OPTIMIZING OCCUPANT EXPERIENCE WITH WOOD

Presented by:

THINK WOOD™

WREN | Architect: Togawa Smith Martin, Inc. | Photo: Kevin C. Korczyk

LEARNING OBJECTIVES

1. Describe the benefits wood structures provide developers and tenants, including density, efficient construction, energy efficiency and other performance gains that help to maximize value and increase occupant comfort.
2. Review building types where wood is often used to optimize occupant experience.
3. Compare the different types of wood structural systems used in these building types and how each is sustainable and can improve occupant well-being.
4. Examine case studies where wood was used to maximize value and optimize occupant experience, including several LEED and affordable housing projects.

CONTINUING EDUCATION

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KEEP UP WITH TENANCY TRENDS

In recent years the building industry has focused on meeting the needs of millennial renters, homebuyers and corporate tenants as well as older generations with changing housing needs. A current perception is that millennials are making an exodus from where they grew up in the suburbs and moving into the city, fueling a trend toward urbanization. This is largely true but doesn't paint the bigger picture. The qualities that make a development desirable have been changing over the past 20 years and are adjusting as millennials mature. Millennials are now at the traditional "buy the first house, then buy a bigger house" stage of life, yet many do not want to buy a house or find homeownership financially out of reach. Millennials who do choose home ownership often seek smaller homes in urban cores rather than larger homes in the suburbs, while a similar population of millennials is perfectly happy settling outside of the city in suburban towns. Whether in an urban center or a suburb, their demands are similar: communities where they can live, work and play in a safe and comfortable environment, with a minimal commute to work. There is even a growing trend to transform inner-ring suburbs with walkable, mixed-use development.

The National Association of Realtors (NAR) 2017 National Community and Transportation Preference Survey revealed, "62 percent of millennials prefer walkable communities and short commutes, even if it means living in an apartment or townhouse." Millennials

Whether in an urban center or a suburb, tenant demands are similar: communities where they can live, work and play in a safe and comfortable environment, with a minimal commute to work. There is even a growing trend to transform inner-ring suburbs with walkable, mixed-use development. Orchards at Orenco | Architect: Ankrom Moisan Architects, Inc. | Photo: CBPhotography & Designs

Tenants are seeking green space such as an atrium, courtyard, rooftop patio and/or pools; podium and wrap construction make this possible. WREN | Architect: Togawa Smith Martin, Inc. | Photo: Kevin C. Korczyk

are tech-savvy home seekers, making use of websites and apps such as WalkScore.com, which provides any address with a "walkability score" based on walkable proximity to transit and amenities. The study further concluded, "The more walkable the community, the more satisfied residents are with their quality of life."

The NAR survey also found that members of the Greatest Generation (born 1925–1945) now seek smaller homes in neighborhoods where they can walk to shops and restaurants. However, Gen-Xers (born 1965–1984) and Baby Boomers (born 1946–1964) still show a strong preference for suburban living. Fifty-five percent of both groups placed having a single-family, detached home as a higher priority than the distance of their commute and walkable access to amenities. According to Stockton Williams, executive director of the Urban Land Institute's Terwilliger Center for Housing, "Healthy regions and fully functioning housing markets require a range of housing choices for households of different backgrounds, means, desires and stages of life. In practical terms, this means a variety of city and suburban housing options."

Overall, the demands of both residential and commercial tenants are fueling current tenancy trends: walkable communities, green space and mixed used developments, which allow for denser, more tightly knit communities in both urban and suburban cores. Most of these demands can be met or exceeded with smart

Light frame wood construction has long been the go-to framing choice for low-rise and, increasingly, mid-rise residential and commercial buildings.

design, which now includes constructing more densely and sustainably with wood buildings. In the following case studies, we'll examine how developers are successfully working affordable housing into mid-rise multifamily developments. Wood infill development in both city centers and the suburbs can offer the opportunity to create relatively affordable new housing in dense, walkable environments.

WHY BUILD WITH LIGHT FRAME?

Light frame wood construction has long been the go-to framing choice for low-rise and, increasingly, mid-rise residential and commercial buildings. Cost-effectiveness, material use efficiency, ease of assembly, minimal environmental impact and the ready availability of labor and materials make light frame construction the most common type of wood construction in North America. Typical light frame roof and floor systems consist of repetitive framing members such as rafters or trusses with wood structural panel decking. Framing components include solid sawn dimension lumber, I-joists, structural composite lumber and parallel chord and pitched trusses. OSB and plywood are used interchangeably as decking and sheathing material for floors, walls and roof decks. There are several approaches to light frame construction, each suited for a specific application and offering unique benefits.

