# Innovations in Timber Construction

WOODWORKS
FOR NON-RESIDENTIAL CONSTRUCTION

# Combining the Beauty of Timber with Modern Construction

Heavy timber construction—used for hundreds of years around the world—successfully combines the beauty of exposed wood with the strength and fire resistance of heavy timber.

The traditional techniques used in ancient churches and temples, with their high-vaulted ceilings, sweeping curves and enduring strength, still influence today's structures. The hallmarks of heavy timber—prominent wood beams and timbers—now also include elegant, leaner framing that celebrates the expression of structure with a natural material. A visual emphasis on beams, purlins and connections lends character and a powerful aesthetic sense of strength.

Historically a handcrafted skill of mortise and tenon joinery, heavy timber construction has been modernized by tools such as CNC machines, high-strength engineered wood products, and mass-production techniques. A growing environmental awareness that recognizes wood as the only renewable and sustainable structural building material is also invigorating this type of construction.

Heavy timbers are differentiated from dimensional lumber by having minimum dimensions required by the building code. Modern versions include sawn stress-grade lumber, timber tongue and groove decking, glued-laminated timber (glulam), parallel strand lumber (PSL), laminated veneer lumber (LVL) and cross laminated timber (CLT). Structural laminated products can be used as solid walls, floors and columns to construct an entire building.

Modern heavy timber construction contributes to the appeal, comfort, structural durability and longevity of schools, churches, large-span recreation centers, mid-rise/multi-family housing and supermarkets, among many other buildings. These wood structures resist the extreme loads caused by strong winds, heavy snow loads and earthquakes, while giving designers the ability to incorporate the beauty of exposed timber members with a fire-resistive structural framing system.

Based on its reliable use for centuries, heavy timber construction has long been recognized by the *International Building Code* (IBC). Indeed, its performance under fire conditions is distinctly superior to most unprotected non-combustible construction materials, such as unprotected steel, which loses strength quickly and collapses under extreme heat. In a fire, timber forms a self-insulating char that provides protection for the unburned portion of the wood.

Under the code, fire resistance is achieved by using wood structural members of specified minimum size and wood floors and roofs of specified minimum thickness and composition; by providing the required degree of fire resistance in exterior and interior walls; by avoiding concealed spaces; and by using approved fastenings, construction details, and adhesives for structural members. In North America, heavy timber construction is classified Construction Type IV—a special class that recognizes the inherent fire resistance of large timber and its ability to retain structural integrity in fire situations.

Outstanding examples of modern architecture have used heavy timber construction. On the following pages we showcase just a few that highlight the scope, strength and durability, sustainability, and beauty of heavy timber.

