Kaiser Group and Path Architecture designed Carbon 12. At the time it was built it was the tallest mass timber and cross-laminated timber building in the country.

CREDIT: ANDREW POGUE

Strides In Fire Safety

for Mass Wood Timber Buildings

Tall Mass Wood Timber buildings have captured the design imagination of North America. As these buildings are poised to go taller, the leading firestop company, Hilti North America, has stepped in with innovative ways to help promote fire safety.

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Carbon 12 shows off the beauty of wood with its exposed Douglas Fir panels doubling as finished ceilings.

WHEN CARBON 12, A BEAUTIFUL EIGHT-STORY Cross-Laminated Timber (CLT) apartment complex was built in Portland, Oregon, the country got excited about the future of Tall Mass Wood Timber (MWT) building. After Carbon 12's 2017 debut, many on-the-boards projects got press as Portland—and other cities, including Chicago, San Francisco, and Philadelphia—dreamed of new ways to go taller with timber. Today, Portland has the country's largest concentration of mass timber buildings and has solid growth potential.

"The question for Hilti became, How long can a structural wood construction element withstand a fire within a building? Hilti has focused on this gray area because no approved firestop solutions existed."

—Neal Clemens, Marketing and Product Manager, Fire Protection, Hilti North America

CREDIT: ANDREW POGUE

Mass timber is the general term for large structural panels, posts, and beams composed of wood. Products in the category include CLT, Structural Composite Lumber, glue-laminated timber, and large section sawn lumber. The market for these products in tall buildings like Carbon 12 is growing rapidly—so rapidly, in fact, that the building and scientific communities are struggling to keep up with the analyses, best practices, and codes needed to ensure a smooth transition from building with steel or post-tension concrete to a wood-built future in tall buildings.

From 2014 to the end of 2018, the number of U.S. mass timber projects grew from fewer than 20 to well over 400, reports nonprofit WoodWorks. And Forterra, a land conservation nonprofit, says that demand for CLT, which is used in Tall MWT projects, is expected to double every five years into the future.

The exponential growth of MWT is good news for the building industry because the technology offers faster construction time, reduced on-site skilled labor requirements, generally lighter weight potentially requiring less substantial foundations, beneficial thermal properties, and positive environmental impact.

"CLT technology is absolutely becoming more popular," says Matthew Winston, Testing and Approvals Engineer, Fire Protection Engineering Team, Hilti North America. "And really that popularity started to rise in 2015, making a resurgence with the green building and sustainability initiatives that design firms were looking to bring into the construction world. The ability to approach tall building from a modular standpoint results in reduced manpower and many other characteristics that make CLT attractive to the building industry—and it's not going away."

WITH INNOVATION COMES RESPONSIBILITY

Perhaps the most important (and misunderstood) aspect of MWT is its fire performance. People often think of wood as a quick-igniting object, like kindling. But the mass wood used in multistory buildings chars in the event of a fire, protecting the inner layers of wood from damage.

In fact, according to "Mass Timber Market Analysis," by The Beck Group, "Recent laboratory burn tests of Mass Timber products have addressed concerns regarding fire safety in large wooden structures. Mass timber structures far outperform stick framed structures and, due to the charring effect, can even outperform steel structures during very high temperature fires, in which steel will melt, deform, and fail."

Hilti, the leading manufacturer of internationally approved and tested firestop systems, monitored the growth of MWT, and in particular CLT, and realized its leadership in producing and testing firestop products had put the company in an excellent position to help propel the mass timber industry forward.

"The question for Hilti became, 'How long can a structural wood construction element withstand a fire within a building?'" says Neal Clemens, Marketing and Product Manager, Fire Protection, Hilti North America. "Hilti has focused on this gray area because no approved firestop solutions existed."

"Really the question around firestop started with Oregon State University, who had contacted SmartLam to build a Tall MWT the University had designed," says Clemens. "SmartLam said they could build it but asked the important question: 'What about life safety?'"

The building industry, antsy to put wood to work in buildings of scale, turned to building codes and testing to maintain the momentum of Tall MWT adoption.

BUILDING CODES EVOLVE

According to the International Code Council (ICC), "Tall Mass Timber" identifies mass timber buildings constructed of mass timber elements that exceed current height limits for wood buildings set by the International Building Code (IBC). Until recently, building codes were the primary barrier to the use of Tall Mass Timber because they were tailored to traditional building systems, such as steel, stick frame, and concrete.

