Achieving Sustainable Urban Buildings with Seismically Resilient Mass Timber Core Wall and Floor System

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Organization:	Portland State University
Country of Publication:	United States
Material:	CLT (Cross-Laminated Timber)
	Glulam (Glue-Laminated Timber)
Application:	Cores
	Walls
	Floors
	Wood Building Systems
Topic:	Design and Systems
	Seismic
Keywords:	Hold-Down
	Seismic Performance
	Core Walls
	Parametric Analysis
	Deformation Capacity
	Overstrength
	Mid-Rise
	High-Rise
	Tall Wood Buildings
Research Status:	In Progress
Notes:	Project contact is Peter Dusicka at Portland State University

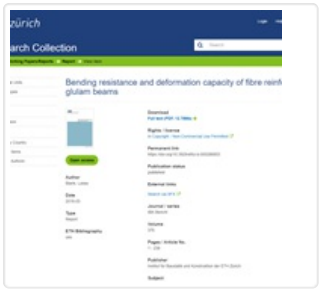
Summary:

The urgency in increasing growth in densely populated urban areas, reducing the carbon footprint of new buildings, and targeting rapid return to occupancy following disastrous earthquakes has created a need to reexamine the structural systems of mid- to high-rise buildings. To address these sustainability and seismic resiliency needs, the objective of this research is to enable an all-timber material system in a way that will include architectural as well as structural considerations. Utilization of mass timber is societally important in providing buildings that store, instead of generate, carbon and increase the economic opportunity for depressed timber-producing regions of the country. This research will focus on buildings with core walls because those building types are some of the most common for contemporary urban mid- to high-rise construction. The open floor layout will allow for commercial and mixed-use occupancies, but also will contain significant technical knowledge gaps hindering their implementation with mass timber. The research plan has been formulated to fill these gaps by: (1) developing suitable mid- to high-rise archetypes with input from multiple stakeholders, (2) conducting parametric system-level seismic performance investigations, (3) developing new critical components, (4) validating the performance with large-scale experimentation, and (5) bridging the industry information gaps by incorporating teaching modules within an existing educational and outreach framework. Situated in the heart of a timber-producing region, the multi-disciplinary team will utilize the local design professional community with timber experience and Portland State University's recently implemented Green Building Scholars program to deliver technical outcomes that directly impact the surrounding environment.

Research outcomes will advance knowledge at the system performance level as well as at the critical component level. The investigated building system will incorporate cross laminated timber cores, floors, and glulam structural members. Using mass timber will present challenges in effectively achieving the goal of desirable seismic performance, especially seismic resiliency. These challenges will be addressed at the system level by a unique combination of core rocking combined with beam and floor interaction to achieve non-linear elastic behavior. This system behavior will eliminate the need for post-tensioning to achieve re-centering, but will introduce new parameters that can directly influence the lateral behavior. This research will study the effects of these parameters on the overall building behavior and will develop a methodology in which designers could use these parameters to strategically control the building seismic response. These key parameters will be investigated using parametric numerical analyses as well as large-scale, sub-system experimentation. One of the critical components of the system will be the hold-down, a device that connects the timber core to the foundation and provides hysteretic energy dissipation. Strength requirements and deformation demands in mid- to high-rise buildings, along with integration with mass timber, will necessitate the advancement of knowledge in developing this low-damage component. The investigated hold-down will have large deformation capability with readily replaceable parts. Moreover, the hold-down will have the potential to reduce strength of the component in a controlled and repeatable way at large deformations, while maintaining original strength at low deformations. This component characteristic can reduce the overall system overstrength, which in turn will have beneficial economic implications. Reducing the carbon footprint of new construction, linking rural and urban economies, and increasing the longevity of buildings in seismic zones are all goals that this mass timber research will advance and will be critical to the sustainable development of cities moving forward.

Resource Link

https://www.nsf.gov/awardsearch/showAward?AWD_ID=1563612&HistoricalAwards=false



Bending Resistance and Deformation Capacity of Fibre Reinforced Glulam Beams

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