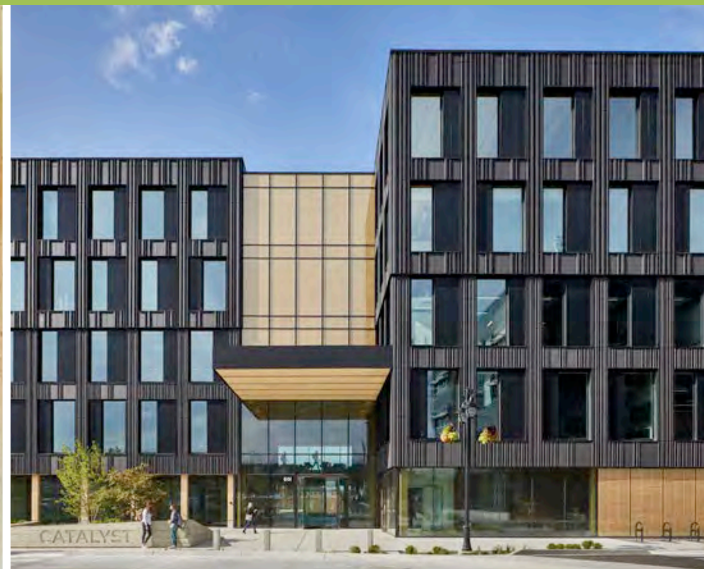

Mass timber building serves as an agent for change

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Aptly named for its goal of inspiring new ways to build, Catalyst is the first cross-laminated timber (CLT) office building constructed in Washington state and the first to use panels produced at Katerra's new CLT production facility. It is also designed to Passive House principles and to achieve zero-carbon and zero-energy certification from the International Living Future Institute (ILFI), making it a leading example of sustainable building design.

"Catalyst, which anchors the new South Landing Eco-District, is more than just another smart building project," said Dean Allen, CEO of McKinstry. "It is the cornerstone of a fully integrated neighborhood that will serve as a living laboratory for new sustainability technologies, materials, construction techniques and operational practices. Catalyst demonstrates how the built environment can be constructed and operated for our partners, our clients, our communities and our planet to deliver sustainability and impact, not just physical space."

PROJECT DETAILS

LOCATION:
Spokane, Washington

STORIES:
Five stories plus partial day-lit basement

SIZE:
164,000 square feet

CONSTRUCTION TYPE:
Type IV Heavy Timber

COMPLETED:
2020

PROJECT TEAM

CLIENT/OWNER:
Avista Development, McKinstry, South Landing Investors LLC

ARCHITECT:
Katerra (Architect of Record) + Michael Green Architecture (Design Architect)

STRUCTURAL ENGINEER:
KPFF

CONTRACTOR:
Katerra Construction

CLT SUPPLIERS:
Katerra, Structurlam

GLULAM SUPPLIER:
Western Archrib

RIB PANEL ENGINEERING AND SUPPLIER:
Katerra

What happens when a technology and building development company joins forces with an energy utility, public university and full-service engineering firm to develop the first building in what they hope will eventually become the smartest five blocks in the world? The end-to-end collaboration used to build Catalyst established a new construction model that set multiple precedents, not only in design, how building materials were fabricated and how the structure was built, but also in how the building will be used.

The five-story Catalyst contains classroom and lab space for approximately 1,000 Eastern Washington University students studying engineering and applied sciences. It also includes leased office space, creating a unique opportunity for public and private sector collaboration.

Adjacent to Catalyst is the Scott Morris Center for Energy Innovation, which houses centralized heating, cooling and electrical systems for buildings in the EcoDistrict. The system includes solar panels, battery and thermal storage, and shared utilities. It is managed through a smart grid that allows for real-time, automated energy management resulting in lower energy consumption and expense.

Catalyst was constructed using an all-wood structural system, including glue-laminated timber (glulam) columns and beams, CLT shear wall panels and glulam/CLT composite floor and roof ribbed panels. Most of the timber structure and the exterior CLT wall panels are left exposed to the interior. "One of the unique things about Catalyst is the fact that it simply looks different," said Jim Nicolow, Director of Sustainability for Katerra. "The use of exposed mass timber gives the building incredible character—and its environmental story is even better."

