ETH zürich

Recherches sur les matériaux bio et géosourcés à l'ETH Zurich

Prof. Dr. Guillaume Habert

21.09.2022

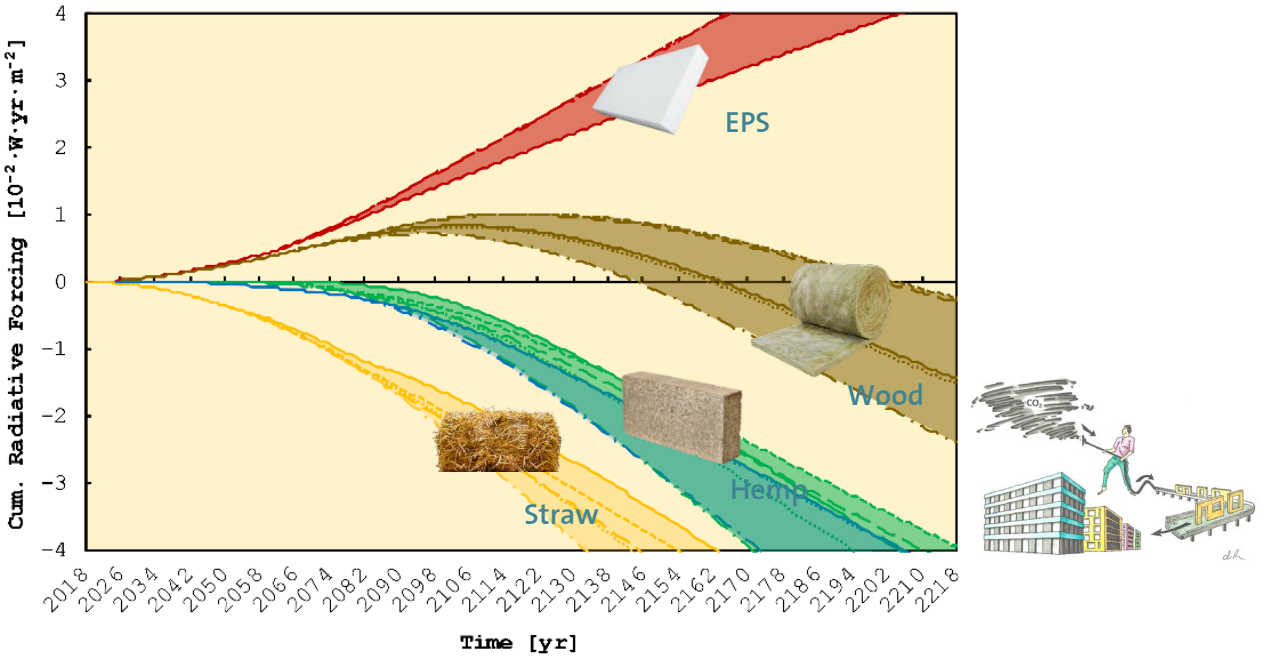
Atba architecture, Soubeyran

1. Biosourcé

1. **Biosourcé**

ACV Dynamique

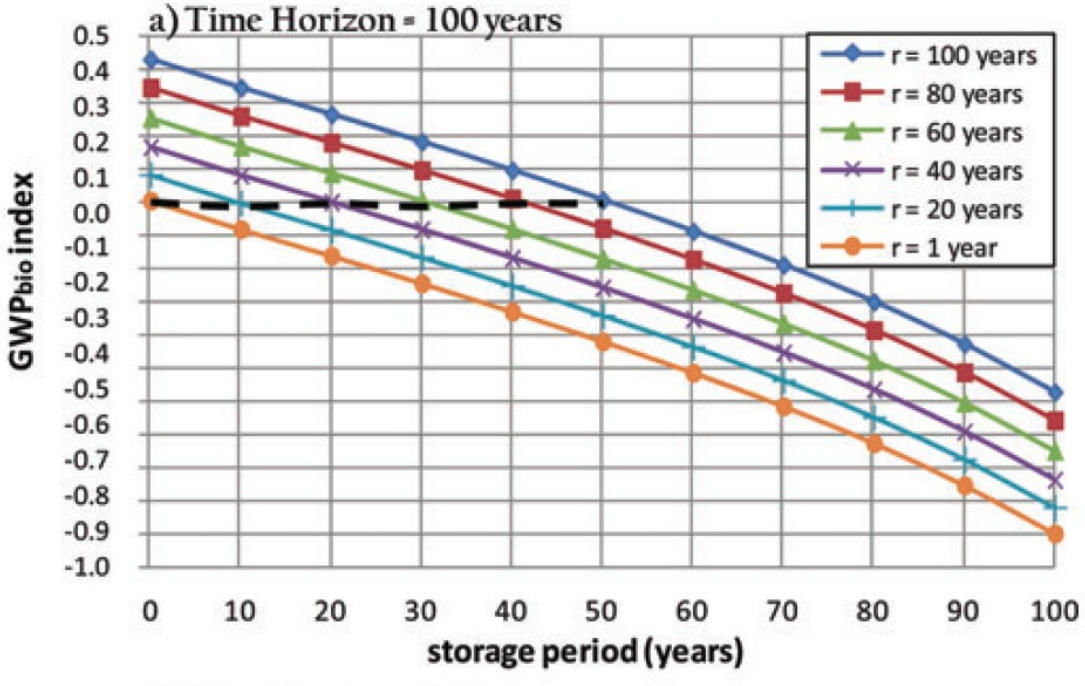
Renovation of the built environment with biobased insulation reduces immediately the radiative forcing from GHGs in the atmosphere



Sce: Pittau et al. 2018. Fast-growing bio-based materials as an opportunity for storing carbon in exterior walls. *Building and Environment*, 129, 117-129

