Innovative solutions for CLT structures

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ZAG

ForestValue

innocrosslam

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ForestValue Midterm Seminar. Online meeting, 18.11.2020

InnoCrossLam team

Project objectives

"…increasing even further the competitiveness of CLT as a versatile engineered product…"

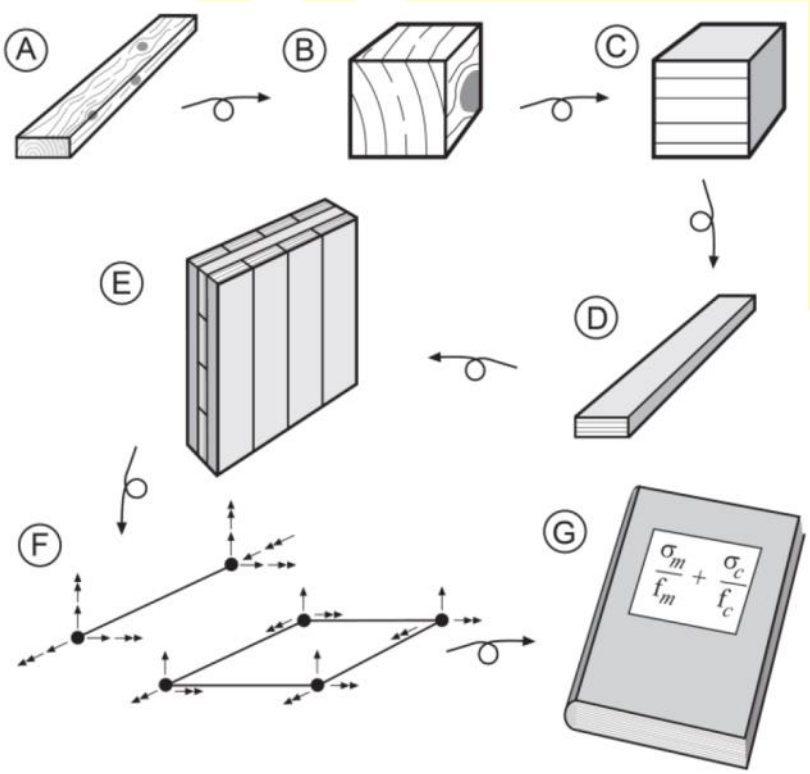
"…increasing its predictability…demanding design situations…not covered by the guidelines of today, or codes and standards foreseeable in a near future…"

"…further develop a … multi-functional use of CLT in terms of its thermal activation … an integrated part of a heating/ventilation system.

Structural performance accessed by computational mechanics

Methods:

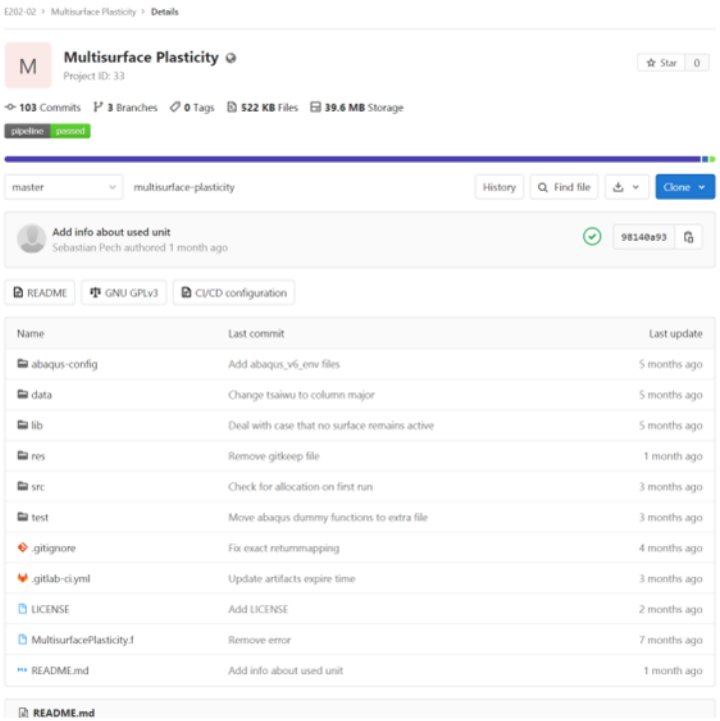
1. Adaption of a 3D multisurface failure criterion for clear wood
2. Generation of accurate 2D & 3D digital models
3. Simulation of common structural details of CLT-based structures

