Building Green with Wood

MODULE 5

# Durability and Adaptability

# The Service Life of Buildings

In North America, we have historically chosen not to exploit the potential longevity of buildings, instead assigning a higher priority to other factors. As a consequence, with the exception of the few that are designated 'post-disaster' structures most buildings have a service life of less than 50 years.

Most structures are demolished because of external forces such as zoning changes and rising land values – often the building fabric itself may still be in good condition. When one considers the embodied energy in these structures and the implications of material disposal, it is clear that these premature losses have a considerable negative environmental impact.

New buildings can be designed for flexibility and adaptability, and the full service life can be extracted from building materials if they are reclaimed and reused as much as possible. In this way, architects can assume the role of curators, not just creators, of the built environment.

# Durability of Materials and Structures

Designers can get maximum performance and service life out of every building material as long as they understand the necessary steps. Improperly detailed masonry and concrete may spall or crack, steel may rust, and wood may rot. In each case, this compromises the integrity of a building and reduces its life expectancy.

Used properly, all of these materials are inherently durable and can endure for decades or even centuries. The most ancient wood buildings still in existence include eighth century Japanese temples, 11th century Norwegian stave churches, and the many medieval post-and-beam structures of England and Europe. These buildings endure partly because of their cultural significance, and partly because they were built and maintained properly.

For example, long posts supporting the multi-tiered roofs of stave churches were air dried for up to two years to prevent shrinkage and distortion after they were installed. Wood foundation beams were laid on a gravel-filled trench to protect the structure from long-term contact with water. Vertical planked walls were protected from the weather by large overhanging eaves, and shingle roofs were steeply pitched to shed rain and snow.

Although we need a more sophisticated understanding of building physics to ensure the integrity and longevity of materials and structures, the same basic principles still apply.

The Cathedral of Christ The Light in Oakland, California, (on the cover) is an extraordinary timber cathedral designed to last 300 years using a unique structural system. Designed by Skidmore, Owings & Merrill LLP (SOM), the soaring 36,000-square-foot, 1,500-seat structure replaces another cathedral

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# Post-disaster Design

While all buildings are at risk of experiencing damage during natural disasters, wood has a number of characteristics that make it conducive to meeting the challenges of seismic- and wind-resistive design.

**Light weight.** Wood-frame buildings tend to be lightweight, reducing seismic forces, which are proportional to weight.

**Ductile connections.** Multiple nailed connections in framing members, shear walls and diaphragms of wood-frame construction exhibit ductile behavior (the ability to yield and displace without sudden brittle fracture).

**Redundant load paths.** Wood-frame buildings tend to be comprised of repetitive framing attached with numerous fasteners and connectors, which provide multiple and often redundant load paths for resistance to seismic and wind forces. Building codes also prescribe minimum fastening requirements for the interconnection of repetitive wood framing members; this is unique to wood-frame construction and beneficial to a building's performance.

*Stella*
*Marina del Rey, CA*
*Architect: DesignARC*
*Photo: Lawrence Anderson*

*The luxury Stella development in California includes four and five stories of wood-frame construction over a shared concrete podium. It was designed to meet requirements for Seismic Design Category D.*

***The Barn at Fallingwater, designed by Bohlin Cywinski Jackson, is a renovated 19th-century barn with a 1940s dairy barn addition. This adaptive reuse project is immediately adjacent to Frank Lloyd Wright's Fallingwater and is the first phase of a conference complex for Western Pennsylvania Conservancy. The Barn's interior is rich with recycled and salvaged materials that celebrate the region's agrarian heritage. More than 80 per cent of the construction debris was recycled.***

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destroyed during a 1989 earthquake. Architecturally stunning, the new building features a space-frame structure comprised of a glulam and steel-rod skeleton veiled with a glass skin. Given the close proximity of fault lines and non-conformance of the design to a standard California Building Code lateral system, the City of Oakland hired a peer review committee to review SOM's design for toughness and ductility. Through the use of advanced seismic engineering, including base isolation, the structure has been designed to withstand a 1,000-year earthquake. Engineers were able to achieve the appropriate structural strength and toughness by carefully defining ductility requirements for the structure, using three-dimensional computer models that simulate the entire structure's nonlinear behavior, testing of critical components relied on for seismic base isolation and superstructure ductility, and verifying their installation.