There are several approaches to light frame wood construction and each is suited for a specific application, most often in the Type III (4–5 stories) and Type V (2–3 stories) categories. These approaches are distinguished by the wall-to-floor connection and include platform, balloon, semi-balloon, plank and beam and truss framing.

While mass timber structures are often built as components off site and assembled at the project site, light frame construction typically occurs entirely on site. Increasingly, however, elements of light frame buildings are fabricated off site and assembled on the job. Off-site construction offers greater control over construction conditions and improved safety oversight for all material types while requiring less skilled labor on site and contributing to faster construction timelines.

MEET THE DEMANDS OF RESIDENTIAL AND COMMERCIAL TENANTS WITH WOOD

Fortunately, wood buildings can help in meeting development and tenant-driven demands:

- Green space—podium and wrap construction make possible green spaces such as an atrium, courtyard, roof top patio and/or pool.
- Access to amenities in walkable communities—wood construction effectively achieves higher density housing at a lower cost, all while reducing the carbon footprint of their projects. The International Building Code (IBC) allows five stories of wood-frame construction in many residential building occupancies and six stories for business occupancies. Wood offers density for the lowest cost with full code compliance, so dense mixed-use developments are possible. More density equates to higher occupancy in midrise buildings, as well as a smaller footprint.
- Flexible office and retail spaces—the open concept of many mass timber designs allows for the space reconfiguration and modification as needs change.
- Sustainable, healthy buildings—environmentally friendly and safe buildings are increasingly expected by both code and occupants. Wood buildings improve aesthetics, thermal comfort, air quality, acoustics and life safety.

THE FITZGERALD—URBAN DESIGN WOOD SOLUTION

The Fitzgerald capitalizes on the benefits of podium design to create sustainable mixed-use living. The podium maximizes versatility, transferring loads from four wood stories above to a 30-foot grid to achieve higher densities and allow a mix of commercial, residential and parking. The Fitzgerald | Architect: Design Collective | Photo: Richard Greenhouse

WHY BUILD WITH MASS TIMBER?

The Fitzgerald—Urban Design Wood Solution
Baltimore, Maryland

On a 4.6-acre site bordered by a light rail station, regional Penn Station and a six-lane interstate, "The Fitz" transformed a brownfield parking lot into a dynamic transit-oriented mixed-use community in Baltimore, Maryland. The development features four stories of wood over a concrete podium with 407,712 square feet (25,000 square feet of retail), 275 class A apartments and a campus/public parking garage. The building connects the community to local schools, cultural arts and the greater region. Informed by the collision of street grids and a web of kinetic infrastructure, The Fitz creates a link between adjacent campuses for the Maryland Institute College of Art and the University of Baltimore.

A four-story glass pedestrian bridge at the entry plaza sets the stage for a dialogue between public and private spaces. Lighter metal panel planes float above fully glazed retail areas, while heavier, grounded masonry planes reflect the privacy of residential areas. Fronting the adjacent Mount Royal Light Rail station, the building's form steps back and opens up to manifest an arts plaza with a secondary entry. The main entry plaza on Mount Royal Avenue and streetscape along Oliver Street encourage socializing, walking and cycling to the adjacent colleges, Penn Station and nearby subway stop.

Recognizing the imperative for sustainable design, The Fitzgerald achieved LEED® Silver certification through strategic siting, material selection, energy/water conservation and construction waste management, among other strategies. Once a rail yard, a tire re-treading company and then an impervious parking lot, this brownfield site is now a didactic tool exemplifying responsible urban living through form and function. The Fitzgerald capitalizes on the benefits of podium design to create sustainable mixed-use living. The podium maximizes versatility, transferring loads from four wood stories above to a 30-foot grid to achieve higher densities and allow a mix of commercial, residential and parking. The wood frame allowed for more dramatic spaces, cantilevers and details above the podium, opening the ground floor facade for retail and pedestrian activity. The use of renewable wood was a cost-effective, fully code-compliant solution to achieve the density and urban vibrancy developers sought.

Because of its strength and dimensional stability, mass timber offers a low-carbon alternative to steel, concrete and masonry for many applications. The Hudson | Architect: Mackenzie Architects | Photo: Christian Columbres Photography

Mass timber is a category of framing styles typically characterized by the use of large solid wood panels for wall, floor and roof construction. Building with mass timber offers a reduced carbon footprint, construction efficiency, fire and life safety, and occupant well-being. The primary types of mass timber construction are glulam, nail-laminated timber (NLT), cross-laminated timber (CLT) and dowel-laminated timber (DLT).

