Seismic Response of Rocking Structures Equipped with PSD through RTHS

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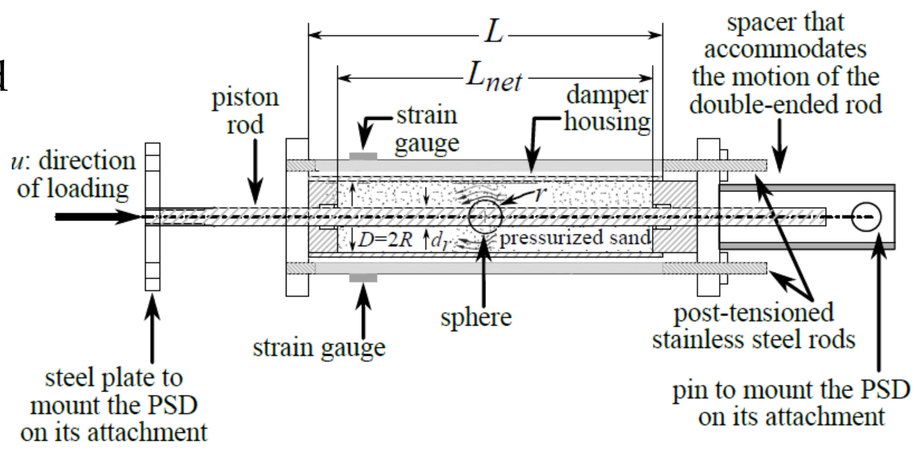
NHERI Natural Hazards Engineering Research Infrastructure

2024 NHERI Computational Symposium
February 1-2
Los Angeles, California

Real-time hybrid simulation (RTHS) was implemented to assess the **seismic response** of a **self-centering cross-laminated timber (SC-CLT) rocking wall** equipped with **pressurized sand damper (PSD)**. The RTHS revealed that the inter-story drift of the SC-CLT rocking wall was significantly reduced when the wall was equipped with the hysteretic PSDs, and also, the hysteretic damping was increased substantially.

Pressurized Sand Damper

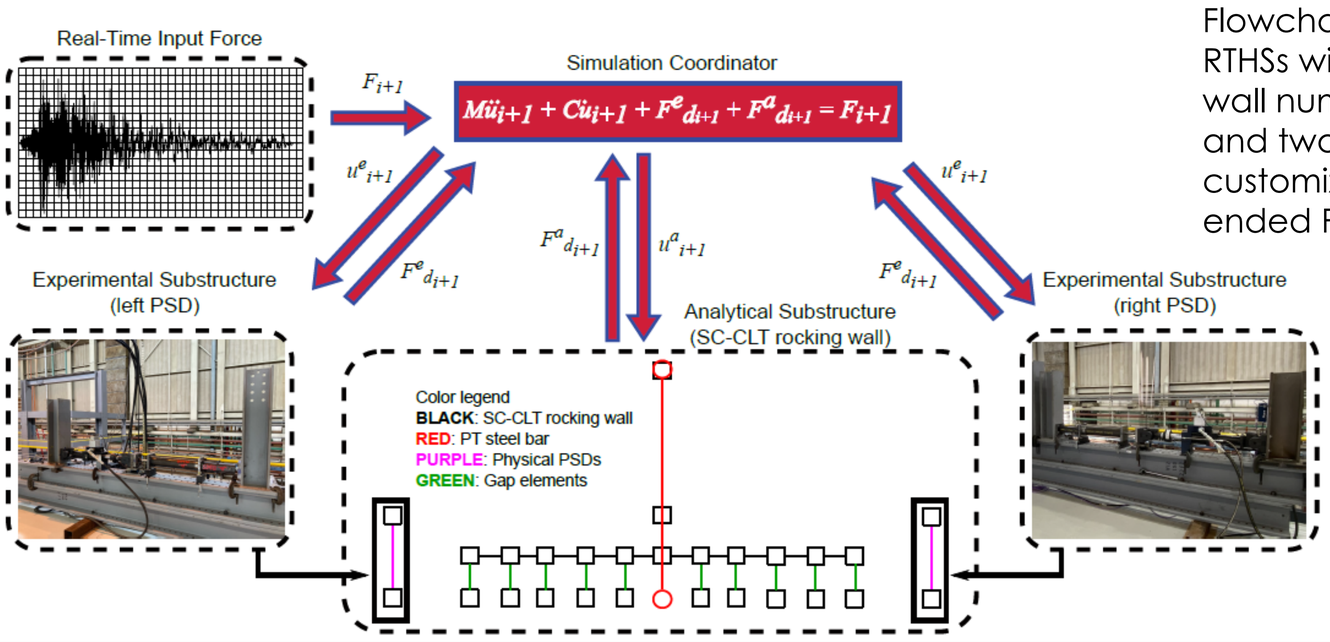
In this study, the sphere appended on the piston-rod of the PSD is merely replaced with a bolt, where the bolt-head and the nut protrude from each side of the piston-rod. The component testing of the PSD with the bolt/nut system reveal exceptional order with stable behavior of the force—displacement loops. The energy in the PSD is dissipated from the shearing action of the sand as the bolt/nut mounted on the damper-piston is plowing through the pressurized sand. The pressure on the sand is exerted with external post-tensioned steel rods that their tensile force can be easily monitored in real-time with strain gauges.



