Wood Specification: Passive Design and Framing Techniques

Passive design is an approach to building design that uses the building architecture to leverage natural energy sources, minimize energy consumption, and improve thermal comfort. Passive buildings rely heavily on high-performing building envelope assemblies and passive solar energy.

Wood is an attractive material for passive design because of how it combines thermal mass with a number of performance merits, including water resistance, structural integrity, and finish quality.

Why Passive Design Adds Value

- The ultimate goal of passive design is to fully eliminate requirements for active mechanical systems (and associated fossil fuel-based energy consumption) and to optimize occupant comfort.
- Passive design and optimal building envelope performance can:
  - › Help reduce or even eliminate utility bills
  - › Improve the quality of the interior environment
  - › Reduce greenhouse gas emissions associated with heating, cooling, mechanical ventilation, and lighting
  - › Reduce the need for mechanical systems and their associated costs
  - › Make alternative energy systems viable.

How to Include Wood as Part of Passive Strategies in Design

Optimum value engineering (OVE) uses advanced principles to optimize the use of wood for framing by:

- Expanding the spacing between exterior and interior wall studs to as much as 24 inches (61 cm) on-centre
- Eliminating headers at non-bearing interior and exterior walls
- Using header hangers instead of jack studs
- Eliminating cripples on hung windows
- Eliminating double plates; using single plates with connectors by lining up roof framing with wall and floor framing
- Using two-stud corner framing with drywall clips or scrap lumber for drywall backing instead of studs.

Structural insulated panels and pre-fabricated wood panels:

- Most structural insulated panels consist of an insulating foam core sandwiched between oriented strand board. Structural insulated panels are gaining market share in the residential and light commercial building market because they are quick to assemble and provide excellent energy performance
- Wall panels reduce thermal bridging/migration, control air leakage, and keep heating and cooling costs to a minimum compared to a conventionally framed wall.

Airtight construction—build tight then ventilate right:

- The following areas of the building envelope should be sealed, caulked, gasketed, or weather-stripped to minimize air leakage:
  - › Joints around fenestration and door frames
  - › Junctions between walls and foundations, between walls at building corners, between walls and structural floors or roofs, between walls and roof or wall panels
  - › All other openings in the building envelope
  - › Passive design framing and carbon-neutral wall assembly
- Passivhaus pre-fabricated wall assembly with effective insulation reaching as high as R32
- Helped by cross-laminated technology and quality
- Insulation, including wood-fibre insulation
- High-performing wood-frame, aluminum-clad, triple-glazed windows.

Terminology

Passivhaus standard:
The most rigorous European standard, Passivhaus, regulates input energy to a maximum 0.55 MBTU/ft²/y (15 kWh/m²/y) for heating/cooling/ventilation. This is about one-tenth of that in a typical new 2,150 ft² (200 m²) Canadian house, and a difference equivalent to 79 gallons (300 litres) of oil, 10,600 ft³ (300 m³) of natural gas, or 3,000 kWh of electricity annually. A building that qualifies for this standard has to meet clearly defined criteria, which include (for a building constructed at a latitude of 40 to 60˚ in northern Europe):

- A total energy demand for space heating and cooling of less than 0.55 MBTU/ft²/y 15 kWh/m²/y
- A total primary energy use for all appliances, domestic hot water, and space heating and cooling of less than 4.4 MBTU/ft²/y (120 kWh/m²/y).

Passive design building:
Passive design buildings share core features with Passivhaus in that they rely on four common strategies:

- A high level of insulation, with minimal thermal bridges
- A high level of utilization of solar and internal gain
- An excellent level of air tightness
- Good indoor air quality.

Resources

Passive Design Toolkits (http://vancouver.ca/sustainability/PassiveDesignGuidelines.htm): the City of Vancouver, British Columbia has developed two toolkits, aimed at the design and development communities, which detail ways to reduce energy use in new buildings.

Passive House Institute (www.passiv.de): does research and development on efficient energy use and the design and construction of passive houses.

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What to Ask Suppliers

- Ask if key wood product suppliers are able to participate in the integrated design process in order to discuss innovative methods of employing wood in the project.
- Request information about the framing techniques available for the proposed project.

Procedure

Step-by-step approach to incorporating passive strategies in building design:

Pre-design: perform bioclimatic and solar site analyses

Pre-design: organize an integrated design process with key project team members in order to review passive design strategies that include (but are not limited to):

- Passive solar power
- Orientation of building
- Thermal performance and effective insulation of the building envelope
- Location and size of windows
- On-site renewable energy generation
- HVAC system size requirements

Design: conduct an energy simulation model with the help of a certified energy advisor to analyze the various design and construction strategies and to verify that the project will meet the proposed energy use targets.

Cross-laminated timber (CLT)
Photo credit FPInnovations

Whistler Passive House

In the Resort Municipality of Whistler, British Columbia, Canada's first passive house requires only 10% of the energy consumed by a conventional structure that is built to current code requirements. This is achieved primarily through the use of a high-performance durable envelope. The average insulative value of the whole wall assembly and the roof reaches R56, which is more than double what is usually seen in British Columbia.

The walls were built from milled 3×4-inch (7.6×10-cm) lumber that was doweled together into 2-ft-wide (61-cm-wide) panels. These are used on the interior face of the wall structure, thus placing a solid core, rather than drywall, over a frame. The wood panels provide thermal mass, thus storing energy in the wall. Three-quarter-inch (2-cm) plywood is applied to the laminated timber panel and taped.

On the laminated timber panels is applied 12 inches (30.5 cm) of insulation. Over this is a waterproof but breathable fibreboard which serves as a rain screen. Black-painted wood siding is on the exterior.

More information about the design and construction of passive houses can be found at www.passiv.de/07_eng/index_e.html.

What is Integrated Design and Why is it Important for Passive Design?

An integrated design is a design in which all major components of the building are considered and designed as a totality, i.e., as an interdependent system. Integrated design means optimizing the entire system, not just parts, with complete analysis of potential synergies and trade-offs; for example, higher building envelope performance can lead to reductions in mechanical equipment size and long-term operating costs.