Photography - Brian Gassel/tvsdesign

# Branson Convention Center

# BRANSON, MISSOURI

**Convention Center and Parking Deck Owner**
City of Branson

**Hotel Owner**
Branson Landing Hotel, LLC

**Architect**
tvsdesign

**Structural Engineer**
Walter P. Moore

**General Contractor**
Turner Construction Company
(Convention Center)
and Killian Group of Companies
(Hilton Hotel)

**Glulam Timber Laminator**
Timberweld Manufacturing

**Glulam Erector**
Londsdale Construction

**Photography**
Brian Gassel/tvsdesign

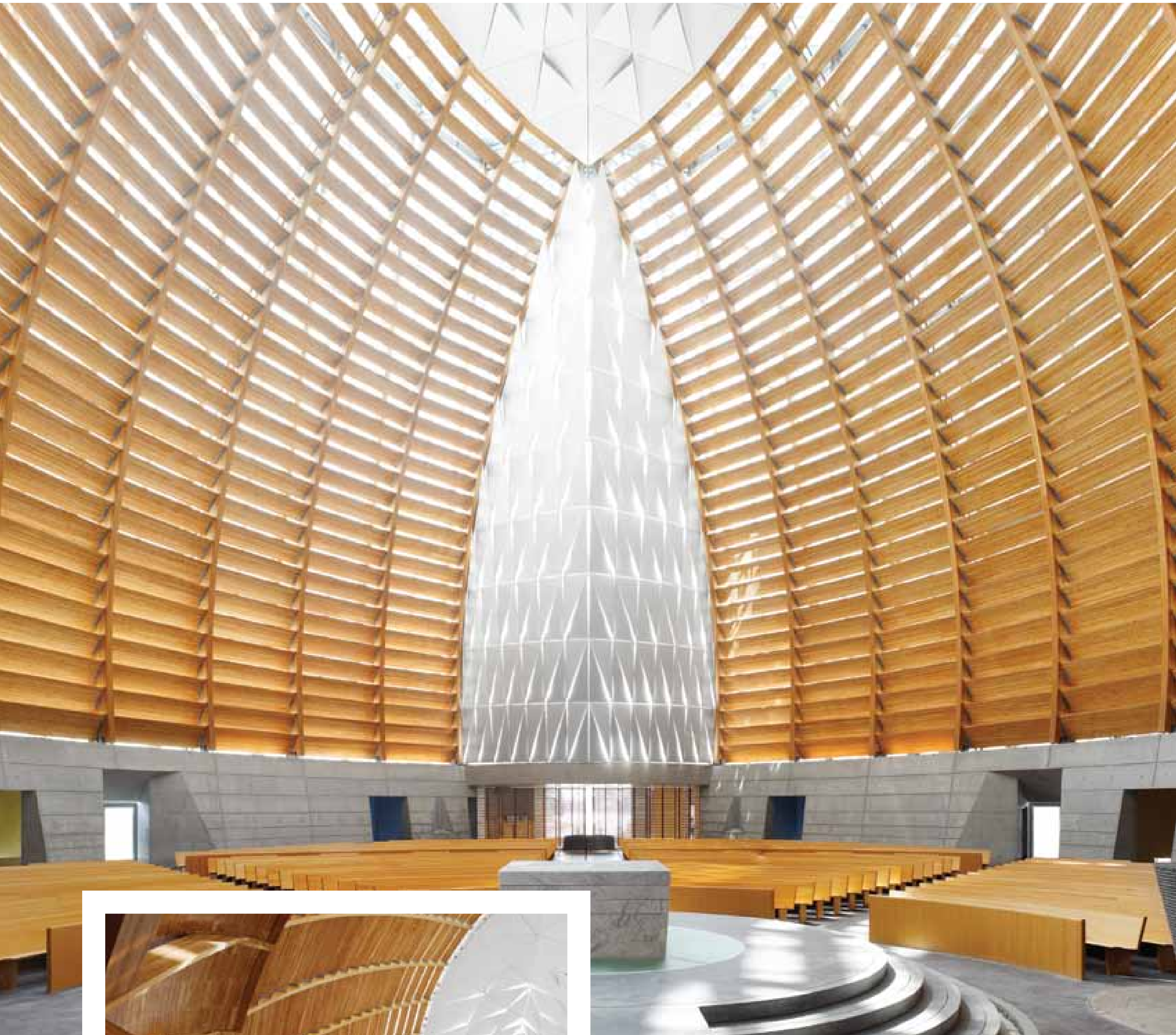
The Branson Convention Center is a major catalyst in the redevelopment of the historic Branson, Missouri city center. The convention center, hotel and parking deck are the latest components of the $420-million Branson Landing mixed-use development that covers 1.5 miles of Branson's downtown Lake Taneycomo waterfront. Inspired by the region's Ozark Mountains, the use of glulam and heavy timber for the convention center ties the building to its natural setting and creates a distinct regional destination.

The 220,000-square-foot convention center shares amenities with the Branson Hilton hotel, creating public spaces that support convention and hospitality functions in a dramatic, but personal, setting. Heavy timber and glulam provided the opportunity to create a contemporary and unique building design: rustic wood is used in a sophisticated manner to convey an honest and warm expression, and provides visitors with an inviting and memorable experience.

The salient feature of the building is a sweeping concourse of heavy timber construction that recalls the natural context of the Ozarks. This use of timber organizes the principal circulation pathways and highlights the large volume of public spaces within the complex. The honesty and integrity of the innovative glulam structural system, as well as the finished ceiling of the main entry and concourse spaces, had considerable cost benefits that worked with the modest budget.

The 800-foot-long concourse façade joins the convention center and hotel into a single architectural expression. Timber is a unifying element. HSS8x4 posts provide lateral support for the 25-foot-tall curtain wall. Exposed heavy timber decking forms the roof and finished ceiling of the structure. The decking is supported on glulam roof beams spaced at 10 feet on center. Twenty-nine sloping V-braces—made from 15-inch diameter circular timber columns—march along the serpentine concourse to support the glulam beams which span up to 80 feet. These timber poles are attached to the structural frame with an exposed adjustable steel tie-rod assembly. Douglas-fir was specified for all applications.

# The Cathedral of Christ The Light



The Cathedral of Christ The Light provides a sanctuary in the broadest sense of the word. Located in downtown Oakland, on the edge of Lake Merritt, this house of worship offers a sense of solace, spiritual renewal, and respite from the secular world. The 1,500-seat sanctuary, with its side chapels, baptistery, health clinic, and dependencies, honors its religious and civic obligations to both the Catholic Diocese and the city.