Innovative CLT Applications

The glulam beams used in the post-and-beam structural frame are 14 and 16 inches wide, and up to 40 inches deep. CLT panel thicknesses varied, with 3-ply used for exterior walls, 5-ply for floors and roofs, and 7-ply for shear walls. All mass timber products were made using spruce-pine-fir (SPF) for a clean and light interior aesthetic. Structurlam provided the 3- and 7-ply CLT panels. The 5-ply floor and roof panels were the first product to roll off the lines at Katerra's new CLT manufacturing facility in nearby Spokane Valley. Today, Katerra's plant is certified for all CLT thicknesses.

Catalyst was built on top of a conventional concrete slab on grade, and a balloon-frame shear wall design was used for the wood lateral system at the building's core. Buckling-restrained braces are used as high-strength ductile hold-down elements for the 7-ply CLT shear walls, making Catalyst one of the tallest buildings to include CLT shear walls in the U.S.

CLT shear panels were stacked and spliced together with a glued-in rod connection. "The rods were glued into the bottom panel so the panel above could be dropped into the slot, and then it was field glued to create a concealed, strong and stiff connection," said Hans-Erik Blomgren, Director of Testing and Certification, Structural Products at Katerra. "It was a progressive design, which the design team verified with testing."

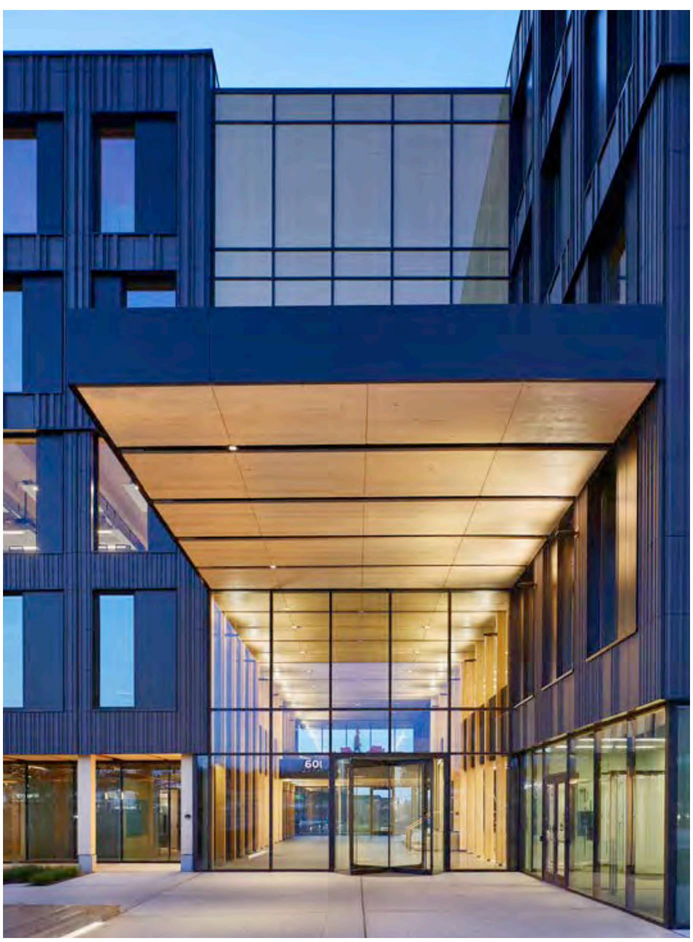
Katerra also utilized an innovative timber-timber composite rib floor panel. Crews glued and screwed two glulam beams to the underside of each 10x30-foot CLT floor panel at the factory, making the panel fit perfectly within Catalyst's 30x30-foot grid while taking full advantage of Katerra's CLT manufacturing capabilities.

"Use of the double-T rib configuration allowed us to maintain a shallow span-to-depth ratio of 15.5," explained Blomgren. "Even when we added lightweight concrete topping, the panel weighed just 41 psf. The 30-foot span is perfect for office use, so from a developer and structural engineer point of view, it offers exciting opportunities."

