COST Action FP1004

Final Meeting

15 April – 17 April 2015 – Lisbon, Portugal

Laboratory Tests and analysis of seismic response of glulam walls with damage avoidance, viscous dampers

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Motivation

1) **Timber structures** are becoming **more popular** → seismic zones
→ low environmental impact

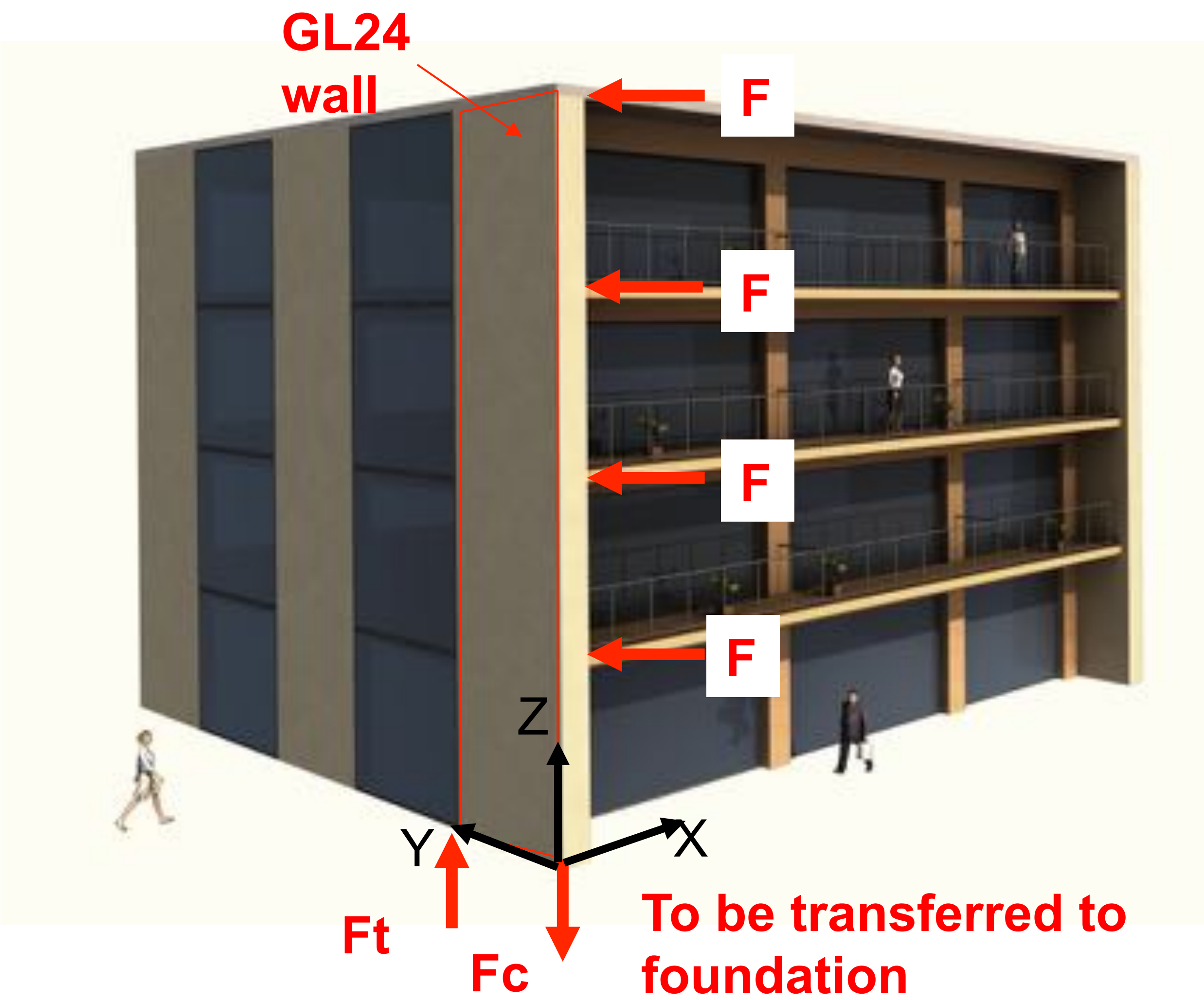
2) **Increase** in approved **height** of timber structures (improvement of fire protection, loosened fire regulations)

