NHERI TallWood

Shake Table Testing of a Full-Scale Resilient 10-Story Mass-Timber Building
Newsletter Issue 4: January 5, 2023

Structural Construction is Complete

A significant achievement was marked by the successful completion of the structural system by the end of December. Following the installation of two additional rocking wall segments, the total height of the building was reached and the roof panels were installed to top out the 10-story building. As it is shown in Figure 1, gravity system was constructed along with the rocking wall segments. Once all rocking wall panels were placed, the post-tensioning operation was implemented to complete the lateral system. All temporary bracing elements for construction were removed and the building is free standing with the resilient rocking wall lateral system.

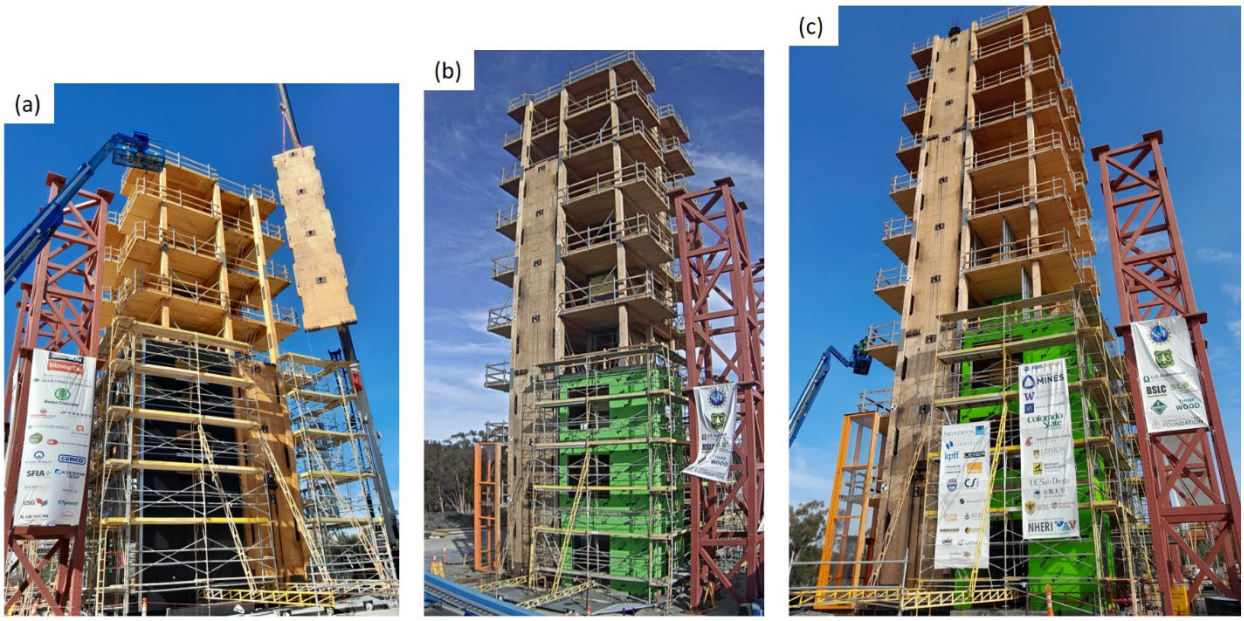

Figure 1: (a) Installation of 2nd wall segment with gravity system reaching floor 8, (b) gravity system built up to the 9th and 10th floors with temporary bracing, (c) building topped out at 10-stories

A significant number of hardware components were installed (e.g. UFPs, shear keys, out-of-plane braces) in order to complete the rocking wall system. The contractor continued to work on punch list items after the building topped out. The structural construction was essentially complete at the end of December just in time for the holiday facility closure.

Progress on Nonstructural Walls

The Southwest Carpenter's Union Training Fund (apprenticeship program) finished all framing and sheathing of the three exterior CFS subassemblies by about mid-November (Figure 2). We are so grateful for this organization's service to the project, and the apprentices were great to

work with. Ehmcke Sheet Metal will complete the remaining steps for the exterior skin layer that features an aluminum composite panel. This work was underway in late December continuing into January, and includes waterproofing, flashing, window installation, and finally panel and joint installation.

