A Seattle office building incorporates castellated beams to balance high-seismic needs with green objectives.

Balanced DESIGN

BY ERIN SPAULDING

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THERE ARE MANY SELF-PROCLAIMED "Centers of the Universe" out there.

Seattle's Fremont neighborhood is one of them. The city and its surrounding communities continue to experience significant growth, with new and resilient structures going up at a rapid pace. One of these, in Fremont, is Data 1, a five-story office building adjacent to the George Washington Memorial Bridge, aka Aurora Bridge (under which lives the famous Fremont Troll, a beloved public sculpture located a couple of blocks uphill).

Completed this past summer, the building is helping to propel what is quickly becoming the area's upper echelon of project standards: resilient, efficient structures that incorporate green initiatives from design through completion and beyond. The 125,000-sq.-ft facility features a fourth-floor, steel-framed conference room that cantilevers 10 ft from centerline into an interior courtyard, an ex-


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RoseBeckhold, DCI

▲ Data 1 incorporates castellated beams throughout.

◀ ▼ The five-story, 125,000-sq.-ft office building sits mere feet away from the supports of the George Washington Memorial Bridge in Seattle's Fremont neighborhood.


Weber Thompson

terior metal shading system for natural building cooling and a bioretention system in the right-of-way that collects and cleans 160,000 gallons of water runoff annually from the adjacent bridge.

DCI Engineers (DCI), the engineer of record, performed structural analysis and design for the higher-rated Seismic Design Category D project, whose upper four levels are framed with structural steel; the retail level is concrete. This combined approach allowed the project to maintain the Type III B rating for the above steel framing, thus avoiding fireproofing requirements, which saved additional costs, and allowing the steel members to remain exposed. The steel provided LEED benefits early on for the project, fulfilling structural performance needs while also meeting architectural desires and daylighting goals.

"The beauty of steel for this project coalesced around its materiality—its lightness, flexibility and industrial aesthetic," noted Myer Harrell, principal and director of sustainability with project architect Weber Thompson. "Under Type III B construction, no fireproofing was required, making steel the best structural choice."

Castellated Beams

One major project component included fulfilling a 60% building transparency goal that would capture more daylight, reduce electricity needs and provide tenants access to fresh air and optimal views of the surrounding neighborhood. Satisfying much of the daylighting needs, a courtyard in the center of the building opens the upper three steel levels to highly desired, albeit often cloud-muted, Pacific Northwest daylight. And the steel framing system was able to further take advantage of daylighting with the incorporation of castellated beams, which allowed the team to achieve adequate floor framing stiffness at a fraction of the weight while also allowing natu-

▲ ➤ Castellated beams allowed the team to achieve adequate floor framing stiffness at a fraction of the weight while also allowing natural light to penetrate the openings in the beam webs.

▼ The central courtyard provides another significant conduit for daylighting.

ral light to penetrate the openings in the beam webs. The project used approximately 830 tons of steel and included W14×109 gravity columns and W24×146 moment frame columns, with typical floor beams being comprised of two W12 sections cut and welded to create an effective castellated depth of 18 in. Fabricator Brooklyn Iron Works took on the entire steel scope of this project, including complete fabrication of the castellated beams. This decision ensured that deliveries were loaded in an erectable manner for the exceedingly tight job site and helped keep the schedule on course.

"To achieve that same floor stiffness with a conventional W12 beam would have increased the weight by 250%," said Jacob Meader, DCI project manager. "That net savings really adds up when the whole building is considered."

"The castellated beams allow higher ceiling clearances and more daylighting, so the overall impact is interiors that feel more open and brighter," said Joanna Callahan, a partner with CoU Limited Liability Co., Data 1's developer.

