

One doctoral position in quantification of water flux and insulation dynamic of newly roof structures with recycled materials at the University of Liege, Belgium

The research groups GeMMe Building Materials and Sustainable Building Design (SBD Lab) of the University of Liege are seeking one doctoral candidate for conducting research on scientific projects strongly related to building element performance simulation and experimentation.

GeMMe Building Materials group is active in the characterization of materials, specifically recycled products from construction industry but also wastes to be introduced in the manufacture of building materials. UEE GeMMe Building Materials group has been involved in several research projects oriented to the increase of the thermal performances of buildings (aPROpaille, DREAM), as well as the development of recycled materials concrete based (VALDEM, ECOLISER, ConRePaD, SeRaMCo).

The Sustainable Building Design (SBD) laboratory is a research facility of the Faculty of Applied Sciences of Liege University. The SBD Lab focuses its activities on design decision support of high-performance buildings. With climate responsive design and adaptive comfort as strategic areas of expertise, research conducted at SBD range from new building technologies to simulation methods or climate-based performance metrics. The activities of the laboratory are mainly based on a combination between computer modelling and data acquisition (quantitative).

Project

CITYROOF project has as main objective to unravel the complex interactions among ecological, built and human environments for a novel ecosystem – green roofs (GR) - and the way those interactions influence ecosystem delivery for the development of nature based urban green infrastructures.

Specific goals of the CITYROOF project are :

- To assess the capacity of extensive green roofs to develop analogous habitat for native dry grassland biodiversity, that contributes to regional ecological networks;
- To disentangle interactions between plant functional diversity and abiotic conditions in analogous green roofs and their influence on water and temperature regulation;
- To assess the contribution of analogous green roofs to building environment sustainability through using recycled building materials and to assess contribution of analogous green roofs to temperature/water budget of buildings;
- To evaluate the potential of cities to develop analogous green roof networks and to assess the global contribution of green roof networks to regulatory and non-material ecosystem services.

PhD research project will focus on the

1. *Benchmarking of recycled materials suitable for analogous green roof implementation.*

The recycled materials constitute valuable resources to create large selection of substrates. A benchmarking is needed to identify the composition and the total volume of the deposit available – for one or two representative cities of Wallonia, the way of preparation of the recycled aggregates, the sieving curve of the obtained materials – with regard to the preparation techniques – and the individual properties of the aggregates: shape, density, porosity, mechanical properties (Los Angeles and Micro-Deval). This characterization will allow to design substrates with similar properties to dry grassland abiotic conditions (analogous habitat) and to determine functional behavior: compactibility, permeability and transmissivity of the substrate lay, thermal conductivity and compressibility to assess their potential to deliver regulation ecosystem services. The two best materials will be selected for the experiment. Durability (wet-dry cycles) and resistance to freeze-thaw cycles will be then evaluated.

2. *Testing functional response of dry grassland flora to substrate in microcosm experiments.*

The objective is to test that GR based on recycled building materials act as dry grassland analogous habitat. The pillar of the task is the analysis of plant community functional responses to different substrates (recycled building material) and their environmental conditions. We do this using microcosms: experimental mini green roofs in 100*80 cm batches (miniGR

– tested in previous work at BP). Substrates based on recycled building materials will be selected. A full crossed experiment will be designed with: substrates (structural properties) x depth (water and nutrient stock) x organic matter addition. Variation of miniGR environmental conditions and physico-chemical properties will be analysed through time in relation to the experimental modalities

3. *Quantification of water flux and insulation dynamic.*

In this experiment, species will be planted as seedlings to gain maximum control of the resulting functional composition. MiniGRs will be equipped with moisture and temperature sensors above the vegetation, at the soil surface and in the substrate in order to monitor the flux dynamic. Physicochemical properties of the substrate will be determined in laboratory. Water permeability and substrate transmissivity will be evaluated on smaller samples (typically 30x30 cm and 30x10 cm, respectively).

4. *Upscaling the experimental devices to sustainable building.*

This is intended to evaluate the capability of buildings to support analogous GR and related urban ecosystem service (ESS). WUFI+ software type will be used to optimize thickness of layers, expected compactness (and porosity) in order to achieve insulation performances. An evaluation of potential energy preservation will be provided at the level of the building and the city. Balance between production and installation costs, and energy saving will be evaluated for profitability appreciation

PhD research project here is only devoted to materials and structural parts (not biological which is another PhD position).

Function

We are looking for highly motivated doctoral candidates to join our group and contribute to the on-going scientific research project dealing with quantification of water flux and insulation dynamic of newly roof structures with recycled materials. The candidate's duties will include the following:

- You will actively participate different tasks of the research project.
- Creation, execution and interpretation of dynamic building energy simulations (BES).
- Designing, carrying out and analysing the monitoring campaign of the operation, measurement of water and heat flux characterizing recycled materials.

- Publication of research results in English.
- Presentation of research results at international conferences.
- Defending a doctoral thesis.
- Educational support, among other things, in the form of supervising master's theses and exercises.

Profile

Applicants for doctoral position must have completed a master degree in a field closely related to building engineering, architectural engineering, computer sciences, engineering. Excellent written and verbal English and/or French communication skills are required. French literacy is an asset. CFD knowledge is an asset (Wufi+). Preference will be given to candidates with a strong interest and some level of proficiency in computer programming.

- You obtained (with minimum distinction) a master's degree in civil engineering technology, building engineering, architectural engineering, computer sciences, engineering.
- You are interested in nearly zero energy buildings and energy efficient cooling techniques
- Writing skills and an active knowledge of English is crucial. Oral presentations do not scare you away.
- You are looking forward to an international project
- You have a strong analytical ability and a sense of synthesis.
- You can work independently, but also well in a team and show sufficient initiative.
- You are able to successfully complete a PhD research under supervision.

We offer

Candidates will be fully funded (tax-free monthly allowance, approx. 2,100 € at the doctoral level) for up to 4 years. They will benefit from a dynamic working environment, with stimulating scientific support, state-of-the-art research facilities and advanced computational modelling tools. They may be requested to apply for extra funding.

The University of Liège offers a comprehensive and innovative training program, which enables early-career scientists to carry out their research in the best possible conditions, in compliance with the European Charter for Researchers.

How to apply?

Outstanding candidates should apply by email to Prof. Luc Courard with a curriculum vitae, full transcripts of Bachelor and Master studies, and two references. Short-listed candidates will have to take part in an oral interview at the University of Liège. The positions will remain open until filled; but the selection will start from August 26th, 2019. Starting date is expected in October 2019 (for international candidates January 2020).