Lab Demonstration: Real-time Hybrid Simulations of Structural Systems with Friction Dampers

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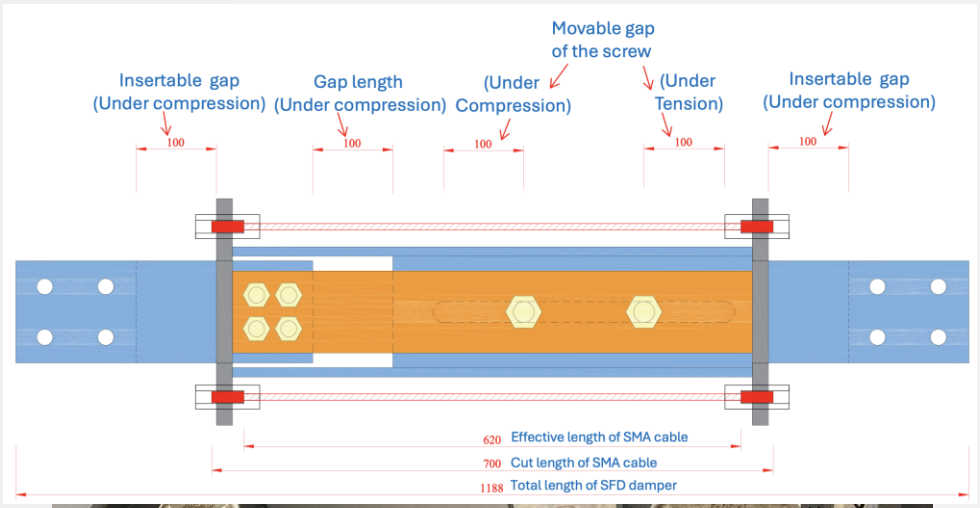
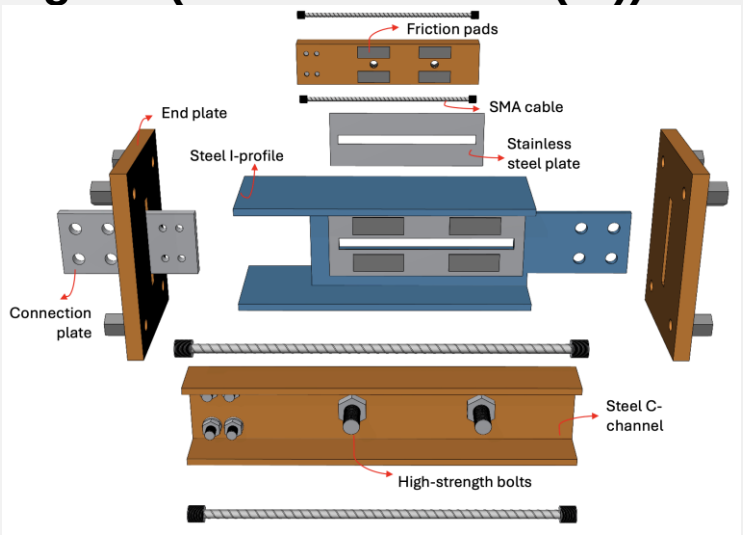
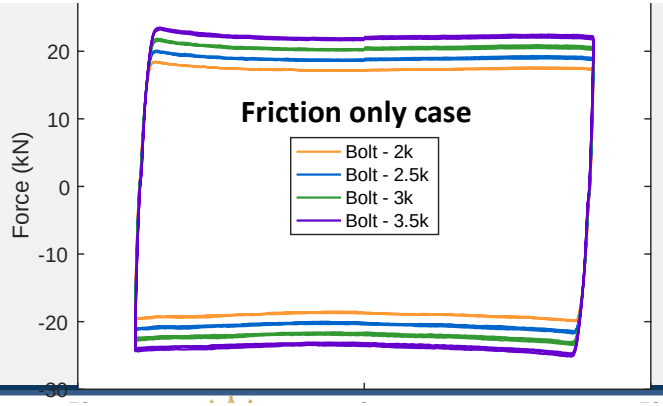
Background of Shape Memory Alloys (SMA) based Friction Damper

