WoodWorks

CaseStudy

A 'Company of Discovery' Discovers Wood

Promega Uses Innovative Mix of Cross Laminated Timber and Glulam for New Facility

You can tell a lot about a company by the way they treat their clients and employees. You can also tell a lot by the way they build their buildings.

Promega, a leading biotechnology firm headquartered in Madison, Wisconsin, bills itself as a company of discovery. "That's their business, biological discovery, and this philosophy of discovery crosses over into everything they do," said David Rousseau from Archemy Consulting, design consultant for Promega. "For example, they allowed us to design their new client and staff center, called The Crossroads, through a process of discovery—and our decision to use wood was one of those discoveries. In the end, we used glulam beams and cross laminated timber (CLT) to make a statement that this is a special and unusual space."

Commitment to Innovation

The Crossroads, a 52,000-square-foot client and staff reception area, is part of a 300,000-square-foot Good Manufacturing Practices (GMP) facility, which is a highly regulated and specialized building used for manufacturing medical device products. "GMPs can be relatively sterile spaces," said Rosseau, "but Promega wanted The Crossroads to give clients and staff a completely different environment from the GMP. They liked the idea of a 'tree-lined indoor colonnade.' They also wanted high design and high quality materials."

Three firms collaborated to design The Crossroads: Uihlein/Wilson Architects, EwingCole and Archemy Consulting. The project team evaluated several types of structural systems during the initial design phase. "There was no particular assumption in terms of what the structural material needed to be," said Rousseau. "I think we may have even initially assumed it would be a steel structure since that's what we were using for the GMP portion of the project."

But Rousseau said they also knew The Crossroads needed to be a unique space. "Cross laminated timber came up because it's a new and innovative material. Because of that, CLT intrigued Promega. Together with glulam, it was a natural fit for the warm aesthetic we wanted to create. Plus, we wanted to have a high quality, exposed roof deck with long spans and minimum on-site construction complexity. CLT met the criteria."

Aitor Sanchez-Prado, structural engineer and principal for EwingCole, said, "CLT provided us with a solution that met all of our architectural and engineering goals. Architecturally speaking, our decision to use CLT for the roof of The Crossroads allowed us to leave the interior ceiling surfaces exposed, which certainly enhanced the glulam beam and column superstructure. From an engineering point of view, the CLT panels gave us the ability to increase deck spans while supporting heavily loaded areas due to snow drifts. In addition, the CLT panels allowed us to design an overhang of three feet while maintaining a slim profile."

The Crossroads

OWNER: Promega Corporation

LOCATION: Madison, WI

ARCHITECTS: Uihlein/Wilson Architects, Inc., Milwaukee, WI • EwingCole, Philadelphia, PA

ENGINEER: EwingCole, Philadelphia, PA

ENVIRONMENTAL CONSULTING: Archemy Consulting, Vancouver, BC

CONTRACTOR: Kraemer Brothers, Plain, WI

CLT ENGINEER: Equilibrium Consulting Inc., Vancouver, BC

COMPLETION: 2013

Complex Footprint

The Crossroads has a fairly complex footprint, forming a sinuous S-curve which wraps around one corner of the rectangular GMP facility. The design team chose to use wood for the two-story, open area of The Crossroads, and used steel and concrete for the enclosed spaces in back, which extend into the GMP facility. Structurally, they were challenged to use a material that would perform well for the long-span deck needed to cover the curved roof. CLT provided the solution.

"The Crossroads had a unique geometry, with almost no parallel lines in the infrastructure," said Kris Spickler from Structurlam Products. "CLT panels are manufactured in huge rectangular sections, so at first glance CLT didn't seem to make sense. But we developed a method to lay these rectangular panels down while only having to shave a few degrees from each to form curves. It became a bit of a puzzle, but they labeled each panel and were able to lay them in quickly and efficiently. There was almost no waste."