Because of its strength and dimensional stability, mass timber offers a low-carbon alternative to steel, concrete and masonry for many applications. Because CLT is prescriptively recognized for Type IV Construction, there is a common misperception that exposed mass timber elements can't be used in other construction types. This isn't the case.

In addition to Type IV buildings, mass timber elements—including CLT, glulam, nail-laminated timber (NLT), structural composite lumber (SCL), and tongue-and-groove (T&G) decking—are permitted as exposed structural elements, whether or not a fire-resistance rating is required, as follows:

- Type III—Floors, roofs and interior walls may be exposed timber in fire resistance-rated construction; exterior walls are required to be noncombustible or fire retardant-treated wood.
- Type V—Floors, roofs, interior walls, and exterior walls (entire structure) may be exposed timber in fire resistance-rated construction.
- Types I and II—Exposed wood may be used in select circumstances (e.g., roof construction of Type IB, IIA or IIB buildings when a 1-hour fire-resistance rating or less is required or when 20 feet or more of horizontal separation from the building is provided).

Section 703.3 of the 2015 IBC lists several acceptable methods of demonstrating fire resistance, one of which is calculations done in accordance with IBC Section 722.

WOOD BENEFITS THE DESIGN AND CONSTRUCTION TEAM

Designing with wood provides numerous benefits to architects, developers, owners and occupants. In fact, wood can be a suitable alternative in applications that use concrete, masonry and steel in many building types including midrise, urban infill, industrial, educational, civic and tall wood projects. The speed of light frame and mass

Urban infill projects typically have construction site constraints due to existing surrounding buildings. In these projects, wood construction provides significant benefits over concrete and steel. WREN | Architect: Togawa Smith Martin, Inc. | Photo: Kevin C. Korczyk

timber construction correlates to revenue in all building types.

Construction Efficiency

Wood provides several benefits that equate to efficiency and maximum value for the project. Consistent structural material use throughout wood buildings reduces the need for different trades on site and fewer workers on the active deck, thereby streamlining the scheduling process and construction timelines and reducing costs.

Urban infill projects typically have construction site constraints due to existing surrounding buildings. In these projects, wood construction provides significant benefits over concrete and steel. The inherent light weight of wood also provides several efficiencies. Wood allows for

- On-site staging (if prefabrication is involved) and a smaller construction footprint, rather than the site being spread out over several parcels.
- Reduced construction traffic (trucks delivering materials).
- Smaller crews and a much quieter job site.
- Faster erection of mass timber buildings than a comparable concrete and steel building. Earlier project completion and occupancy equates to more money for the owner.
- Greater efficiency. Mass timber construction incorporates large, prefabricated, precise structural members with no cure time.
- Smaller foundation requirements and lower forces for seismic resistance reduce costs.
- A good solution where poor soil is an issue.

Sustainability

The construction industry is currently one of the largest contributors to carbon emissions. However, the industry can have a positive effect on the environment, with efficient practices and sustainable building materials. Construction practices can affect indoor air quality, materials recycling, energy use, vegetation and habitat quality. Architects, and the construction industry as a whole, can minimize the impacts of construction activities on the environment through materials selection, recycling and reuse and designing sustainable, energy-efficient buildings. Because of the longevity of building products, the construction industry is in a unique position to support environmental benefits.

Architecture 2030, a non-profit organization established in response to climate change, states that, "Buildings consume nearly half the energy produced in the United States, use three-quarters of the electricity and account for nearly half of all carbon dioxide (CO_2) emissions." And according to the Environmental Protection Agency, "Although construction practices typically do not produce large quantities of greenhouse gases compared to the operations of many other sectors, the sheer number of construction projects results in significant aggregate emissions for the sector." When architects and developers set out to design and build a sustainable building with low carbon emissions, they should certainly consider wood.

Using wood from sustainably managed forests can reduce a building's carbon footprint, as fossil fuel consumption and potential contributions to the greenhouse effect tend to be minor for wood products compared with competing products. Photo: Ian Shive

There is growing awareness that using wood from sustainably managed forests can reduce a building's carbon footprint, as fossil fuel consumption and potential contributions to the greenhouse effect tend to be minor for wood products compared with competing products. According to the FPInnovations report, *A Synthesis of Research on Wood Products and Greenhouse Gas Impacts*, wood products require less energy to manufacture than other major building materials, and most of that energy comes from renewable biomass.