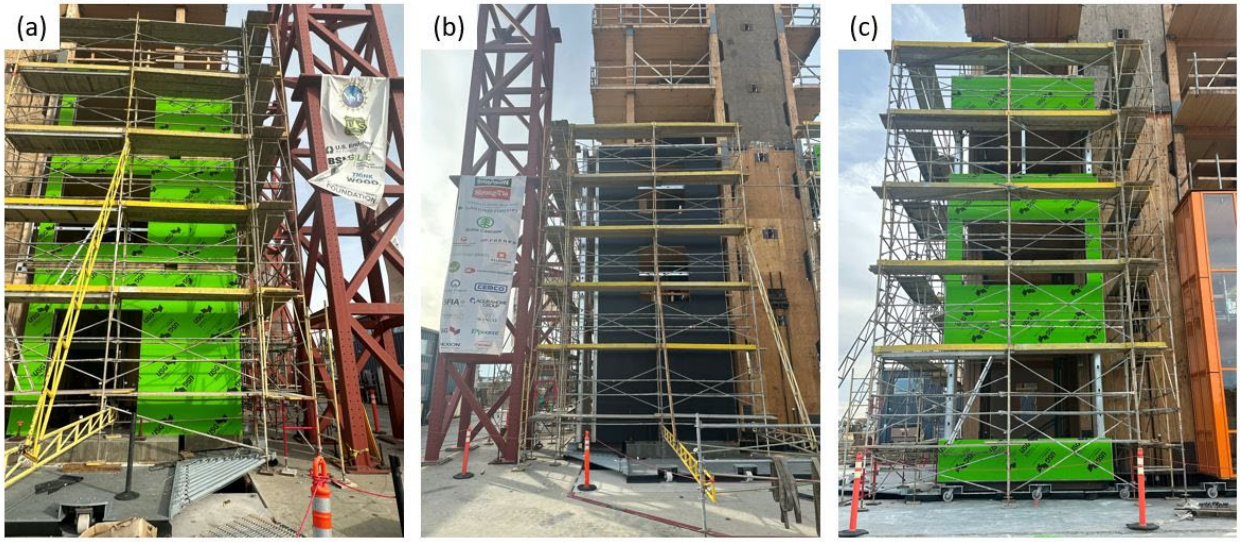

Figure 2: Framed and sheathed exterior wall subassemblies, representing different construction techniques: (a) platform framing, (b) bypass framing, (c) spandrel units with ribbon windows

At the same time, Pacific Coast Drywall is finishing the installation of CFS-framed interior walls on three levels. Like the exterior subassemblies, these interior walls utilize techniques to accommodate the floor-to-floor movement, including horizontal slip joints at the top of the wall, and vertical expansion joints to accommodate the displacement incompatibilities at intersecting walls (see Figure 3). Solutions are proposed for a fire-rated shaft wall adjoining to conventional interior partition walls.

Testing Timeline

Many of you are curious about the testing timeframe and test plan. We will be testing over a period of 5 weeks, starting with low level shaking and gradually/systematically increasing intensity over the duration. There will be ample opportunity for interested participants to view a test in person; if you are interested please email us or reach out to one of the project investigators.

Our current projection is that testing will start in February. To be ready for testing, 800 sensors and approximately 60 video cameras need to be installed in the building (along with all the preparation work that accompanies these installations). This newsletter aims to keep you informed of progress and schedule, especially around test time.

