PhD Opportunity: AI-Driven Sustainable Concrete Research (Caen, France)

Revolutionizing Concrete: Combining Archaeological Waste, Artificial Intelligence, and Sustainable Construction Practices

Laboratories : CRISMAT, GREYC, ESTP, ENSICAEN, CNRS, Université de Caen Normandie, France

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Project Summary: Join us in developing the next generation of low-carbon concretes, addressing a critical need for sustainable solutions in the construction industry. This fully funded PhD project at the University of Caen Normandie seeks a highly motivated candidate to explore the innovative use of archaeological waste materials and advanced artificial intelligence techniques to significantly reduce CO_2 emissions associated with concrete production. We aim to develop sustainable concrete formulations and methodologies that minimize environmental impact while enhancing material performance.

The Challenge: The cement industry, a cornerstone of concrete production, is a major contributor to global CO_2 emissions. Current efforts to mitigate this impact include incorporating bio-based and recycled materials into cementitious materials. This project expands upon these efforts by investigating the potential of archaeological waste from the Normandy region as a sustainable alternative to traditional concrete components.

Our Innovative Approach: This project combines two key strategies: **Sustainable Materials:** Utilizing locally sourced archaeological waste, transforming a regional environmental burden into a valuable resource for concrete production. **Artificial Intelligence:** Developing and implementing AI models to analyze X-ray diffraction (XRD) data, enabling precise characterization of the complex phase compositions in bio- and archeo-sourced concretes. This will overcome the limitations of traditional XRD analysis, providing a deeper understanding of concrete behavior and CO_2 uptake potential.

PhD Project Goals:

The successful candidate will:

- Develop sustainable concrete formulations incorporating archaeological waste materials.
- Conduct X-ray diffraction experiments to characterize the phase composition of cementitious materials.
- Develop and train artificial intelligence models for automated and accurate phase fraction analysis from XRD and XRF data.
- Investigate the mechanical properties, durability, and CO_2 uptake capacity of novel concrete formulations.
- Publish research findings in peer-reviewed journals and present at international conferences.

Benefits for the PhD Candidate:

- **Cutting-Edge Research:** Contribute to a highly relevant and impactful research area at the forefront of sustainable materials science.
- **Interdisciplinary Expertise:** Gain expertise in concrete technology, materials characterization, artificial intelligence, and environmental science.
- **Advanced Training:** Develop advanced skills in X-ray diffraction and fluorescence, machine learning, data analysis, and scientific communication.
- **Career Advancement:** Build a strong foundation for a career in academia, research and development, or the construction industry.
- **Collaborative Environment:** Work within a dynamic and supportive research team, collaborating with leading experts in their respective fields.
- **State-of-the-Art Facilities:** Access to cutting-edge research facilities at CRISMAT, GREYC, and ESTP, including advanced XRD-XRF equipment and high-performance computing resources.

Candidate Profile:

We are seeking a highly motivated and talented individual with:

- A Master's degree in Physics, Materials Science, Chemistry, Civil Engineering, Computer Science or a related field.
- Strong analytical and problem-solving skills.
- Programming experience in Python (or similar language) is highly desirable.
- Familiarity with X-ray diffraction techniques is a plus.
- A strong interest in sustainable materials and environmental science.
- Excellent written and oral communication skills in English (and preferably French).

Participating Laboratories:

- **CRISMAT (Laboratoire de CRIstallographie et Sciences des MATériaux – Caen):** A leading materials science laboratory specializing in the synthesis, characterization, and modeling of advanced materials. Possesses extensive expertise in X-ray diffraction and combined analysis techniques. https://crismat.cnrs.fr/
- **GREYC (Groupe de Recherche en Informatique, Image, Automatique et Instrumentation de Caen):** A renowned computer science laboratory specializing in artificial intelligence, image processing, and data analysis. https://www.greyc.fr/
- **ESTP:** A research and development center focused on innovative concrete formulations, mechanical testing, and bio-sourcing strategies for sustainable construction. https:// https://www.estp.fr/

Funding:

This PhD position is fully funded for 3 years by the Région Normandie.

Application Procedure:

Interested candidates are invited to submit the following materials to daniel.chateigner@unicaen.fr and/or Frederic.jurie@unicaen.fr :

- A detailed curriculum vitae (CV).
- A cover letter outlining your research interests, relevant experience, and motivation for applying to this position.
- Transcripts of your academic records (Bachelor's and Master's degrees).
- Contact information for two academic references.

Application Deadline: 15/07/2025

We encourage early applications. Shortlisted candidates will be contacted for an interview.

Keywords: Sustainable Concrete, Artificial Intelligence, X-ray Diffraction, X-ray Fluorescence, Waste Valorization, CO_2 Emissions Mitigation, Machine Learning, Materials Characterization, Archaeological Waste.