3) **More open space structures = reduction of lateral load** bearing walls

4) **Re-thinking in design approach** of structures under seismic loads
High repair cost after earthquake → Call for **damage avoidance design**

Challenge: **1) less connections**
2) under increased impact
3) not to undergo damage

Background – Prototype Structure

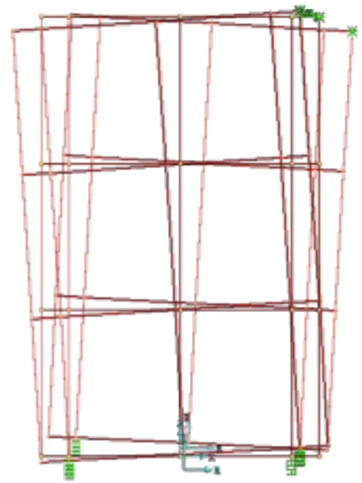


WALL CHARACTERISTICS:

- **Glue laminated timber**
- Fabricated as beam, then turned vertically
- Spanning over full height of structure **12.80m**
- Width: **3.0m**

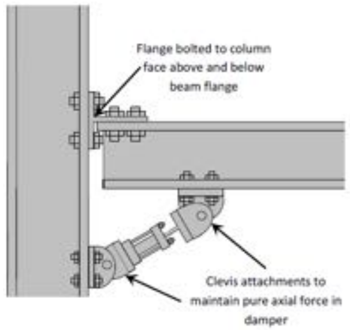
Connection Possibilities

Passive Base Isolation (only when seismic loads are governing design criteria)



Viscous/Mild Steel Dampers

HF2V-Viscous dampers



Connection Possibilities – HF2V Dampers

Characteristics:

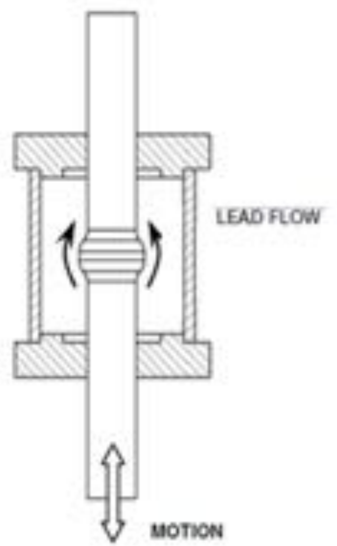
- Low velocity dependency

$$F_D = C_\alpha \cdot v^{0.11}$$

- Static rigidity
- No yielding = Damage free

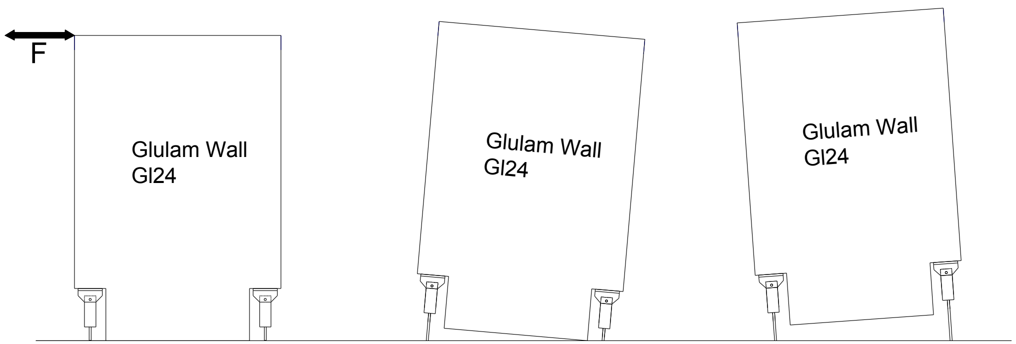
Drawback:

- No self-centering
- only applied in steel + concrete structures

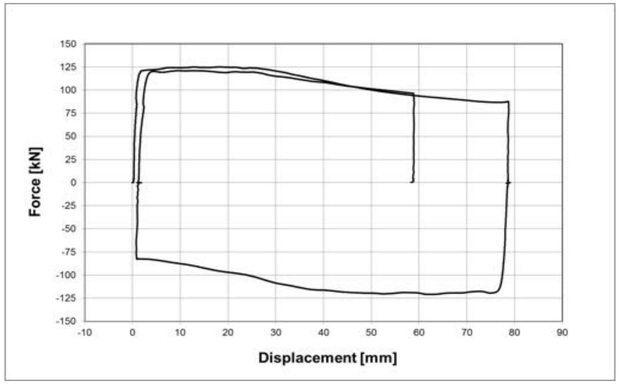


Laboratory Tests

- Test 1: No vertical load, max. drift = 2% (60mm)

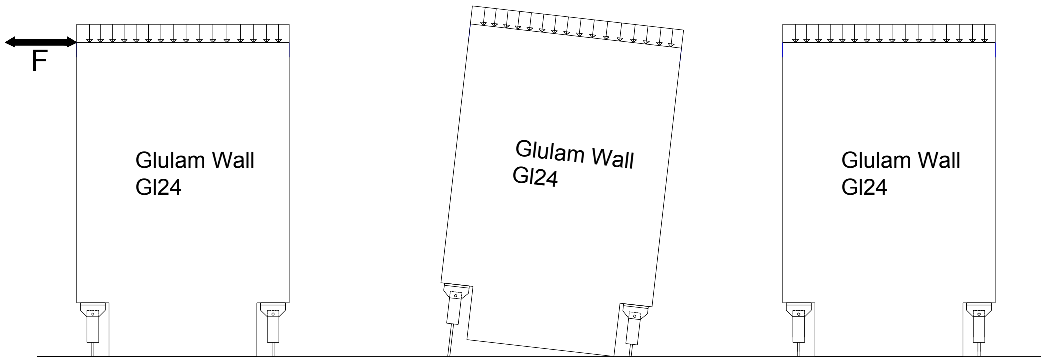


Initial Position | Rocking | Final Position



- Test 2: vertical load = 25kN/m, max. drift = 1.3% (40mm)

