

# **POTENTIAL OF CROSS-LAMINATED TIMBER AS INDEPENDENT SHEAR WALL**

Eero Tuhkanen

26.09.2019

# CONTENT

- PREFABRICATED MODULAR BUILDINGS: PROS AND CONS
- DEFINITION OF INDEPENDENT SHEARWALL SYSTEM
- WALL TYPES AND TESTING
- TEST RESULTS
- CONCLUSION

# **PREFABRICATED MODULAR BUILDINGS: PROS AND CONS**

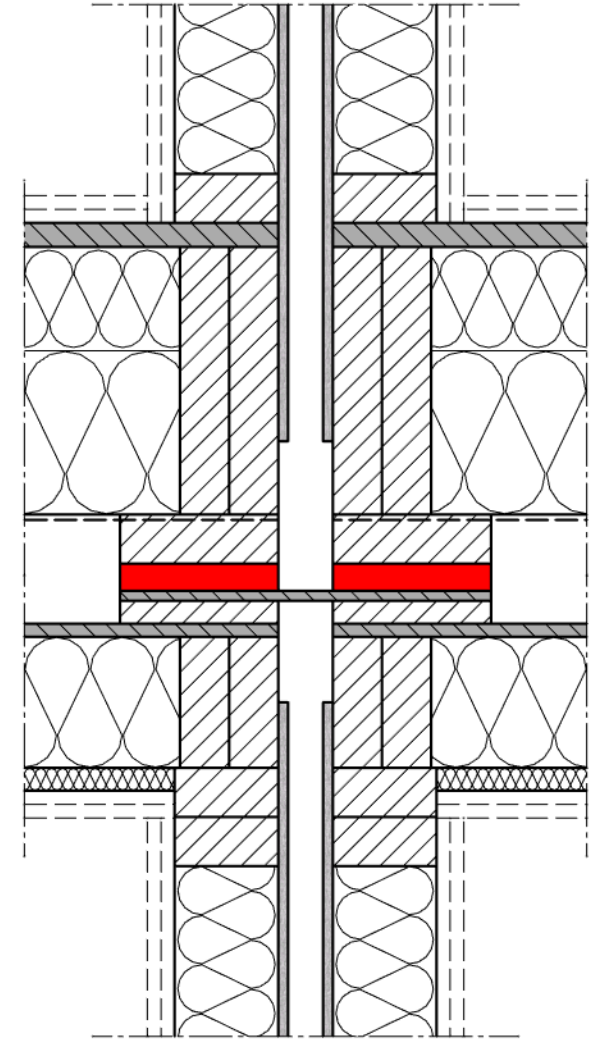
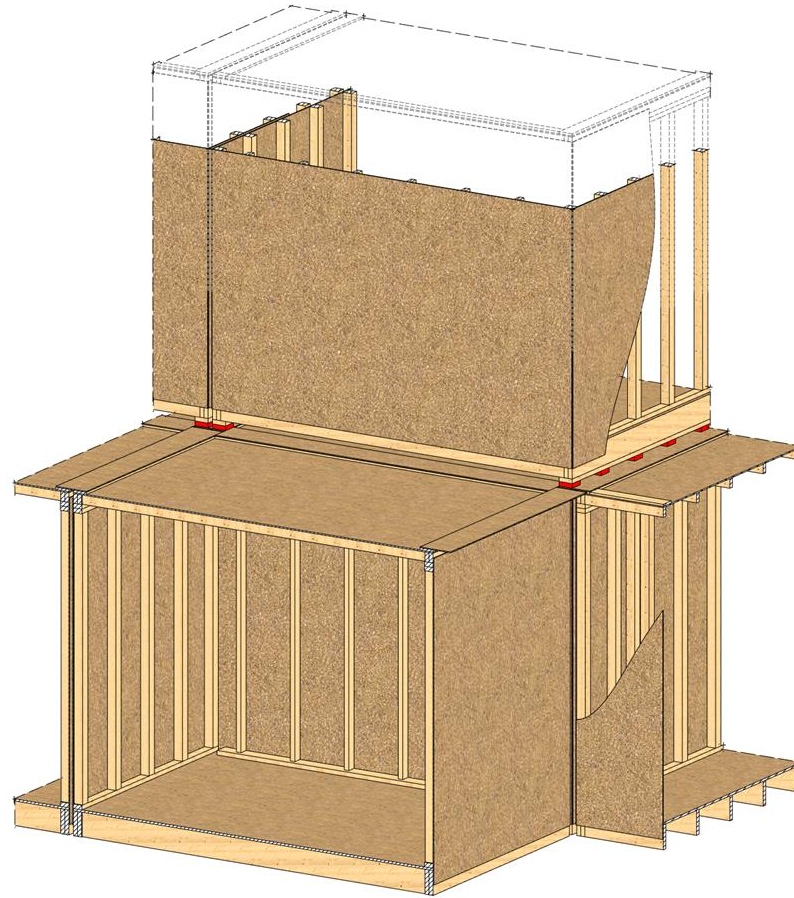
# ADVANTAGES



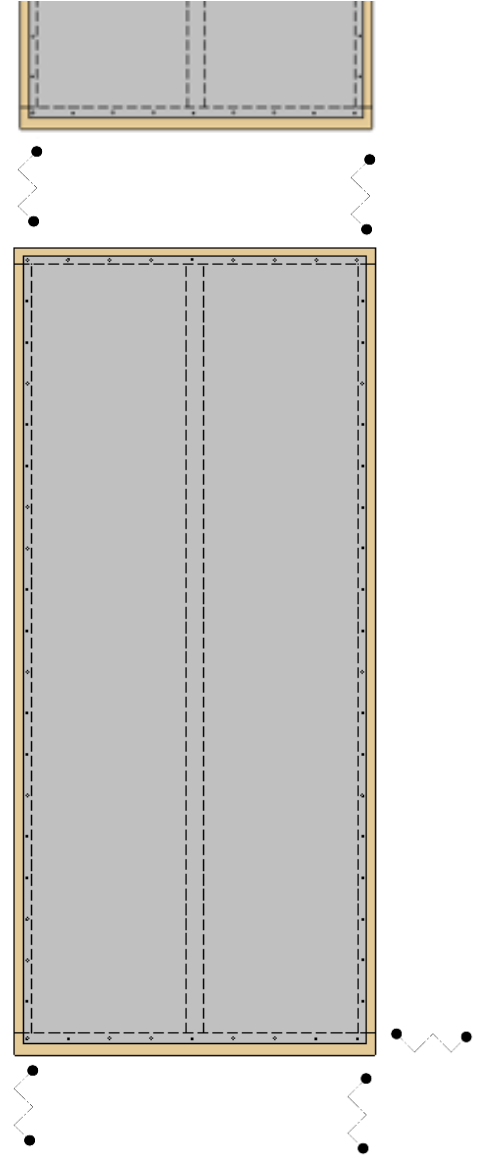
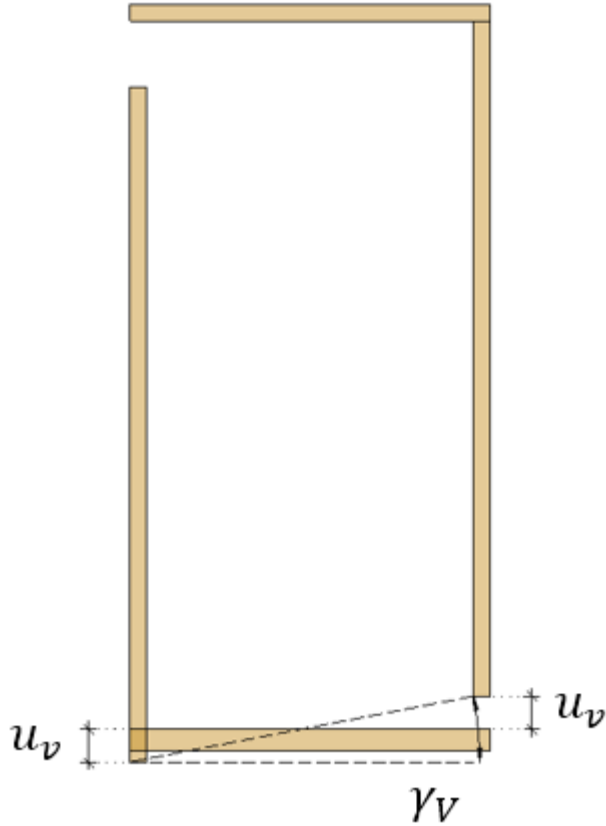
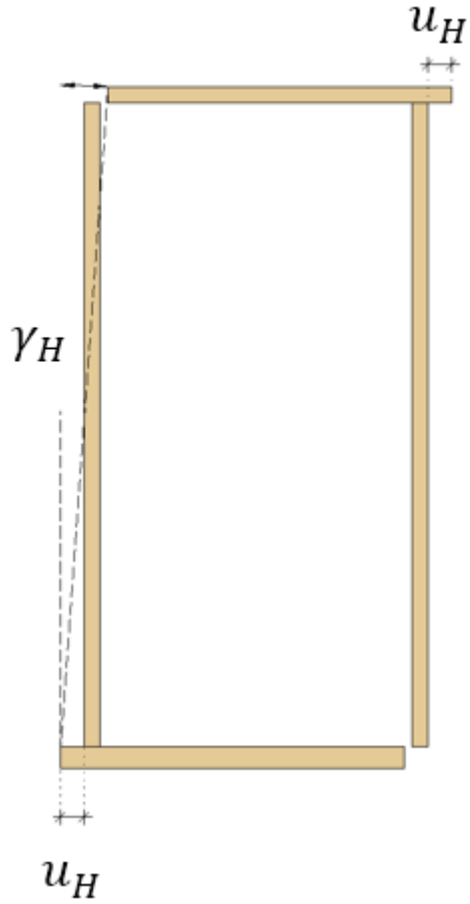
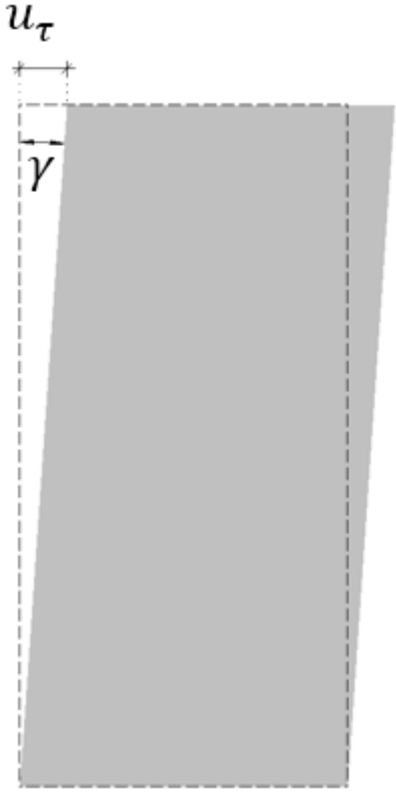
**TAL  
TECH**