PFI-TT: Self-Centering Seismic Dampers for Resilience-Based Earthquake Design of Buildings: (CMMI 2141073) **University of Virginia (Osman Ozbulut (PI))**







(1) Asfaw, Amedebrhan M. and Cao, Liang and Ozbulut, Osman E. and Ricles, James "Development of a shape memory alloy-based friction damper and its experimental characterization considering rate and temperature effects" Engineering Structures , v.273 , 2022

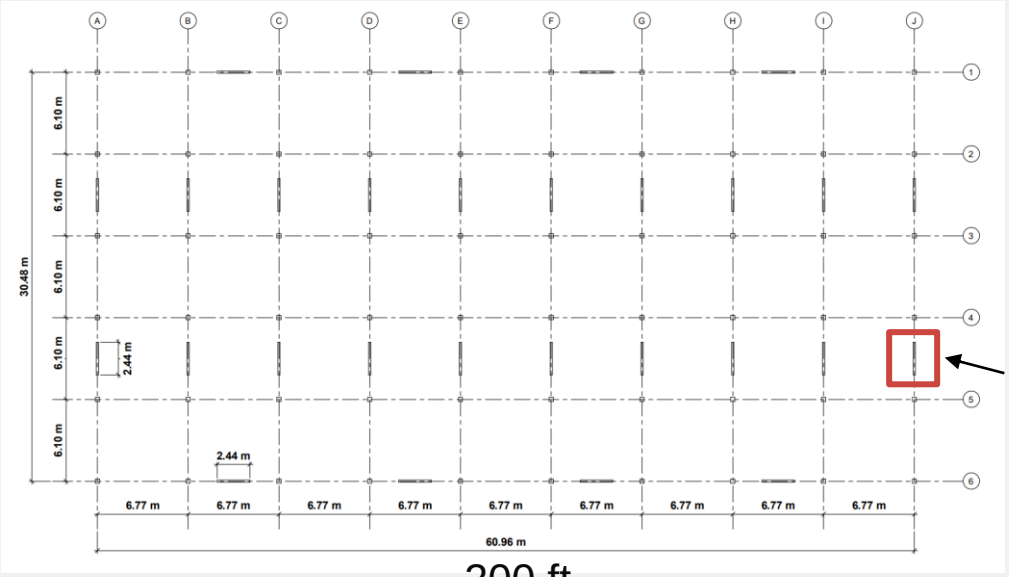
Designed 5-story CLT Structure

- A 5-story CLT structure was designed[(2)] .
- 20 self-centering CLT(SC-CLT) walls in weak direction and 8 self-centering CLT(SC-CLT) walls in strong direction
- Assume one wall for all 5 floors
- Use of ASCE 7-22 to estimate weight, W, and base shear, V

$$V = WC_S$$

- C_S is seismic response coefficient, depending on material, site, period, etc.