$F_D = 125 kN$, $C_\alpha = 138 kN \cdot (s/mm)^\alpha$



Initial Position | Rocking | Final Position

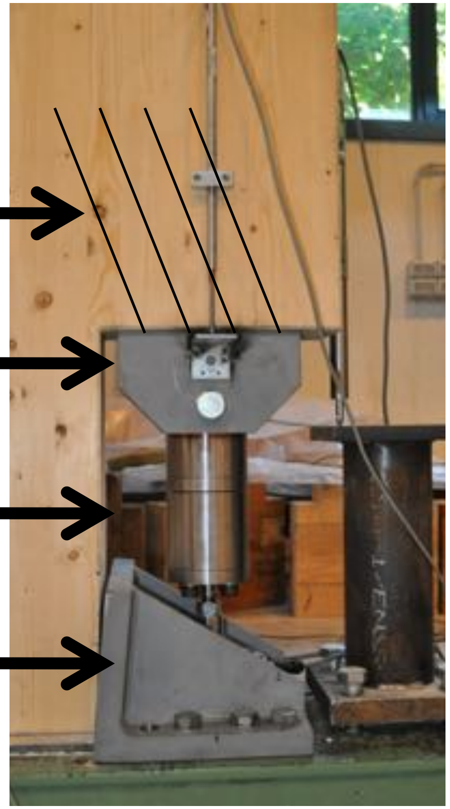
Laboratory Tests

Self tapping screws

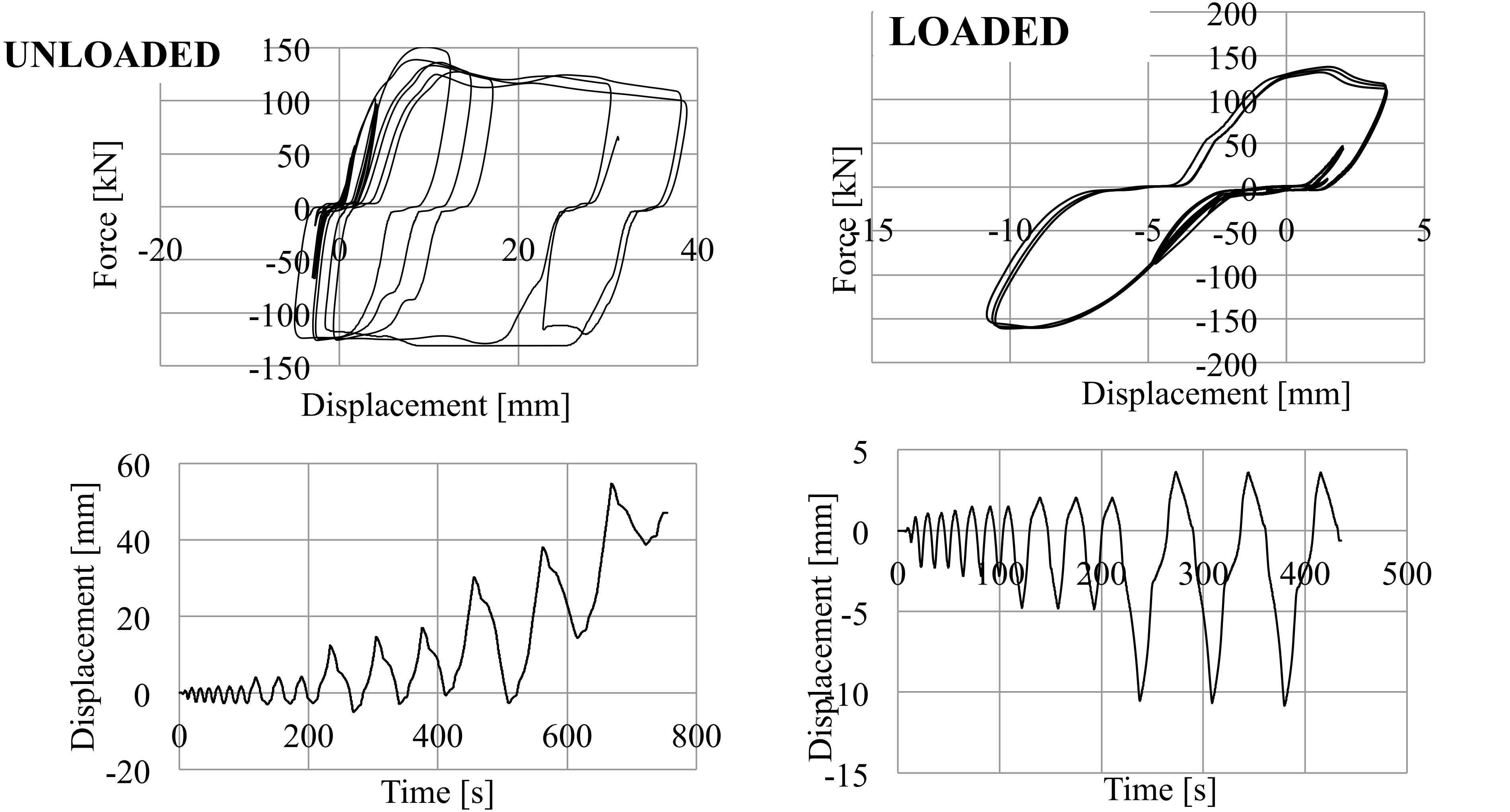
Hinged connection

Damper

Shear Key

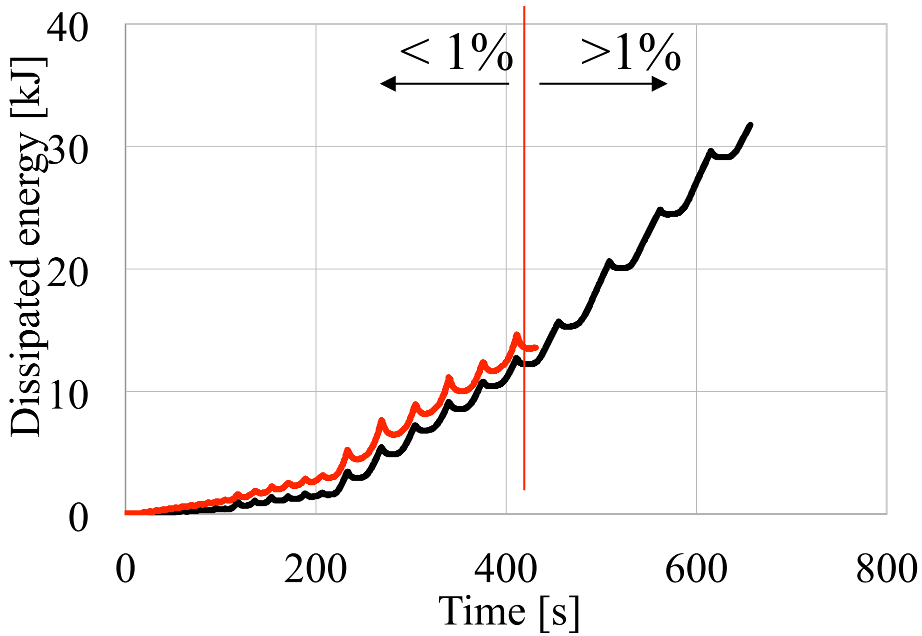


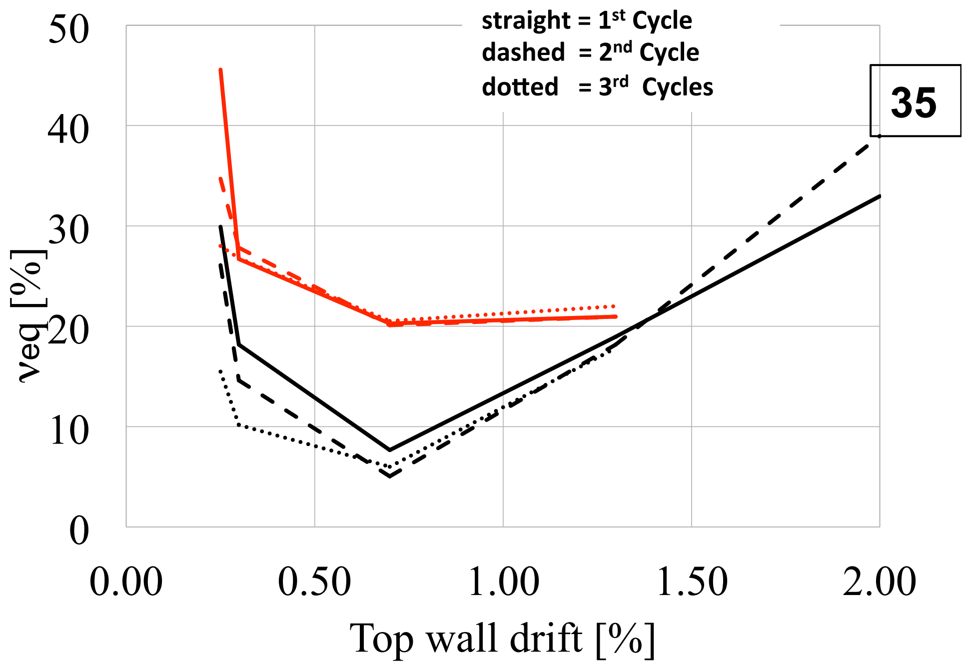
Test Results – Force/Displacement Damper



Test Results – Damping and Energy

- **UNLOADED**
- **LOADED**





Test Results - Summary

- **No damage in device and connection damper/wall** or device itself for drift **≤ 2%**
- Self-centring system for 1.3% drift
- **Pinching** = **negligible**
- **Slip** connection **damper/wall** (3mm) = **negligible**
- Max. **veq,unloaded = 35** (2%), Max. **veq,loaded = 20** (1.3%)

High force to Volume damping devices provide a damage free connection solution also in timber structures, but additional mass/tendon is required to provide self-centring.

WHAT A MISSION!