CASE STUDY

District Office

Developer chooses mass timber to differentiate speculative office project

Portland-based Hacker became its own client when the leadership team decided to make District Office their new home. It was a unique opportunity to design a building that reflected their goals as a company. But, since Hacker would only occupy two of six stories, the design also had to meet development goals typically associated with a speculative building—including market appeal, adaptability and cost. In the end, District Office brings together the best of all worlds: a beautiful new home for the architects and a desirable address for prospective tenants, all within the developer's budget.

PROJECT DETAILS

District Office

LOCATION:	Portland, Oregon
STORIES:	Six stories
SIZE:	90,400 square feet
CONSTRUCTION TYPE:	Type III-A
COMPLETED:	2020

PROJECT TEAM

CLIENT/OWNER:	Beam Development & Urban Development + Partners
ARCHITECT:	Hacker
STRUCTURAL ENGINEER:	KPFF
CONTRACTOR:	Andersen Construction
MASS TIMBER SUPPLIERS:	DR Johnson Wood Innovations, Freres Lumber Co., Inc. (feature staircase)

Connect with the District Office project team at *https://www.woodworksinnovationnetwork.org/projects/73*

WOODWORKS INNOVATION NETWORK

It almost goes without saying that the rules for workplace design have shifted, but some things never change, including the need for a return on investment that makes a project financially worthwhile.

"District Office is unique in that it is a viable, speculative commercial office built using mass timber," said Brad Nile, Project Executive at Andersen Construction. "It's a beautiful building, certainly, but the fact that it also made financial sense sets this project apart."

Glue-laminated timber (glulam) beams and columns support 3-ply cross-laminated timber (CLT) panels in the six-story structure, which has five floors of office space above ground floor retail and restaurant space, plus underground parking. All wood members are left exposed to the interior.

Big open spans within the structure were perfectly suited to mass timber. "We're seeing a trend toward the use of mass timber in office buildings, especially those with larger open floor plates," said Levi Huffman, Director of Technical Services for DR Johnson Wood Innovations. "Prospective tenants want exposed wood, which benefits workers with its biophilic benefits. And developers appreciate the fact that mass timber can be used to create a flexible structure that can be modified in the future."

Portland's central east side had several other commercial office buildings nearing completion at the same time District Office would be hitting the market, so differentiation was key to attracting tenants. "District Office was almost completely leased soon after completion, while many of the other buildings still had vacancies," said David Keltner, Design Principal at Hacker. "The developer was elated, and said the distinctive wood interior was a real draw."

Keltner added that architects at his firm were also elated, since they were able to design a creative space that supports the way they want to work. Before the project, Hacker surveyed their team to better understand what people wanted in the new workspace; room to support their collaborative culture, access to natural daylight, neighborhood views and sustainability topped the list. People also wanted an environment that would help them feel good at work.

"We saw District Office as an opportunity to study the future of workplace design and all the issues that folks are confronting in that realm right now," said Keltner. "We recognize that when we connect with nature, we can create a much healthier, positive work environment for people."

Unique Office Grid Spacing

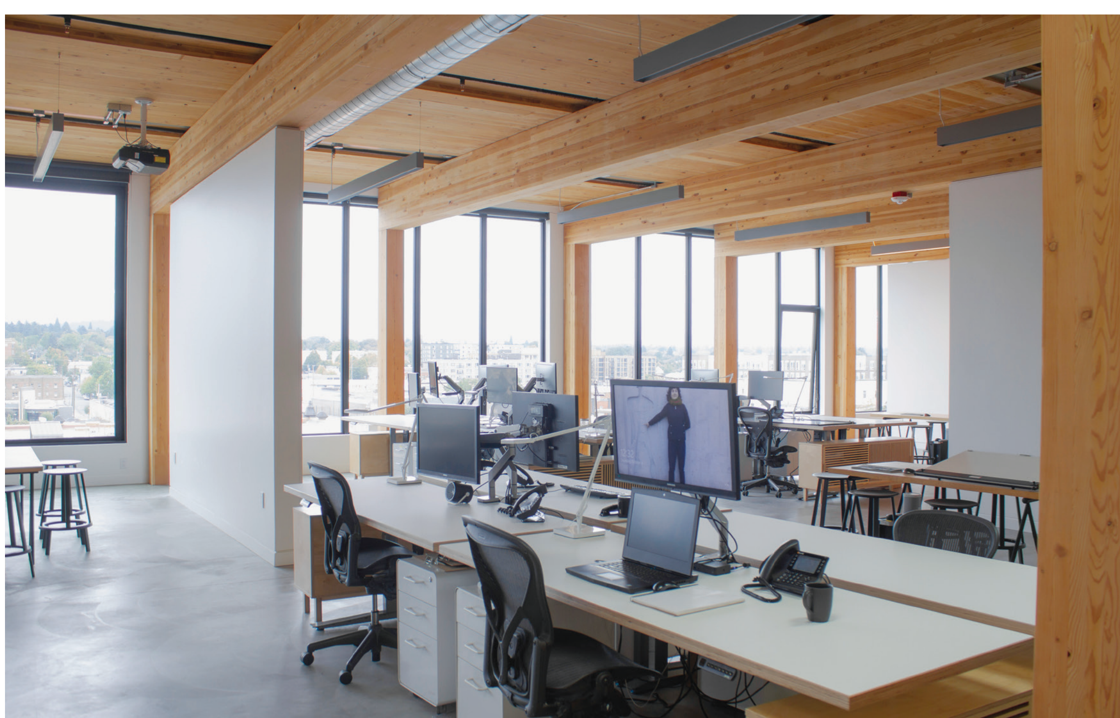
One thing that makes District Office particularly useful as a speculative office building is its unique grid spacing. About five feet from the core wall, a colonnade of glulam columns marches down the center of the building, spaced 10 feet on center for efficient one-way CLT floor spans. This leaves 38-foot colonnade-to-window spans on one side and 28 feet on the other, creating a spacious, open office layout. The design intent of the wide grid layout also recalled the open warehouses in the district, providing a connection to the area's history and reinvention of places for work.