Carbon neutral vs climate neutral

It is the difference between the time of residence in the built environment And the natural rotation time that creates real carbon pump.



Sce: Guest et al., 2012. GWP of CO2 emissions from biomass stored in the anthroposphere and used for bioenergy at end of life. Journal of Industrial ecology, 17, 20-30

1. **Biosourcé**

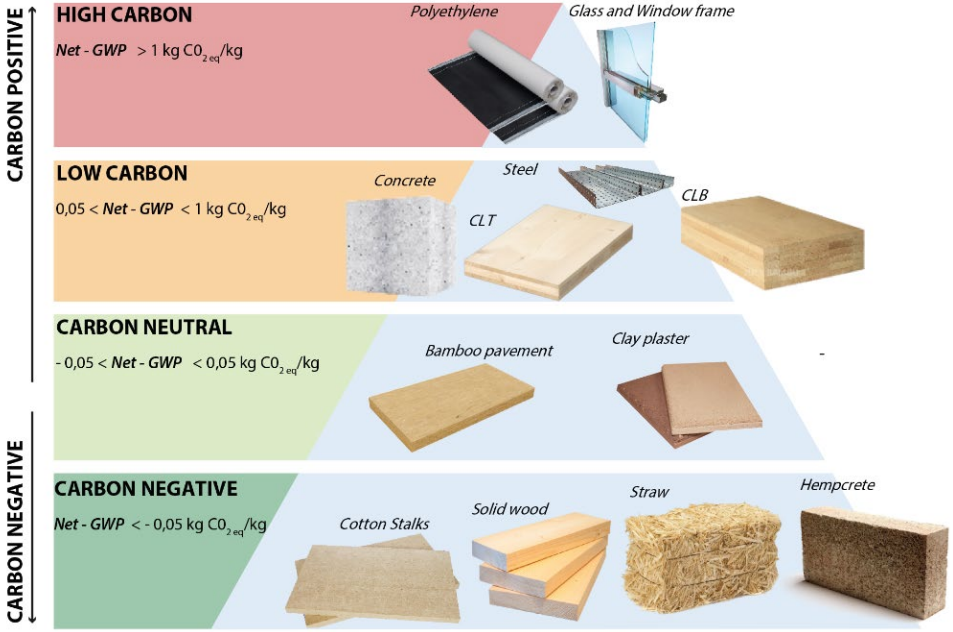
   ACV Dynamique

   Climate neutral buildings

It’s possible to build climat eneutral building

We need to change our material diet

Less carbon intensive materials and more vegetables..