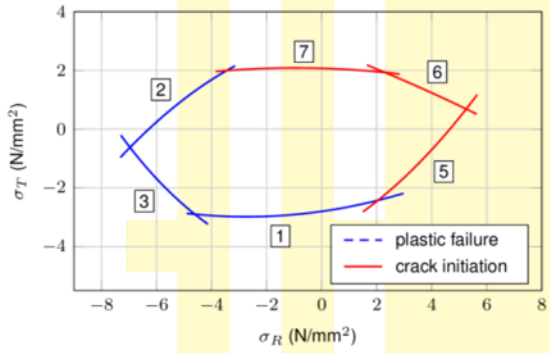


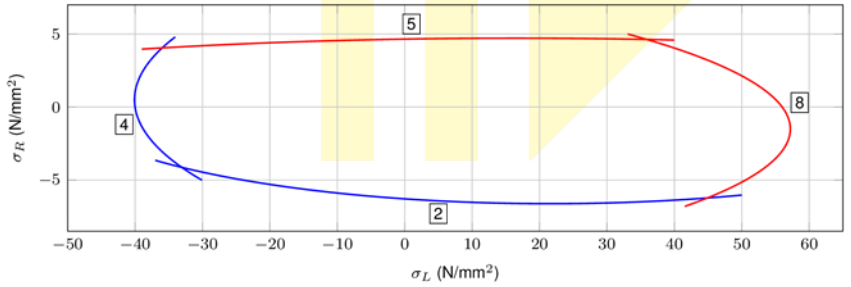
1. Adaption of a 3D MSF criterion for clear wood

Multisurface failure criterion with ideal plasticity

- Abaqus user material subroutine (UMAT, UVARM)
- https://gitlab.imws.tuwien.ac.at/e202-02/multisurface-plasticity

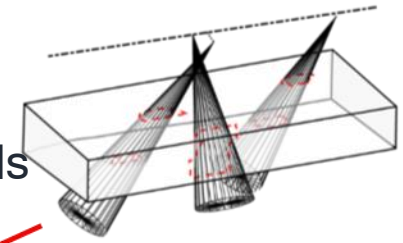






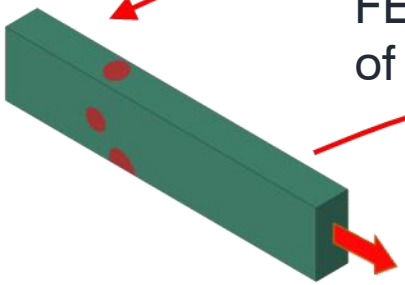
2. Generation of accurate 2D & 3D digital models

Virtual recon-
struction of boards

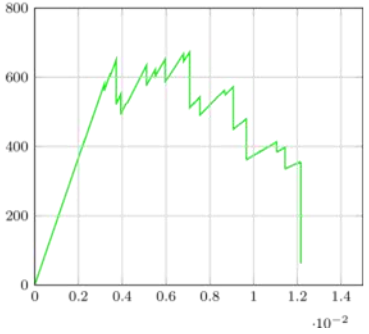


Effective material properties:

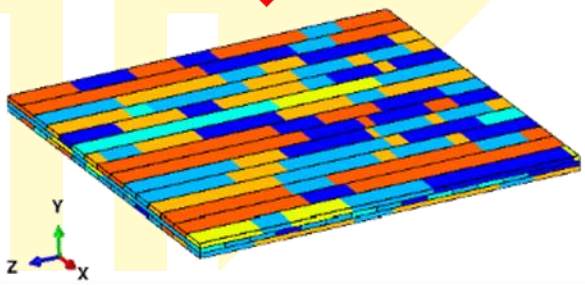
- strength values
- fracture energies
- …



FE simulations
of knot groups



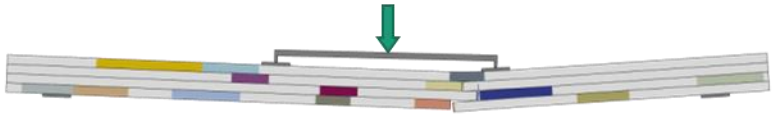
phase field method for fracture



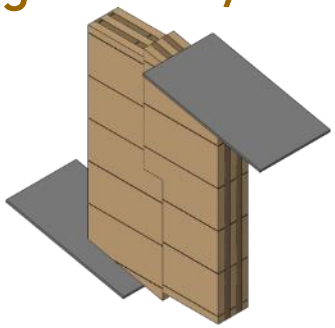
wood product with section-wise
constant material properties

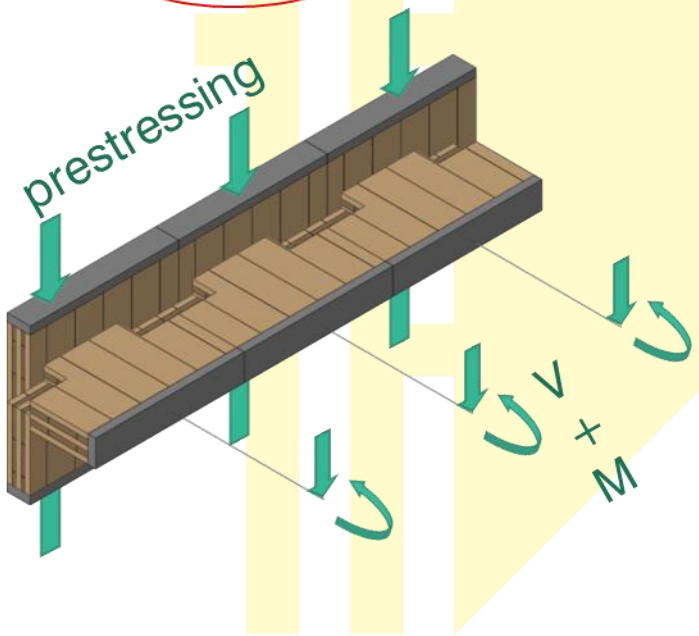
3. Simulation of common structural details