***The Fulton County Stadium in Atlanta, Georgia, was imploded in 1997 – just 32 years after it was built and shortly after it had been refurbished to host the baseball events for the 1996 Olympics. It is a clear example of premature demolition because the building could not meet changing needs.***

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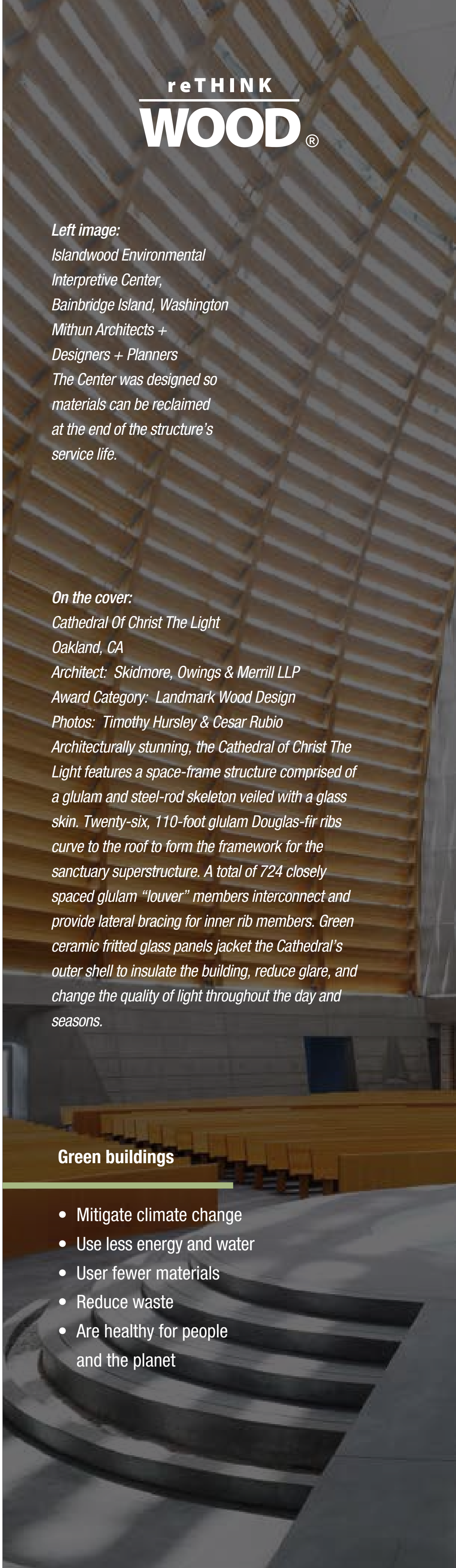
## Flexibility and Adaptability

Designing for flexibility and adaptability is also critical to secure the greatest value for the net energy embodied in building materials. Wood structures are typically easy to adapt to new uses because the material is so light and easy to work with. The inherent structural redundancy in light-weight wood-frame structures provides many opportunities for adaptation, while post-and-beam structures provide complete flexibility in the reconfiguration of non-load bearing partitions.

Wood also lends itself to dismantling. The Islandwood Environmental Interpretive Center on Bainbridge Island in Washington state has a post-and-beam frame so partitions can be non-load-bearing, with fully demountable bolted connections to permit reclamation of the complete structure at the end of its service life. In contrast to other materials, reclaimed wood can often be reused for its original purpose (e.g., as structural members), with little or no loss of value.



*Left image:*
*Islandwood Environmental Interpretive Center, Bainbridge Island, Washington*
*Mithun Architects + Designers + Planners*
*The Center was designed so materials can be reclaimed at the end of the structure's service life.*

*On the cover:*
*Cathedral Of Christ The Light*
*Oakland, CA*
*Architect: Skidmore, Owings & Merrill LLP*
*Award Category: Landmark Wood Design*
*Photos: Timothy Hursley & Cesar Rubio*
*Architecturally stunning, the Cathedral of Christ The Light features a space-frame structure comprised of a glulam and steel-rod skeleton veiled with a glass skin. 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.*

**Green buildings**

- Mitigate climate change
- Use less energy and water
- User fewer materials
- Reduce waste
- Are healthy for people and the planet