Sce: Carcassi et al., 2022. Material diets for Climate-Neutral construction. *Environmental Science and technology*

1. **Biosourcé**

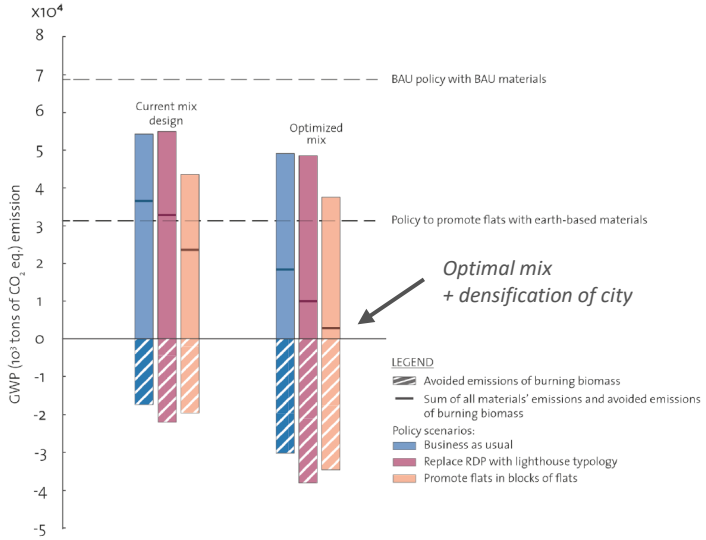
    ACV Dynamique

    Climate neutral buildings

    Climate neutral building stock

Identify pathways for sustainable construction

Invasive plants as concrete aggregates, combined with optimised building design and urban planning
In order to reach nearly ***carbon neutral*** *activities while accomodating* ***urbanization boom*** *and* ***reduction of townships***



ETH sustainable construction
Swiss Federal Institute of Technology Zurich

Sce: Göswein et al. 2021. Invasive alien plants as an alternative resource for concrete production - Multi-scale optimization including carbon compensation, cleared land and saved water runoff in South Africa. *Resources, Conservation & Recycling*