"In the 2018 code cycle, wood coalitions put forth proposed changes to include MWT," says Edward Goldhammer, Director of Codes and Approvals for Hilti North America. "The bulk of these proposals were rejected because they did not have enough data on fire performance in tall buildings. As a result ICC agreed to create an ICC Tall Wood Building Ad Hoc Committee. The committee in conjunction with the wood industry conducted a series of large scale fire testing to demonstrate how MWT performs in a fire. Based on this research the committee developed a set of code change proposals to accommodate the use of MWT in tall buildings.

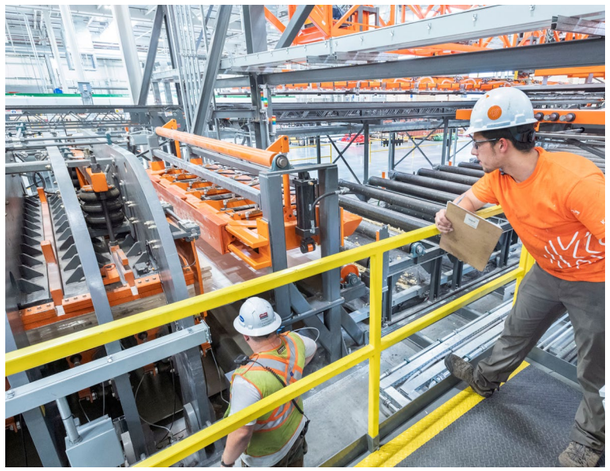
Based on favorable research results, ICC approved code changes to 2021 IBC allowing for Tall MWT.

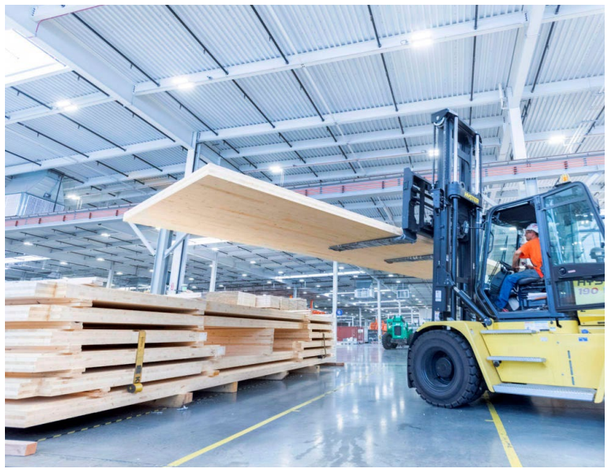
"For the 2021 IBC, ICC classified MWT within a Class IV building and then added three more categories types--IV-A, IV-B, and IV-C. These categories allow fully encapsulated MWT buildings (IV-A) to go up to a maximum 18 stories depending on the occupancy and partially encapsulated MWT buildings (IV-B) to go up to a maximum of 12 stories," Goldhammer explains.

The encapsulated buildings use gypsum or other noncombustible products to add passive fire resistance, which is why they are approved for taller structures. The partially encapsulated buildings are still safe, Goldhammer says. "Even though the IV-B structure performs well, having the gypsum just adds another level of safety."

Designers can opt for the IV-B structure for designs that celebrate the wood look of CLT building. Exposed Douglas Fir panels can, for example, serve as unit ceilings.

While the ICC and other stakeholders worked through building code issues, Hilti continued to focus on firestop solutions. "We asked ourselves, 'How do we tie firestop into the building of MWT, addressing these taller and bigger buildings?' The code gives requirements like it does for any other type of construction, but you have to have rated assemblies and still meet the requirements for compartmentalization," Goldhammer says. "We have always had firestop through a rated assembly, so that's not a big change. The challenge is that these new assemblies are not part of a listing/certification [such as UL or Intertek] so we can not obtain a firestop certification without a certified assembly."





In 2019, Katerra opened a 270,000-square-foot CLT factory in Spokane Valley, Wash. At full capacity, this factory will produce the highest volume of CLT in North America–13,000,000 square feet of 5-ply panels annually. The factory also represents one of the largest CLT presses currently in operation globally, offering customers unmatched design flexibility. IMAGE BY KATERRA WWW.KATERRA.COM

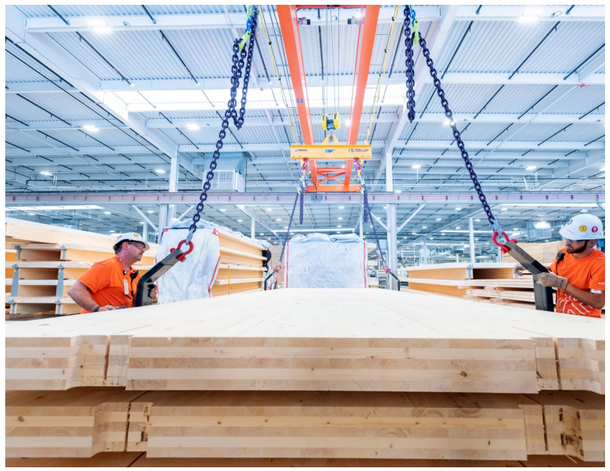
While Winston points out that quite a few Tall MWT buildings have gone up in places like Portland and Seattle, a large part of the inspection community is still waiting for a chance to review a MWT project. "For example, I recently provided an analysis of test data for firestops in CLT to a design team," says Winston. "The initial firestop designs were provided in 2018 and now, in 2020, the design teams are sitting with building inspectors [to review life safety.]"