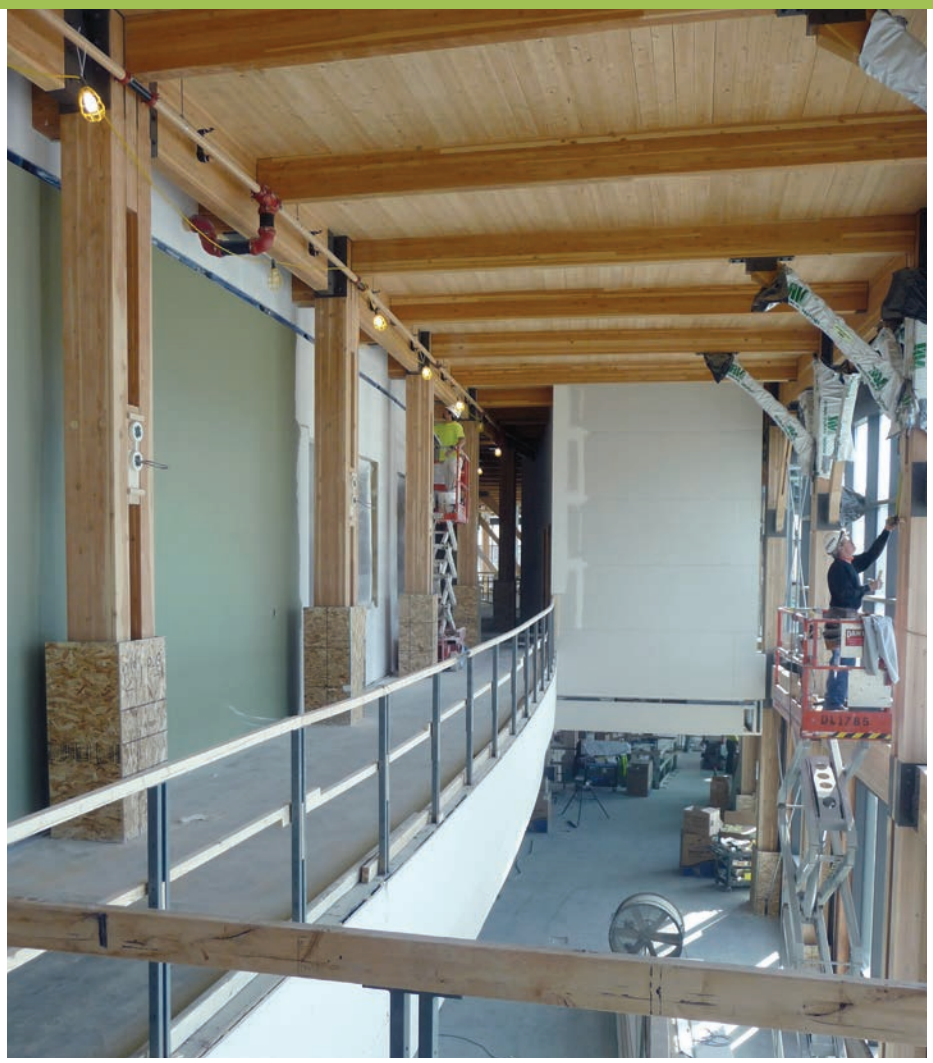
Code Acceptance

While CLT has been used in Europe for years, it is still relatively new to North America. Fortunately, US building codes are flexible enough to accommodate new materials.

Promega's design team earned local building department approval by using *ANSI/APA PRG 320-2011 Standard for Performance-Rated Cross-Laminated Timber*. The design team discussed the standard with building officials early in the process, and submitted engineering information under the 'alternate designs' section of the *International Building Code* (IBC). IBC Section 104.11 states that 'An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of the code.'

"The building was designed per the 2009 IBC with State of Wisconsin amendments," said Sanchez-Prado. "The basic criteria for the project consisted of minimum roof snow loads of 30 psf with a maximum snow drift load of 132 psf. The structure was designed for basic wind speeds of 90 mph and seismic design category B. These loads, together with diaphragm chord and tie forces, set the design criteria that the custom-made CLT panels were required to meet."

According to Steve Wellenstein, design manager for Uihlein/Wilson Architects, "The building type was dictated by the steel-framed GMP because it was the largest mass which



What is CLT?

CLT is made from layers of dimension lumber, each stacked at right angles to the adjacent layers and glued to form a solid panel. By varying the number of layers as well as the lumber species, grade and thickness, CLT panels can be used in almost any assembly type, including walls, floors, roofs, elevator shafts and stairways. Lumber is kiln dried prior to lamination, which adds to the dimensional stability of the panels.

CLT is currently available in North America with dimensions up to 15 inches thick, 10 feet wide and 64 feet long. Manufacturers use CNC equipment to pre-cut panels and openings to exact specifications, often to meet very tight tolerances (within millimeters).

had specific requirements. The code reviewer interpreted the wood portion of the building as being better or equal to the GMP structure in terms of fire resistance. So the whole structure is actually classified as a Type II-B steel frame structure. We just had to show that The Crossroads timber portion had equivalent performance, which we did."