- GLT model with effective properties

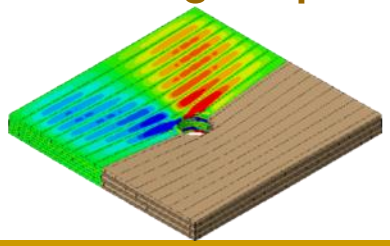


- FE modeling of wall/floor joints





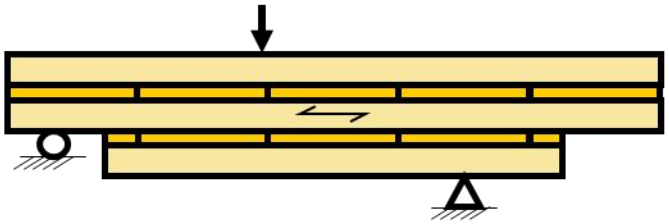
- FE modeling of point supports

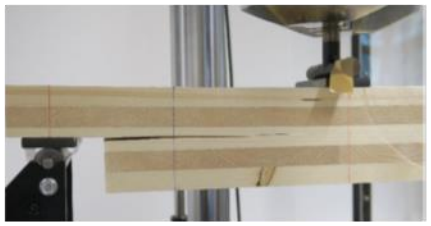


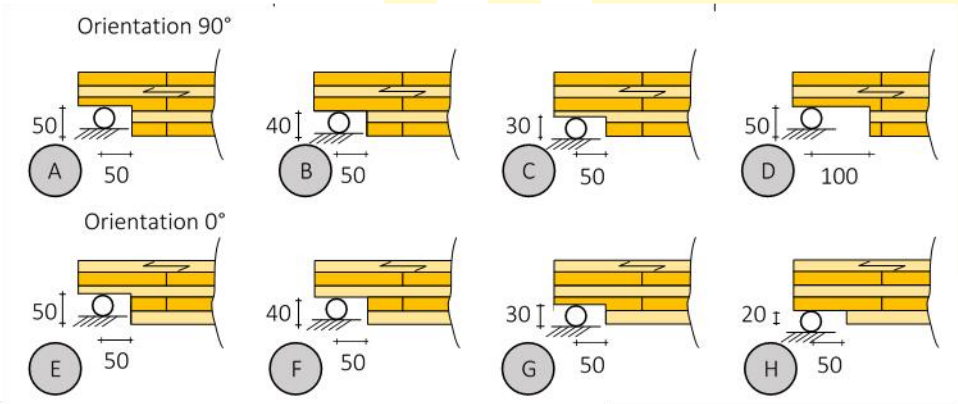
3. Simulation of common structural details

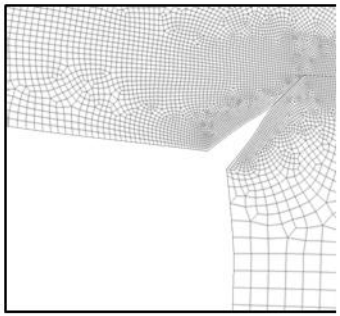
Notched CLT plates

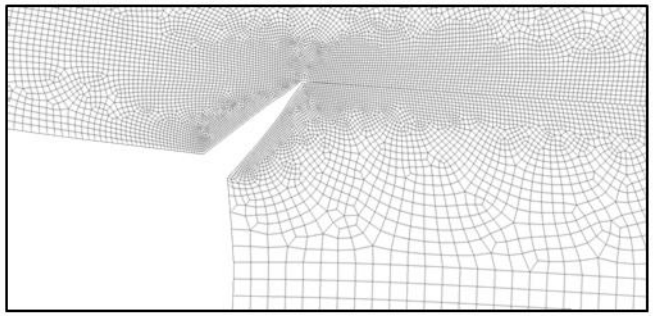
Experimental testing and numerical modelling of various notch geometries