Hilti wants to streamline the process for building designers and the inspectors who are tasked with signing off on firestop systems in MWT buildings, but until the assemblies are listed or certified, says Winston, approvals will rest on project-specific designs called Engineering Judgments. "Typically, someone who needs a firestop system would refer to a listing from a third-party certification body. To date, however, no such listings exist for firestops in MWT," he says.

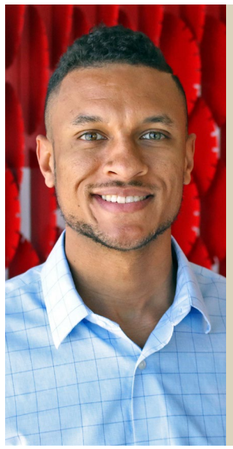
With the goal of developing more data

HILTI GOES TO BAT

"There has been a big push back around fire safety in tall wood buildings," Winston says. "On the one hand, design firms, the mass timber industry and ICC code committees have paved the way; on the other hand, fire inspectors, fire departments, and city inspectors have pushed back on life safety issues and the lack of assembly certifications."



When CLT members, such as this one being manufactured by Katerra, are tested by Hilti, they are built into mock-up assemblies with penetrations included. The testing plans are designed to show what happens when mechanical or electrical conduit is put through the floor to determine how to fire rate it. The tests include different CLT manufacturers' products and different species of wood, which are tested in ovens. COURTESY HILTI



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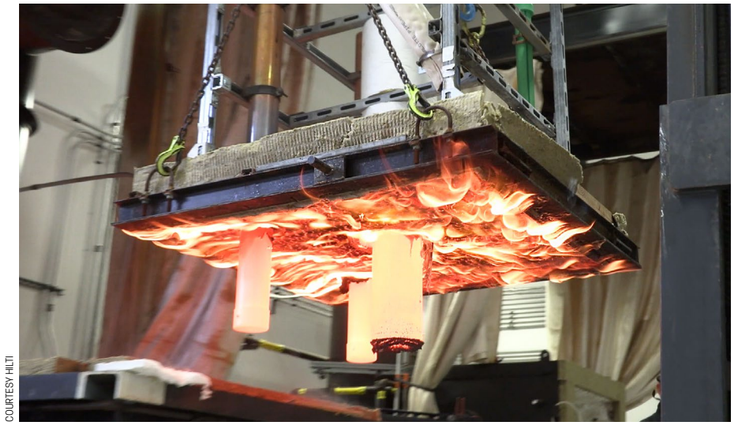


COURTESY HILTI

Hilti engineers test CLT assemblies to UL 1479 (ASTME 814) for penetrations and UL 2079 (ASTME 1966) for joints. The photo above shows a MWT assembly as it is removed from the furnace at the end of a UL 1479 fire endurance test.

for CLT assemblies, Hilti has worked with Katerra, Nordic, and other manufacturers on firestop solutions for CLT since 2017. "We requested Hilti provide tested firestop assemblies for use on our first CLT projects—The Postmark, Lifebridge, Amberglen, and The Grove," says Hans-Erik Blomgren, PE, SE, Director of Testing and Characterization, Katerra.

Hilti put its state-of-the-art research facility and the expertise of its engineers to work testing firestop solutions on CLT specimens. "Together we designed the test plan and did all the research necessary to test the assemblies in the lab, including creating all the openings for penetrating items like PVC drain pipes or conduit, applying different firestop material, and prepping the assembly for testing," Winston says.

Tests were performed at the Hilti North American Testing and Development Center in Irving, Texas. Engineers focused on two standards applicable in the United States: UL 1479 (ASTME 814) for penetrations and UL 2079 (ASTME 1966) for joints. For Canada approvals, Hilti tested to CAN/ULC S115, both in-house and with external partners. Hilti provides these types of collaborative tests for a variety of customers. "We provide services, products, and custom testing plans for each project to help Katerra," Clemens says.

This work should inspire confidence.