"To our knowledge, this is one of the first projects in North America able to achieve a long span using true wood-to-wood composite action in these rib panels instead of concrete composite action," added Katerra's Design Project Manager, Drew Kleman.

Extensive Testing

Katerra conducted destructive structural testing of critical CLT shear wall corner connections and full-scale rib panels at Oregon State University. "Testing gave us the confidence of knowing the true strength and stiffness of the rib and shear wall panels, and a way to streamline future product and building code approvals," said Blomgren. "Both stiffness and strength slightly exceeded our predictions and proved that this system can be replicated in the future."



Acoustic and vibration performance also exceeded the predictive models. "We tested the rib panel floor vibration during construction, and again after the tenant improvement was completed to quantify performance," added Blomgren. "There were a few nervous engineers and developers in the room because the structural system spans 30 feet and is so lightweight, but the test results make for a good success story."

Long-term energy performance was another success story. RDH, the consulting firm that performed the air leakage test for the building envelope, reported that the air tightness measurements, at 0.035 cfm per square foot, were the best they have seen for a commercial building—even exceeding Passive House requirements.

Catalyst Also Tells a Great Carbon Story

The client's desire to build a zero-carbon building was supported by Katerra and heavily influenced design decisions. The design team knew that mass timber would provide a smaller carbon footprint than a comparable steel or concrete building, but they wanted to know how much smaller.

In 2019, Katerra commissioned the Carbon Leadership Forum and the Center for International Trade in Forest Products (CINTRAFOR) at the University of Washington to undertake a two-part Whole Building Life Cycle Assessment (WBLCA)—one part focused on its supply chain and manufacturing process, and the other on Catalyst.[1] The goal was to understand the environmental impacts and highlight opportunities for impact reduction.

For Catalyst, the overall global warming potential was calculated at 207 kg CO_2e/m^2 in emissions, and the carbon dioxide stored in the wood building components was calculated at 204 kg CO_2e/m^2. According to the report, "…the biogenic carbon storage practically offsets the impacts of construction, at least in the near-term before the wood decomposes in a landfill at end-of-life."

Nicolow emphasized the significance of the findings. "The global warming potential for Catalyst was about half what you might expect for a project like this; the median reported value in the Carbon Leadership Forum's *Embodied Carbon Benchmark Study*[2] for commercial projects is 396 kg CO_2e/m^2," he said. "The manufacturing side, which includes harvesting, fabricating, and building the mass timber panels, generates significantly lower carbon emissions than concrete or steel. So, Catalyst tells a great story, even before you consider biogenic carbon. But when carbon storage is considered, the story is even better. You not only have a low-embodied carbon building, but you have a carbon-sequestering material that essentially makes up for some of the emissions associated with the conventional materials that went into the building."

The leading standards for life cycle assessment, ISO 14040 and 14044, both consider biogenic carbon in their calculations. In 2020, the American Wood Council also updated environmental product declarations[3] for seven wood products, all of which also consider biogenic carbon.

End-to-End Design, Manufacturing and Construction Efficiencies

One of Katerra's corporate philosophies is to reduce on-site labor and maximize efficiency by using factory-built assemblies to speed construction. Catalyst accomplished that on several fronts.

For example, the design team collaborated closely with the CLT manufacturing team to optimize the fit between the desired 30x30 grid spacing and the CLT plant's capabilities. "We considered manufacturing efficiency and used it to inform the overall building design and floor plan," said Kleman.

"When designers know the optimal capabilities of the CLT fabrication line, we can work to use the entire panel, which improves manufacturing efficiency and lowers cost and waste," Nicolow added. "Design for manufacturing is a matter of optimizing one to take advantage of the other."

Efficiency also translates to energy efficiency over the life of the building, added Nicolow. "When you move to a manufacturing paradigm and you're bringing large, factory-built panels to the job site rather than site-building from a kit of smaller parts, it all translates to improved air tightness of the envelope and better performance over time."

Catalyst was progressive in terms of collaboration; everything was coordinated, from design to installation on site, by a vertically integrated team. Blomgren noted that, "It's easier to make key decisions early in design when the pain of change is lower ... decisions that will make fabrication and installation more efficient. Future Katerra projects are going to benefit from the lessons learned from the Catalyst experience."