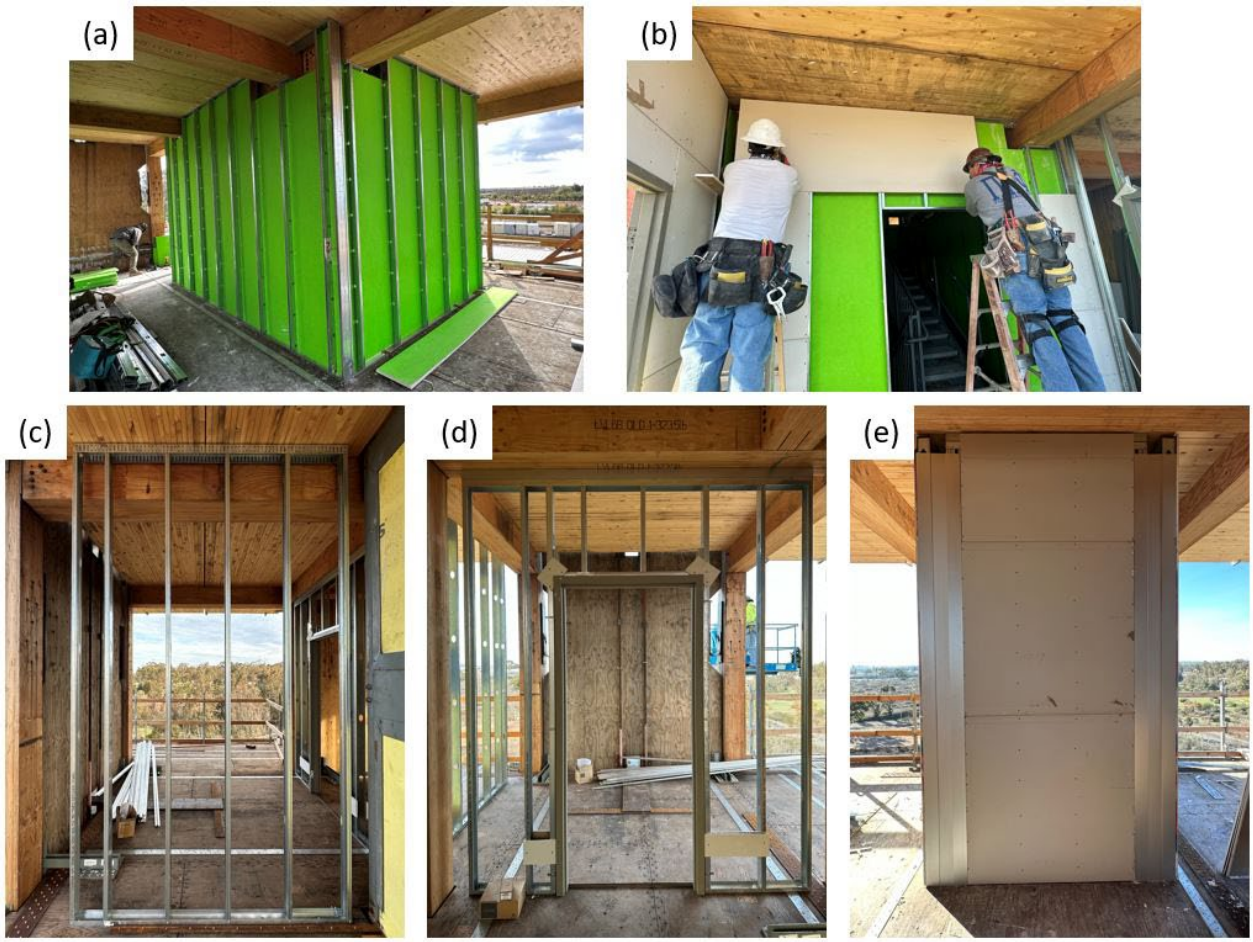

Figure 3: Interior wall construction: (a) shaft wall outline, (b) – (d) various wall junctions with gaps for vertical joints (not yet installed), (e) finished wall with corner joint assembly.

Test Feature Highlight: 10-story Stair Tower

The importance of continued functionality of egress stairs was highlighted by high profile stair collapses in the 2011 Christchurch Earthquake that stranded occupants in the respective buildings. Subsequently, ASCE 7-16 introduced new language stating that stairs that are nonstructural must be designed to accommodate the drift movement and retain their load carrying capacity post-earthquake. However, there is limited guidance or performance validation of deformation compatible details.

