IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Post-doctorate

Study of the development of ISR concrete pathology, interpretation through the notions of durability indicators and scale effect applied to the international ODOBA project

Thematics: Civil engineering; Materials; Engineering Sciences
Keywords: Internal Sulfate Reaction (ISR), experimental data interpretation, sustainability indicators, scale effect, international ODOBA project
Place: Cadarache (13), France
Availability date: As soon as possible (May 2023)
Duration: 18 months
Supervising: Céline PELISSOU and Benoit DURVILLE

Description:

The proposed work is part of the research conducted at the Institute for Radiation Protection and Nuclear Safety (IRSN) concerning the ageing of concrete in nuclear power plant containments (extension of the operating life of nuclear reactors) in the framework of the international ODOBA project. This project focuses on internal swelling reactions (ISR) at the scale of massive blocks. They are of two types: the Internal Sulfate Reaction (ISR) and the Alkali-Aggregate Reaction (AAR). These reactions can lead to the degradation of the mechanical properties of the concrete but especially to cracking, potentially resulting in a loss of efficiency of the third containment barrier for radioactive materials.

At the international level, the studies of these reactions are almost exclusively carried out at the laboratory scale, on small specimens (for example, cylindrical specimens 11x22cm2). The ODOBA project aims to study the evolution of these reactions at the structure scale in order to better understand the phenomena involved, their evolution and eventually to constitute an experimental database at the structure scale.

This base will be used to develop and validate simulation tools for the prediction of behavior of concrete structures affected by ISR pathologies. To do this, the ODOBA project is carrying out tests on widely instrumented (temperature, deformation) large dimension blocks (1x2x4 m3) in normal and accelerated aging. Periodic controls are associated to evaluate the mechanical, physical and chemical properties evolutions.

Mission:

The overall objective of this post-doctorate is to contribute to the interpretation of experimental ISR data at different scales obtained in ODOBA. The ambition is to put these data in perspective with those from the literature and to actively interact with the people in charge of the modeling to guide the choice of models. The post-doctoral work is broken down into different areas of work, presented in a not necessarily chronological order:

- Updating a literature review on AAR pathology with a focus on identifying the scale factor between specimens and metric scale blocks affected by ISR;

- To appropriate the experimental data from the ODOBA database on blocks undergoing aging. To enrich this database with the missing information (destructive examinations, surface measurements and hygrometry measurements of concrete).

- From this base, to extract relevant information, for example by relying on the actions already initiated on data post-processing (data science proof of concept on DSS-Dataiku).

- Within the framework of the study of the scale factor, to make a comparative analysis of the development of the pathology (indicators of durability) between the tests carried out at the scale of the test piece and of the structure. To do this, carry out/participate in the production of ISR specimens and analysis (expansion, dynamic Young's modulus) to be linked with the measurements on the large blocks of large size. For information, these specimens will be studied according to different profiles reproducing those obtained on a large scale.

- By comparing the two experimental sources, determine the existing links between indicators of durability (experimentally measurable, linked to pathology) and the levels of modelling levels selected (micro, meso, macro) allowing to take into account the scale effect.

- To write a report on the interpretation of the ODOBA data.

- To valorize this work (participation in conferences and writing one publication).

Skills and degree required:

The candidate must have a background in civil engineering and/or materials (PhD) with a strong taste for research and experimentation. Knowledge of concrete pathology, programming tools (Python) and mechanical laboratory tests as well as mechanical tests in the laboratory as well as brief skills in mechanical modeling or data science will be appreciated.

A developed sense of teamwork and autonomy are two qualities required to successfully carry out this R&D work.

The candidate will have to evolve within a team and will have a transverse position between the experimental and experimental and modeling activities. He/she will have to be at the interface with the people deploying a mechanistic approach (mechanics-chemistry-transport) and understand their needs. He will also participate in meetings with international partners and will be a force for scientific proposals.

Contacts: Send CV, letter of motivation, letter(s) of recommendation from thesis and post-doc supervisors, minutes of the thesis defense and reports from the rapporteurs to:

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