Job offer – Post-doctorate in Construction materials and processing
(*For non-French scientists only*)

Research Project Title: ORGANOPRINT
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Reference Number of the Job Offer: IFI_CEF_26_08

Project description

- **Keywords:** Organic wastes, rheology, permeability, elasticity, 3D printing

- **Context:** 3D Printed stay-in-place formworks are expected to show lower permeability in order to protect the inner low-carbon concrete. Such a feature can be reached through the integration of some non-metallic compounds that are known to potentially clog the microporosity, display some hydrophobic properties and reduce the elastic modulus of the resulting composite. In parallel, our societies are producing tremendous amounts of such non-metallic wastes including epoxy resin, polypropylene, polyethylene, polyester and melamine formaldehyde. Most plastics are waste materials and pose significant environmental threats. Their integration in construction materials is considered challenging but they were however to limit the opening of cracks and decrease the permeability of the resulting cement-based composites.

- **Abstract of the Research Project**

  The ORGANOPRINT project addresses the dual challenges of reducing organic plastic waste and enhancing the sustainability of 3D-printed concrete by integrating organic waste into stay-in-place formworks. Current 3D-printed formworks require low permeability to protect inner low-carbon concrete, a feature achievable through the incorporation of non-metallic compounds that clog microporosity, impart hydrophobicity, but reduce elastic modulus. Meanwhile, societies generate vast quantities of plastic waste—epoxy, polypropylene, polyethylene, polyester, and melamine formaldehyde—posing environmental risks but offering potential as construction additives to limit cracking and permeability in cement-based composites.
  The project's primary objective is to develop novel 3D-printable mixes using organic waste, such as epoxy or PET, to pioneer sustainable additive manufacturing in construction. By embedding processed plastics as fibers or powders, ORGANOPRINT seeks to minimize the environmental footprint of construction and promote circular economy practices.
  Methodologically, the project evaluates how organic additives influence permeability, elasticity, and hydration of cementitious materials. Techniques include isothermal calorimetry, XRD/TGA, SEM, and dynamic mechanical analysis, alongside environmental assessments of processing energy and CO_2 emissions. Over 20 months, the team will study model materials, screen waste materials and develop and validate protocols. Deliverables include publications, validated protocols, a transferable manual, and a dataset linking additives to material properties, advancing both scientific understanding and practical application of sustainable 3D-printed concrete.

- **Scientific Objectives of the Project**

  The primary objective of the ORGANOPRINT project is to integrate organic wastes to develop new 3D printable mix for additive manufacturing techniques for the fabrication of Stay in Place Formwork. By leveraging on novel technology of additive manufacturing of concrete, the project aims to pioneer novel methods for incorporating organic wastes, such as epoxy or PET, within 3D printed concrete components. The objective reflects the growing importance of environmental sustainability in the construction industry and aims to reduce the environmental footprint of construction activities. By incorporating organic waste as fibers or fine powder into the printing process, the project aims to promote sustainable construction practices and minimize the reliance on traditional, resource-intensive materials.

Methodology and Timeline of the Project

The project evaluates how organic macromolecules, powders, and processed plastic-derived fibers affect permeability and elasticity of 3D-printable cementitious materials, and how these effects link to hydration (including early ettringite formation) and microstructure.

Methodology

- Hydration and pore-solution analysis: monitor hydration with isothermal calorimetry and time-resolved XRD/TGA; sample pore solution for dissolved organic carbon (TOC/DOC) and targeted organics to assess carbon release and additive interactions.
- Permeability, elasticity: Develop and validate two protocols: (1) permeability adapted to printed geometries (steady-state water/gas permeability), (2) elasticity assessment (dynamic DMA/ultrasonic and static uniaxial compression). Correlate results with packing/porosity metrics.
- Micro-structural characterization: apply SEM (imaging, EDS), backscattered imaging, and image analysis to quantify hydrate morphology, pore structure, and additive distribution; integrate with hydration and property data to establish structure–property relationships.
- Waste screening and environmental assessment: screen processed plastics for performance and printability; perform simplified environmental assessment (processing energy, leaching potential, cradle-to-gate CO2-eq).

20-month draft timeline

- Months 0–3: project setup, model and real materials sourcing, baseline mixes, preliminary screening.
- Months 3–7: hydration and pore-solution studies (calorimetry, XRD/TGA, TOC/DOC); draft permeability and elasticity protocol outlines.
- Months 7–11: protocol development and intra-lab validation on baseline and modified mixes; standardize specimen preparation.
- Months 11–14: microstructure–property mapping (SEM, porosity) and correlation with hydration and mechanical/permeability data; iterate formulations.
- Months 14–17: process and screen candidate plastic wastes; evaluate performance and simplified environmental metrics; select top additives.
- Months 17–20: produce printed demonstrators on both platforms with selected formulations; finalize and validate protocols; prepare reports, dataset, and dissemination materials.
- Deliverables: two validated protocols (permeability, elasticity); transferable protocol manual; dataset linking additives to hydration, microstructure, and properties; waste screening.

Candidate profile

- Candidates can be all nationalities except French. In case of double nationality (French and another one), the candidate is not eligible. In the context of CEFIPRA, Indian candidates are preferred
- Applicants for post-doctorate must have a PhD degree (or be in the process of obtaining one);
- No competences in French language is required
- **Candidate competences:** Rheology of cement-based materials, Valorization of waste, Additive Manufacturing of concrete.
- **Candidate know-how:** Micro-structural characterization, Mix design of construction materials, Performance evaluation of cement-based materials.
- Expected starting date: 01/05/2026
- Expected duration: 20 months

How to candidate ?

Documents to be provided :

i. A cover letter (reasons for the candidature, professional project …) max 2 pages
ii. A copy of the master's degree or a proof of the program followed (and expected date of end) OR A copy of the PhD degree or a proof of the PhD program followed (and expected date of defense) max 1 page
iii. A copy of results for previous scholarship (max 3 pages)
iv. International curriculum vitae (max 2 pages)
v. One letter of recommendation from any Indian institution –mandatory- (max 2 pages)
vi. All should be submitted within 1 pdf file of no more than 10 pages.

Applications must be submitted through this Google Form selecting the appropriate reference number for the job offer.

Research Project Title as Submitted to CEFIPRA: "ORGANOPRINT"

Benefits:

- Monthly allowance of 2400 euros for Post-Doc
- Travel allowance
- University fee
- Carte de séjour fee
- Campus France management fee
- Registration to the French social security scheme

Selection process:

The final selection is made by a dedicated selection committee of scientific experts after a pre-selection phase by the French principal investigator. Decisions will be transmitted by the Embassy of France to CEFIPRA.

Criteria for applicants' selection:

Academic excellence

- Excellence of the Academic background, Academic records, Honors, Letters of support, Participation to international research projects, exchange programmes and conferences.

Motivation and qualities

- Academic maturity: appropriation of the thesis project (stakes and contexts)
- Quality of the presentation (oral expression, skills for synthesis, English level)
- Maturity of the professional project: capacity to project her/himself within five years in terms of career development.

About CEFIPRA:
Indo-French Center for the Promotion of Advanced Research (CEFIPRA/IFCPAR) is an Indian body which promotes scientific cooperation between France and India in advanced fields of Science and Technology. It is supported by the Department of Science and Technology, Government of India and the Ministry of Europe and Foreign Affairs of the French government