We have partnered with Construction Specialties to test several different concepts for drift compatible connections of stair stringers to landings. To facilitate this, Construction Specialties donated 10 stories of pre-fabricated steel stairs for inclusion in the test building. Stories 1-8 are comprised of Construction Specialties patented modular stair system (MSS) units, while stories 9-10 use conventional stair framing techniques. The self-supporting MSS units incorporate a channel band framing around the top of the stair units supported by gravity columns (Figure 4). The MSS units are entirely prefabricated and arrive at the site fully assembled. They are quickly

stacked into place, speeding up the construction process. Six stories incorporate Driftready™ connections, two stories have slotted connections and two stories have fixed-free connections. In the slotted connection scheme, longitudinal slots are placed at the bottom connection of each flight, and transverse slots are placed at the top connection of each flight. The free connection will be like the slotted connection, but the bolts at the bottom connection of each flight will be removed during the testing. Finally, three stories have been installed with fire protection walls surrounding the stairs (Figure 5). Fire-rated panels surrounded by a flexible fire-rated material within the framing are intended to allow the wall panels to freely move within the stair frame.

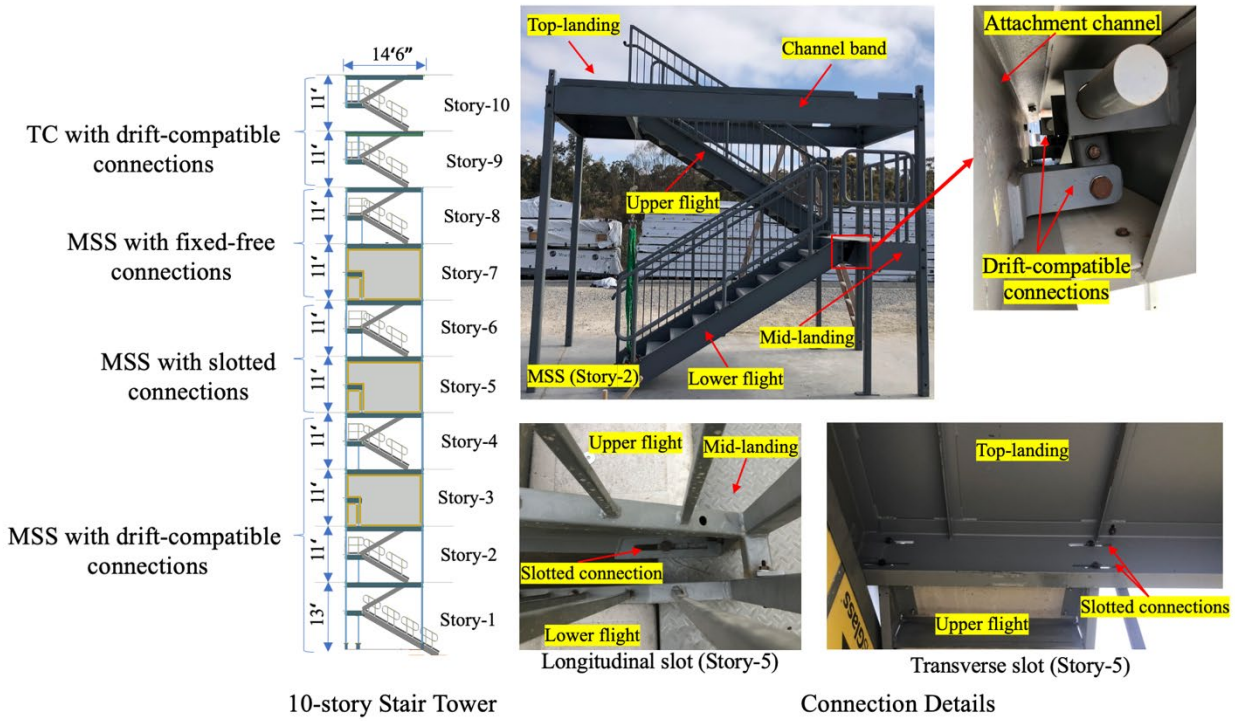

Figure 4: 10-story steel stair tower with various configurations and connection details.