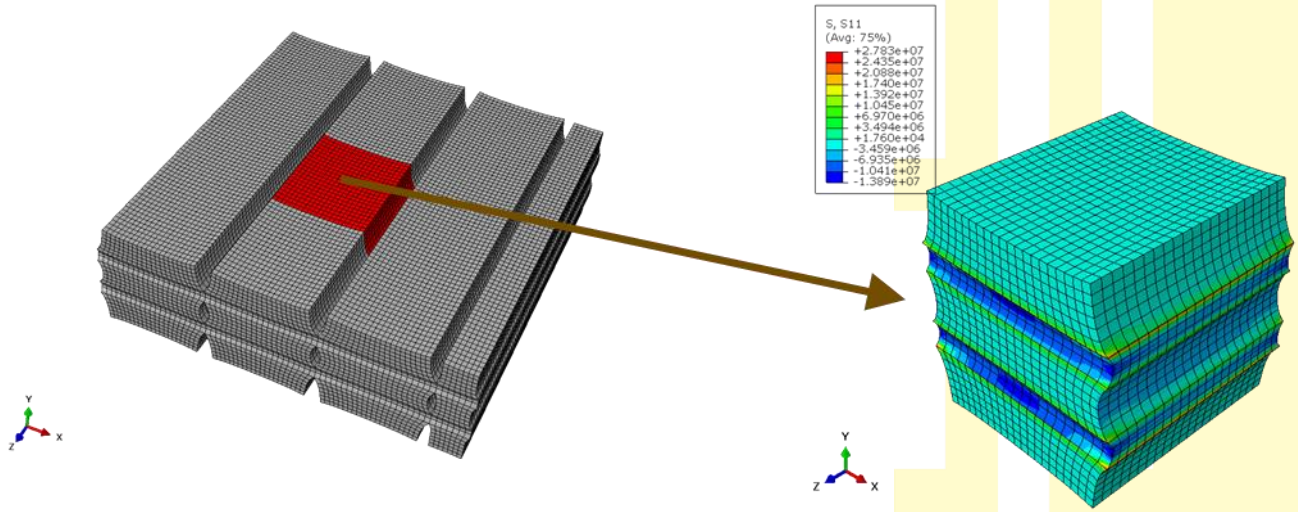




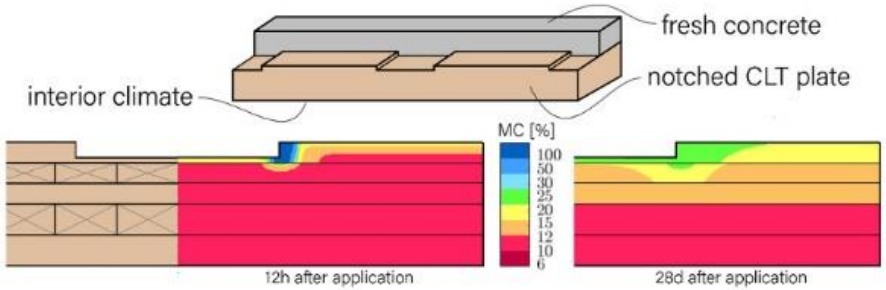


3. Simulation of common structural details

Moisture induced deformations in CLT



Moisture simulations of TCC systems with in-situ concrete



Components and joints

Structurally challenging situations encountered in technically and architecturally innovative designs

Main aim

Development of reliable models at the component level:

- CLT beams/walls/floors with notches and openings
- Point supported components
- Joints between components and
- Brittle failure of CLT connections

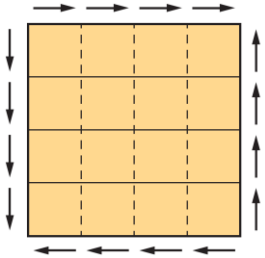
Main activities

Theoretical work – Modelling (FEM)
Mechanical testing

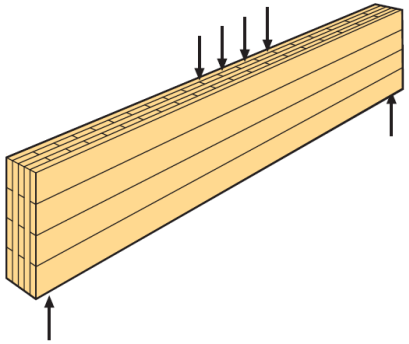
In-plane shear loading of CLT

Verification of load-bearing capacity of CLT at:

#1 Pure in-plane shear loading



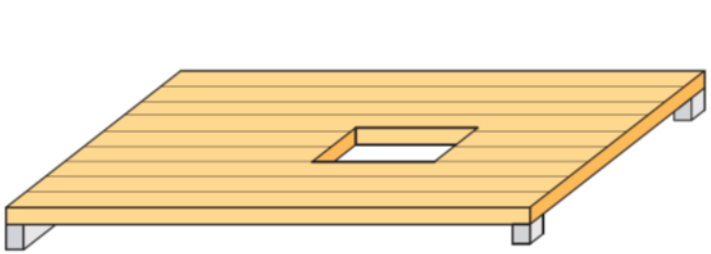
#2 In-plane beam loading

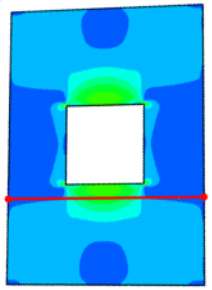


AIM: Development of rational and consistent structural design approach for both #1 and #2

Design of CLT plates with openings

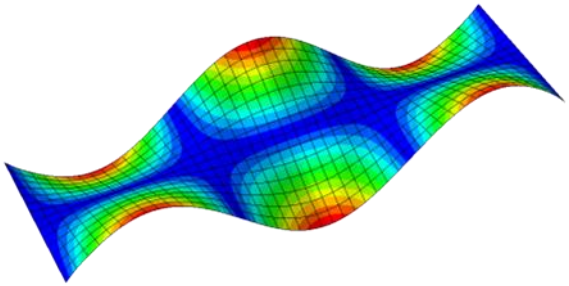
Investigations of stiffness and load-bearing capacity