Photos taken from [www.kodumaja.ee](http://www.kodumaja.ee)

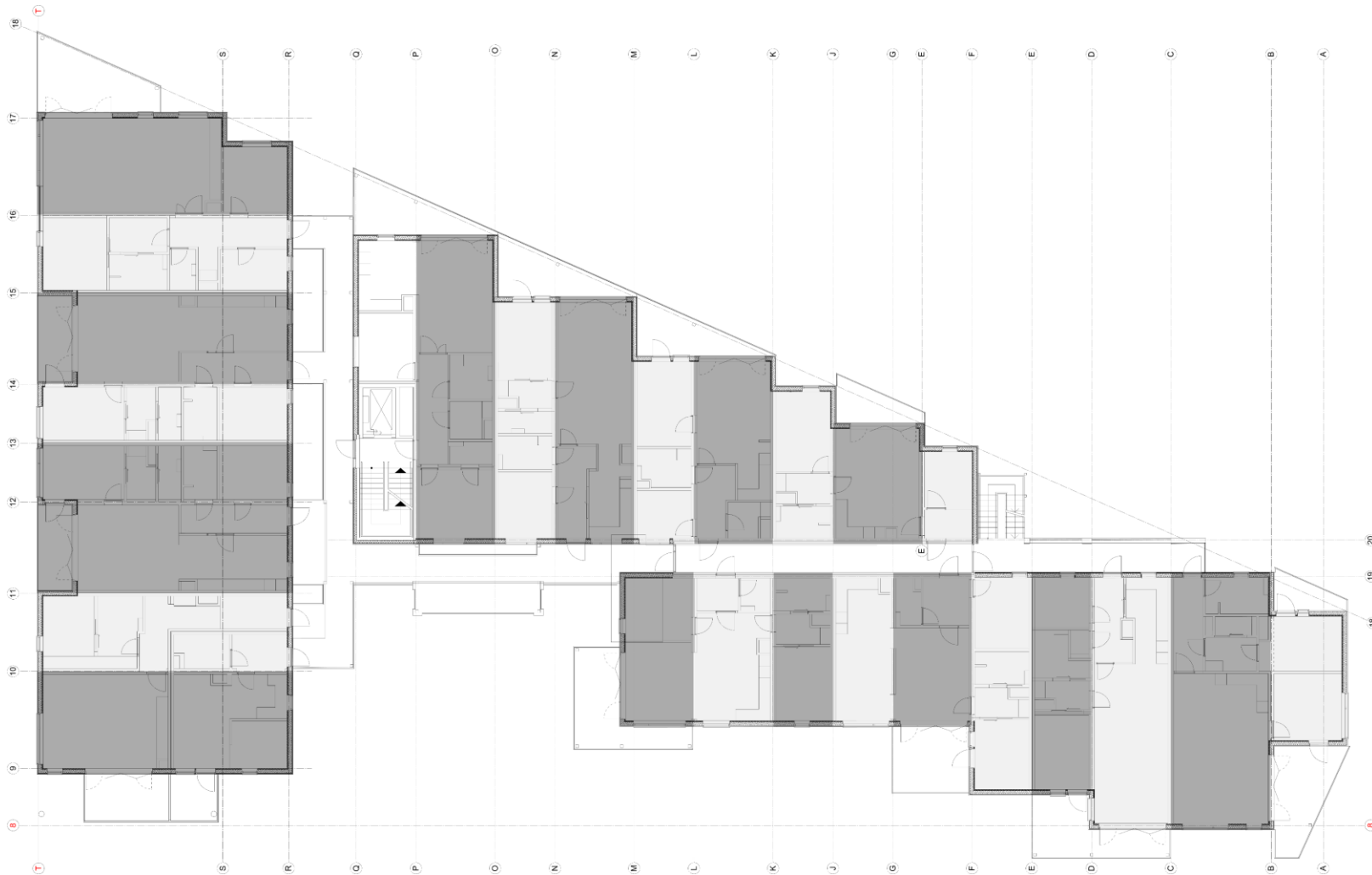
# PRINCIPLE OF MODULAR BUILDING



# HORIZONTAL STIFFNESS OF TIMBER FRAME SHEAR WALL



# COMPLEXITY



Project example: **Kodumaja**

# ARCHITECTURAL FREEDOM



**TAL  
TECH**

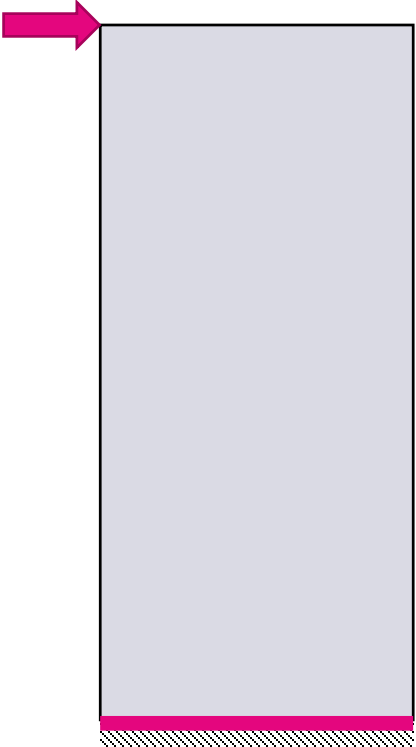
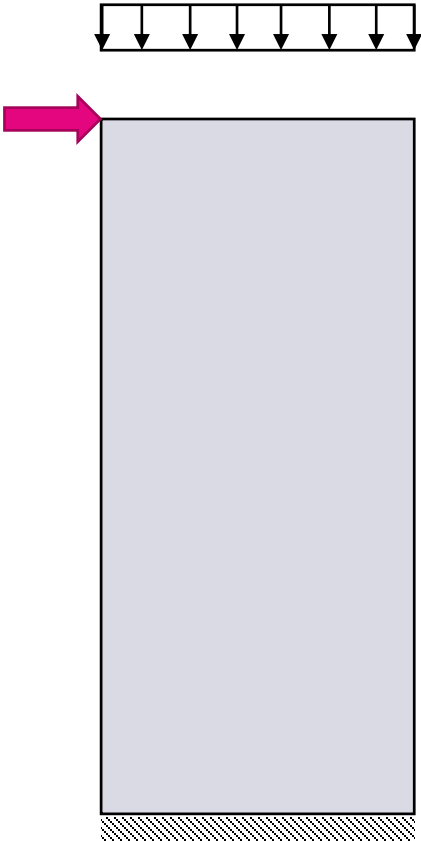


Photos: [V.Laanemaa](#)