Figure 5: Installation sequence of modular stair system (MSS) unit with fire-rated shaft wall panels

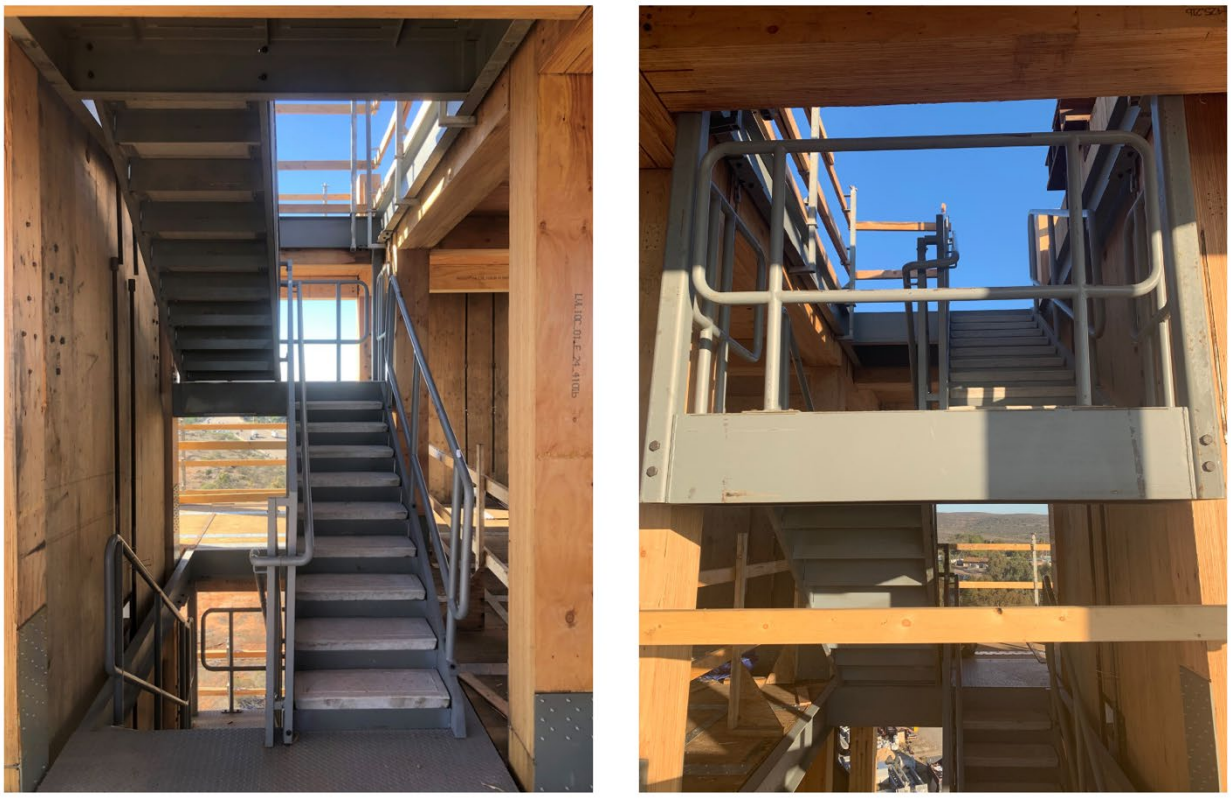

Figure 6: Stair system representing the traditional construction (TC) with drift-compatible connections at stories 9 and 10. This stair system, unlike MSS, does not have columns extending from floor to floor.

Follow Construction Progress

Reminder: You can follow construction progress on your own by looking for our newsletters on the NHERI TallWood website: http://nheritallwood.mines.edu/, checking in with the site webcam http://nheri.ucsd.edu/video/, or following Ling on Twitter: @slpei.

Acknowledgements

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