1. **Biosourcé**

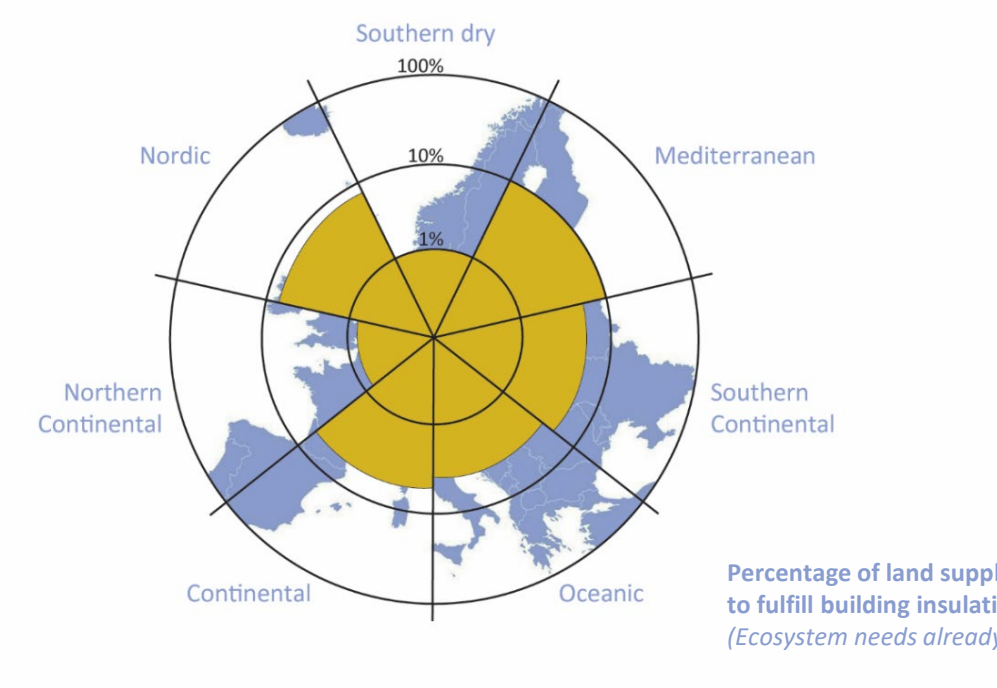
    ACV Dynamique

    Climate neutral buildings

    Climate neutral building stock

    Disponibilité de la resource

There is enough straw in all european regions to renovate the existing building stock and build the new buildings to fulfil housing demand

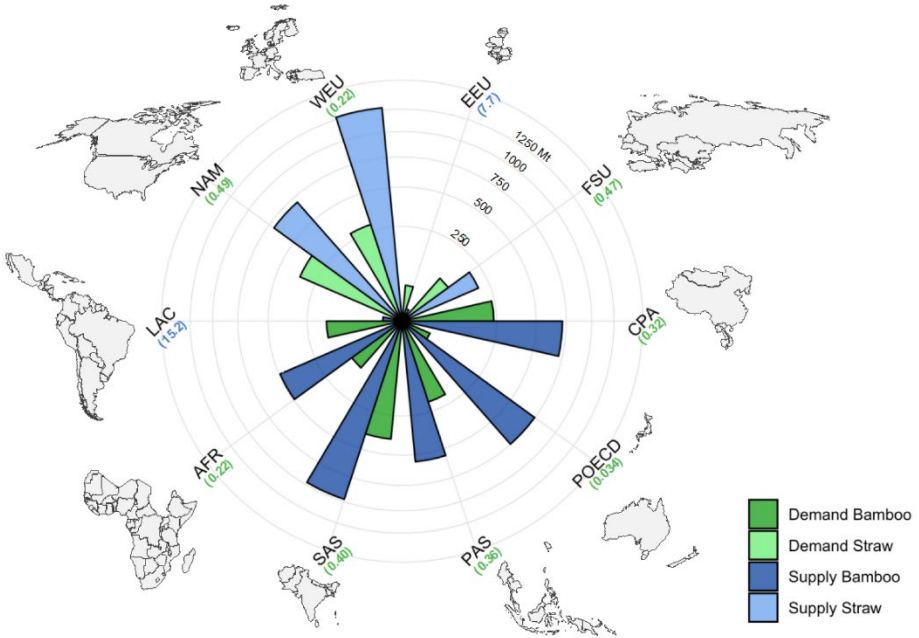


Percentage of land supply required to fulfill building insulation demand
(Ecosystem needs already withdrawn)

Sce: Göswein et al. 2021. Land availability in Europe for a radical shift toward bio-based construction. *Sustainable Cities and Society*

We shouldn’t move from one material fit all constraints (concrete)
To one material solve all environmêntal problems (wood)

Diversity of biobased material should be highlighted to fit the various needs of the built environment



Bamboo as structural material in new construction for global South

Straw as insulation material in renovation for global North

Sce: Göswein et al. Accepted. Barriers and opportunities of fast-growing biobased material use in buildings. *Buildings and cities.*