The other aspect to wood's carbon footprint is that as trees grow they absorb carbon dioxide (CO_2) from the atmosphere; they release oxygen and incorporate the carbon into their wood, leaves or needles, roots and surrounding soil. When trees are harvested and manufactured into products, they continue to store much of the carbon (wood material is approximately 50 percent carbon by dry weight). In the case of wood buildings, stored carbon never enters the atmosphere during the lifetime of the structure—and longer when the wood is reclaimed at the end of the building's service life and reused or manufactured into other products.

In addition, wood structural systems are fully capable of meeting a building's longevity expectations. Wood buildings are very durable and resilient in cases of seismic or high wind events. With proper design and construction, wood frame buildings resist damage from moisture, insects and other organisms and provide decades of service, equivalent to other building types. Further, wood should be considered a preferred material because it enables easy building modification in response to changing needs and wood materials are easy to recover when a building is decommissioned. The sustainable attributes of wood buildings provide effective marketing messages for building owners once occupancy begins.

BENEFITS FOR OWNERS, OCCUPANTS AND THE BOTTOM LINE—OCCUPANT EXPERIENCE AND PERFORMANCE GAINS

Wood has been extensively researched and shown to be sustainable by measures that include renewability, embodied energy, air and water pollution and carbon footprint. But it also performs well in areas that are essential to occupant comfort and performance, resulting in spaces where people feel good and do well over long periods of time. Wood makes use of natural daylight, views of nature and exposed wood (in mass timber buildings) to create a warm, natural aesthetic, improve performance, productivity and occupant well-being. Left exposed, visible wood structural elements offer impressive visuals that accentuate a project's design. Mass timber wood structural systems allow for soaring atriums and large expanses of glass, increasing daylighting. Modern wood products bring warmth and beauty to the interior while promoting a healthy environment.

Aesthetics and Exposed Wood—A Study in Biophilia

The "average North American" spends 90 percent of their time indoors, yet humans have a natural affinity for nature. Being in a natural environment such as a forest, park or garden can make us feel more relaxed. The term "biophilia" has been coined to refer to this phenomenon. Although most of us understand the connection intuitively, the stress-reducing effects of nature are also well documented from a scientific perspective. Exposure to nature has been shown to lower blood pressure, heart rate and aggression. Nature also increases the ability to focus attention and perform concentration and creative tasks.

In addition to views of nature itself, there is

PROMEGA FEYNMAN CENTER—MASS TIMBER BIOTECH HEADQUARTERS

Promega Feynman Center—Mass Timber Biotech Headquarters
Madison, Wisconsin

Promega is a leading biotechnology firm headquartered in Madison, Wisconsin. Their 52,000 square foot client and staff reception center, The Crossroads, was designed with a glulam beam and cross-laminated timber structure.

The Crossroads is important to Promega's 300,000 square foot Good Manufacturing Practices (GMP) facility, a highly regulated and specialized building used for manufacturing medical device products. "GMPs can be relatively sterile spaces," said David Rosseau of Archemy Consulting, design consultant for Promega. "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."

GMPs can be relatively sterile spaces, but Promega wanted The Crossroads to give clients and staff a completely different environment; they liked the idea of a 'tree-lined indoor colonnade' and also wanted high design and high-quality materials. Promega Feynman Center | Architect: Uihlein Wilson Ramlow Stein | Photo: C & N Photography courtesy Ewing Cole

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."

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."

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 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."

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."

growing evidence that a positive relationship exists between humans and natural materials. An increasing number of studies focused on wood's biophilic aspects have linked the use of exposed wood in buildings with improved occupant health and well-being. For example, a 2012 study at the University of British Columbia and FPInnovations demonstrated that the presence of visual wood surfaces in a room lowered sympathetic nervous system (SNS) activation. The SNS is responsible for physiological stress responses in humans. In the study, four office environments were created to examine the effects of natural materials on autonomic nervous system responses. The rooms were identical except for either wood finishes (birch veneer) or white finishes and the placement of either plants or non-natural objects. Stress as measured by SNS activation was lower in the wood room in all periods of the study. Temporary spikes in skin conductivity (associated with stressful thoughts or stimuli) were also measured. Once again, the subjects in the wood room had statistically fewer of these responses, interpreted as fewer stressful thoughts.