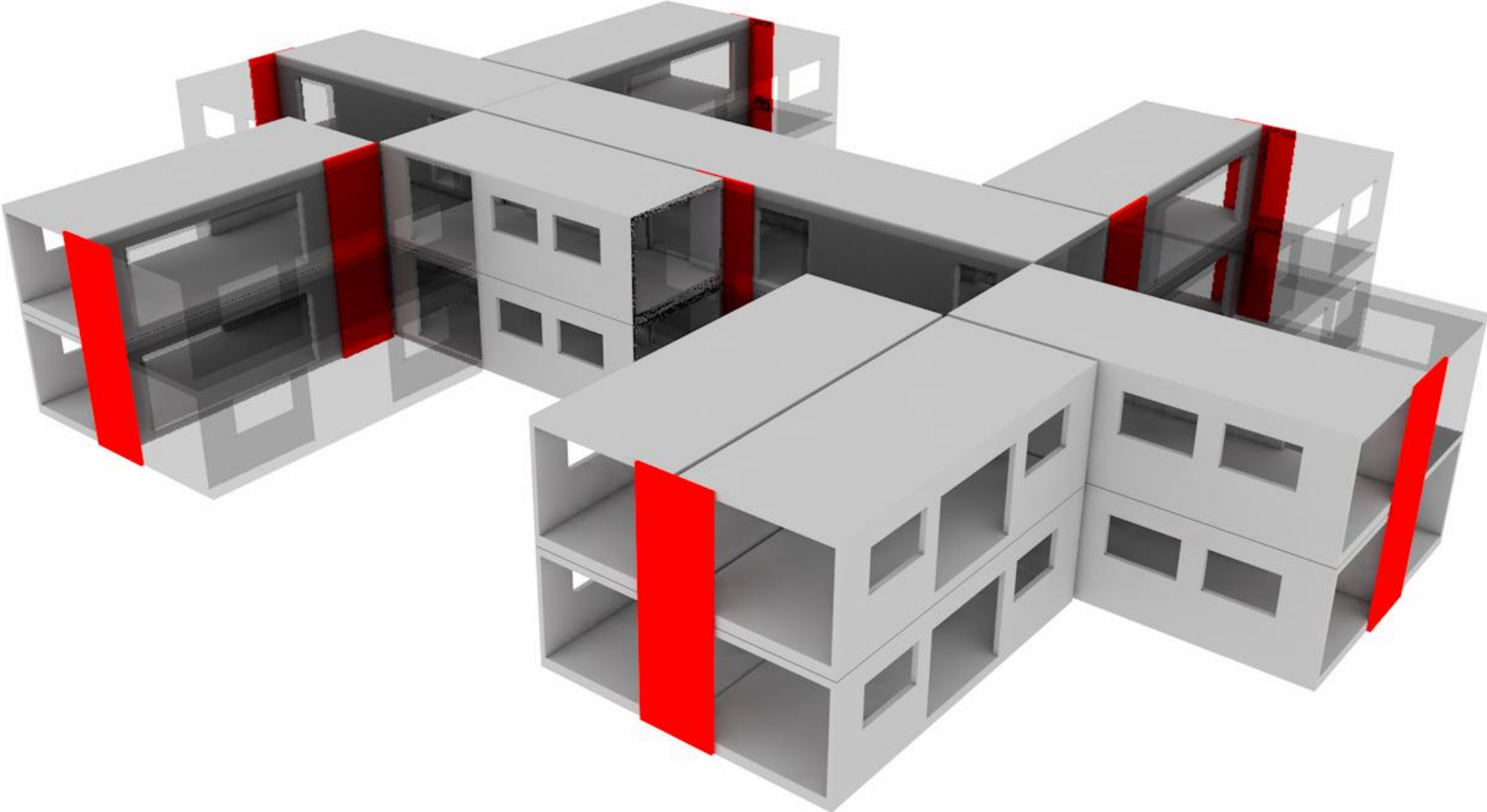
# **DEFINITION OF INDEPENDENT SHEAR WALL SYSTEM**

# INDEPENDENT SHEAR WALL SYSTEM

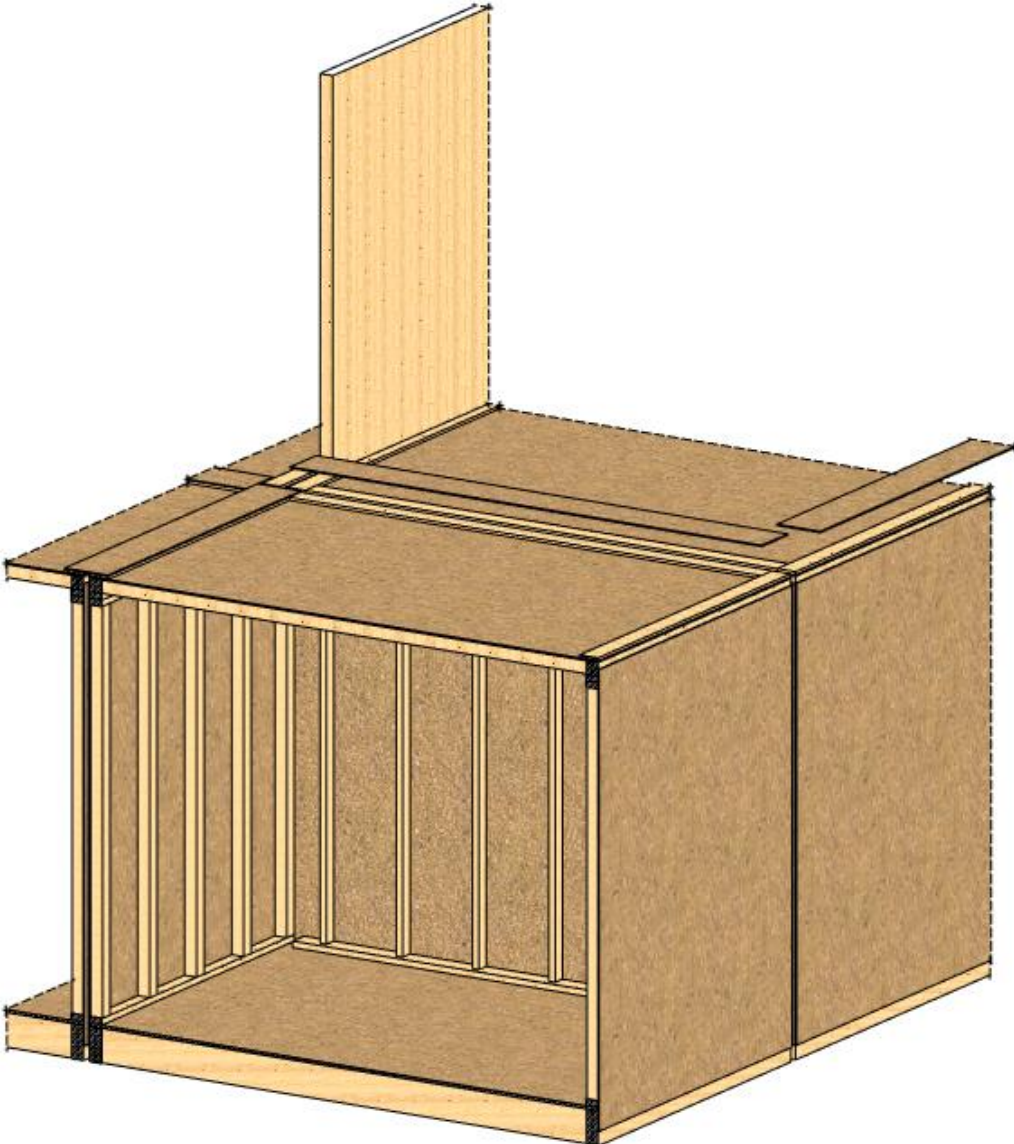
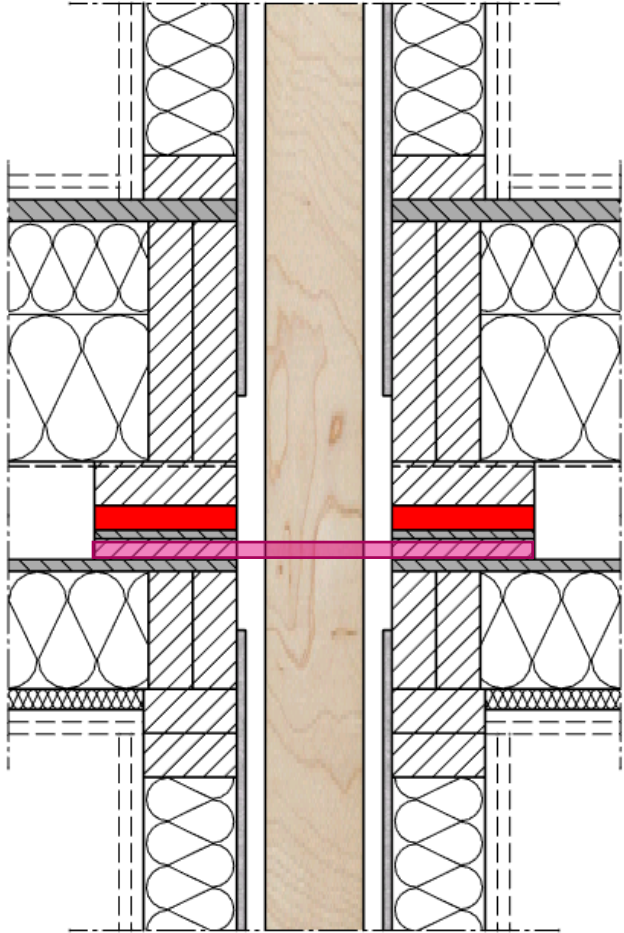
INDEPENDENT = NO VERTICAL LOAD