1. **Biosourcé**

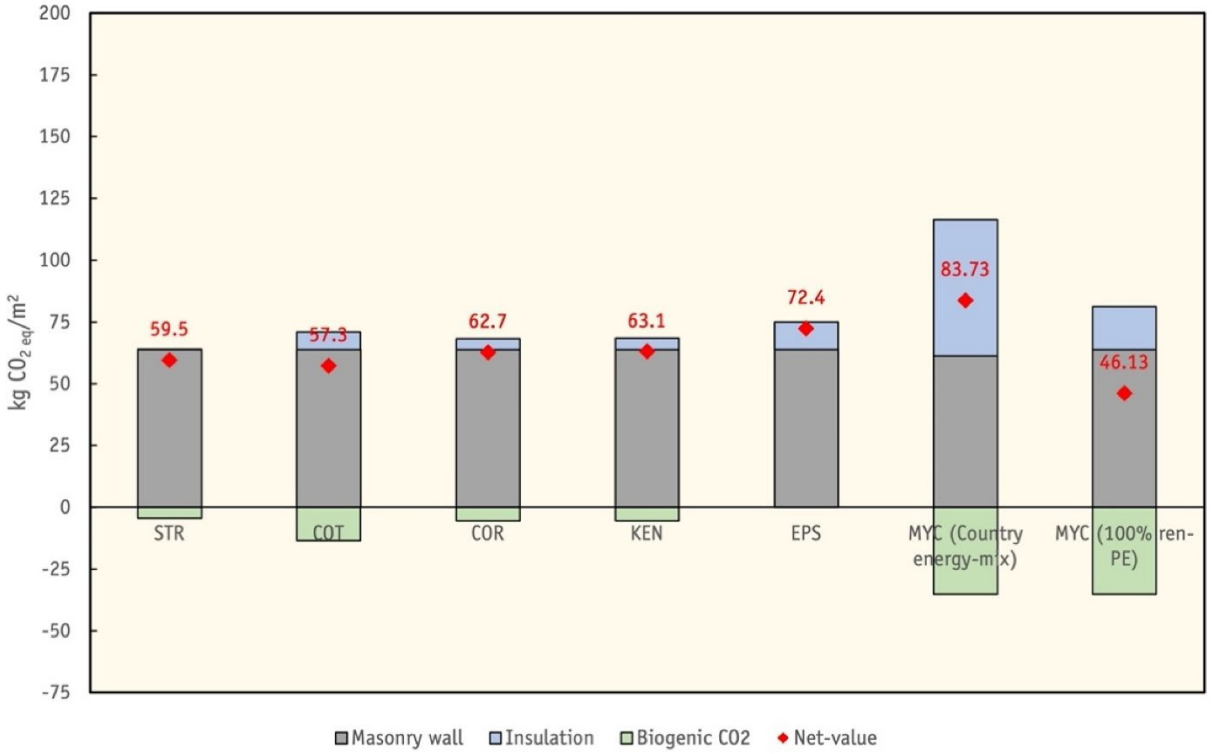
   ACV Dynamique

   Climate neutral buildings

   Climate neutral building stock

   Disponibilité de la resource

   matériaux où la disponibilité n’est pas contrainte par la surface de production…



Sce: Carcassi et al. 2022. Carbon Footprint Assessment of a Novel Bio-Based Composite for Building Insulation. *Sustainability*

1. **Biosourcé**
2. **Géosourcé**

    Terre coulée

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La terre coulée sans ciment... *mais avec un peu d'additifs*

→ Modifie propriétés des argiles pour réduire l'eau et pouvoir me passer de ciment

Argiles
Dans l'eau

+ dispersant
Change polarité

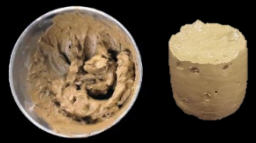
Sodium Hexametaphsphate (NaHMP)
Sodium silicate (NaSil)