Dynamic response of CLT plates

Eigenfrequency analysis and dynamic load response



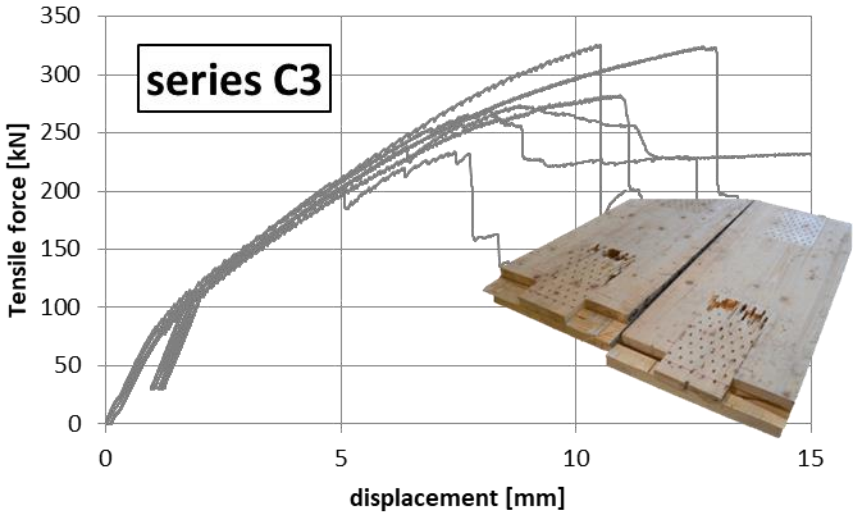
Dynamic response as influence by:

- Element lay-up
- Laminations properties (species)