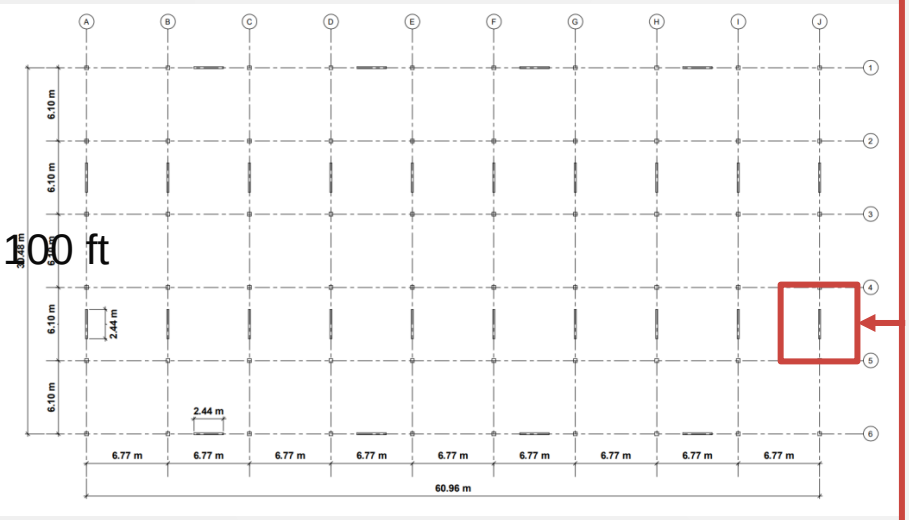
100 ft

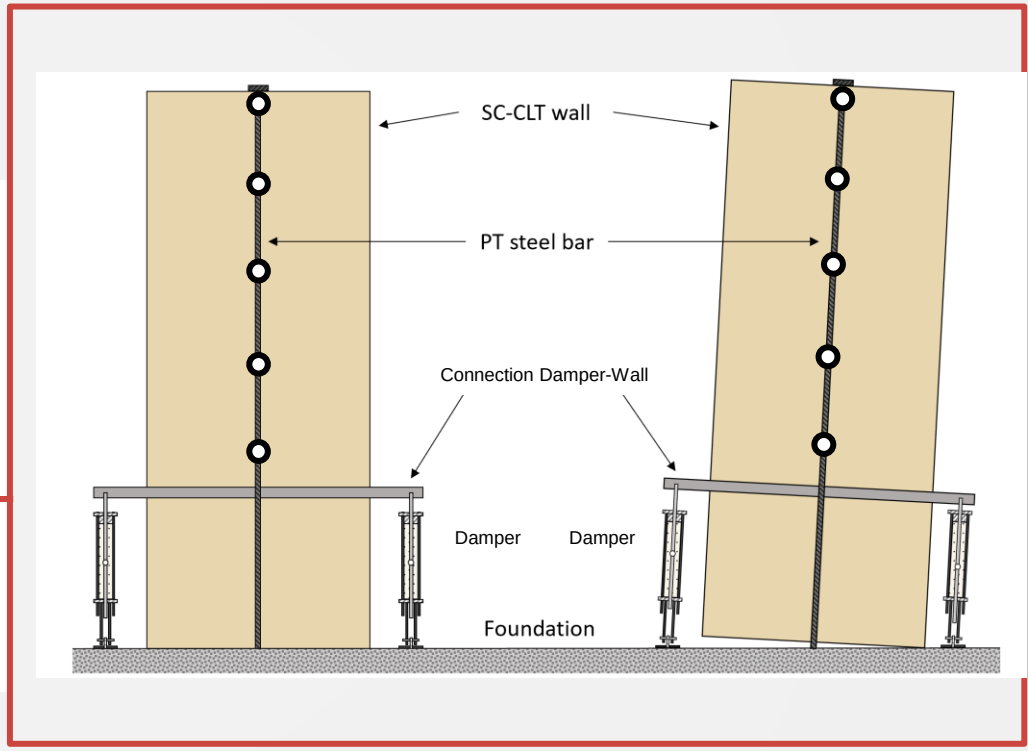


200 ft

[(2)] Alia M. Amer "Multidirectional Experimental Performance of a Seismically Resilient Self-Centering Cross-Laminated Timber Shear Wall System" May 2023