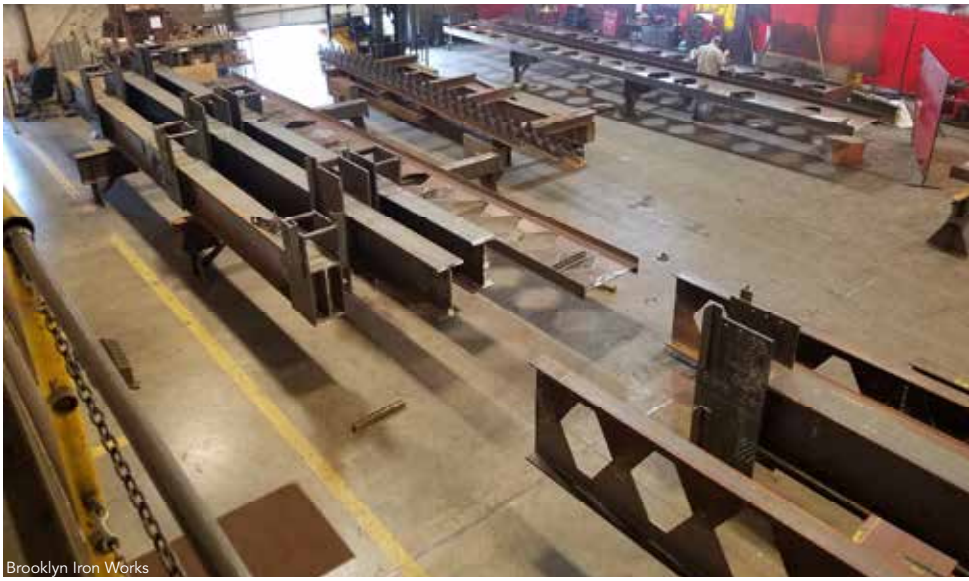
CoU, which stands for "center of the universe," was formed specifically for the Data 1 project by Callahan, along with Mark Grey and Callahan's partner at Hess Callahan, Mike Hess. This ownership team was also behind the Terry Thomas, Seattle's first green commercial office building designed without mechanical cooling and an example of the advantages of office daylighting efficiencies. That DCI project is located on the other end of Lake Union from Data 1, in the city's South Lake Union district, and also uses castellated steel beams. In both buildings, the beams allow routing for mechanical, electrical and plumbing systems while eliminating the need for additional finishes like ceilings and beam wrapping—serving as much an architectural purpose as a performance one.

"The team encouraged the tenant to paint the steel beams, girders, columns and underside of the metal deck white and keep them exposed where possible, to support the core and shell building daylight strategy," said Myer.


Ryan Furth, Lewis Builders


Brooklyn Iron Works

▲▼ Castellated beams in production at Brooklyn Iron Work's shop. The castellated beams allowed for higher ceiling clearances and more daylighting. More than 800 tons of structural steel in all was used in the project.


Brooklyn Iron Works

With the beams visible from street level, DCI chose a hexagonal pattern over a typical cellular (round) cut for added material savings. However, because the roof had a fairly large area consisting only of metal decking, DCI had to upsize the castellated beams in line with the moment frames to act as collectors and take the required axial load, due to dragging the diaphragm forces, into the seismic force-resisting system. This system included highly ductile steel special moment frames, further enhancing the building's seismic performance through the moment frames' minimized drift.

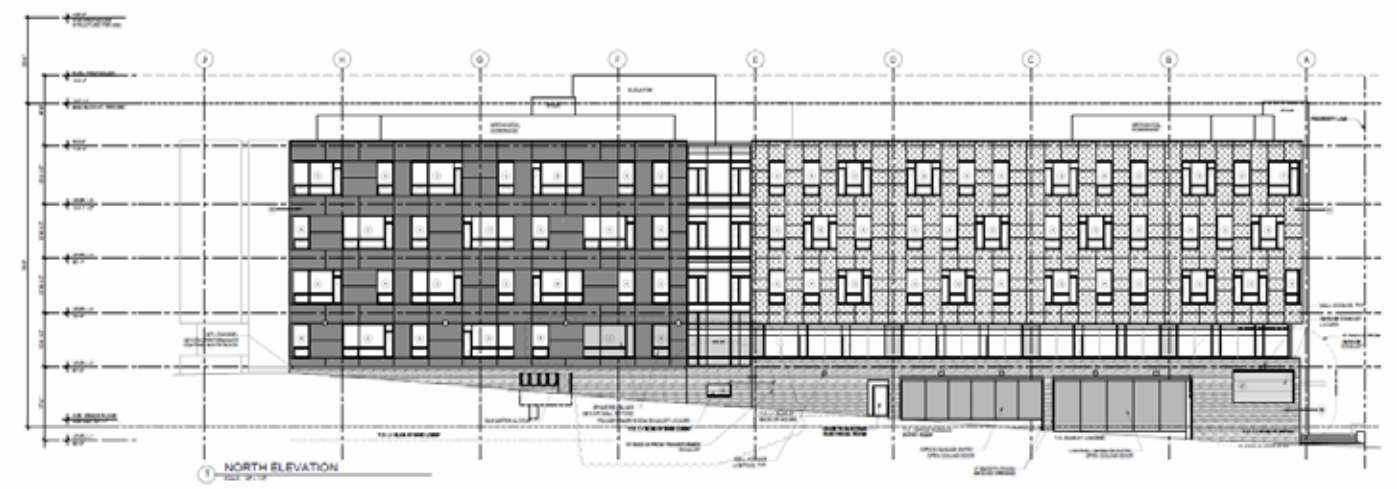
Transferring Loads

Designed in partnership with SidePlate, an engineering firm specializing in connection systems designed specifically for projects in high-seismic regions (like Data 1) the moment frames did not require complete joint penetration (CJP) welding. Instead, the team used a field fillet-welded solution that accomplished optimal connection stiffness without the added size of CJP welding, thus lowering inspection and labor costs.