Wood makes use of natural daylight, views of nature and exposed wood (in mass timber buildings) to create a warm, natural aesthetic, improve performance, productivity and occupant well-being. Clay Creative | Architect: Mackenzie Architects | Photo: Christian Columbres

Thermal Comfort

From a thermal perspective, wood-frame building enclosures are inherently more efficient than steel-frame, concrete or masonry construction because of the insulating qualities of the wood structural elements, including studs, columns, beams and floors. Options also exist for insulating wood-frame buildings that aren't available for other construction types. For example, while requirements for lighting systems or mechanical systems do not change based on structural material, wood's versatility related to building envelope configuration gives designers more insulation flexibility.

While wood-frame buildings have a history of cost-effectively achieving energy-efficiency

77H—LEED SILVER, MIXED-USE MID-RISE PODIUM WRAP

In addition to a LEED® Silver for Retail-certified Walmart, 77H residents have access to a three-season rooftop pool, spacious lounge area, a warehouse-style fitness center and a variety of public transportation options, including a new streetcar system and bikeshare station. 77H | Architects: MV+A Architects and The Preston Partnership | Photo: Fred Gerlich and Michael Carpenter

77H—LEED Silver, Mixed-Use Mid-Rise Podium Wrap
Washington, DC

77H is a 375,000 square foot residential infill mixed-use structure built on the 2.1 acre site of a former gravel parking lot near the United States Capitol. Its 90,000 square feet of retail includes a 75,000-square-foot LEED® Silver for Retail-certified Walmart, North America's first multifamily building to include an urban-format Walmart. 77H residents also have access to a three-season rooftop pool, spacious lounge area, a warehouse-style fitness center and a variety of public transportation options, including a new streetcar system and bikeshare station.

77H is a wood-frame, mid-rise podium wrap project. The project complies with Section 602.3 of the 2012 International Building Code for Type IIIA, four-story wood-frame construction on a one-story concrete podium with exposed cellar. It is also among the first projects to be fully compliant with D.C.'s new Inclusionary Zoning Regulations, a model for serving income-qualified families and individuals.

The decision to specify wood was made for a couple of reasons. First, building with wood is safe. Today's fire-resistive materials and building practices, including a fire sprinkler system throughout all rooms and public areas, ensures that 77H meets or exceeds the safety performance expected from any code-compliant building system. Wood has a high strength-to-weight ratio and exceptional ductility, meaning great structural durability during high winds and seismic events.

Wood also maximizes the owner's investment. Because the property is a tight infill site in an active urban location, wood offered the owner the most density for the lowest cost with full code compliance. The designers looked at other construction options, including metal framing, but their comparative analysis of wood vs. metal framing concluded that metal, at the same density, would have spiked construction costs by 20 percent. 77H was able to achieve an affordable density of 303 units and 90,000 square feet of retail on just 2.1 acres. This translates to a density of 144.3 dwelling units per acre, which made 77H economically viable.

The top four floors are designed for class A apartment units, thoughtfully blending historic detail with rusticated bases, deep recessed windows, jack arch lintels, and stone cornices. The affordability of wood frame construction allowed the developer to spend more on the brick façade.

Sustainability was also another important consideration. Wood is natural, renewable, biodegradable, non-toxic, recyclable and reusable. Today, 77H is on track to receive Green Communities Certification through the Enterprise Green Communities Initiative and is LEED® Silver certified by the U.S. Green Building Council.

objectives, new energy codes and standards have increased the minimum thermal requirements for building enclosure assemblies, and many of the new requirements exceed the cost effective thermal insulation limits of traditional wood-frame construction. This has prompted the need for alternative assemblies—e.g., with insulation outside the framing spaces or deeper wall cavities—as well as more thermally efficient detailing. With proper attention to detail and the application of building science in design, wood buildings can meet or exceed the requirements of new energy codes and standards as well as conservation programs and labeling systems such as Passive House, net-zero energy and the Architecture 2030 Challenge.

Indoor Air Quality

Indoor air quality is a basic requirement for humans in any space. Wood itself is considered to be hypoallergenic and its smooth surfaces are easy to clean and prevent the buildup of particles that are common in soft finishes like carpet. Most wood structural panel and engineered wood products use phenolic resins or diphenylmethane diisocyanate (MDI). Their unique chemistry makes these waterproof adhesives highly durable and stable, resulting in negligible formaldehyde emissions. In fact, large-scale chamber tests have shown that formaldehyde emission levels in wood structural panels are no higher than the levels found naturally in the environment.

The use of wood products can also improve indoor air quality by moderating humidity. Acting like a sponge, the wood absorbs or releases moisture in order to maintain equilibrium with the adjacent air. This has the effect of raising humidity when the air is dry and lowering it when the air is moist.

