INNOVATION IN WOOD CONSTRUCTION

Two Projects

Presented on 2014.02.26 by Jana Foit

Course Description

Recent investigations into and discussions about solid wood construction in British Columbia, Canada are resulting in many projects looking at heavy timber as a viable structural material. Furthermore, the benefits of wood are becoming increasingly relevant in the context of global warming and non-renewable resource depletion, and its use can have a large impact on a project’s carbon footprint through both carbon sequestration and avoided greenhouse gas emissions. This presentation will focus on the use of panelized wood in two innovative Perkins+Will projects, both located at the University of British Columbia: the Centre for Interactive Research on Sustainability (CIRS) and the Earth Sciences Building (ESB).
Learning Objectives

1. Identify approaches to using heavy timber in a large-scale application
2. Describe the environmental benefits of using wood
3. Explain several innovative timber technologies
4. Understand how timber systems were implemented in two unique institutional applications

OUTLINE:

- The Problem
- Why Wood?
- Wood as a Modern Building Material
- A New Generation of Wood Buildings
- CIRS: Centre for Interactive Research on Sustainability
- ESB: Earth Sciences Building
- Lessons Learned
Building Industry Energy Consumption

- Industry 23.2%
- Building Operations 43.1%
- Transportation - Other 11.6% (rail, air, bus, truck, ship)
- Transportation - Light Duty 16.5% (auto, SUV, pickups, minivans)
- Building Construction and Materials 5.6%

US Energy Consumption by Sector
Source: Architecture 2030

why WOOD?
Grown by the **SUN**

Sequesters **CARBON**

**Low** EMBODIED ENERGY

REGIONAL material that supports the **ECONOMY**
Reduced ECOLOGICAL and ECONOMIC impact

SUSTAINABLY harvested RENEWABLE resource

WOOD as a modern building material

Structural Timber Systems

POST AND BEAM
Centuries old

STICK FRAME
Last Century

SOLID CONSTRUCTION
Last 15 years
A New Generation of Wood Buildings
WOOD STRUCTURE:
• wood roof structure using side nailed dimensional lumber supported by glulam ribs
• prefabricated and modular structural elements

CHALLENGES:
• Combustible materials in a public assembly occupancy
• Vandalism
• Weather exposure

BENEFITS:
• High Quality
• Economical + Efficient
• Reduced construction time by 3½ months
WOOD STRUCTURE:

• panelized wood roof structure using side nailed dimensional lumber held with steel v-shaped kingposts

• prefabricated roof panels

BENEFITS:

• High Quality
• Economical + Efficient
• Reduced construction time by 4 months

Samuel Brighouse Elementary School Richmond, BC
2012 Lieutenant Governor Award – 2012 Wood Design Award

VanDusen Botanical Garden Visitor Centre Vancouver, BC
2012 Lieutenant Governor Award – 2012 Wood Design Award
WOOD STRUCTURE:
- Geometrically complex form
- Prefabricated, panelized wood roof structure pre-installed with insulation and services

BENEFITS:
- High Quality
- Custom design
- Schedule - roof fabricated while concrete footings being poured

Project Goals
- To be the most innovative and high performance building in North America at the time of its construction
- To act as a “living laboratory” that promotes research and investigation of current and future sustainable building technologies, serving as a catalyst of change

Case Study:
Centre for Interactive Research on Sustainability

Regenerative Building Concept
**Green:**
- CIRS will have a net positive impact on the ecosystem health

**Humane:**
- CIRS will provide a socially and biophysically healthy environment for human inhabitation

**Smart:**
- CIRS will integrate the performance of the building with the human inhabitants
CIRS – Ambitious Goals

LEED Platinum and Living Building Challenge

Design Concepts

- Programmatic needs
- Maximize the use of passive environmental design strategies
- Site constraints and opportunities

Floor Plans

- Organized into two wings linked by atrium
- Houses 200 researchers who work collaboratively toward a common mission: to accelerate sustainability

Building Form Drivers: Program

- Office
- Assembly
- Emphasize sustainable features
Social Space
- Four-storey atrium serves as:
  - Building lobby
  - Entry to daylit 500-seat auditorium
  - ‘Social condenser’ space that builds academic community

Office Space
- Flexibility for all interior spaces

Building Form Drivers: Site
- Dense site adjacent to Sustainability Street
- Retained pre-existing desire line as opportunity to highlight reclaimed water system
- Engage pedestrians with the project’s sustainability goals

Building Form Drivers: Passive Strategies
- Solar Shading
  - Incorporate PV into solar shading
- Green Roof
  - Encourage habitat, reduce stormwater runoff and heat island effect
- Daylighting
  - 10m wide office bars to bring daylight in
- Natural Ventilation
  - Narrow office bars with partial height partitions allow for natural cross ventilation
Feature Sustainable Design and Materials

- Green screen
- Wood cladding
- Solar aquatics reclaimed water treatment

Performance

- Net positive energy and operational carbon
- Net positive water quality
- Net positive structural carbon
- Net positive in human health, happiness and productivity

NET POSITIVE ENERGY AND OPERATIONAL CARBON

By harvesting renewable and waste energy, CIRS supplies its own energy needs as well as a portion of the needs of an adjacent building.