The tests were successful, helping show firestops in CLT can perform well in accordance with consensus fire test standards. "The tested solutions have allowed us to use Hilti testing as evidence to demonstrate life safety building code requirements are met," Blomgren says.

A key next step for Hilti is to work with certification agencies to develop a pathway for MWT firestop listings. "Hilti has tested firestops in CLT assemblies with representatives from leading certification agencies as witnesses. These tests have been positive, which has opened the pathway for discussing how to approach listings," Winston explains. "We have done a lot of work to find safe solutions, and it is important for designers and building officials to have clear options for firestops in CLT assemblies. The goal is to avoid the use of a firestop solution that was not tested, and the best way to accomplish this is to have publicly available firestop listings in CLT as we have for concrete, gypsum, and other building systems. I am hopeful that we can reach this goal with our certification partners in the next year."

FIRESTOP PRODUCTS ARE THE KEY

Firestop solutions are the key to why CLT assemblies continue to pass Hilti's rigorous lab tests. "Firestop is important because as we approach 2021—when they actually adopt fire protection for tall mass timber into the building codes—there needs to be a way to balance going higher and higher with safer and more effective structures," says Clemens. Winston agrees, and says Hilti's firestop products are crucial if the building industry continues to push the vertical boundaries.

Firestop products that have been tested in MWT assemblies can be grouped into three major categories: sealants, intumescent wraps or collars, and firestop devices.

Firestop sealants are popular on jobsites because they are simple to install once the opening and penetrating item, or joint, has been made. Sealants are the last item to be installed for a firestop system in most cases and allow contractors to be reactive to changing jobsite plans.

PRODUCT SOLUTION:
High-Performance Intumescent Firestop Sealant FS-ONE MAX

This product seals most common through penetrations in a variety of base materials including concrete, masonry, drywall, and mass timber. Appropriate for metal pipe penetrations (copper, steel, and EMT), insulated metal pipe penetrations (steel and copper), and plastic pipe penetrations (closed or vented). The sealant is easy to use, water based, paintable, ethylene glycol free, and offers industry-leading VOC results. **Visit: FS-ONE MAX**

With penetrations through MWT, firestop sealants are often intumescent (designed to expand with heat) and paired with mineral wool insulation to fill the annular space around penetrating items. Hilti has tested firestop sealants with metallic penetrating items, ducts, and cables with success. In joints, sealants will consist mainly of flexible sealants, either acrylic or silicone based, that accommodate small amounts of joint movement.

PRODUCT SOLUTION:
Firestop Top Track Seal CFS-TTS

CFS-TTS is a preformed polyurethane firestop device designed to be a versatile solution for fire-rated assemblies on flat concrete construction. Designed to saddle over top track without additional folding, taping, or gluing, the product achieves a durable and reliable system tested in accordance with UL2079 5th Edition and CAN/ULC-S115. **Visit: Top Track Seal CFS-TTS**

Intumescent wraps or collars are a unique firestop tool that excel when protecting penetration openings with nonmetallic pipes. During the fire endurance test nonmetallic penetrating items melt and break down, which leaves a void equal to the original pipe size in the opening. Intumescent wraps and collars are designed to expand at the time nonmetallic pipes start to break down to fill the void space created.

Testing for intumescent wraps in MWT involves wrapping the nonmetallic penetrating item and then inserting it into the annular space within the MWT assembly. Intumescent collars are attached to the outer surfaces of the MWT assemblies (to both surfaces for walls or the bottom surface only for floors) using wood screws.

PRODUCT SOLUTION:
Firestop Drop-In Device CFS-DID

An out-of-the-box, one-step firestop solution for a variety of pipe materials and diameters, this product helps reduce labor costs and increases productivity. It offers integrated moisture and smoke seal and quick install, and is easily identifiable to building inspectors. The device is for use in MWT, concrete, hollow core, and metal deck slab thicknesses ranging from 2½" to 12½". Options for fastening include gas actuated fasteners, metal hit anchors, and Kwik con screw anchor systems. For MWT assemblies the device is fastened with wood screws. **Visit: Firestop Drop-In Device CFS-DID**

One critical reason that firestop testing in MWT is so important is to understand how intumescent collars will perform when the MWT they are attached to begins to break down under fire conditions. Hilti has successfully tested the use of collars attached to exposed MWT floors.