# INDEPENDENT SHEAR WALL SYSTEM



# INDEPENDENT SHEAR WALL SYSTEM

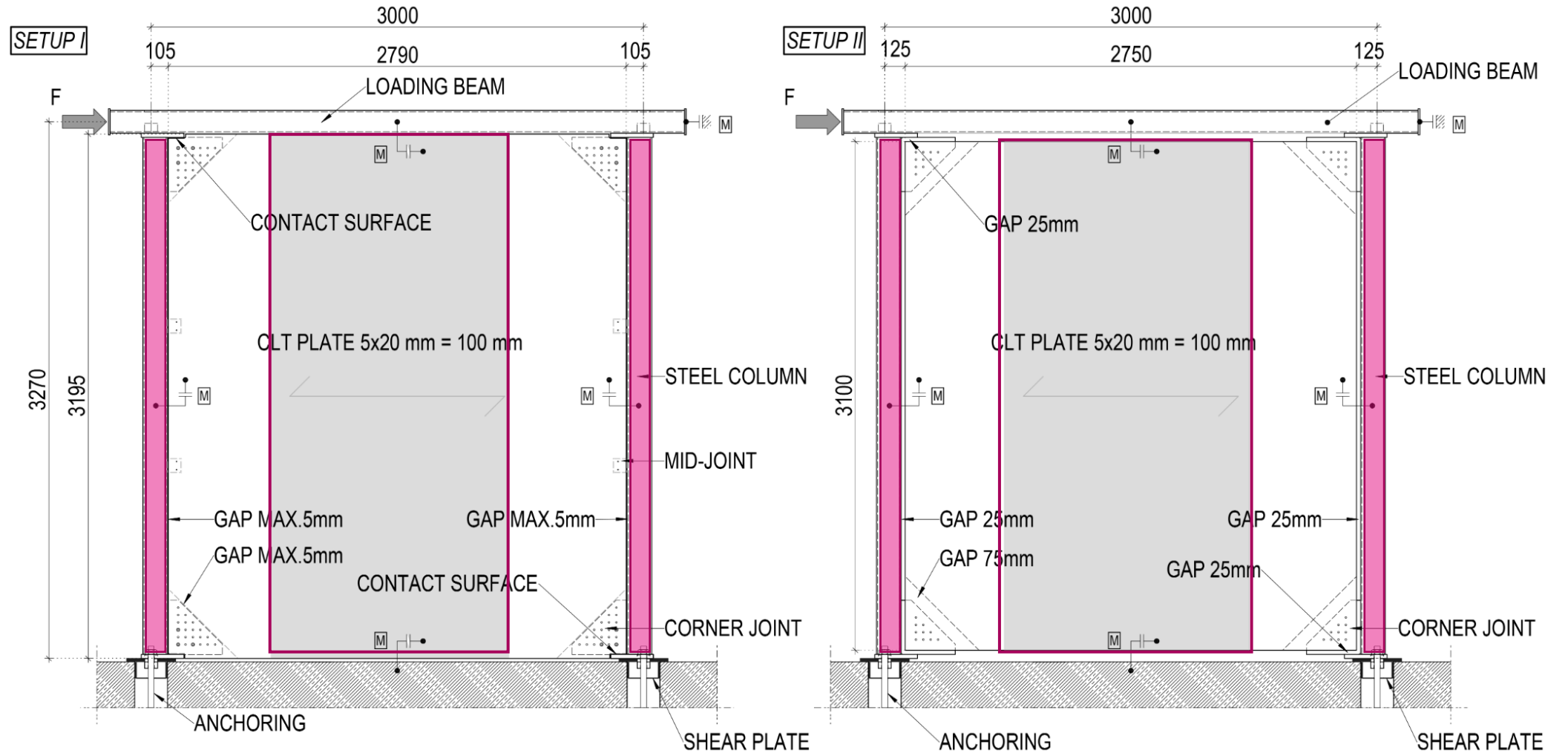


# REQUIREMENTS FOR THE SHEAR WALL SYSTEM

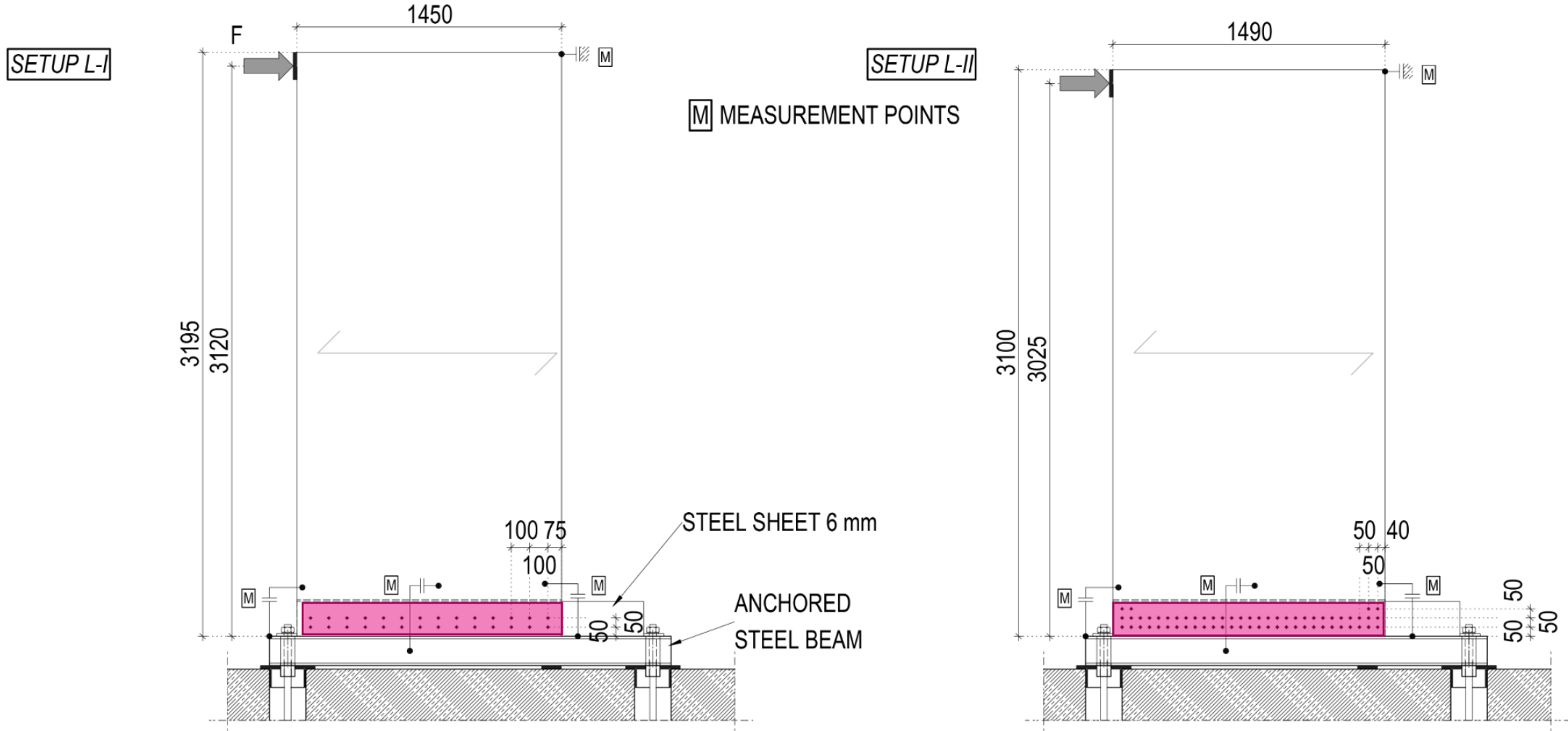
- COMPATIBLE WITH THE MAIN SYSTEM
- PREFABRICATED AND PREPARED FOR FAST INSTALLATION ON SITE
- EFFICIENT AND DUCTILE CONNECTIONS ARE CRUCIAL
- POSSIBILITY FOR SIMPLIFIED CALCULATIONS AND FOR SYSTEMATIZATION

# WALL TYPES AND TESTING

# TESTED WALLS: CLT PLATE WITH STEEL COLUMNS



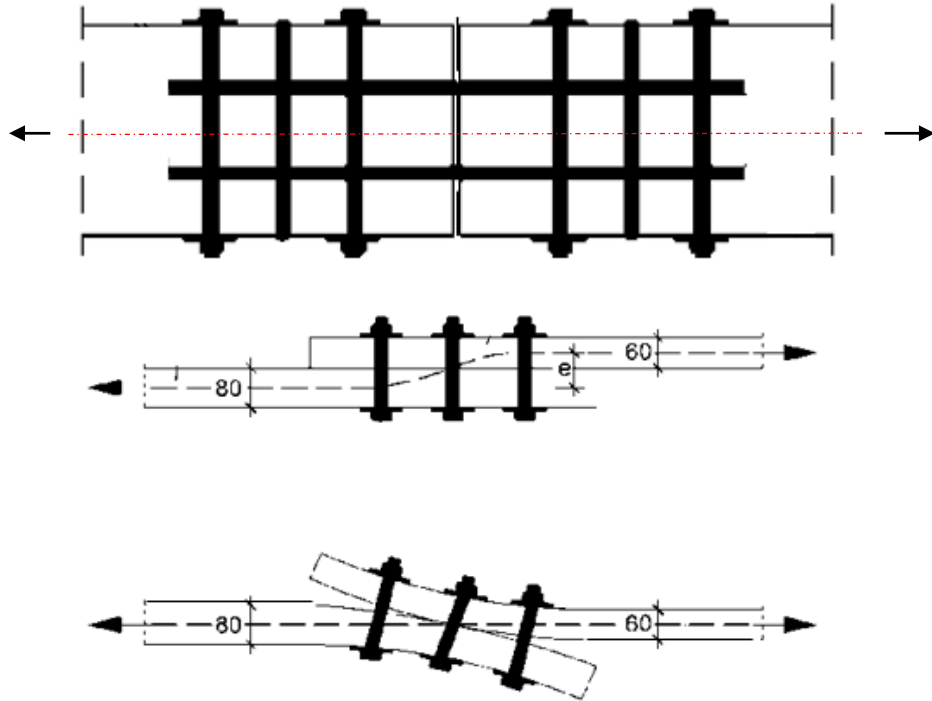
# TESTED WALLS: LINE-CONNECTED CLT SHEAR WALL



# TESTED WALLS



# CONNECTION TYPE: SLOTTED IN STEEL PLATE



Picture source:

Holzbau Bemessung und Konstruktion | Rug/Mönck

**TAL  
TECH**

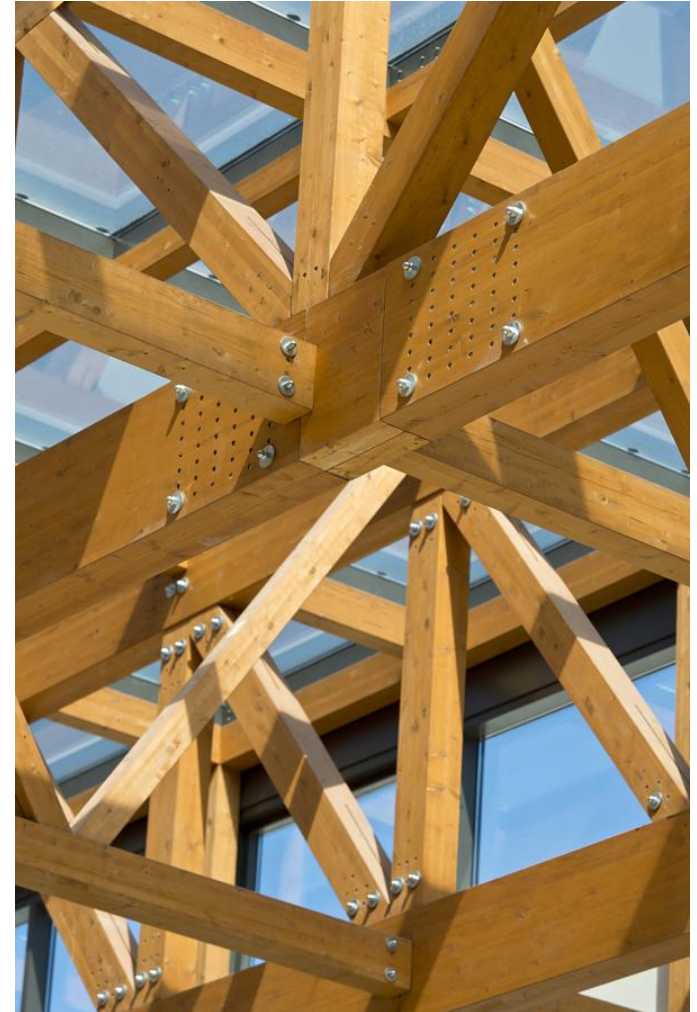
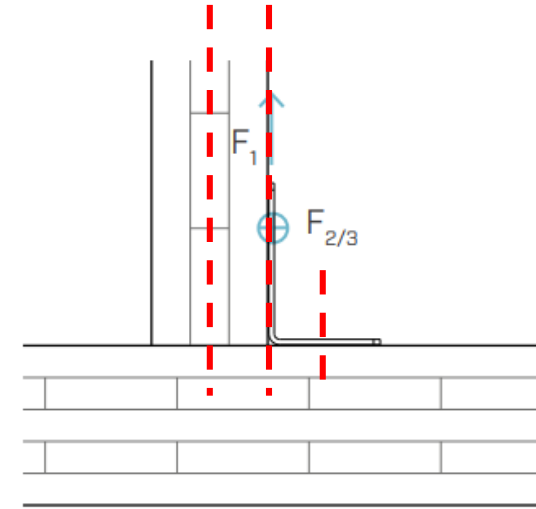
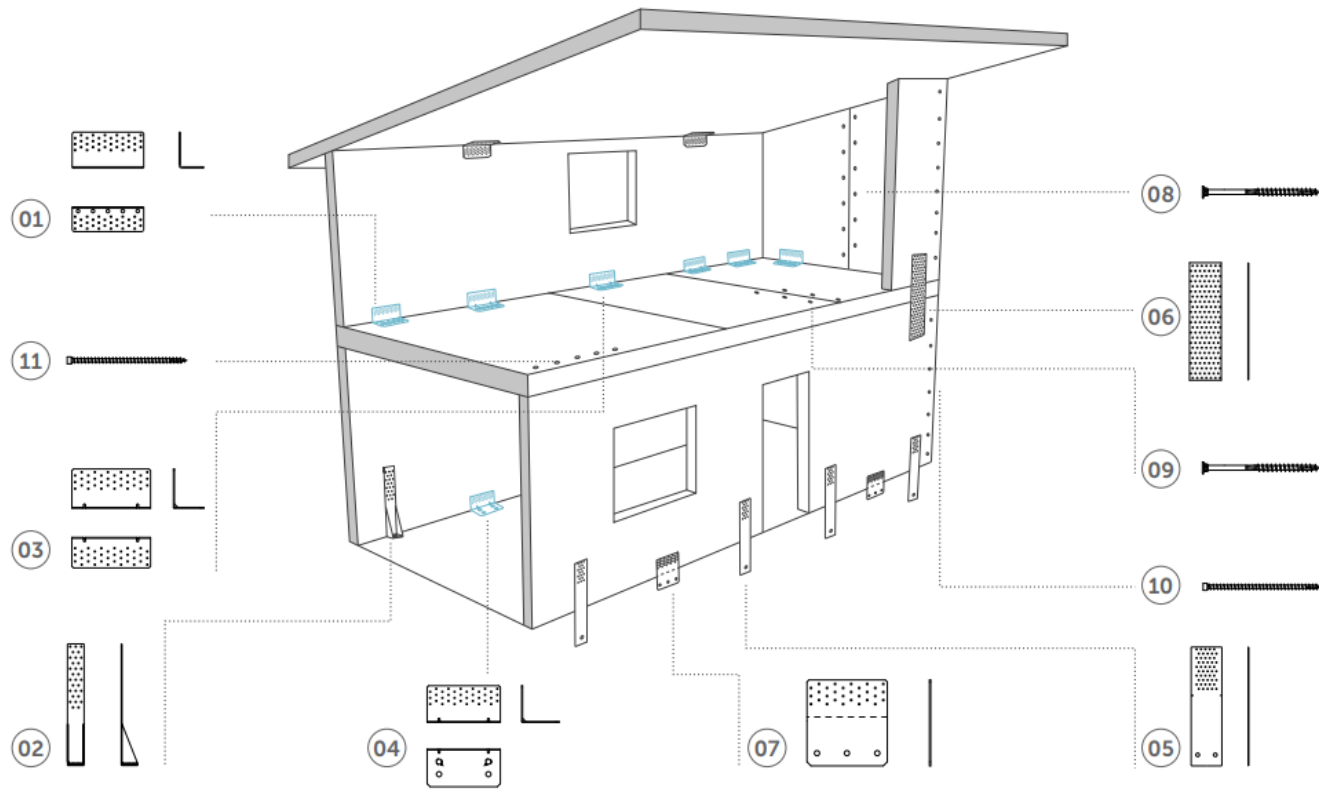


Photo: R.Sau

# SLOTTED-IN-STEEL PLATE IN THE CONTEXT OF CLT SHEAR WALL

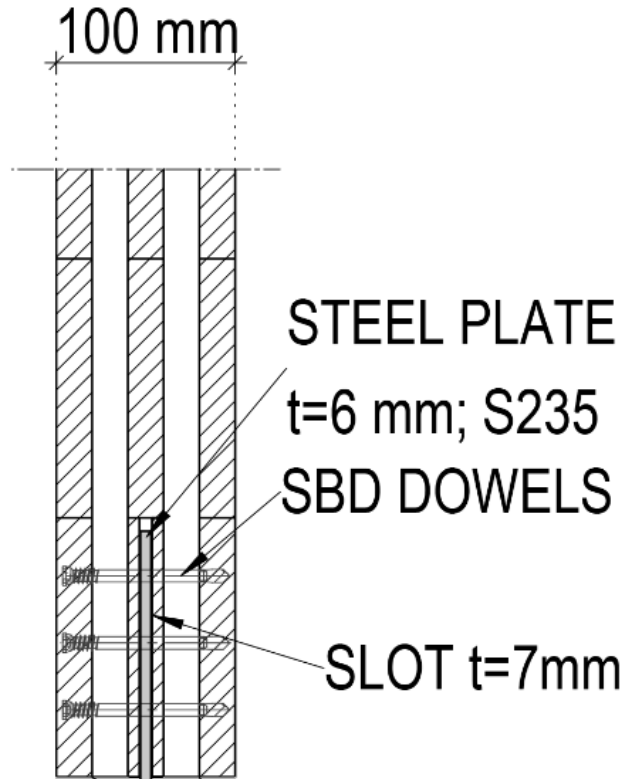


Picture source: <https://www.rothoblaas.com>

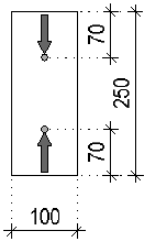
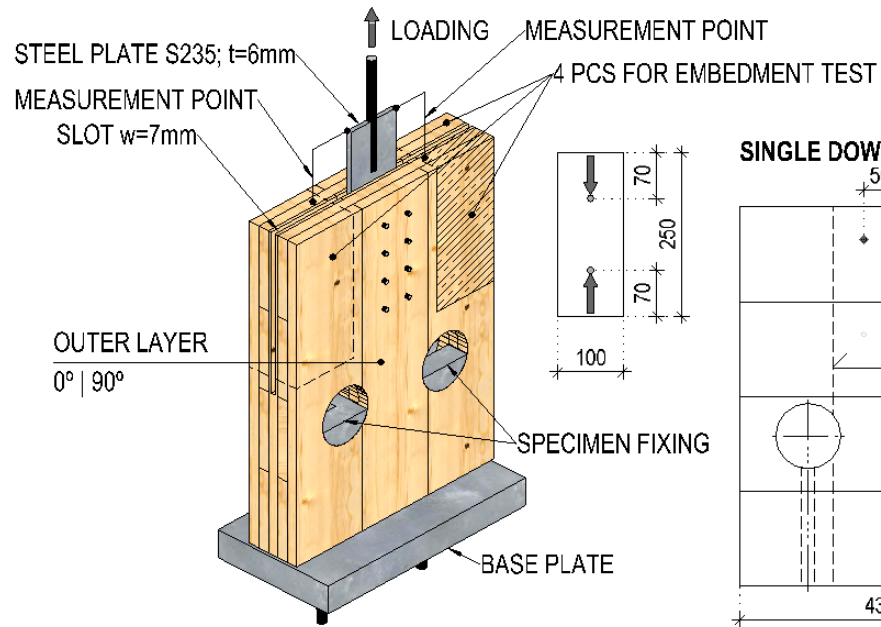


