such as communities).

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The working environment is mainly in Navier Laboratory, Ecole nationale des ponts et chaussées.

6. Please specify if your topic is interdisciplinary (e.g. inter-lab)

No

Description of the project and the candidates' eligibity criteria :

This position will be part of the EU-funded project **MISCEA**, which is an ambitious inter- and multidisciplinary Doctoral Training Network under the Horizon-Europe Marie Skłodowska-Curie Actions.

PhD candidates' can be of any anationality but you have to meet these eligibity criteria :

- **Not being a current employee** working at ENPC.
- Not having resided or carried out their main activity (work, studies, etc) in France **for more than 12 months** during the past 36 months immediately before the deadline of the MISCEA Programme's call. Compulsory national service, short stays such as holidays and time spent as part of a procedure for obtaining refugee status under the Geneva Convention are not taken into account.
- **Holding a Master's degree** or having a University degree equivalent to a European Master's degree (5-year duration) at the deadline of the MISCEA Programme's call.
- Researchers must be doctoral candidates, i.e. not already in possession of a doctoral degree at the deadline of the co-funded programme's call. Researchers who have successfully defended their doctoral thesis but who have not yet formally been awarded the doctoral degree will NOT be considered eligible.
- **Signing a declaration** of the veracity of the information provided (Declaration of honour, free of form).

If you comply with the eligibility criteria and you wish to submit your application, you must :

- Contact the thesis supervisor and explain your thesis project to her/him so that she/he validates your application.
- Submit a **5-pages thesis proposal** under the proposed research areas, with the agreement of the future supervisor. Additionally, to the submission of the 5-pages thesis proposal, the applicant will have to complete an ethics checklist based on ethics guidance from the HorizonEurope programme guide.
- **English-translated transcripts** from the master's degree or equivalent.
- **Any specific requirements of the Doctoral School** corresponding to the targeted MISCEA
  fellowship offer.
- English curriculum vitae, including information about the level on English language knowledge.
- A motivation letter.
- One letter of reference, at least.

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Templates are available on the MISCEA website (link).

Then your candidature is complete, please send inquiries and applications to miscea-program@enpc.fr

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Requirements

Research Field : *Domaine de recherche pré-nécessaire pour la thèse / Thesis's pre-required research area*

Education Level : Master Degree or equivalent

Skills/Qualifications : *Master degree or equivalent in civil engineering, materials science or mechanical engineering, numerical simulation and computer programming skills*

Languages : ENGLISH or FRENCH

Level : Excellent

Where to apply

E-mail : miscea-program@enpc.fr

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