Improved Acoustics

In large buildings with hundreds or even thousands of occupants such as apartment buildings, condominiums, hotels or dormitories, every acoustic detail has a positive or negative effect on the quality of daily life. Post-occupancy evaluations of buildings have revealed that poor acoustic performance is a common problem in buildings with large areas of hard, acoustically reflective surfaces. Ironically, such surfaces are frequently found in buildings designed to be sustainable, where the use of absorbent materials is minimized due to indoor air quality concerns. But greenbuilding certifications such as LEED are beginning to incorporate acoustics more prominently, and many designers

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are beginning to reconsider wood for its advantageous acoustic performance.

For centuries, wood has been the material of choice for architects and designers intent on delivering the highest quality acoustic performance. Wood is naturally sound-damping, offering excellent noise control. As a result, wood has long been specified for applications requiring the amplification of sound (such as a concert hall) or its mitigation (such as a library). Acoustic design considers a number of factors, including building location and orientation as well as the insulation or separation of noise-producing functions and building elements. Wood can contribute to both the insulating and separating areas of a project.

According to Woodworks' publication, *Acoustical Considerations for Mixed-Use Wood Frame Buildings*, "In residential buildings, the International Building Code provides a minimum design requirement for unit-to-unit acoustical protection between floors. It requires a Sound Transmission Class (STC) rating or Impact Insulation Class rating of 50. The International Residential Code (IRC) requires a minimum design separation of STC 45 for townhouses. In a mixed-use project, consideration must be given to the acoustics between all of the adjacent spaces—not just dwelling unit to dwelling unit. Acoustical separation between residential and other occupancies can be a significant challenge and is not yet addressed in the IRC or IBC."

The paper continues, "In wood-frame construction, the most effective wall in terms of acoustical performance is a double stud wall, which can achieve a rating of approximately STC 63 when insulated with batt insulation and covered with two layers of gypsum wallboard on the outside faces of the studs. STC 63 is the highest rating possible unless rooms and spaces are detailed like a studio with floating floors, etc."

Life Safety

Finally, life safety building codes ensure tenants are safe from fire, earthquakes and other elements such as high wind. Design and engineering analysis, along with supporting research, shows that structurally, wood meets and often surpasses prescriptive building code requirements for fire, seismic performance and wind resistance that allow its use in larger buildings. Building fire safety incorporates a combination of passive and active features. A passive fire safety feature may limit the height and area of the building, prescribe the use of fire-rated building elements or provide for adequate means of egress. Active fire safety features are those such as automatic fire detection or suppression systems that provide occupant notification, alarm transmittance and the ability to suppress fire growth until the fire service arrives.

Active fire suppression systems, such as sprinkler systems and fire extinguishers, are widely recognized. Passive fire protection contains a fire at its point of origin, and despite its name, is always at work. Wood products such as the large beams used in heavy timber construction and cross laminated timber may perform better in a fire situation than noncombustible

materials. Because these wood products are thick and solid, they char on the outside at a slow and predictable rate while retaining strength, slowing combustion and allowing time to evacuate the building. The char protects the wood from further degradation, helping to maintain the building's structural integrity and reducing its fuel contribution to the fire, lessening the fire's heat and flame propagation. Light frame systems should include active fire protection measures such as sprinklers, fire watch during construction, firewalls, etc.

Earthquakes are another critical concern for design professionals working in some of the most populated regions of the U.S., particularly the West Coast. Research and building code development have proven that wood components, assemblies and entire structures are capable of meeting or exceeding the most demanding earthquake and seismic design requirements. Products like cross-laminated timber, nail-laminated timber, dowel-laminated timber, glue-laminated timber and even light frame structural systems give designers and engineers a readily available and robust selection of code-approved building materials that can help commercial and residential buildings and other infrastructure better withstand seismic events.

Seismic events tend to be regional, but buildings everywhere face the risk of damage due to high winds, with each structure reacting differently according to its stiffness, strength and shape. Because of that, all buildings must be designed to safely respond to lateral wind loads. Wood frame construction is inherently flexible, lightweight, has ductile connections, is code compliant, has redundant load paths, and has strength and stiffness. Wood's elasticity and strength give buildings an advantage during high-wind events.