Photo source: [Málaga-Chuquitaype et al.](#)

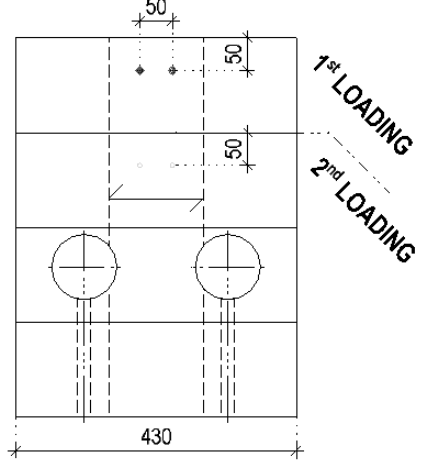
# CONNECTION WITH SELF-PERFORATING DOWEL USED IN TESTS



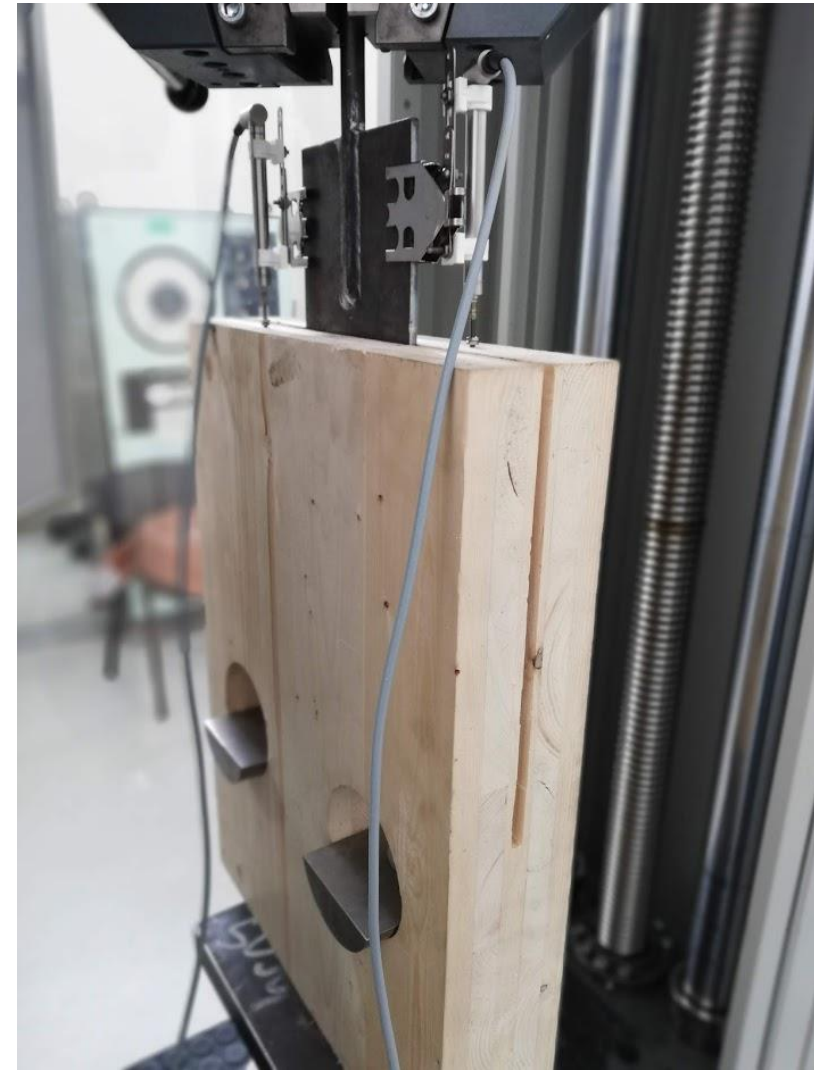
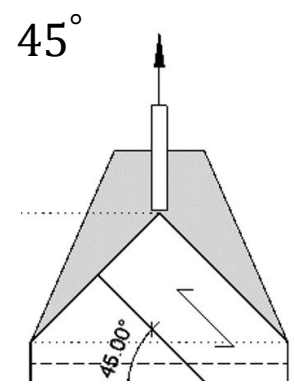
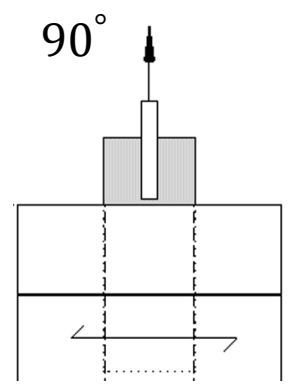
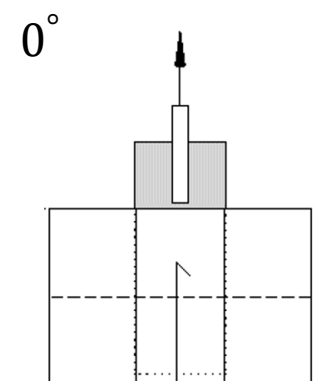
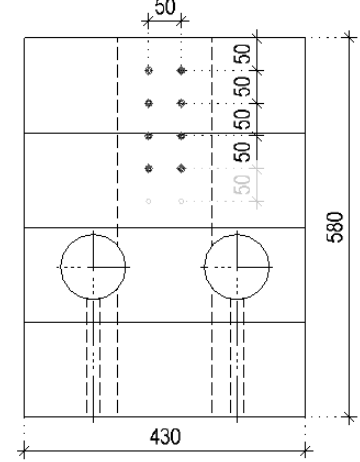
# SMALL SCALE TESTS



