Steel is Sustainable Construction

Outdoors Inside

By Beth S. Pollak

The Oregon Department of Forestry's new Operations Building combines structural steel and re-sawn timber to create attractive offices.

Forest, water, wildlife, and protection from fires are the basic elements of The Oregon Department of Forestry's (ODF) jurisdiction—and its new Operations Building is designed to reflect them. Located in a forested area on the banks of Mill Creek in Salem, OR, the new steel structure combines a natural setting with sustainable design and innovative construction to avoid harmfully impacting the serene surroundings—and to ensure that the building remains standing in a fire- or earthquake-emergency situation.

With long, horizontal lines and a gabled roof, the two-story, L-shaped 34,000-sq.-ft Operations Building reflects the contemporary practices of forest management and 21st century "green" design. ODF wanted an open workplace that allowed extensive daylighting, and that used renewable products. The building features recycled products, including exposed structural steel. Structural steel has a recycled content near 100% and can be recycled repeatedly without losing its quality. Among cantilevered roof eaves and high, sloping roofs, a recycled wooden roof deck showcases Douglas Fir timbers salvaged from several deconstructed buildings on the site. Long clerestory windows bring daylight inside, where it is reflected off the wood surfaces. The desire for long, clear spans, wide bays, a sustainable design, and seismic resistance made structural steel the best solution for the building.

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Seismic Challenge

ODF required a high level of reliability from the Operations Building to improve chances of maintaining a functioning facility after an earthquake. The building houses the ODF's fire operations, dispatch, and coordination sections. As a result, the building was designed as an essential facility under the Uniform Building Code, with seismic performance equal to that required for emergency-response facilities like hospitals and fire stations. To meet this challenge, Degenkolb used a special concentric braced-frame system that reduces steel tonnage and performs well under cyclic earthquake loading. Eleven special concentric braced frames are hidden in the building walls. A split-X configuration, where a beam runs through the middle of the two-story X-brace, creates chevron braces on the lower floor and V-braces on the upper floor. The braces are 5″-square HSS, with welded connections.

Floor beams typically are W14×26 and girders are W16×26. Columns are exposed 8″- square HSS and bays are 21′ by 25′. Connections are single-tab shear connections, with slotted shear tabs through the HSS members. Standard AISC tolerances are used. The building is sprinklered, so no fire-protective coatings are required for the structural steel. The foundations are concrete spread footings, and the first floor is concrete slab-on-grade.

Multi-level roofs with overhanging eaves, hips, varying slopes, and clerestories create a complex roof configuration that required a high level of coordination between the architect, engineer, and steel detailer. The geometry of the roof created engineering challenges, and the interconnection between reclaimed timber decking and structural steel in the roof added complexity.

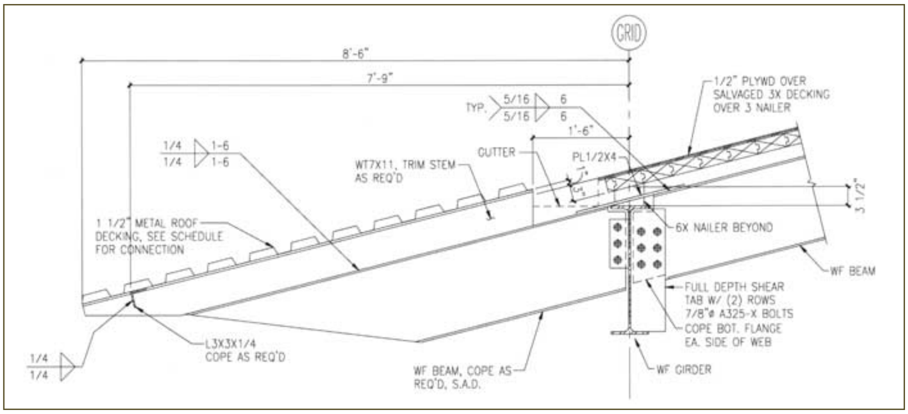
"There were different pitches, different directions, and many slopes, so you had to deal with all of the hips," said Jake Stept, P.E. project engineer for Degenkolb Engineers. "The roof overhangs were typically 4′ eaves. In one area, the clerestory is offset from a column line. In some places we had to use horizontal X-bracing to drag the shear loads from the roof diaphragm into the braced frames."

Roof beams were W14×22s, and roof assembly was facilitated by welding threaded studs on the top flange of the steel beams. Wooden nailers were bolted to the studs, and then the recycled wood decking was installed. An additional layer of plywood on top added diaphragm shear strength.