High load-bearing connections – brittle CLT failure

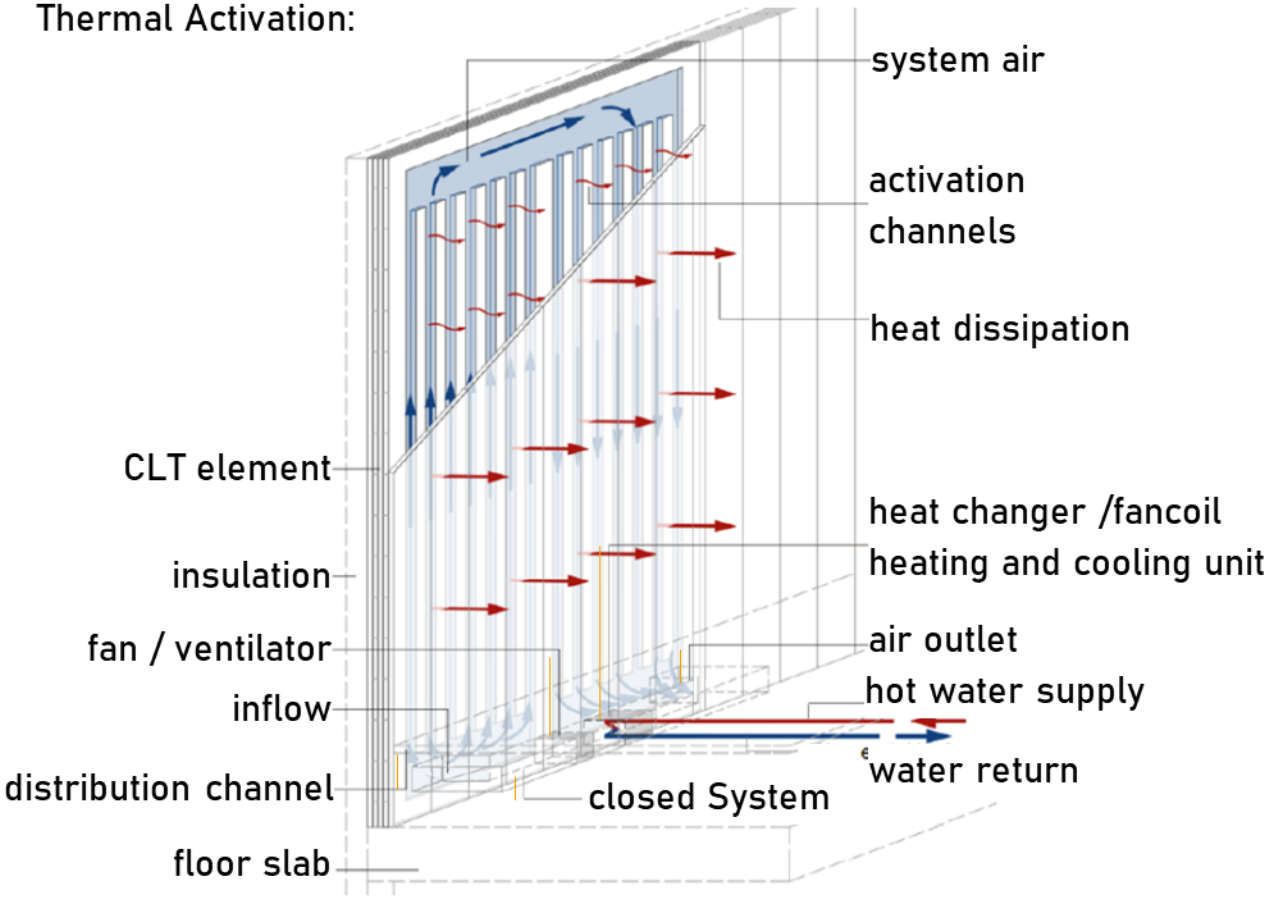
tensile tests

failed connection

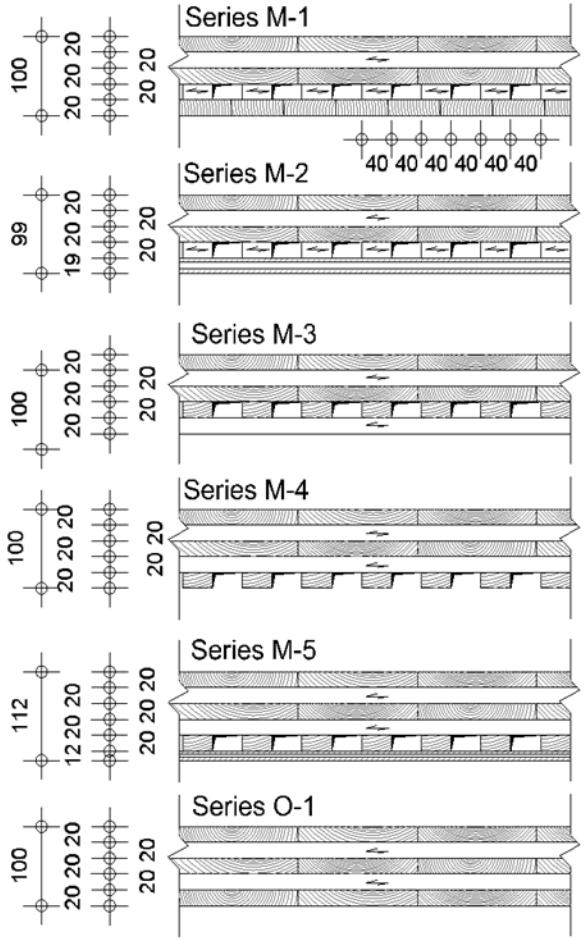


Innovative multifunctional CLT

Multifunctionality in Terms of Thermal Activation:



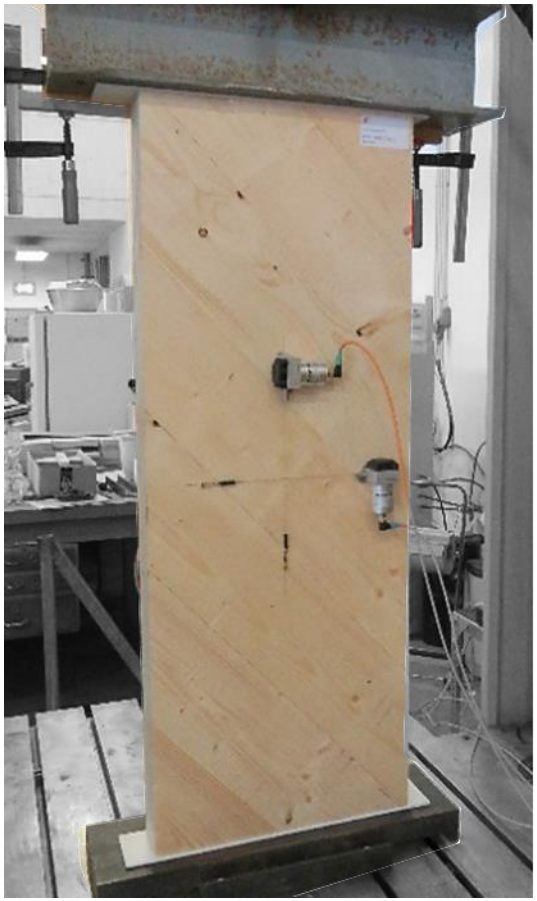
Developed Test Series:



Innovative multifunctional CLT

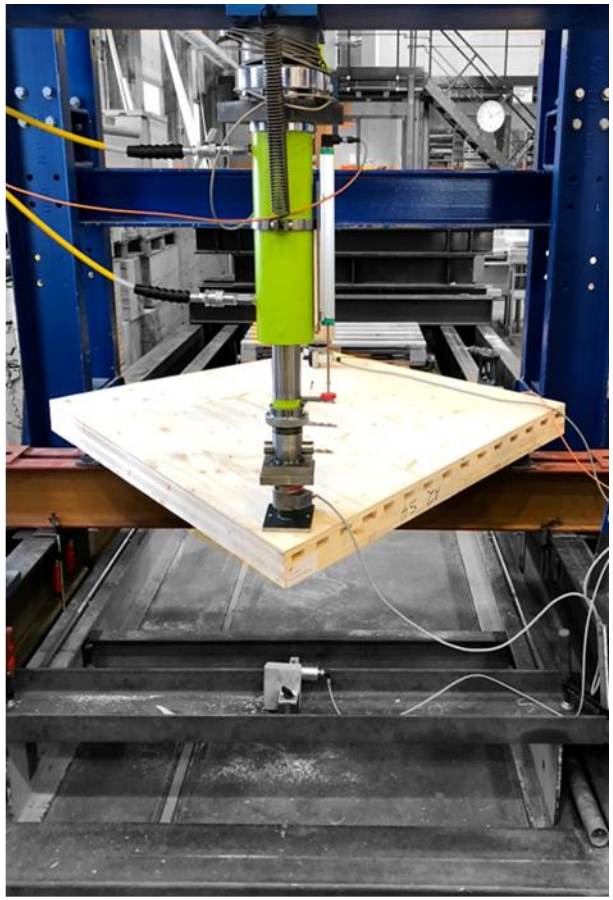
Determination of the Mechanical Properties