The addition of CIRS to the UBC campus reduced UBC’s overall energy consumption by over 1 million kWhr per year.

STRUCTURAL CARBON: the design team compared the carbon footprints of steel, concrete and wood for the building structure.

- 1076 Tonnes CO2 generated in construction
- 904 Tonnes carbon stored in the wood
- 172 Tonnes Net

CIRS carbon footprint is 90% less than the UBC average.
Material Considerations

Sustainable, healthy, natural, innovative

- The ecological and human health impacts
- Visual and tactile expression
- Cost, durability and maintenance requirements

Wood Products Used in CIRS:
- Glulam for heavy structural members
- Dimensional lumber for the structural decking
- Multiple ply cedar panels used for exterior cladding
- Suspended Linear Wood Ceilings

Primary Structure

- Glulam moment frame: columns, beams, boxbeams
- Solid wood floor slabs: face-nailed 2x4’s, plywood diaphragm
- Shear in endwalls
- Loading: 100 lb/sf

The wood moment frame was created with vertical glulam columns and a box beam spandrel between the columns.
CIRS Technical Manual

- A ‘living’ document
- Lessons learned from the design, construction and operation of the building
- Developed to disseminate information
- Accompanies the CIRS website (cirs.ubc.ca)

Earth Sciences Building
University of British Columbia
**Project Goals**

- Public realm / community outreach
- State-of-the-art teaching and research spaces
- Consolidation of various departments into one building
- Informal learning spaces for discussion and collaboration
- Flexibility to accommodate future needs
- Research synergy

**Design Drivers**

- Program
- Site
- Integration with public realm

**Program**

- Research labs
- Faculty / staff offices
- Lecture theatres and classrooms
- Social and informal spaces
  - Cafe
  - Museum

**Ground Floor Plan**

1. Atrium
2. Lecture thea
3. Classroom
4. Cafe
5. Museum
6. Laboratory
Support Public Realm

- Create museum precinct
- Highlight research on display

Campus Connections

- Maintain E/W and N/S connections
- Emphasize exposure of program

Connections to the Outdoors

- Full-height glazing
- Canopy-to-ceiling extension
Promote Collaboration
- Visibility of departments
- Vertical circulation

Structural Materials in ESB:
- The two structural materials are wood and concrete:
- Glulam for heavy structural members in north wing
- LSL and CLT for structural decking
- Steel beams for long spans and seismic
- Concrete in south wing

Structural Innovations in ESB:
- Composite wood-concrete floor structure
- Glulam post and beam connections
- Transfer trusses over column free spaces
- Chevron Ductile Braces
- CLT Canopy and Roof
- Cantilevered glulam stair
Composite Wood-Concrete Floor Structure: Holz-Beton-Verbund-System™ (HBV)
Glulam Post and Beam Connections: Sherpa
Solid Wood Canopy and Roof
CLT
Full Storey Transfer Trusses over Lecture Theatres
Lateral Load Resisting System: Ductile Chevron Braces
Cantilevered Solid Wood Staircase
BUILDING CODES:

• Combustible | Heavy Timber | Non-combustible Construction

• Regulate the size + height of built structures relative to fire safety by limiting area + height of buildings of combustible construction

• NBC currently allows up to 4 storeys for residential

• BCBC allows up to 6 storeys for residential

Lessons Learned
Weather Protection

- Update and improve specifications
- Consider cash allowance for additional protection
- Review schedule to align wood construction in dry season
- Limit exposure during construction


Dropped Beams + Ceiling Heights

- Consideration of alternative routes for mech / elect
- Commitment from contractor and consultants is critical


Stains

- Not all wood substrates are equal
- Perform test patch or sample for review


Service Runs

- Lighting
- Sprinklers
Performance
- Vibration
- Acoustics
- Loading
- Seismic
- Passive design

Carbon
ESB:
+6169 Tonnes embodied energy in total construction
-1094 Tonnes CO2 stored in the wood
5075 Tonnes Net

CIRS:
+1076 Tonnes embodied energy in total construction
-904 Tonnes CO2 stored in the wood
172 Tonnes Net

Schedule
- Requires proper planning
- Prefabrication can have significant positive impact
- Consider product availability
- Spend time planning ahead

Public Perception
(+)
- Comfortable
- Warm
- Organic material
- Beautiful

(-)
- Not durable
- Combustible
- Weak
Questions?

This concludes The American Institute of Architects Continuing Education Systems Course

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