Distributing loads and strengthening the load path, however, were complicated by the need to transition the forces at the post-tensioned concrete transfer level. While fabricating the steel portion of the moment frames was somewhat routine, the anchorage and transfer to the concrete portion below was anything but.

"There was a forest of rebar, steel and post-tensioning tendons," said Brett Hart, director of engineering for SidePlate and project manager on Data 1. "We went out to the project very early to focus on the base conditions and the construction team was particularly concerned about fitting everything into such a confined space."

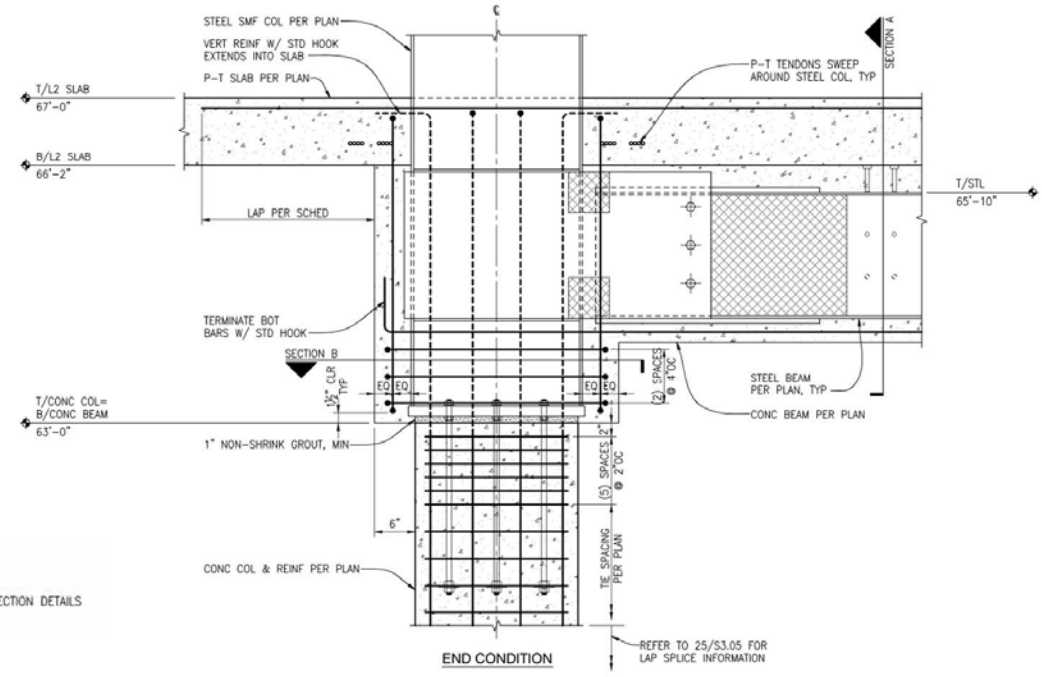
DCI and SidePlate worked together to find flexibility where it could work, which included adjusting rebar size and positioning within those connection areas. The design team also accounted