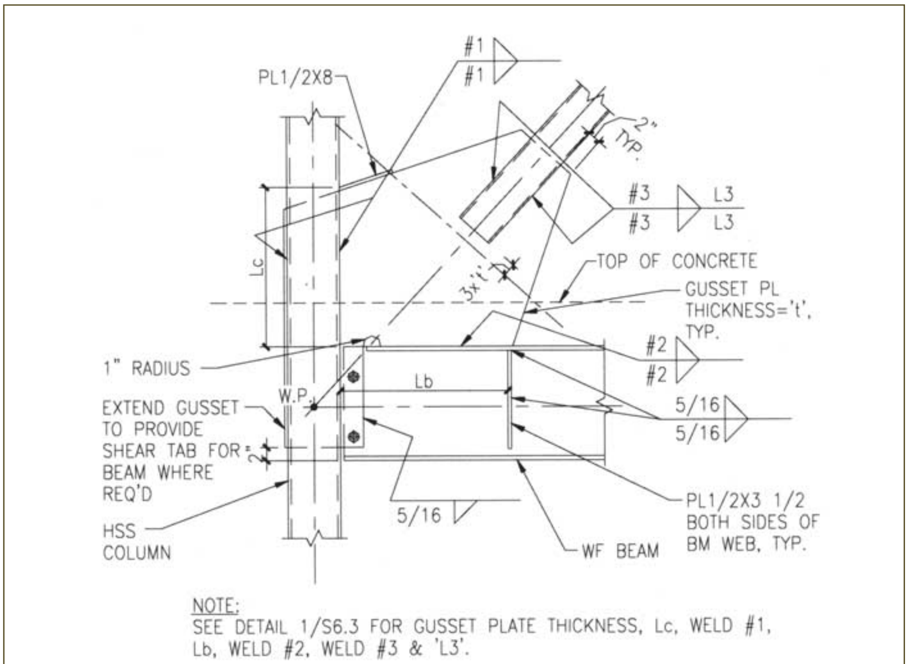
Sustainable Design

Sustainable elements include the reuse of the already developed site, reduction of paved areas, restoration of creek riparian zone, daylighting, natural ventilation, use of well-managed forest products, no- or low-maintenance materials and finishes, recycled and recyclable products, and products with no or low toxicity. The use of structural steel especially contributed to the building's sustainable design: steel's recycled content is

The ground floor is slab-on-grade construction.



Roof overhangs are typically 4'. Recycled wood decking was covered with a layer of plywood to create a shear diaphragm.



Lateral forces are resisted by special concentric braced frames. Braces are typically HSS members.

Smaller windows on the building's south side bring in daylight but block direct penetration of sunlight. Larger windows are placed on the northern exposure to capture cooler air for natural ventilation. Photo © Rick Keating Photography

near 100%, and it's a material that can be recycled repeatedly without losing its quality.

The operations center is oriented to protect the ecological and historical character of the site. The design incorporates materials, shapes and forms that are consistent with those of the original timber buildings on the site. Rafters from the deconstructed buildings were reused as roof decking in the new buildings. Beams and columns from the deconstructed buildings were used to build outdoor benches located around the campus. Air quality was enhanced by using natural materials that emit few, if any, volatile organic compounds (VOCs). Wood surfaces were used where possible, as well as materials like linseed-based linoleum flooring instead of vinyl flooring.

The new ODF building takes advantage of natural light whenever possible and uses artificial light strategically. Work areas are located in open spaces where windows, skylights and clerestory openings provide ambient natural light during the day. Task lights provide the bright light required for working at a desk. At night, indirect lighting provided by fixtures that reflect light off the ceiling uses less energy to provide ambient light. The new facilities consume 30% less energy than Oregon's energy code requires.

Rather than relying on air conditioning, the new building takes advantage of natural ventilation for maintaining comfortable temperatures. Windows in the clerestory in the high ceilings at the center of each building are motorized, and windows in private offices and open areas have manual controls. When the internal temperature of the building reaches a predetermined temperature range (between 66° and 73°), computer controls automatically open the clerestory windows. Cool air then enters the lower areas and pushes warm air out through the clerestories to encourage just the right amount of air circulation.

The orientation of the buildings also helps this process. Smaller windows that are shaded by broad eaves on the south side of the buildings bring in daylight but block direct penetration of sunlight with its radiant heat. Larger windows are placed on the northern exposure to capture cooler air.

Building design began in 2000, and the entire project was completed in June 2003.

Owner
State of Oregon, Department of Forestry, Salem, OR

Architect
SRG Partnership, Inc., Portland, OR

Structural Engineer
Degenkolb Engineers, Portland, OR

Mechanical Engineering
PAE Consulting Engineers, Portland, OR

Landscape Architecture
Walker-Macy, Portland, OR

Geotechnical Engineering
Foundation Engineering, Inc., Corvallis, OR

General Contractor
Pence/Kelly Construction, LLC, Salem, OR

Engineering Software
RAM Structural System

For more information on the use of structural steel in sustainable design, please visit **www.aisc.org/sustainability** or view the article "Structural Steel Contributions Toward Obtaining a LEED™ rating" in the May 2003 issue of *Modern Steel Construction*, available online at **www.modernsteel.com**.)