Construction efficiency also added value. "End-to-end collaboration and modeling were key," said Katerra's construction manager, Kora Todd. "We held to tight tolerances; doing so made it easier to identify a problem when something didn't fit precisely. I told everyone I never wanted to hear a chainsaw on the job site—and 99.5 percent of the members fit perfectly."

Safety was another benefit of the CLT rib panels, since all 350 could be picked and quickly lifted into place, reducing the amount of time workers spent under a crane. Crews improved the rib panel installation process along the way; they began with 30 minutes between panel crane picks, and eventually cut that time by more than half.

Two-story CLT exterior wall panels arrived at the site almost fully prefabricated, with a gasketed silicon strip system where panels met. Fabricating crews applied the weather-resistant barrier, window pre-flashing and insulation to the 3-ply CLT panels at the factory for quick on-site panel installation.

Katerra ran four crews—shear walls, columns and beams, floor panels and hardware—and each had four to five people working at any one time. The entire structure took 11 weeks to erect.

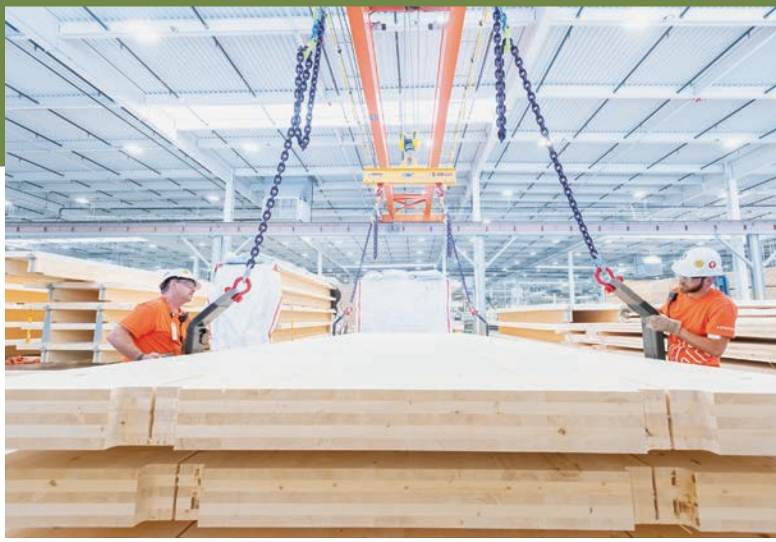
Education, Innovation

Catalyst provided learning opportunities for all involved, even the students who will use the facilty.

"Our goal was to create a building that would promote learning and create an overall sense of student well-being," said Mingyuk Chen, Design Team Lead at Michael Green Architecture. "So many studies point to the biophilic benefits of natural materials. We like to use a building itself as teacher, and Catalyst achieves that by exposing the structure."

Extensive testing opened doors for future projects. "We learned we could effectively build a five-story CLT shear wall, avoiding the need for concrete," said Blomgren. "We also learned we could design rib panels to meet the 30-foot column grid needed by the developer. A lot of thinking went into that structural frame, even down to the vibration and acoustic design, and it was all verified by actual testing. We rarely get the chance to do that."

The WBLCA shed light on the overall sustainability of the project. "There's been so much attention in the building sector on operational energy and operational emissions," Nicolow said. "We're just now shifting our attention to the impact of the building products themselves, to the embodied carbon story. Catalyst provides a great example of how wood can help lower embodied carbon in buildings. To me, it's one of the most exciting aspects of the project."



Catalyst is the first CLT office building in Washington State, and the first to use CLT panels produced at the new Katerra facility in the Spokane Valley. The use of CLT means the building will have a smaller carbon footprint than comparable buildings built with steel and concrete.

1 LCA of Katerra's CLT and Catalyst Building, Carbon Leadership Forum and the Center for International Trade in Forest Products at the University of Washington (2020), https://carbonleadershipforum.org/katerra/

2 *Embodied Carbon Benchmark Study,* Carbon Leadership Forum (2020), https://carbonleadershipforum.org/embodied-carbon-benchmark-study-1/

3 Environmental Product Declarations (EPDs) for Wood, American Wood Council, www.awc.org

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