Schematic of the PSD.

Real-Time Hybrid Simulation

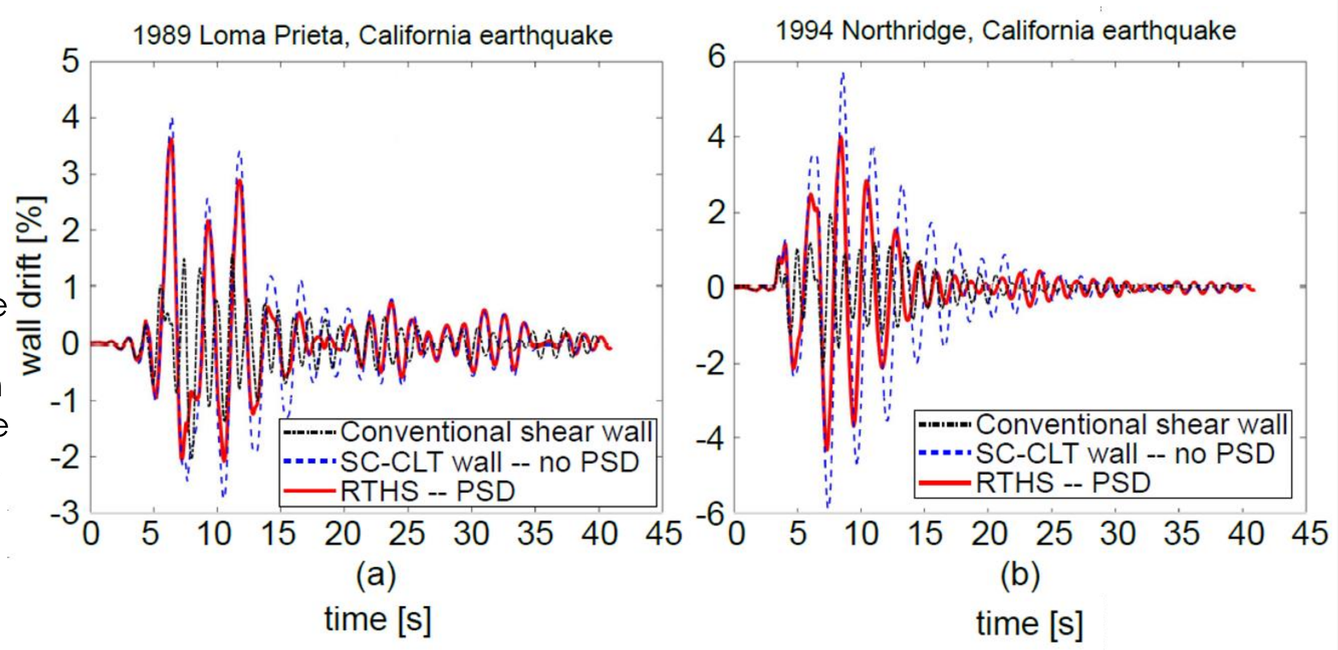
- Physical elements: two customized double-ended PSDs
- Analytical substructure: a SC-CLT rocking wall