Scott Barton-Smith, Associate Principal and Senior Architect with Hacker, said, "We're fortunate to have done multiple mass timber buildings, and have learned lessons on each. We know grid spacing will be different with each project, but there were many benefits that came out of our grid decision with District Office."

A Whole New Look at WBLCA

In 2019, the TallWood Design Institute did a whole building life cycle assessment (WBLCA) on five buildings, including District Office, to better understand the environmental footprint of a mass timber building and the possibilities and limitations of WBLCA for CLT construction. Hacker was happy to help.

"We know people love wood buildings," said Sarah Post-Holmberg, Associate Principal and Design Director at Hacker. "But we also need to learn more about how the biophilic and sustainability benefits of wood should inform our future decisions as architects."



For example, the building has one level of below-grade parking, and the 10-foot column spacing led to an efficient car park. Upstairs, the open floor plan gives tenants flexibility. The space between the colonnade and the core is now a hallway, and the 10-foot span between columns was cost-effectively achieved with a 3-ply CLT panel, making efficient use of the wood fiber.

“We found another advantage in that,” Keltner added. “When the primary beam spacing fits with the spanning capability of the CLT, you can eliminate all of the beams at the perimeter of the building. Therefore, when you look at the building from the outside, all you see is the edge of that thin, 3-ply CLT panel and concrete topping. This meant our windows could go all the way up, maximizing daylight inside.”

System Optimization

Grid spacing decisions also solved mechanical-electrical-plumbing (MEP) challenges. “The basic premise with a mass timber building is that you want to leave the structure exposed, so you can all see the beautiful wood,” said Anne Monnier, a Principal at KPFF Consulting Engineers. “The 10x38 configuration allowed us to tidy up the MEP systems.” The bulkiest MEP elements are located above the colonnade in a beam-free space. Because the 10x38 bays have no need for cross beams, MEP systems can branch into each bay without ever dropping below a beam.

In every bay, CLT panels were installed with 24-inch gaps, creating a mechanical chase that allowed services like sprinkler lines to be installed without penetrating beams. The gaps also reduced the total volume of required CLT, which lowered material costs.

“We initially approached this as a MEP distribution solution, but then also realized cost savings because it reduced the required CLT volume by 15 percent,” said Keltner. “Plus, it gave us great flexibility in distribution of pipes and ducts, which is so important in a speculative office building.”

Another decision made to provide future tenants with flexibility was to use a 3-inch reinforced concrete topping slab for diaphragm capacity. This enabled the team to gap the CLT panels, and the concrete’s mass helped mitigate vibration. The topping also serves as a durable, flexible floor, which gives future tenants the freedom to use any flooring they want, or to leave the concrete exposed. Finally, the concrete provided the required one-hour fire rating. “It was a complete optimization,” Monnier said. “That one decision to use the concrete topping slab accomplished several objectives.”

Removable Floor Sections

Hacker wanted a more compact workspace for their team, rather than have people spread throughout an entire floor, so they created an atrium between floors five and six. Knowing that future tenants may be interested in something similar, they included the option to remove floor sections to create interconnected spaces on other floors.

To do so, they installed 7-ply CLT panels at predetermined locations on opposite ends of floors three and four. The heftier panels span 20 feet on top of upsized beams and columns, allowing a 20x38-foot area to be removed. They even left a score in the concrete topping so it could be popped out, allowing future tenants to remove parts of the floor without having to modify the lateral system.

Monnier said they analyzed the structure two ways—for how it was originally built and for the option with the floor portion removed. “It was a rigorous analysis, but pretty cool that this option is already designed into the building,” she said.