In-plane Shear Stiffenss



Maximum Buckling Load

Torsional Stiffness

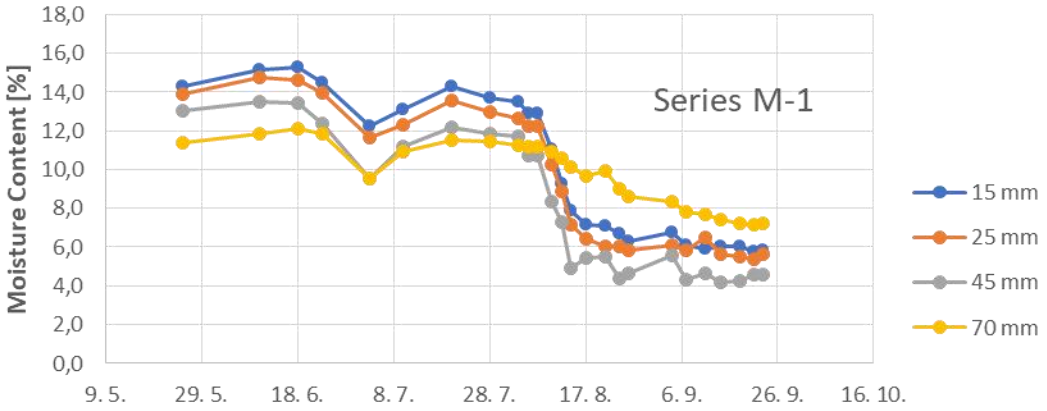


Innovative multifunctional CLT

Deformation Behavior under Moisture Change

During the heating and cooling process, temperatures between 15 and 45 degrees occur in the channels.

The change of the moisture profile over the cross-section and the overall curvature are measured.



Seismic behaviour

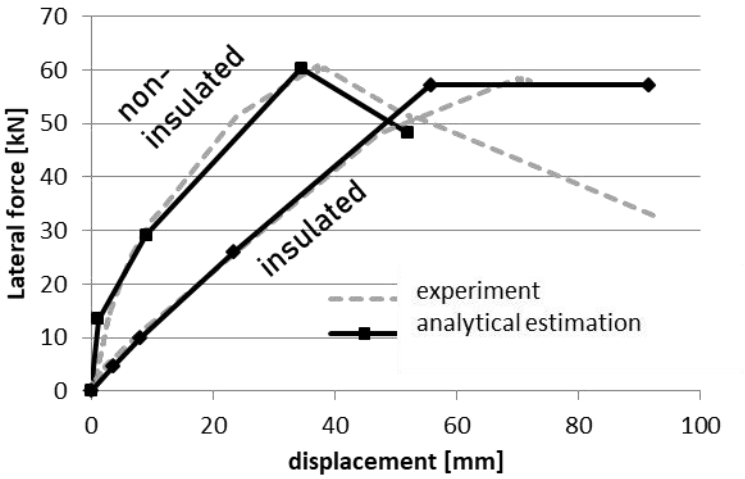
practice-oriented design approaches and seismic risk assessment

Main aim — analysis of tall CLT or hybrid structures:

- Role of sound insulation layers on seismic resistance of CLT walls
- High load-bearing connections
- Buildings of irregular shapes

Main activities — Theoretical work – Modelling (FEM)
Mechanical testing

Role of sound insulation layers on seismic resistance of CLT walls

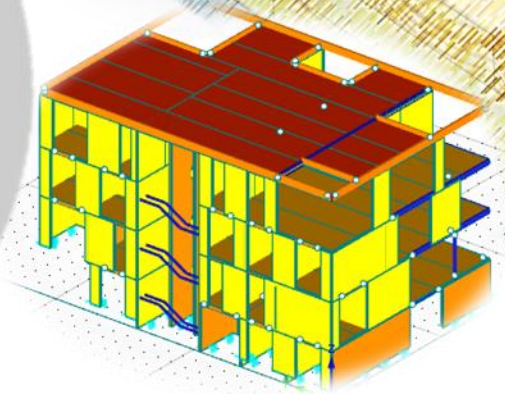


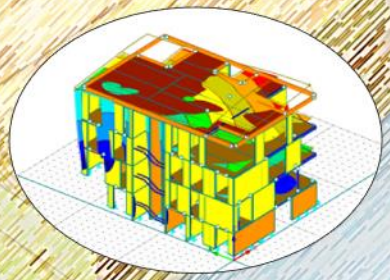
- On-site ambient vibration tests, collaboration with DynaTTB.

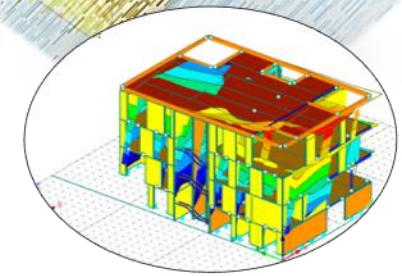
DynaTTB
Dynamic Response of Tall Timber Buildings under Service Load

- modal analysis – comparison with measured values.