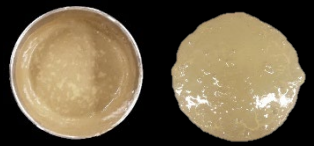
1. Deflocculation
Toute l'eau est libre

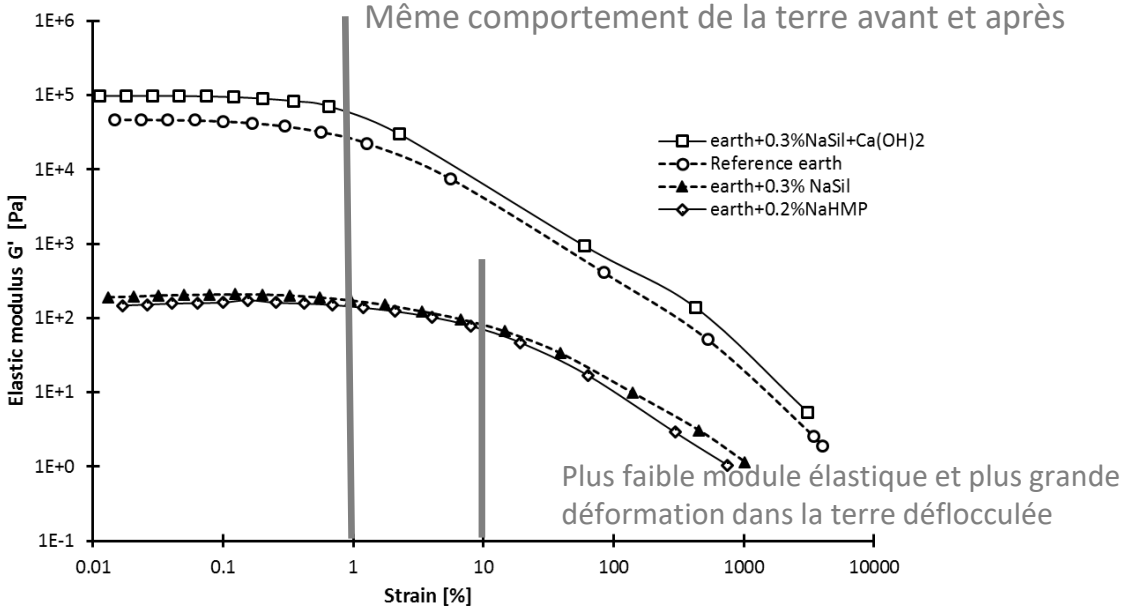
+ coagulant
Revient au stade initial

Base Calcique(Carbonte ($CaCO_3$), hydroxide ($CaOH_2$), Chloride (CaCl))
Base Magnesienne (oxide (MgO))

2. Coagulation
Eau est de nouveau piégée





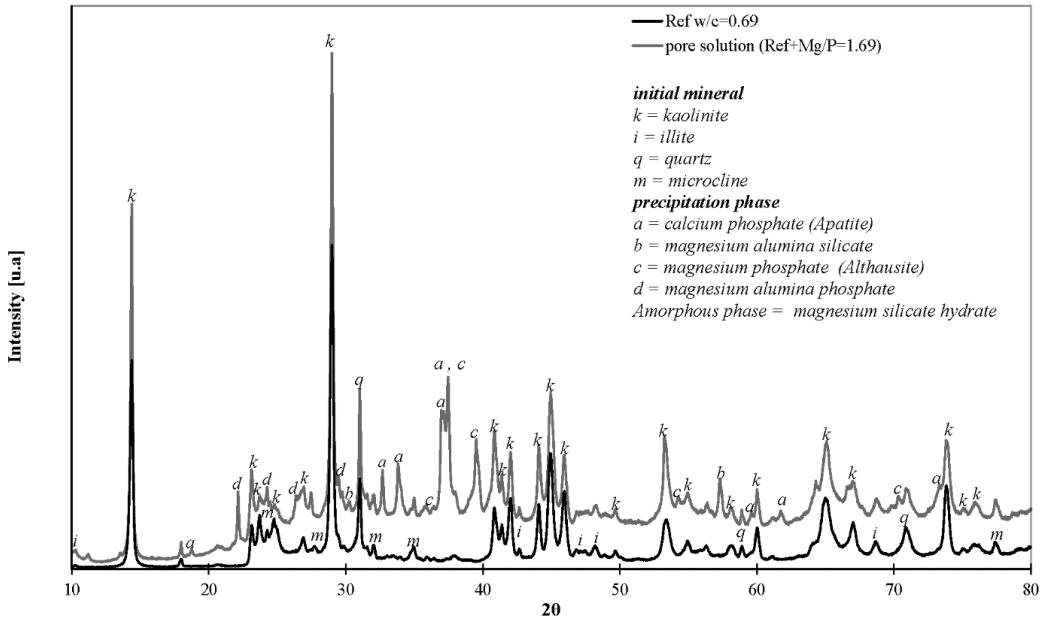


Pas de transformation de la terre

Précipitation des plastifiants avec le calcium

Sce: Landrou et al., 2016 Lime as an Anti-Plasticizer for Self-Compacting Clay Concrete. Materials