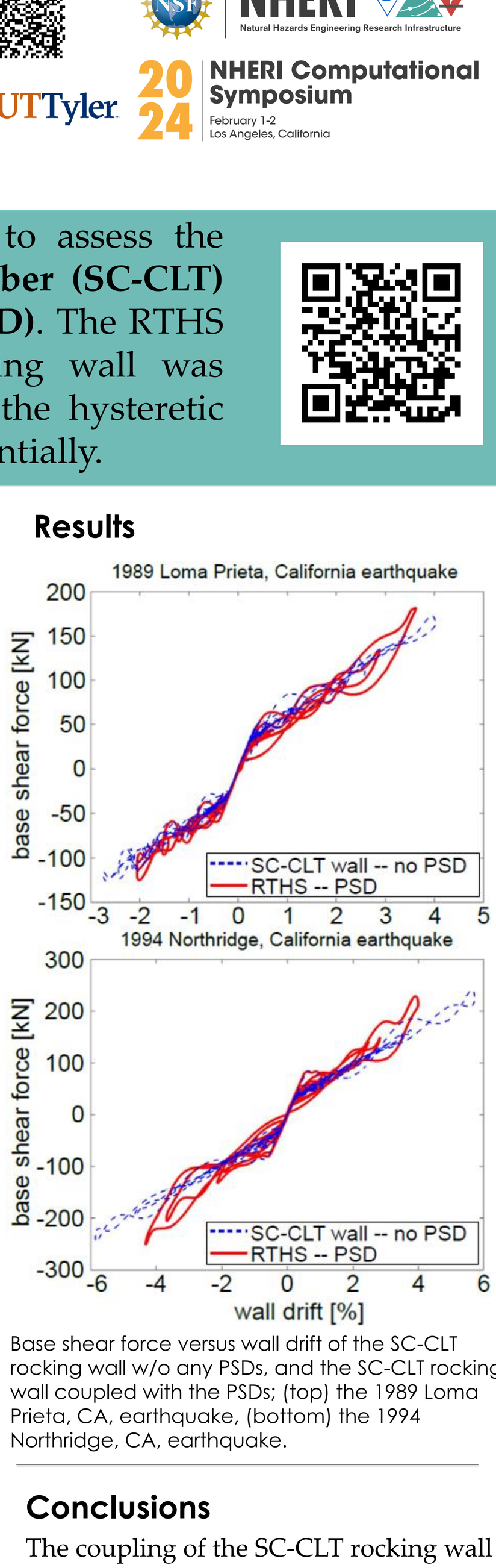
Flowchart of the RTHSs with a SC-CLT wall numerical model and two physical customized double-ended PSDs.

Results

Wall drift time-histories of the conventional fixed base shear wall, the SC-CLT rocking wall w/o any PSDs, and the SC-CLT rocking wall coupled with the PSDs; (left) the 1989 Loma Prieta, CA, earthquake, (right) the 1994 Northridge, CA, earthquake.



Results



Base shear force versus wall drift of the SC-CLT rocking wall w/o any PSDs, and the SC-CLT rocking wall coupled with the PSDs; (top) the 1989 Loma Prieta, CA, earthquake, (bottom) the 1994 Northridge, CA, earthquake.

Conclusions

The coupling of the SC-CLT rocking wall with PSDs:

- reduces the wall drift of the SC-CLT rocking wall, and
- increases the energy dissipation of the CLT wall/PSD system.

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant Nos. CMMI-2036131, CMMI-1520765 and CMMI-2037771. The authors would like to thank the SMU machinist, Mr. Ken Sangston, and to acknowledge the contributions of the ATLSS Engineering Research Center staff. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.