Presentation Outline

• Case Study: What is the VanDusen Botanical Garden’s new Visitors Centre?
• What are the Governing Bodies and Sustainability Programs influencing the project?
• How did they affect the enclosure?
A look at Design Challenges:
  • Roofing; Glazing & Opaque Walls
• Discussion
But why is it special?
Aim for Sustainability

- Aim to be the most sustainable and environmental building in the area
- Several governing programs needed to be followed
- So what were the criteria for the project?
Criteria set by City of Vancouver

- Mandate for all civic buildings with area > 500 m² (5,382 ft²) to meet LEED® Gold certification
- All civic buildings to reduce energy consumption by 30% (to fight against greenhouse gas emissions)
• **Introduction of the Wood First Act**
  • Mandates all new publicly-funded buildings to utilize wood as the primary building material
  • Big impact on construction – BC invests average of $3 billion in construction of civic buildings per year
• Living Building Challenge is a performance-based program:
  • Performance qualified after **12 months of operation** – not based on modeled or anticipated results
  • Building must meet **20 imperatives** or cannot be called a “Living Building”
• Common goal – Bettering design and construction of buildings today by reducing impact and consumption
• Straightforward concept on the surface; in some cases dictating key design decisions
• But how did these stringent requirements affect the enclosure?
• Let’s look at the Design Challenges encountered at the glazing system, roof assembly and mass walls
Design Challenge #1: Integrated Design at the Oculus

- Driving factors:
  - Architecture
  - Daylighting
  But most importantly…
  - Reduced energy consumption
  - Natural ventilation
From Enclosure perspective:
- Heavy steel sub-frame, with Double glazed skylight with pressure cap purlins & SSG rafters
- Original intent: top vent to tilt open with pivot point at center of lite
- Design modification: awning style vents on steeply sloped walls
Design Challenge #1: Integrated Design at the Oculus

- In construction / shop drawing review
- Vents controlled by mech. actuators linked to temp. sensors at heat sink – no rain sensors
- Fix: move awning vents to high side of oculus; add baffles & overhangs.
- Not perfect solution: still risk of water & reduced thermal resistance
Design Challenge #1: Integrated Design at the Oculus

- Integrated design not achieved at oculus to meet intent of LEED Platinum and Living Building Challenge targets for energy reduction
- Should have been dealt with at development stage rather than being a reactive solution
- Knowing the mechanical intent could have improved the layout of the oculus while maintaining good water penetration resistance and lower thermal conductance
- Without the benefit of changing the shape of the building, it is sourcing the appropriate enclosure system that becomes the salvation.
Design Challenge #2: Wood Roof in a Wet Climate

• Wood First Act is driver in design of the structure

• Wood panels make sense from architectural perspective given roof profile

• Complications for roof assembly, construction sequencing, quality control and environmental conditions
Design Challenge #2: Wood Roof in a Wet Climate

• Decision made in conceptual design: insulate wood structure from underside using closed-cell spray polyurethane foam:
  • Ease of installation with curved substrate
  • Board products too labour intensive and wasteful
  • Higher thermal resistance per inch thickness
• Imperative 11 – Red List of Material:
  • Difficulty is finding substitutes that provide same or better performance for enclosure
  • In the case of the roof, mineral wool could have been an option - fully exterior insulated roof, conforming to shape & allows drying to the inside – but it appears to contain *formaldehyde*

- Asbestos,
- Cadmium
- Chlorinated and Chlorosulfonated polyethylene
- CFCs
- Neoprene
- Formaldehyde (added)
- Halogenated Flame Retardants
- HCFCs
- Lead (added)
- Mercury
- Petrochemical Fertilizers and Pesticides
- Phthalates
- PVC
- Wood treatments containing Creosote, Arsenic or Pentachlorophenol
• Enclosure concerns:
  • Plywood sheathing between 2 impermeable layers (spray foam & roofing membrane)
  • Limited drying capacity because of multi-layered plywood
  • Depending on quantity of moisture in wood and drying time, could lead to deterioration
  • Venting not possible given complex shape
  • Winter was roofing season
Design Challenge #2: Wood Roof in a Wet Climate

Efforts to keep wood dry:

- Protection of materials prior to fabrication
- Spray polyurethane foam and bituminous self-adhered waterproofing membrane installed concurrently in plant
- Temporary protection, proper sequencing and good workmanship critical when stitching panels on site
- Bad weather was a constant issue
Verification:

- Moisture content readings by consultant and contractor
- Over long term, concern that leaks would not be detected before deterioration of wood had set in – leak detection system.
Design Challenge #2: Wood Roof in a Wet Climate

- Wood First Act had good intent to build a wood roof, but big impact on several fronts:
  - Atypical design of roof assembly
  - High risk because of rainy season
  - Rigorous quality control
  - From prefabrication to final roofing
  - Significant involvement from all parties required: designers, suppliers, builders, roofing and insulation trades, monitoring firm, warranty provider, and owners

- Without all these steps, durability and performance of roof assembly greatly affected, and consequences would be severe
Design Challenge #3: Sourcing from Site for Rammed Earth Walls

• Living Building Challenge’s Imperative 14 – Appropriate Sourcing
• Solidified choice to build Rammed Earth Walls
• What is rammed earth?
Design Challenge #3: Sourcing from Site for Rammed Earth Walls

- Rustic technology mainly used on houses and desert in BC
- Structural behaviour highly dependent on workmanship
- Structural design introduced at shop drawing stage – conservative (steel in the wall)
- Created issues with ramming and spray foam processes, energy modeling, & waterproofing details
Design Challenge #3: Sourcing from Site for Rammed Earth Walls

- From a waterproofing perspective:
  - First approach: Roof overhangs → Architecture overruled, full exposure to elements
  - Second approach: Waterproofing between rammed earth and puddled earth cap → Conservative structural design, concern of bond between rammed earth & cap, non-practical with steel projections
  - Third approach: Waterproofing at top of cap
Design Challenge #3: Sourcing from Site for Rammed Earth Walls

• Criteria:
  • Respect architectural intent of no visible waterproofing or flashing
  • Unknown behaviour of puddled earth cap re. cracks
  • Waterproofing needed to be UV stable
  • Good adhesion to unfamiliar substrate
  • Remember the Red List?
Design Challenge #3: Sourcing from Site for Rammed Earth Walls

- Chosen material: Poly Methyl Methacrylate → Mock-Up

- With LBC, design approach reactive rather than proactive
Discussion

- Governing bodies and certification programs have good intention, but can cause challenges
- Centering design on sustainability emphasizes the criticalness of integrated design
- Meeting LEED & LBC invites new ‘green’ technologies but lessons learned need to be passed on
- Red List makes you think twice of material selection
- Limited available products today and need for alternative solutions
- Nothing is gained in sustainability if frequent renewals and widespread repairs are necessary
Thank You