New Wood Materials

Cross Laminated Timber (CLT)

By John "Buddy" Showalter, P.E.

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Cross Laminated Timber (CLT) is a flexible building system suitable for use in all assembly types (e.g., walls, floors, and roofs). Made from industrial dried lumber stacked together at right angles and glued over their entire surface, it is an exceptionally strong product that retains its static strength and shape, and allows transfer of loads on all sides. Panels are prefabricated based on the project design, and arrive at the job site with windows and doors pre-cut. Although size varies by manufacturer, they can be as large as 54.1 x 9.7 x 1.6 feet and include 3, 5, 7, or more layers.

Common connections for CLT assemblies include wall-to-foundation, wall-to-wall (straight or junction), floor-to-floor, wall-to-floor, and wall-to-roof. Panels may be connected to each other with half-lapped, single or double splines made from engineered wood products, while metal brackets, hold-downs, and plates are used to transfer forces. Mechanical fasteners may be dowel-type (e.g., nails, screws, glulam rivets, dowels, bolts) or bearing-type (e.g., split rings, shear plates).

CLT assemblies excel in terms of fire protection because, like heavy timber, they char at a rate that is slow and predictable, maintaining their strength and giving occupants more time to leave the building. CLT structures also tend to not to have as many concealed spaces within floor and wall assemblies, which reduces the risk that a fire will spread. The American Wood Council (AWC) conducted a successful ASTM E119 fire resistance test on a CLT wall last year at NGC Testing Services in Buffalo, NY. The wall, consisting of a 5-ply CLT (approximately 6⅞ inches thick), was covered on each side with a single layer of ⅝-inch Type X gypsum wallboard. The wall was loaded to the maximum load attainable by the NGC Testing Service equipment. The test specimen lasted 3 hours, 5 minutes, and 57 seconds (03:05:57). **www.awc.org/Code-Officials/2012-IBC-Challenges/NGC-CLT-Report.pdf**

In terms of seismic performance, wood buildings perform well because they're lighter and have more repetition and ductility than structures built with other materials, which make them effective at resisting lateral and uplift forces. To illustrate this, the Trees and Timber Research Institute of Italy tested a full-scale seven-story CLT building on the world's largest shake table, in Japan, with excellent results. Even when subjected to severe earthquake simulation (magnitude of 7.2 and acceleration of 0.8 to 1.2 g), the structure showed no residual deformation. The maximum inter-story drift was 1.5 inches and the maximum lateral deformation at the top of the building was just 11.3 inches.

Recently, an AWC code change to expand the use of CLT into the heavy timber construction classification (Type IV) was approved for incorporation in the 2015 *International Building Code* (IBC). The change will allow more options for CLT use in non-residential buildings. In addition to the Type IV classification, a new product standard, ANSI/APA PRG 320-2011 *Standard for Performance-Rated Cross-Laminated Timber*, will be referenced in the 2015 IBC. Until the 2015 IBC is published and adopted, building officials are approving designs using the alternate materials and methods provision of the code.

Additionally, Skidmore Owings & Merrill LLP (SOM) recently released the Timber Tower Research Project, an initiative sponsored by the Softwood Lumber Board (SLB), to establish the structural viability of a 42-story-tall prototypical mass timber framed building. The new prototype is a hybrid system that uses the most efficient structural combination of mass timber (including CLT), concrete, and steel to reduce the carbon footprint of the resulting design by between 60 and 75 percent when compared to the concrete benchmark.

As with all wood products, the benefits of CLT include the fact that it comes from a renewable and sustainable resource. Wood also has a low carbon footprint by continuing to store carbon absorbed during a tree's growing cycle, and avoiding greenhouse gas emissions that are often the result of using other building products that require large amounts of fossil fuels to manufacture. In fact, the architect of a CLT apartment building in the UK estimated that, between the carbon stored in the panels and emissions avoided by not using concrete, he kept about 300 metric tons of carbon out of the atmosphere. The CLT building was also estimated to weigh four times less than its concrete counterpart, which reduced transportation costs, allowed the design team to reduce the foundation by 70 percent, and eliminated the need for a tower crane during construction. It took four carpenters just nine weeks to erect nine stories – and the entire construction process was reduced from 72 weeks to 49.

Leading wood organizations have collaborated to publish a new *CLT Handbook* which can be downloaded at **www.masstimber.com**. Printed copies are available at **www.awc.org**.▪

John "Buddy" Showalter, P.E., is Vice President of Technology Transfer at the American Wood Council and a member of STRUCTURE magazine's Editorial Board. He can be reached at ***bshowalter@awc.org****.*