The Diocese challenged the design team to create a building for the ages. Through the use of advanced seismic techniques, including base isolation, the structure has been designed to withstand a 1,000-year earthquake. While wood provides an important unifying architectural, structural, and spiritual design element, its use as a primary structural element of the Cathedral's glulam superstructure was tantamount to the desired long-term performance objectives. As a result, the Cathedral of Christ The Light will endure for centuries.

The design positions symbolic meaning within contemporary culture. In consideration of the traditions of Bay Area architecture, the most elemental qualities of material, light, and form were used to create sacred space within an ethos of sustainability.

Douglas-fir, obtained through sustainable harvesting processes, was used throughout the complex. Readily available on the West Coast, it proved to be aesthetically pleasing, economically sound, and structurally forgiving. The wood's surfaces add warmth while its natural strength characteristics, when laced with the high-strength steel tension rods and timber compression struts, allow for the structure to efficiently resist gravity, wind, and seismic loads.

Twenty-six 110-foot glulam Douglas-fir ribs curve to the roof to form the framework for the sanctuary superstructure. A total of 724 closely spaced glulam "louver" members interconnect and provide lateral bracing for inner rib members. Green ceramic fritted glass panels jacket the Cathedral's outer shell to insulate the building, reduce glare, and change the quality of light throughout the day and seasons. With a building form based on an inner wooden vessel contained within a veil of glass—both of which are anchored on an architectural concrete base—the design conveys an inclusive statement of welcome while recalling the narrative of Noah and his ark. The natural warmth of wood in both color and texture was well suited to capture the intuitive feeling of shelter in the main sanctuary space.

The natural variations in the surface of the wood ribs and louvers were the perfect backdrop on which to modulate the ever-changing effects of natural light throughout the day. Once visitors pass through the entrance and under the Alpha Window, which diffuses light 100 feet above the Cathedral's entrance, they cross the sanctuary's open and ethereal nave. Changing light streams from the oculus roof, illuminating the marble-sheathed altar at the sanctuary's center and the curving pews that surround it. With the exception of evening activities, the Cathedral is entirely lit by daylight to create an extraordinary level of luminosity.

## OAKLAND, CALIFORNIA

**Architect**
Skidmore, Owings & Merrill LLP

**Client**
Catholic Cathedral Corporation of the East Bay

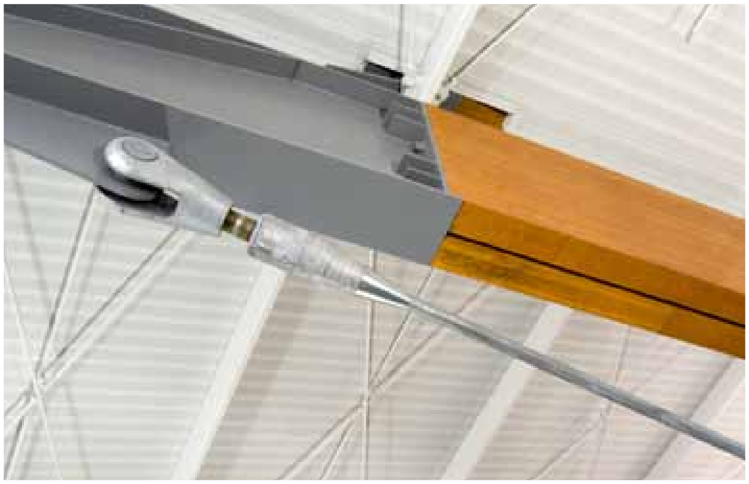
**Structural Engineer**
Skidmore, Owings & Merrill LLP

**General Contractor**
Webcor Builders

**Glulam Supplier/Installer**
Western Wood Structures, Inc.

**Photography**
Timothy Hursley
Cesar Rubio Photography
John Blaustein Photography

# Raleigh-Durham International Airport – Terminal 2

## RALEIGH, NORTH CAROLINA

**Architect**
Fentress Architects

**Structural Engineers**
Stewart Engineering, Inc.
ARUP Engineering

**General Contractor**
Archer Western Contractors

**Glulam Supplier**
Structurlam Products Ltd.

**Glulam Engineer**
Equilibrium Consulting, Inc.

**Photography**
Nick Merrick © Hedrich Blessing, courtesy of Fentress Architects

Designed to reflect the rolling hills of North Carolina, the new Raleigh-Durham airport terminal features a stunning and innovative timber roof system. The unique structural system—the first U.S. application of its kind—pays homage to the region's past as a leader in furniture manufacturing and its future in high technology.