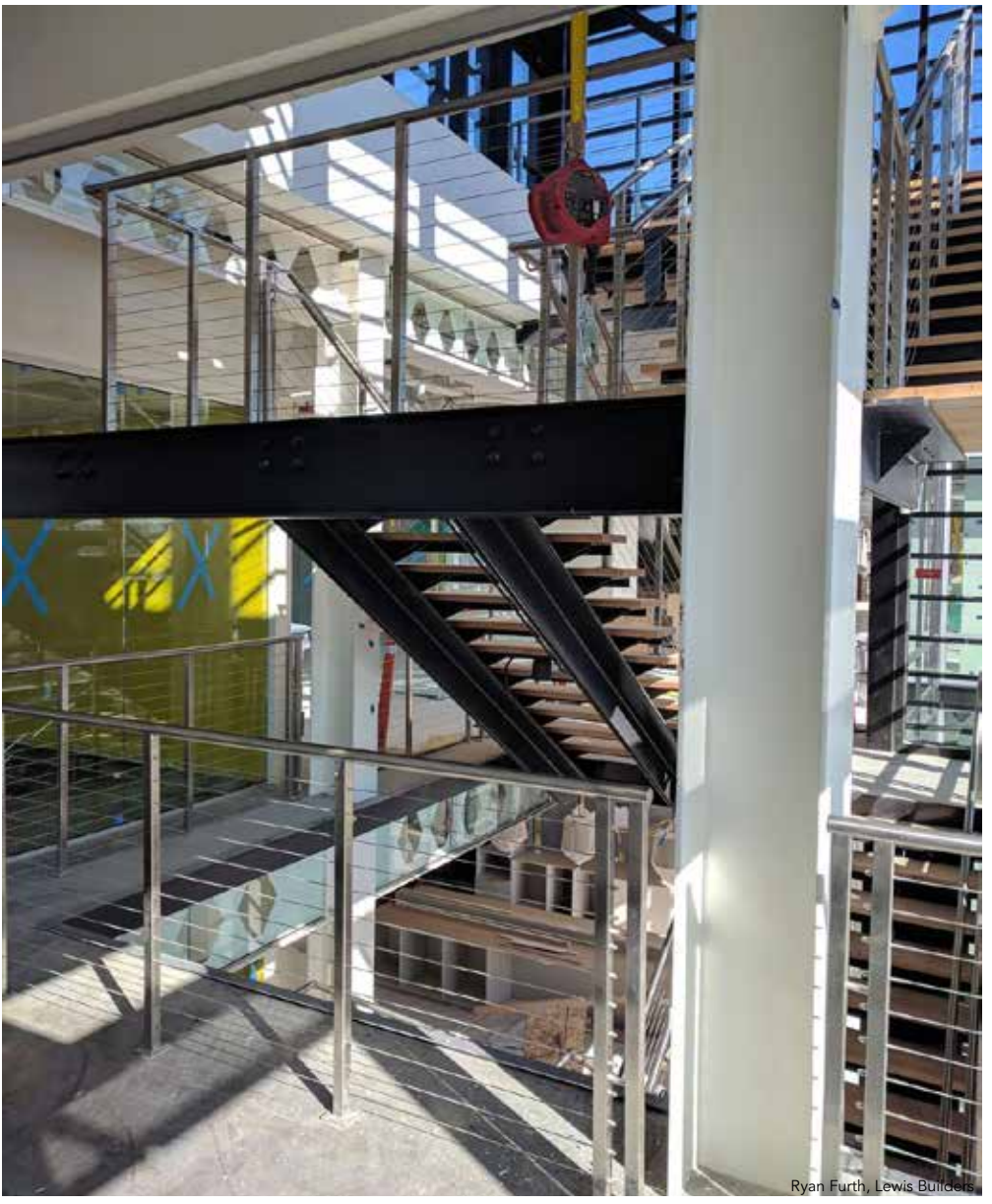
North elevation.

The upper four levels are framed with structural steel while the retail level is concrete.

An SMF base connection.



NOTE:
REFER TO SIDEPLATE DRAWINGS FOR SMF CONNECTION DETAILS AND PROTECTED ZONE INFORMATION.



Ryan Furth, Lewis Builders

A steel-framed signature stairwell.

for the three-story courtyard, which essentially created a hole in the building's diaphragm. The lateral structural framing included all four sides of the building with an added frame around the courtyard to provide redundancy, "a strategy cooked up to bolster the load path for lateral forces in the event of a seismic event," according to Hart.

This would ensure an adequate load path around the opening to the vertical/lateral force-resisting system components such as the moment frames. But it also meant coordinating moment frame locations through several levels of mixed-use, mixed-material construction using a minimal number of transfer beams to accommodate the building's open area parameters. This load path would go from the roof, through four levels of steel-framing office space, a concrete retail level and two levels of subterranean parking. Occupancy encroachment, particularly to parking, had to be minimal.

Combining these factors with the slope of the site, the DCI team performed a two-stage lateral analysis, per the requirements of ASCE 7 Section 12.2.3.2 to design the combined lateral systems and eliminate any torsional irregularities.

Resilient, seismic-centric design doesn't mean sacrificing project goals like increased daylighting or energy efficiency. In fact, Data 1 proved that it can actually enable stakeholders to invest in the life span of a building, providing an opportunity for sustainable practices for years to come. And it's certainly at the center of the universe in terms of buildings that balance seismic and sustainable goals. ■

General Contractor
Pennon Construction

Architect
Weber Thompson

Structural Engineer
DCI Engineers

Steel Team

Fabricator
Brooklyn Iron Works, Inc., Spokane, Wash.

Detailer
Axis Steel Detailing, Inc., Lehi, Utah

Weber Thompson

The building adroitly combines green design and seismic performance.