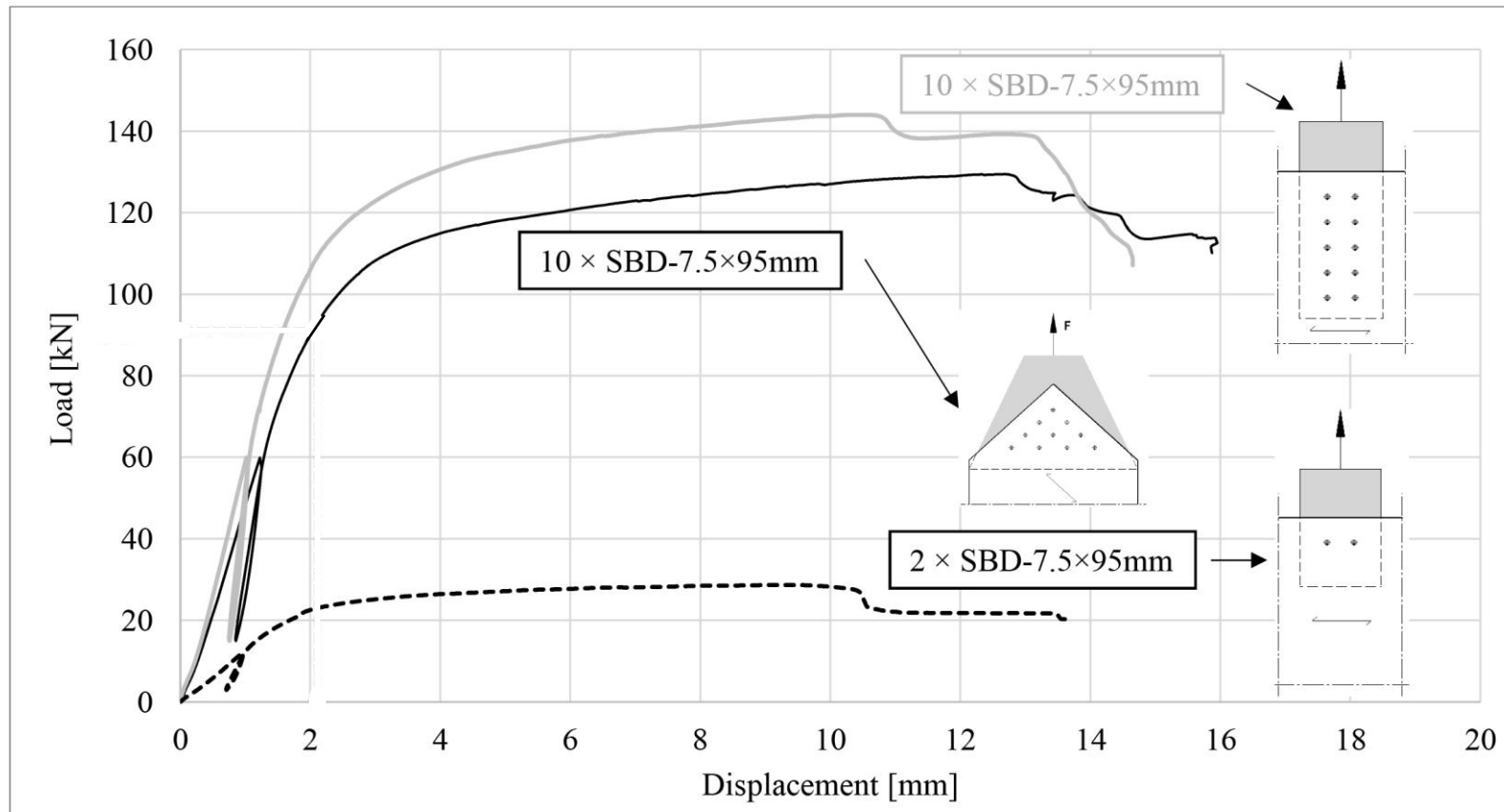
**SINGLE DOWEL IN ONE ROW**



**MULTIPLE DOWELS IN ONE ROW**

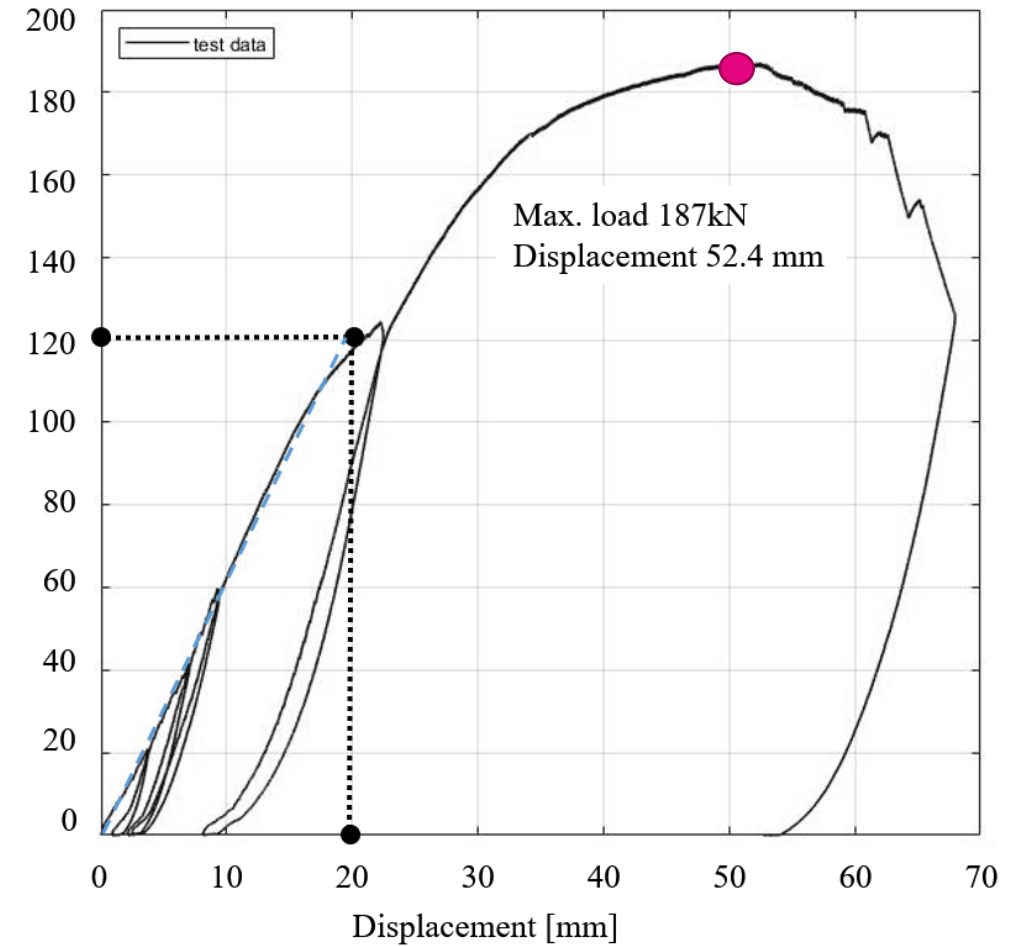
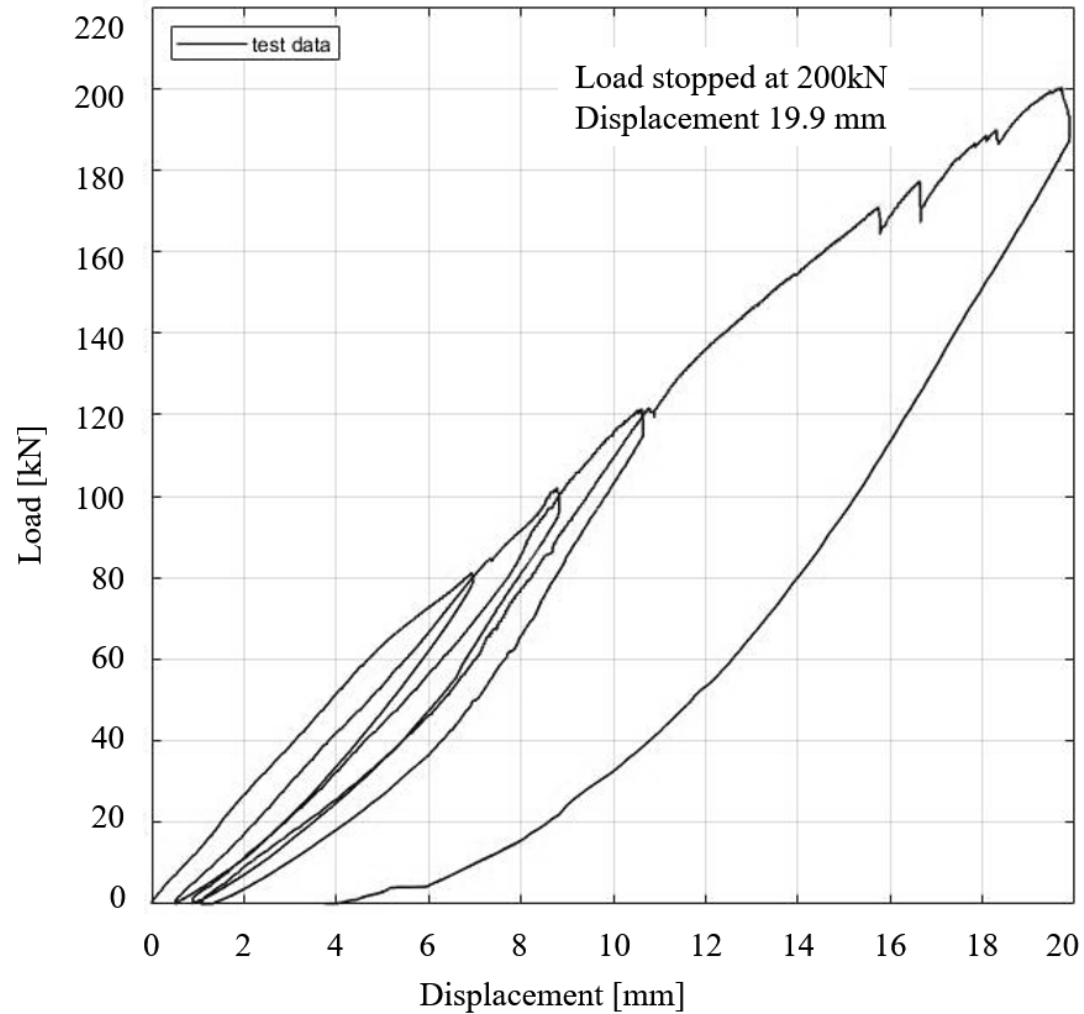