Inspired by the form of the Piedmont hills, designers envisioned a seamless rolling roof line, an overhang at the entrance that extended 100 feet over the road, and an interior without columns—a plan that would require a combination of large wood and steel members to achieve.

To realize such an innovative design, a hybrid structural system was created featuring lenticular, long-span king post trusses built from glulam members, steel sections, and locked coil cable tension chords—a highly unusual combination. The major challenge was to develop a connection design to handle significant forces at the steel-wood joints, while maintaining a clean, craftsman-like appearance.

The result is a system in which the connection mechanisms are nearly invisible, fitting seamlessly into the wood. The solution involved using a proprietary German system manufactured by Bertsche, which utilizes interlocking pins to embedded dowels to connect to the glulam members. Although tested in Germany and Japan, this was the first time the system was used on a project of this scale in the United States. To ensure that the structural system would support the design, contractors built several prototype samples of the wood-to-steel joints with the connectors.

Working with North Carolina State University's Constructed Facilities Laboratory, three samples of the 8-1/2-by-30-inch glulam member-to-steel joints were tested to failure, as were three samples of the 10-by-54-inch glulam-to-steel joints. The university measured strains, loads and displacements of each sample to determine the ultimate capacity of each configuration, confirming that the system could indeed be used to carry significant loads in complex structures with large spans.

An additional unique feature of the terminal roof is the main entry canopy which extends 100 feet over the passenger crosswalk and departures level roadway in front of the terminal. It is supported by the same locked coil cables used for the roof trusses which extend down to the roof from a 130-foot-tall steel mast projecting overhead.

# Saint Joseph Adoration Chapel, Belmont Abbey

Saint Joseph Adoration Chapel at Belmont Abbey College in North Carolina took inspiration from its forested setting. The timber structure and roof of the chapel mimic the surrounding trees—growing straight and vertical before branching out to create a canopy to shelter the forest floor. Glass walls were used to create transparency, further blurring the divide between indoors and out.

The adoration chapel is open twenty hours a day and is designed to accommodate a single person in prayer and meditation, or a small group for mass. The 1,240-square-foot space is located close to student residence halls and near a public access to be readily accessible to the campus and the community.

The design goal was to create a serene and peaceful building; a retreat from academic and professional work and a respite from daily life. The realized vision takes visitors across a small bridge into a foyer and immediately into the chapel, immersing them in the forest.

The building—which cost a total of $624,000—is constructed on piers that were carefully placed to minimize damage to the roots of the existing trees. This allows the building to float above the forest floor and permits the forest to grow back under the chapel. The building is constructed with natural finish Douglas-fir and glass. The timber frame was hand hewn by Lancaster County Timber Frame and joined utilizing handcrafted mortise and tenon connections. Each frame member was numbered and each frame segment was first assembled at their shop. Once all joints and dimensions were checked, the frames were disassembled to ship to the site, where they were reassembled and lifted into place.

Once the frame was erected, the roof, floor, and exterior glass walls were added. A wood floor and wood ceiling further enhance the experience of being in the natural forest. The sunlight is filtered through the forest canopy and floods the interior with natural light, minimizing energy use during the day. Mechanical systems are hidden under the floor and electrical distribution to the lights is concealed within the roof structure.

## BELMONT, NORTH CAROLINA

**Architect:**
WGM Design, Inc.

**Client:**
Belmont Abbey College

**General Contractor:**
Spectrum Builders, Inc.

**Timber Framer:**
Lancaster County Timber Frame

**Photography:**
Tim Buchman,
courtesy of WGM Design, Inc.

## RESOURCES:

American Institute of Timber Construction
www.aitc-glulam.org

American Wood Council
www.awc.org

APA – The Engineered Wood Association
www.apawood.org

Canadian Wood Council
www.cwc.ca

Forest Products Society
www.forestprod.org

Forestry Innovation Investment
www.naturallywood.com

FPInnovations – Forintek Division
www.forintek.ca

International Code Council (International Building Code)
www.iccsafe.org

Southern Forest Products Association
www.sfpa.org

Timber Framers Guild
www.tfguild.org

USDA Forest Service, Forest Products Laboratory
www.fpl.fs.fed.us

Western Wood Products Association
www.wwpa.org

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Cover photo:
Timothy Hursley, Cesar Rubio Photography, John Blaustein Photography



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