Self-centering CLT wall equipped with Dampers

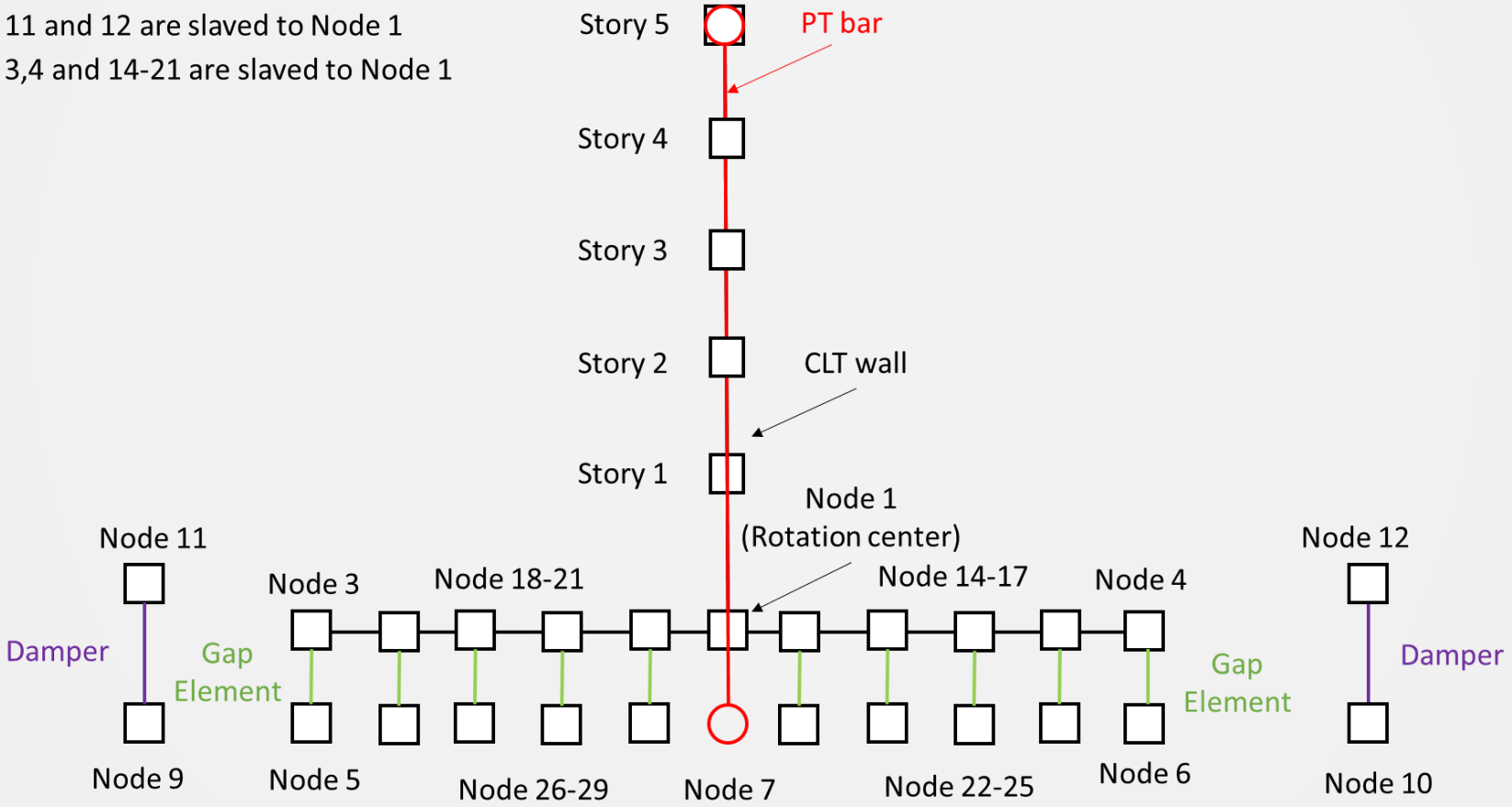




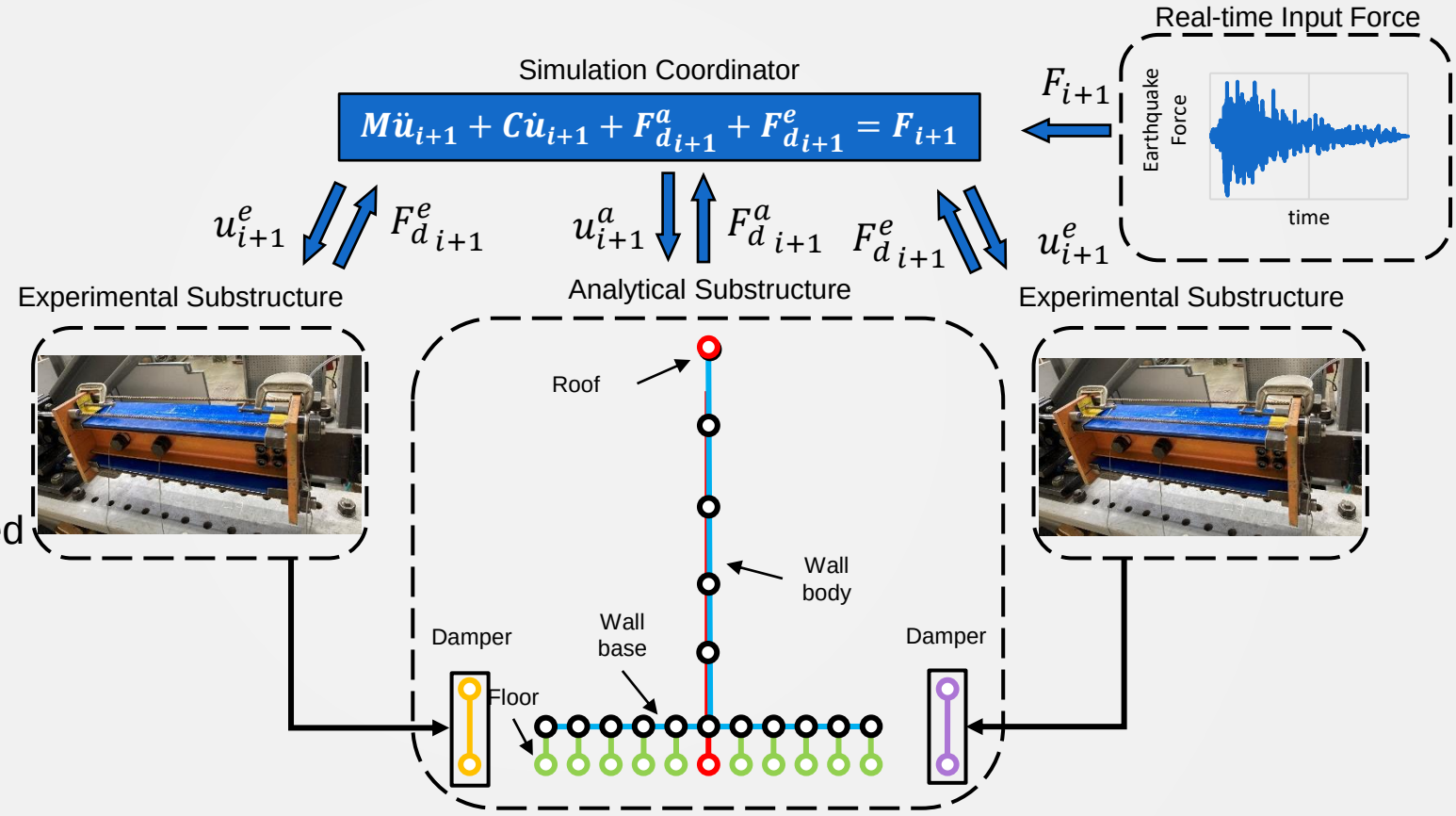
Prototype of the SC-CLT wall.

Modeling of Self-centering CLT wall equipped with Dampers

Node 11 and 12 are slaved to Node 1
Node 3,4 and 14-21 are slaved to Node 1



RTHS of SC-CLT Wall equipped with SMA based Friction Dampers



Analytical Substructure Key Features:

- P-Δ effects included
- 37 Nodes
- 10 Nonlinear gap Elements
- 20 DOFs
- Time step for RTHS, Δt=1/1024 sec.

Real-time Hybrid Simulation of a 5-story CLT Rocking Wall System equipped with Shape Memory Alloy (SMA)-based Friction Dampers subject to DBE Level Kobe Earthquake