MASTER INTERNSHIP 2025

Microstructural analysis of bio-based granular packing using X-ray microtomography

Context

Biobased building materials offer many advantages, such as local availability and functional performance in terms of mechanical, acoustic, and hygrothermal properties. The new French RE2020 environmental regulations require that the "potential of global warming" of buildings be taken into account throughout their life cycle. Biobased products made from plant particles, which sequester CO_2, are therefore highly promising solutions for building insulation. However, mastering their functional performance still raises several issues directly related to their microstructure, which is characterised by a high porosity distributed over several scales. The LOCABATI collaborative project, supported by the French Environment and Energy Management Agency (ADEME) and which this internship is part of, aims at characterizing and predicting these performances by understanding the links between the different scales of the material (from particle to wall). One of the project challenges is to analyse the mechanical, acoustic and hygrothermal properties of granular packings in relation to their microstructure.

Objective

X-ray microtomography observations were performed, at Synchrotron Soleil, on biobased granular packing (without binder) at several levels of compaction and humidity, in order to study the impact of building processes. Tests were carried out on various plant particles, including sunflower pith particles (Figure 1), which are highly porous.

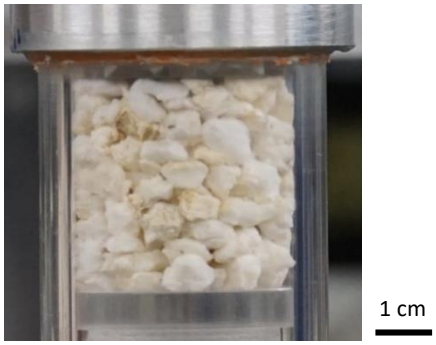

Figure 1 : Packing of sunflower pith particles (without compaction)

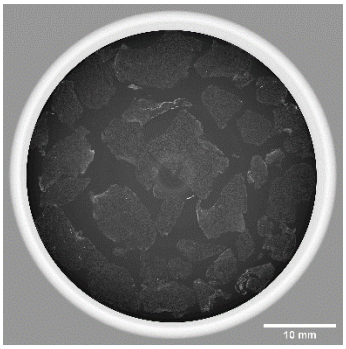

Figure 2 : Microtomography image of sunflower pith particles (cross-section view, Synchrotron Soleil, Anatomix beamline)

The main aim of the internship is to characterise the 3D microstructure of these groups of particles, identifying the relevant properties that relate to their physical properties. It will involve quantitatively exploiting existing 3D images obtained by microtomography to (i) isolate and characterise particles and pores in the sample (geometry, size distribution, spatial distribution, etc.), (ii) evaluate particle densities and (iii) characterise the

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packing evolution and particle deformations. The location of water in wet samples may also be studied. Specific developments will be required to analyse these low-contrast images (Figure 2), and may be based on artificial intelligence techniques (deep learning model). Additional studies on other plants or samples with binders may be carried out using the microtomograph in the laboratory, depending on the progress of the internship.

Profile :
- Master of Science, with skills in image processing and/or mechanics and material sciences.
- Strong taste for image processing and data analysis required.
- Skills in Python programming would be appreciated.

Duration : 4 to 6 month, from February-March 2025

Location : Navier laboratory (77420 Champs-sur-Marne, France)

Salary : ~550 €/month

Application and information:
Send your CV, motivation letter and academic transcript to camille.chateau@enpc.fr

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