Structural Versatility

With virtually no square angles in the structure, beam-to-column connections created a challenge. To avoid the need for more than a hundred different configurations, Sanchez-Prado designed a steel pin connector which allowed most joints throughout the project to have elegant and typical connections. The single connector allows as much as ten degrees rotation in either direction, giving it the required swivel to fit nearly all column and beam connections for the complex building geometry.

The contractor built a full scale mockup, which allowed the team to test the connections and identify constructability issues before installation began. "Doing this brought extreme value to the whole project," said Rousseau. "The connections in The Crossroads are expressed. So, besides ensuring a smooth installation, the mockup helped us better understand proportions and detailing."

Loading was also a challenge. "The roof of the GMP is slightly higher than the roof for The Crossroads," said Sanchez-Prado. "Wisconsin's snow drift gave us loads of 132 psf but we didn't want to have beams at 4 feet on center to be able to accommodate this loading. We wanted to maximize the decking spans and minimize the number of structural members. CLT allowed us to develop a diaphragm type of scenario where we could actually span larger spaces between the lateral systems and embrace this open plan. The CLT panels allowed beam spacing of about ten feet due to their ability to span while supporting snow loads with drift accumulations."

Sanchez-Prado added that CLT's structural versatility was also a benefit. "Most roof decks are viewed as single span, whereas CLT can span in both directions. Since there wasn't a single perpendicular line in The Crossroads, CLT's two-way geometry allowed us to integrate almost a regular pattern, where we didn't necessarily have to follow every little angle of the building to be able to make that work structurally."

CLT also gave them the advantage they were looking for in terms of having a low profile. Localized reinforcing was introduced at the overhang locations where the panels were mainly spanning parallel to the roof beams.

The group also carefully evaluated seismic and lateral loads before selecting CLT. "The lateral system of the building in combination with the building shape created interesting challenges to resolve the diaphragm forces," said Sanchez-Prado. "We wanted a very open space, so we needed to incorporate a lateral support system within the building that was still elegant. CLT panel properties allowed us to space the lateral frames further apart while maintaining load distribution without additional structural elements."

Innovation at Work

While CLT and glulam can be effectively used for more straightforward building projects, The Crossroads was anything but ordinary. With discovery comes challenge, and the innovative use of wood in The Crossroads took all involved into new territory.

"Once we decided to use wood, our main challenges were to achieve the desired proportions and rhythm, then select the materials, detail the connections, resolve the shear bracing, and provide the roof diaphragm to transfer lateral loads," noted Rousseau. "We had a strong, collaborative design team, and Promega was an inspiring client. I had never been involved in such a complicated fusion of timber with other structural systems. Constructability and aesthetics brought us to CLT and glulam. It was an innovative solution for an innovative company."

Carbon Benefits

Wood lowers a building's carbon footprint in two ways. It continues to store carbon absorbed during the tree's growing cycle, keeping it out of the atmosphere for the lifetime of the building—longer if the wood is reclaimed and used elsewhere. When used in place of fossil fuel-intensive materials such as steel and concrete, it also results in 'avoided' greenhouse gas emissions.

Volume of wood products used:
14,133 cubic feet

US and Canadian forests grow this much wood in:
1 minute

Carbon stored in the wood:
302 metric tons of CO_2

Avoided greenhouse gas emissions:
391 metric tons of CO_2

TOTAL POTENTIAL CARBON BENEFIT:
692 metric tons of CO_2

EQUIVALENT TO:

132 cars off the road for a year

Energy to operate a home for 59 years

Source: US EPA

Estimated by the Wood Carbon Calculator for Buildings, *based on research by Sarthre, R. and J. O'Connor, 2010, A Synthesis of Research on Wood Products and Greenhouse Gas Impacts, FPInnovations. Note: CO_2 on this chart refers to CO_2 equivalent.*

Use the carbon calculator to estimate the carbon benefits of wood buildings. Visit **woodworks.org**.

Measuring Moisture

Researchers from the USDA Forest Service Forest Products Lab (FPL) have installed wireless sensors to collect in-service moisture and temperature data for the CLT roof panels in The Crossroads. Because this installation was the first large-scale commercial utilization in the United States using CLT manufactured in North America, FPL scientists want to show building professionals how CLT can effectively control heat, air and moisture as a component of a well-designed and constructed building enclosure.

Image credits: (front) Uihlein/Wilson Architects; (p2 top) Promega Corporation; (bottom) USDA Forest Service Forest Products Lab; (p3 top and bottom) Uihlein/Wilson Architects; (center) CST Innovations; (back top) Uihlein/Wilson Architects, (bottom) USDA Forest Service Forest Products Lab

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