Même effet avec du MgO



Précipitation de MgPhosphate qui consomme le plastifiant

Sce: Landrou et al., 2018. A new coagulation route in deflocculated kaolinite suspension: mechanism and kinetic control. Journal of material chemistry A

Travaux récents: Autres additifs que le phosphate et magnesium

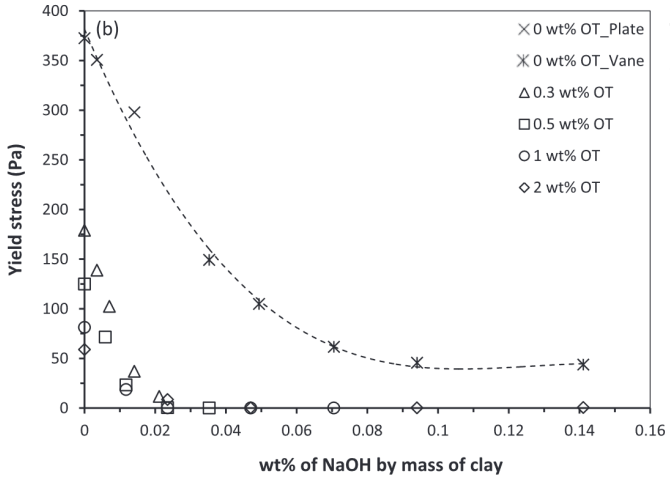


Fig. 5. The yield stress of clay pastes as a function of (a) NaOH/OT mass ratio and (b) amount of NaOH added in the mix.

Tannins (de chène et solubles) agissent comme plastifiants + soude → augment efficacité!

Sce: Du et al., 2021. Mechanisms for efficient clay dispersing effect with tannins and sodium hydroxide. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*

Travaux récents: Autres additifs que le phosphate et magnesium

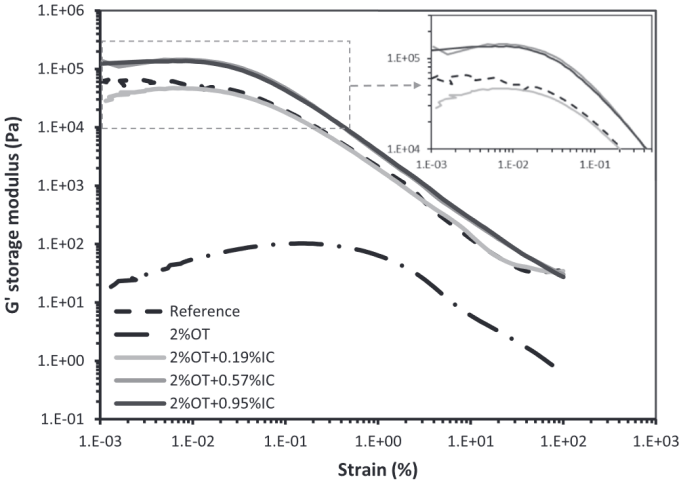


Fig. 3. Elastic modulus as a function of strain amplitude measured with SAOS, for kaolinite clay paste prepared with OT and IC, at 1 Hz. Measurements were carried out immediately after the mixing stage.

Tannins (de chène et solubles) agissent comme plastifiants
+ soude → augment efficacité!

+ Oxide de fer → refloccule les argiles.
→ et procure résistance à l'eau!

Sce: Du et al., 2022. Influence of tannin and iron ions on the water resistance of clay materials *Construction and building materials*

1. **Biosourcé**
2. **Géosourcé**

    Terre coulée

    Ciments alternatifs

1) Pires et al. 2022. Beyond efficiency: Engineering a sustainable low-tech cementitious binder for earth-based construction. *Cement and Concrete Research*
2) Voney et al. 2021. From casting to 3D printing geopolymers: a proof of concept. *Cement and Concrete Research*, 143, 106374. DOI: 10.1016/j.cemconres.2021.106374
3) Komkova and Habert G. 2022. Environmental impact assessment of alkali-activated materials: examining impacts of variability in constituent production processes and transportation. *Construction and Building Materials*