RFEM
RSTAB

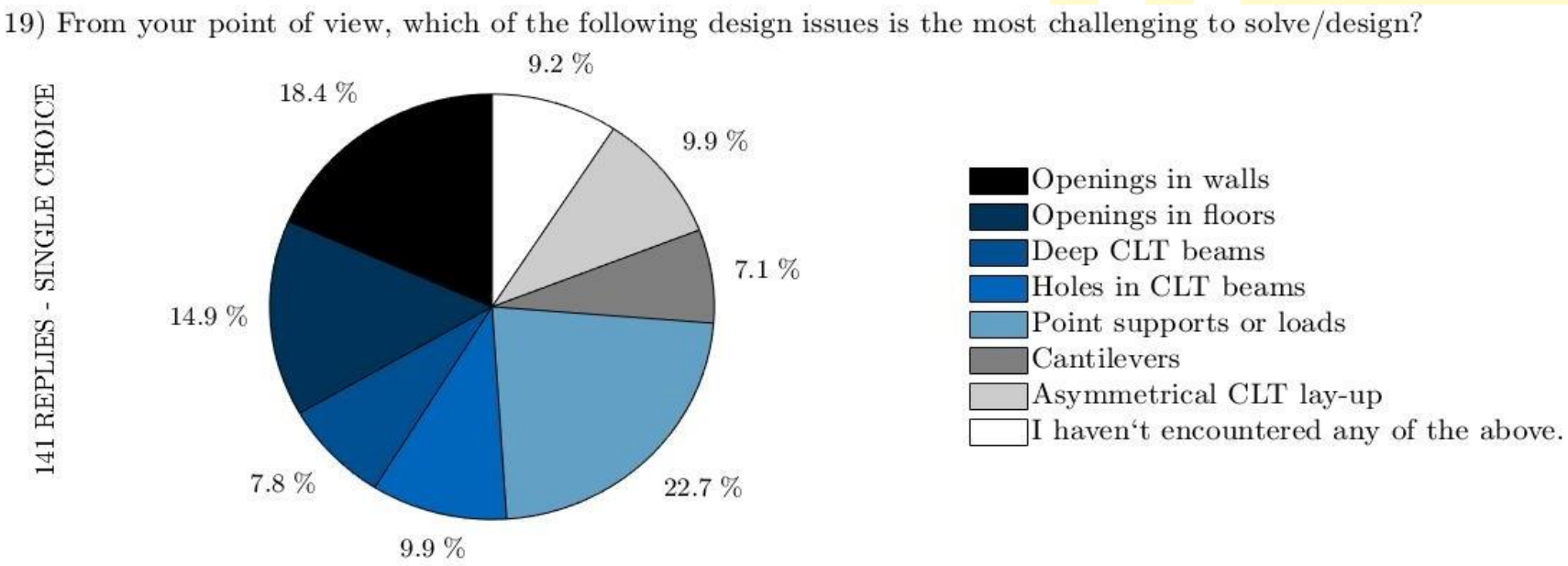






Structural design

Digital questionnaire (140 participants, over 20 countries)

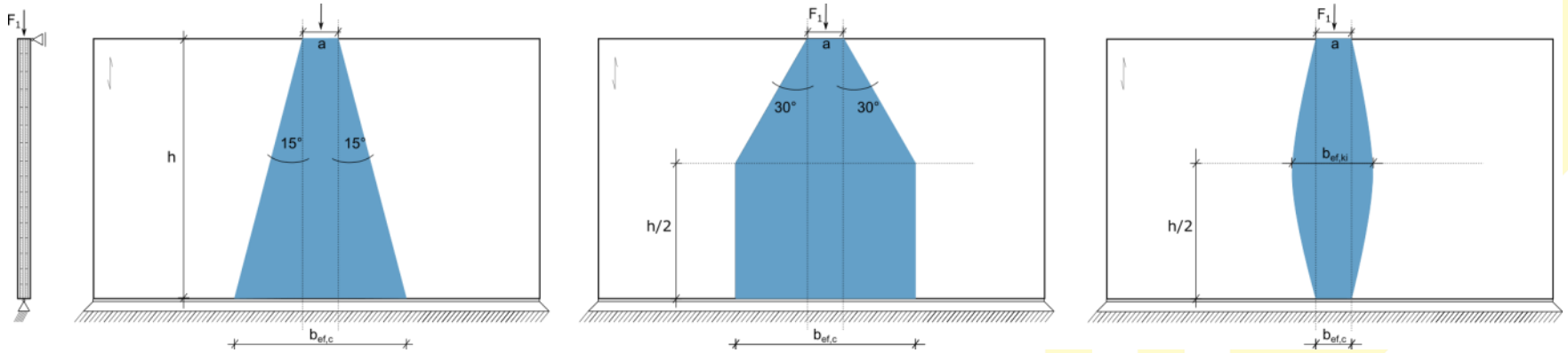


→ important research fields spotted

Structural design

Face-to-face interviews

e.g. individual approaches for the estimation of stresses in-plane under compressive loads



Verification approaches very disparate
→ further harmonization crucial

Thank you.

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Midterm Seminar, November 18th 2020