CONCLUSION

Today's tenancy trends may be the result of technology, which has left people feeling over-connected to their devices yet disconnected from person-to-person contact. Multi-family tenants and workers occupying buildings are seeking a more communal, walkable, close-knit, healthy environment in which to live and work. This is particularly true of the younger generation; some are trading suburbs for urban areas, while others may not value home ownership as much as older generations. Denser, more urban developments (even if they're in the suburbs) naturally put you in touch with more people, from the barista brewing your morning coffee to the concierge at the front desk, knitting buildings and occupants together, all a part of the urban fabric. In addition, sustainable design is becoming an expected attribute of buildings where people live and work. Not only do tenants expect that a building will protect them in a life safety sense from fire, earthquakes and hurricanes but that it will actually be a healthy environment with low-VOC materials, minimal unwanted noise and a connection with nature. Whether commercial, residential, mid-rise, multi-family, luxury or affordable housing, high performance wood buildings are livable, workable buildings. ■

ALBINA YARD—U.S. SOURCED AND PREFABRICATED CLT BUILDING

The relative lightness of CLT panels and beams permitted a smaller foundation, which can preclude the need for expensive piles or allow a taller structure. Albina Yard | Architect: LEVER Architecture | Photo: Jeremy Bitterman, courtesy of LEVER Architecture

Albina Yard is an elegantly simple yet modern structure that showcases an "economy of means." Albina Yard | Architect: LEVER Architecture | Photo: Jeremy Bitterman, courtesy of LEVER Architecture

Albina Yard—U.S. Sourced and Prefabricated CLT Building
Portland, Oregon

It's fitting that the center of a fast-growing locavore movement is home to the first U.S. mass timber structure using domestically produced cross-laminated timber. Some say Portland's Albina Yard stands as an inflection point for U.S. CLT design and manufacturing. Albina Yard has attracted hundreds of inquisitive visitors to its Portland address since its delivery in September 2016. The 16,000 square foot, four-story office and retail center is an attractive, daylight-friendly addition to North Portland that was fully leased prior to delivery. "Building more sustainably and the idea of carbon sequestration is a big part of the culture here. There has been a lot of talk about building with domestic CLT. People come to Albina Yard and say, 'Hey, it's real' and can kick the tires, so to speak. It helps people confidently move forward with domestic CLT," explains project architect, Thomas Robinson, principal of LEVER Architecture of Portland, OR.

What do people find when they visit Albina Yard? An elegantly simple yet modern structure that showcases an "economy of means," in Robinson's words. Wood was always planned as the primary structural material, but the LEVER team priced two approaches: standard tongue-and -groove wood decking and CLT. Working closely with engineers and fabricators, the design team optimized CLT costs by simplifying details and leveraging CLT's two-way spanning capacity to minimize beams.

Wood columns and beams were prefabricated offsite to 1/8-inch tolerances. Prefabrication allowed components to be assembled on site five times faster than a conventional wood decking system.

Code compliance wasn't an issue. "We weren't going higher than 75 feet and the building has a sprinkler system. Type III-B heavy timber construction is fully code compliant. Life safety was permitted through the state and land use through the city. The state has ultimate jurisdictional control. They were very rigorous, thorough and professional," observes Robinson. Each of the 4,000 square foot CLT floor decks was installed in about four hours. The carefully orchestrated, speedy assembly also resulted in a quiet work zone. Just-in-time material delivery eliminated the need for on-site storage and staging, often a key consideration for dense urban projects. The relative lightness of CLT panels and beams permitted a smaller foundation, which can preclude the need for expensive piles or allow a taller structure, according to Albina Yard project engineer Eric McDonnell of KPFF Consulting Engineers.

The Albina Yard experience served as a test bed for an even more ambitious CLT project. Not far away in Portland's Pearl District, work on a 12-story mixed-use CLT tower is slated to begin early this year. It will be America's first wooden high-rise, a design that earned the project team the U.S. Department of Agriculture's Tall Wood Prize. "We're really excited to see it start," Robinson says.