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Thank you very much for your attention

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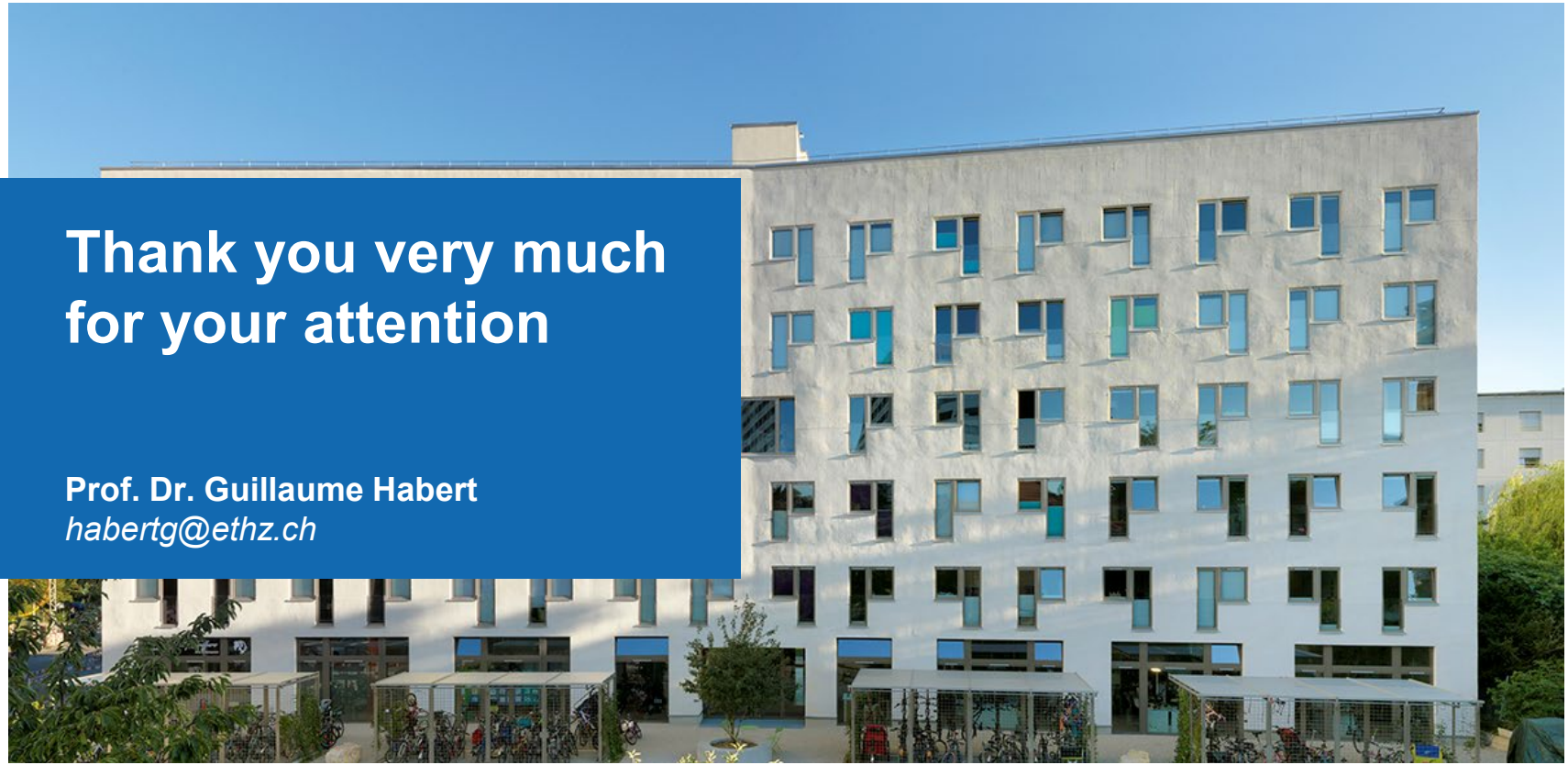

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