PRODUCT SOLUTION:
Speed Sleeve CP 653 BA

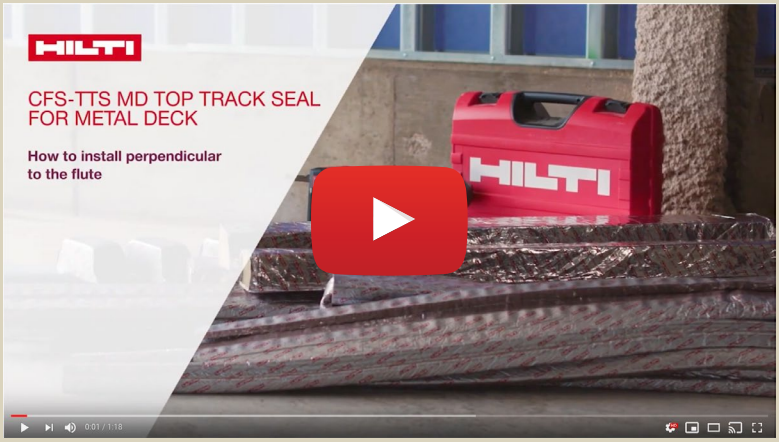
For use with concrete floor rated up to three hours and gypsum walls rated up to four hours, and MWT assemblies for up to 1½ hours, this product is a re-penetrable cable management device electrical and premise wiring, as well as low-voltage and datacom. It offers fast installation, easy penetration and re-penetration, the industry's best "Air Movement" ratings, Low L-ratings. Test in accordance to UL 1479, ASTM E 814, CAN/ULC-S115. **Visit: Speed Sleeve CP 653 BA**

Firestop devices bring many advantages when planning and jobsite coordination can accommodate their installation. Hilti's firestop drop-in device is a great example for MWT of a firestop device that can accommodate a variety of metallic and nonmetallic penetrating items, can be installed on the jobsite or accommodate modular design with factory installation, and simplify inspection.

The device contains intumescent strips at the bottom of a steel sleeve with an integrated flange. The device flange is attached to the top surface of the MWT floor. The intumescent strips are located on both the inside and outside of the sleeve. This affords protection of the annular space around penetrating items in the sleeve, and it protects the opening in the MWT around the sleeve by filling the space with intumescent material.

Katerra is constructing the 150,000-square-foot Catalyst Building in Spokane's new South University District. This is the first project to receive CLT from Katerra's newest factory and the first office building in Washington State to be constructed from CLT. The Catalyst will be connected to an energy and resource sharing eco-district that serves as a bridge between Spokane's downtown core and the growing U-District.

In joints involving MWT, Hilti has had success with firestop devices. One example is the joint between gypsum board and the bottom surface of a MWT floor. This joint is called a head-of-wall joint, and it can be protected with Hilti's Firestop Top Track Seal. This firestop device is placed over the ceiling runners used for the walls prior to attaching the framing to the bottom of the MWT assembly. Intumescent flanges on the device then hang over the ceiling runner, and once gypsum board is installed, fill the space between the gypsum board and MWT floor.



STREAMLINING FOR THE FUTURE

While Hilti is the undisputed leader in firestop solutions for MWT building—as well as a tireless champion of streamlined adoption of Tall MWT—the company has a broader role.

"We are Hilti, and we are committed to fire protection," Clemens emphasizes. We also offer more than that. Think of us as mass timber everything—everything a firestop professional would need to install in MWT or other types of construction, we can do."

The streamlining includes the tireless lobbying and grueling data gathering for listings and code approvals, as well as the company's commitment to be the one source for developers and designers. "We have developed products for concrete and steel construction that work for wood, such as tools, screw fastenings, anchors," Clemens reminds. "We don't have to reinvent the wheel or create brand-new products to support the industry, to help everyone on site."

Looking to the future, Clemens says that Hilti's suite of products, expertise, and customer support put the company in an excellent position to help building designers dream up ever more exciting Tall MWT projects.

"One of the most exciting things about the mass timber industry is prefab," Clemens says. "Companies can create assemblies off site, put them on a flatbed, and they go up just like puzzle pieces on site. All the construction concerns of the industry—budget, safety, timing, pay, and income—are all tied to schedule, and we can help solve that."

Katerra and other manufacturers are bullish about the future. "We see mass timber, specifically CLT, as the backbone for future generations of high-performance, low-carbon buildings," says Blomgren. "Mass timber is a technologically advanced and sustainable product that offers a shift towards greater productivity through prefabrication. When sourced from well-managed forests, mass timber can benefit the environment and the built environment by contributing to forest health, reducing the carbon footprint of buildings and increasing the well-being of its occupants."

"From my side, looking at the future, we will continue to support projects directly," says Winston. "For manufacturers and organizations that want to take mass timber to the next level, such as in modular buildings, we will help those companies bring efficiency to the building process and provide firestop solutions that support the life-safety mission." ■