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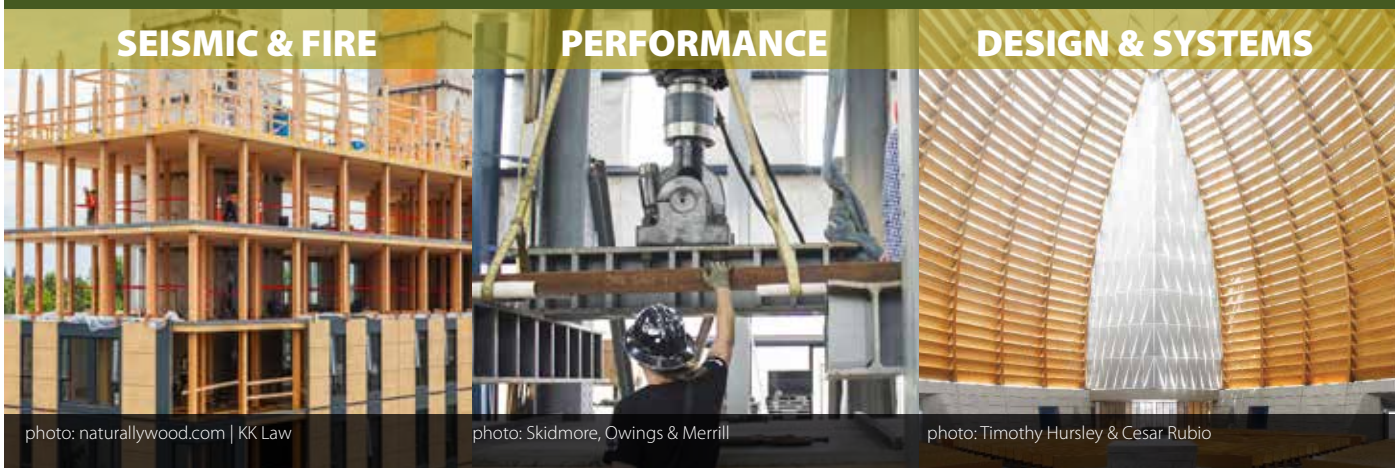

For current mass timber research in the United States and worldwide, including CLT and tall wood buildings, the Think Wood website includes a library of studies, categorized by topic area and updated regularly.

DESIGN GUIDANCE AND RESOURCES

There are many resources available to architects and engineers designing mass timber projects.

- For general information, the Think Wood website (www.thinkwood.com) offers an expanding library of materials on mass timber products, research, building examples, and developments related to tall wood buildings.
- The National Design Specification (NDS) for Wood Construction (www.awc.org) is the IBC-referenced design standard for lumber, glulam, SCL, and CLT, including fire design, fasteners and connections, etc. A mass timber building in the United States cannot be designed without the NDS.
- The U.S. CLT Handbook (www.thinkwood.com) includes detailed technical information on the use of CLT. It should be used in conjunction with information provided by manufacturers since most CLT currently available in North America is propriety (i.e., lay-ups aren't standard across suppliers).
- APA Product Reports (www.apawood.org/product-reports) signify a product's compliance with relevant provisions of the model building codes. The L-Series covers products manufactured from lumber, veneer, or other wood base, such as glulam and structural composite lumber (SCL).

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For one-on-one support (at no cost), technical experts at WoodWorks are available to provide free project assistance related to nonresidential and multifamily buildings in the United States, including those using mass timber. Designers have the option of contacting an expert in their region (www.woodworks.org/projectassistance) or emailing help@woodworks.org.

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QUIZ

1 Which of the following is a current tenancy trend?

a. Walkable communities
b. Mixed-use developments
c. Short commutes
d. Green space
e. All of the above

2. True or False: Podium and wrap construction make green space such as an atrium, courtyard, roof top patio and/or pool more difficult to incorporate into building designs.

3. True or False: Wood offers density for the lowest cost with full code compliance, so dense mixed-use developments are possible. More density equates to higher occupancy in midrise buildings, as well as a smaller footprint.

4. _____ roof and floor systems consist of repetitive framing members such as rafters or trusses with wood structural panel decking.

a. Light frame
b. Mass timber

5. _____ is a category of framing styles typically characterized by the use of large solid wood panels for wall, floor and roof construction.

c. Light frame
d. Mass timber

6. Which of the following is a benefit of wood construction in urban infill projects?

a. Smaller construction footprint
b. Reduced construction traffic
c. Smaller crews and quieter job site
d. Faster erection
e. All of the above

7. True or False: Using wood from sustainably managed forests can reduce a building's carbon footprint, as fossil fuel consumption and potential contributions to the greenhouse effect tend to be minor for wood products compared with competing products.

8. Which case study is LEED Silver certified?

a. Albina Yard
b. 77H
c. Promega
d. The Fitzgerald
e. Both B and D

9. Which of the following is a benefit of wood buildings to occupants?

a. Exposed wood
b. Thermal comfort
c. Indoor air quality
d. Improved acoustics
e. Life safety
f. All of the above

10. True or False: Design and engineering analysis and supporting research show that structurally, wood meets and often surpasses prescriptive building code requirements for fire, seismic performance and wind resistance, allowing wood's use in taller buildings.

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