Unique Staircase

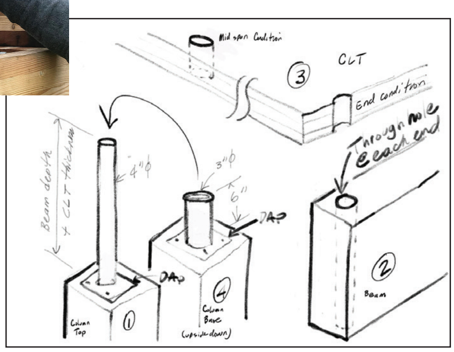
To connect their offices in the double height space, Hacker wanted something that visually spoke to the mass timber building. They found their answer in a relatively new, veneer-based CLT product manufactured by Freres Lumber. The staircase is built using stringer shapes that were then combined to form the stair itself. Panel veneers usually run horizontally, but in this case, the veneers run vertically so people can see the end grain.

There are no published span values for a CNC-cut mass timber stair, particularly one with unique stringer geometry, so the design team needed to conduct testing to prove to themselves and the City of Portland that it could carry the load. KPFF and KPFF Structural Investigation Group (SIG) developed a testing plan conforming to Chapter 17 of the 2014 Oregon Structural Specialty Code for preconstruction load testing. They built and loaded stair mockups, then measured deflection at two times the required load. “It passed with flying colors,” Keltner said. “When you walk on it, you realize how rock solid that stair is. Plus, it’s unique and beautiful.”

Connection Simplicity

Certainly, District Office has unique features, but it still needed to meet the developer's budget. Recognizing that speedy construction can reduce overall cost, the team developed a custom, repeatable beam-to-column connection that was simple to fabricate and easy to install. The connection consisted of a 30-inch-long steel pipe "stinger" attached to a steel base plate, which was screwed to the top of each column. The pipe fit into a hole predrilled through the beam and CLT panel. The base of the column above was similarly outfitted with a steel pipe of a slightly smaller diameter that nested within the steel tube below. The gravity load path through the steel pipes eliminated any perpendicular-to-grain loading of the CLT floor panels. The connection was concealed and protected from fire by the surrounding mass timber.

"We felt like this was one of our greater achievements on this project, coming up with a system to efficiently drill a 5-1/2-inch diameter, 30-inch-deep hole on both sides of a 30-foot-long beam," said Huffman. "We essentially used electronic hand tools, as there was no CNC available with the capability to do all this. We created custom jigs, manufactured custom drill bits, and were still able to complete the fabrication efficiently and economically."



"Not only did the stinger that came off the top of the column provide a seat for the beam, but it also provided a simple means of capturing the end of the beam," said Andersen Construction's Nile.

Used more than 350 times in the building, there were only four variations of the beam-to-column connection. The columns arrived at the jobsite with the stingers already attached, making the entire assembly quick to install.

Leaving a Financial Legacy

Certainly, a beautiful office building attracts tenants. But it must also make sense financially. The District Office team made sure of that.

"Anyone who's done mass timber construction knows there's a moment early in design where the concept is going to live or die," said Hacker's Barton-Smith. Keltner agreed, adding, "The mistake many people make is just looking at the structure. You need to consider foundation work, finishes, fireproofing, construction speed and more. It requires an early but holistic look at all of the building systems."

The team certainly found ways to save along the way. "It was a big financial win for this project to utilize 3-ply CLT panels," said DR Johnson's Huffman. "Plus, they chose panels with an industrial sanded appearance grade, which saved money without sacrificing a beautiful appearance." Construction time was shortened with the simple beam-to-column connections, and the contractor coordinated closely with the CLT and beam manufacturer to get just-in-time delivery, so the wood components could be easily lifted directly from the truck into place.

Barton-Smith added, "Those of us in the design industry, and those of us who are concerned about the environment are hopeful about mass timber. There's so much potential, but our challenge is to make sure these buildings can compete with conventional framing. I guarantee that if this building had been more expensive than concrete or steel, it would not have been built with wood.

Our focus with District Office was to make it economical by innovating and by optimizing the fiber. It's a beautiful building for sure, but in the end, District Office showed us how a mass timber building can be cost competitive with other types of construction. And I think that will be its legacy."

District Office

Volume of wood products used:
82,750 cubic feet

U.S. & Canadian forests grow this much wood in:
6 minutes

Carbon stored in the wood:
2,078 metric tons of CO_2

Avoided greenhouse gas emissions:
804 metric tons of CO_2

TOTAL POTENTIAL CARBON BENEFIT:
2,882 metric tons of CO_2

EQUIVALENT TO:

609 cars off the road for a year

Energy to operate 304 homes for a year

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.

Reducing Carbon Footprint

The use of wood lowers a building's carbon footprint in two ways. Wood continues to sequester carbon absorbed by the trees while they were growing, keeping it out of the atmosphere for the lifetime of the building—longer if the wood is reclaimed at the end of the building's service life and re-used. Meanwhile, the regenerating forest continues the cycle of carbon absorption. Wood products also require less energy to produce than other building materials, and most of that comes from renewable biomass (e.g., bark and sawdust) instead of fossil fuels. Substituting wood for fossil fuel-intensive materials is a way to avoid greenhouse gas emissions and reduce embodied carbon.

Photos: Jeremy Bittermann (cover), Hacker, Andersen Construction (sketch on p.5)