# RESULTS OF SMALL-SCALE TESTS: EXAMPLE GRAPHS

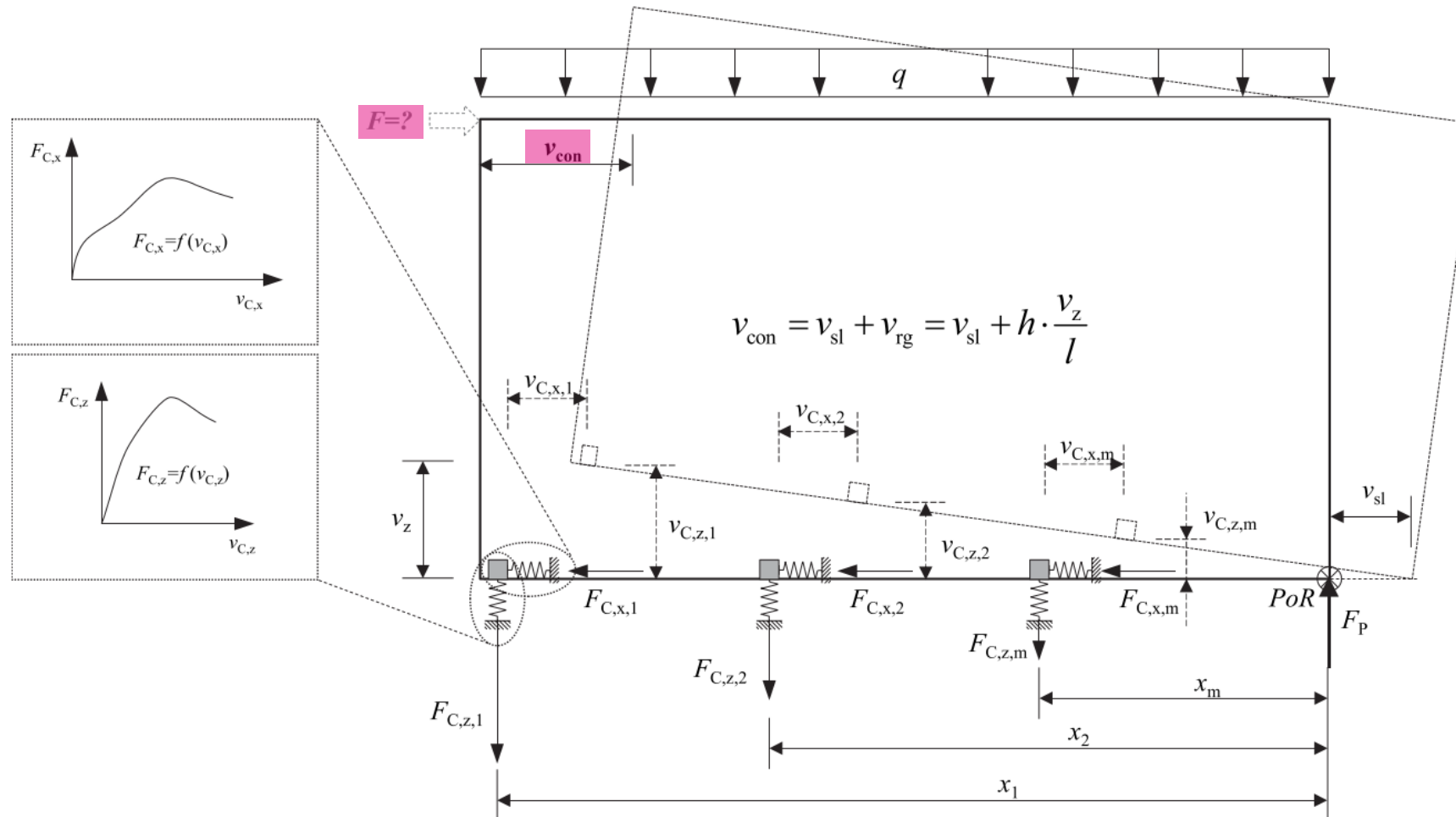


# WALL TEST RESULTS

# RESULTS: WALL WITH STEEL COLUMNS: LATERAL TOP DISPLACEMENT



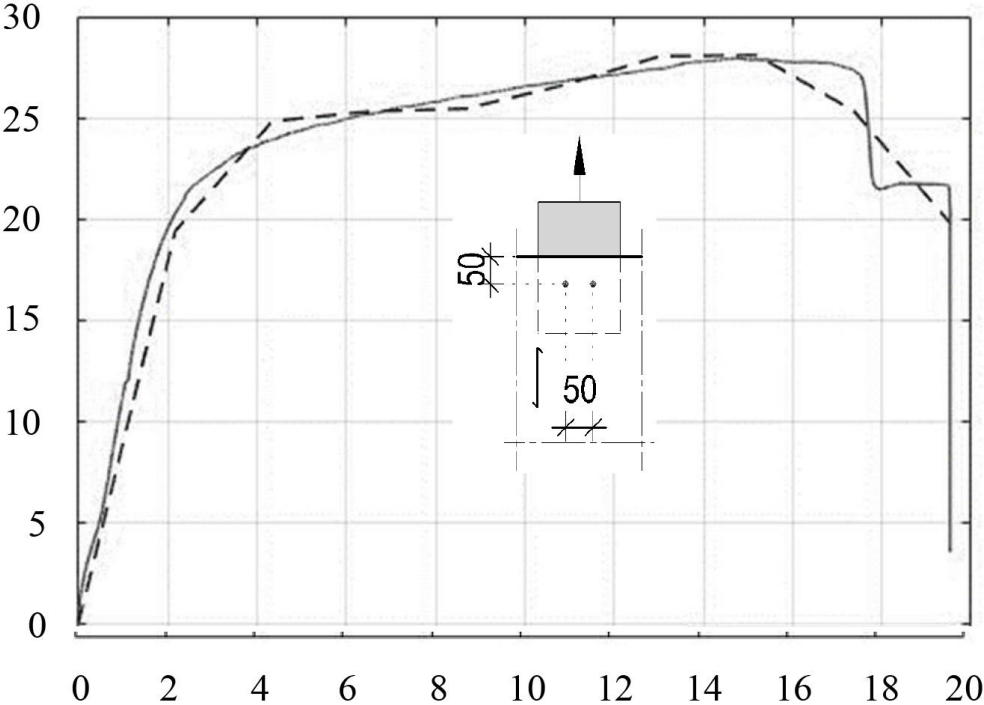
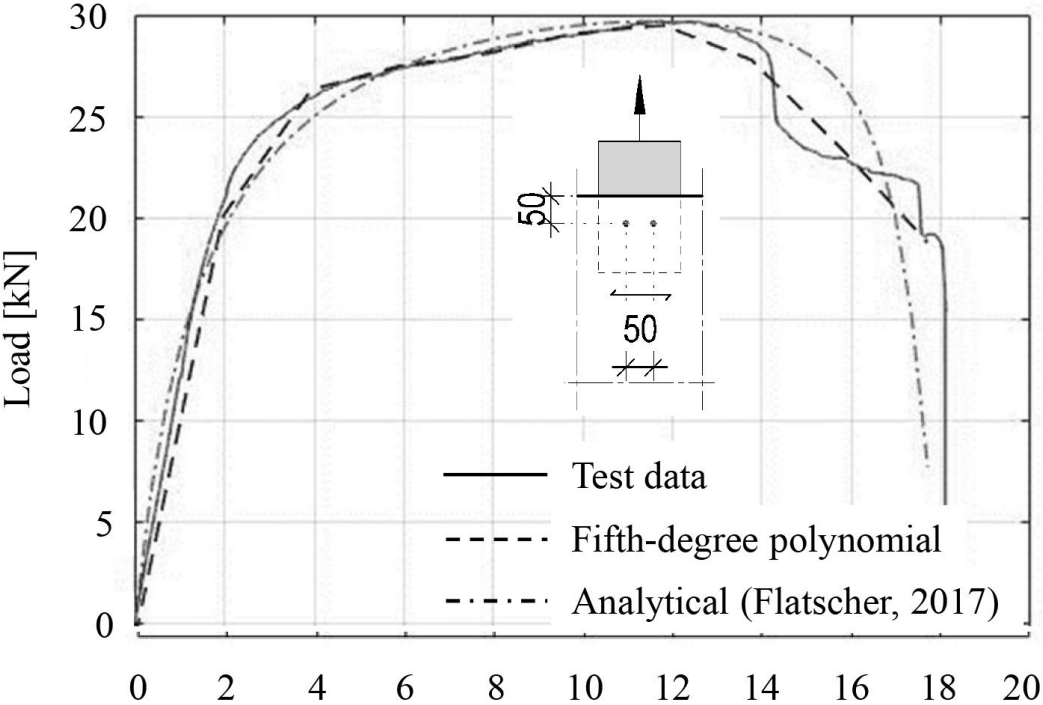
# EFFICIENT USE OF LINE-CONNECTION



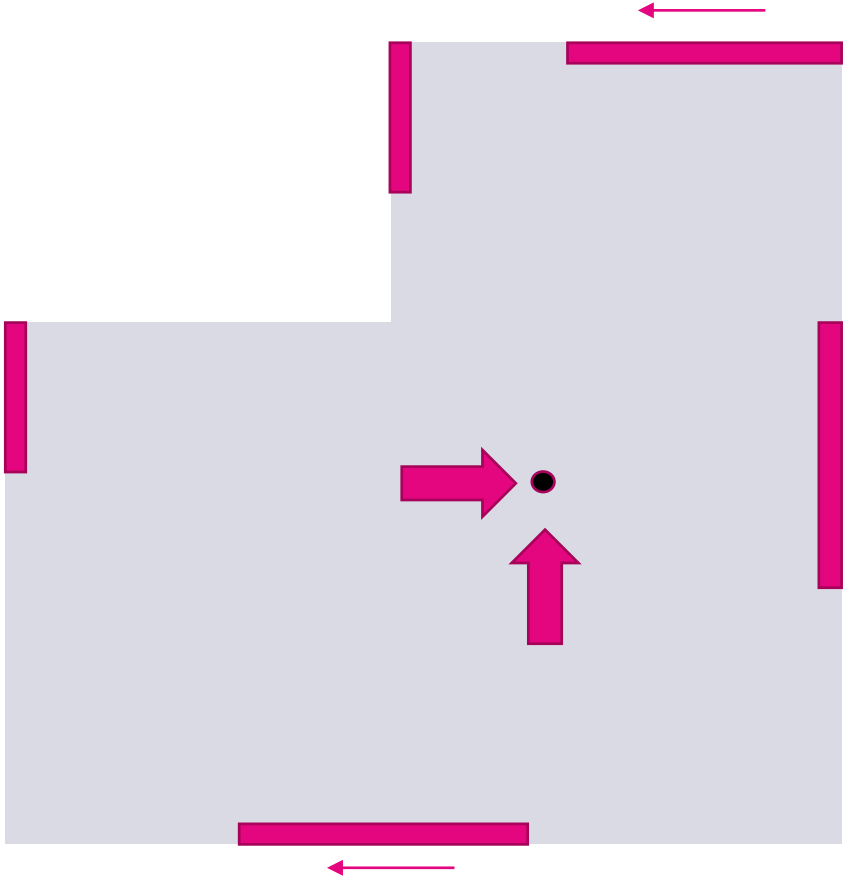
Flatscher G. (2017).

Evaluation and approximation of timber connection properties for displacement-based analysis of CLT wall systems [PHD Thesis]

# APPROXIMATION CURVES OF THE CONNECTION



# SYSTEMATIZATION



TYPE

- ████████████████████
- ████████████████████
- ████████████
- ████████████

DEFORMATION LEVEL	CORRESPONDING LOAD	MAXIMUM CAPACITY
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# CONCLUSIONS

- CLT together with steel columns could work as part of a high-precision, universal industrialized system
- A simplified equivalent diagonal-based calculation model can be used for manual and FE calculations
- Line connection may not be economical, but will give more clarity in the calculation and will simplify automation
- Displacement-based calculations could be suitable for reasons of optimization and systematization, meaning module-based and tabulated calculations

# TAL TECH

## THANK YOU !

### SPECIAL THANKS

- Unit Module Finland
- Arcwood
- Rotho Blaas
- Lauri Rauk
- Martin Ojamaa