Doctoral course on Earthen constructions

Date and location: 21 August 2024 and 22 August (2 days), INSA Toulouse, France

Overview of the course

In collaboration with RILEM technical committees PEM, BEC, and MAE, the aim of this doctoral course is to present a multi-disciplinary approach to research on earth construction. The program of this course will cover a large variety of topics from vernacular practices to the latest developments of the scientific community. It will also gather experts in material sciences, processing and structural design.

This course is based on recent scientific data described in the literature, as well as the recognized skills of researchers involved in these topics.

Objectives

The aim is to deepen students' knowledge in:

- the applications of earthen materials in construction

- their behaviour in the “fresh” wet state

- their manufacturing processes, from vernacular methods to digitalization

- their hygrothermal and mechanical behaviour

- their durability and biostabilisation as a means of improvement

Target audience

The courses are aimed at doctoral/post-doctoral students, as well as practitioners, architects, etc. in the field of construction materials and civil engineering.

Prerequisites

Basic knowledge in civil engineering or geotechnics.

Detailed content

In addition to a session focusing on earth construction techniques, there will also be a session defining earth material and clays as the binder explaining the mechanical strength, three main themes, linked to the three TCs on earthen construction, will be addressed. The first will deal with rheological properties of earthen materials, with a focus on processing methods, fresh state behavior modeling and characterization, drying and shrinkage. An exploration into new construction processes such as 3D printing will also be discussed. The second theme is the assessment of the mechanical behavior of earthen materials in the framework of unsaturated poromechanics. It will be completed using a structural dynamics approach to assess both the seismic behavior of earthen structure and their characterization through modal analysis methods. The third theme will cover bio-stabilisation and durability enhancement of earthen materials.

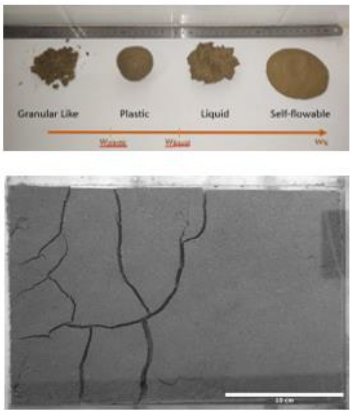
Topic 1: Introduction to earthen construction

- Introduce clay minerals, their properties and earthen materials
- Understand the cohesion of clayed matrix

- Illustrate the different applications of earthen materials in construction

Topic 2: Rheological properties and processing

- Link earth physical properties (clay activity, particle size distribution, water content) to the fresh state behaviour
- Describe the rheological behaviour of earthen materials at fresh state
- Adapt earthen material rheology to process requirements including 3D printing
- Describe rheological characterization methods
- Understand the physics of the drying kinetics



Topic 3: Hydro-mechanical performances of earthen materials

- Describe and quantify the evolution the mechanical behavior with water content
- Provide some theoretical backgrounds for modelling it
- Present methods and approaches for assessing the dynamic behavior
- Provide practical application of their uses

Topic 4: Durability and Bio-stabilisation

- Describe the mechanisms of bio-stabilisation
- Classify the bio-stabilasers and bio-stabilisation methods based on the origins and effects.
- Understand how bio-stabilisation could improve durability.
- Give practical examples.

General organization

The doctoral course will consist of 3 half-days of theoretical courses complemented by one half-day of practical work on material formulation and modal analysis methods.

A certificate of attendance will be issued at the end of the course.

Fees and registration to the course: https://rilem-week2024.sciencesconf.org/resource/page/id/19

More details about the conference: https://rilem-week2024.sciencesconf.org/

Speakers

Céline Perlot is a full professor of the University of Pau (France) and, PhDs in Civil Engineering from the Toulouse U. (France) and Sherbrooke U. (Canada). As a specialist in the physical chemistry of construction materials, she conducts research into microstructural characterization and transfers in earthen materials. She is the head of a scientific innovation chair of the Institut Universitaire de France on the effect of raw earth biostabilization on indoor building comfort, and co-chair of the TC BEC "Bio-stabilised earth-based construction".

Arnaud Perrot has been professor at Bretagne Sud university, France, since 2007. His research topic mainly deals with construction materials rheology and processing. He is an active member of RILEM Technical Committees on concrete 3D printing and Deputy Chair of TC PEM "Processing of earthen materials". He is also Associate Editor of RILEM/Springer Materials and Structures journal.

Emmanuel Keita graduated from the École Polytechnique and received a Ph.D. in physics. He is a researcher at the Navier Laboratory and a teacher at the École des Ponts ParisTech. His research work focuses on the physical understanding of construction materials. Using innovative imaging techniques, he adapts the concepts of applied physics to the development of construction materials with low environmental impact, by minimizing the material required (3D printing) or by using recycled concrete or concrete without hydraulic binder (earth). Emmanuel Keita is the chair of the RILEM Technical Committee "Processing of Earthen Materials".

Antonin Fabbri got his PhD in 2006 on physics and mechanics of freezing-thawing behavior of porous media at "Laboratoire Navier". Since 2011, as a research professor at ENTPE, he has focused on the hydrothermal and hydromechanical behaviors of earthen materials such as rammed earth and earth plasters, as well as their durability. He is Chair of the RILEM TC on Mechanical Performance and Durability Assessment of Earthen Elements and Structures. He serves as an executive board member of the French National Project on earthen construction.

Sophie Claude

Florent Vieux-Champagne is associate professor in 3SR lab/Université Grenoble alpes. He leads the working group 1 of the TC Rilem MAE and the mechanical group of the Earth French National Project. He is involved in B2M and Pisez ! projects dealing with the characterization of the masonry and the rammed earth respectively. He is also leading the ParaSisTerre project focusing on the seismic behavior of rammed earth structures.
His research team RV from 3SR lab and him are working on the characterization of the mechanical behavior of the geo and bio-based structures under ambient, wind and seismic loadings. His work is based on multi-scale approach from mesoscale to full scale of the building where experimental and numerical results are compared.