Passive House 2.0

LESSONS LEARNED FROM THE FIRST GENERATION OF MULTI-UNIT PASSIVE HOUSE BUILDINGS IN B.C.

PASSIVE HOUSE NORTHWEST, APRIL 6 2017

MONTE PAULSEN, PHI-ACCREDITED BUILDING CERTIFIER
RDH Building Science

→ New Construction
  → Façade Engineering
  → Enclosure Consulting
  → Passive House
→ Existing Buildings
  → Repair, Renewal & Rehabilitation
  → Reserve & Depreciation Reports
→ Research & Forensics
  → RDH Labs in Waterloo
→ 200+ staff in eight cities
  → Seattle
  → Portland
  → Vancouver
  → Victoria
RDH Passive House

→ PHI-accredited Building Certifiers
  → Vancouver
→ Certified Passive House Consultants
  → Seattle, Portland, Victoria, Vancouver
→ Current projects
  → Townhome developments
  → Multi-unit residential
  → Mixed-use midrise
  → Infill office buildings
  → High-rise feasibility studies
  → First Nations housing
  → Arctic worker housing
  → Monitoring & research
Passive House 2.0

→ Lessons from the first generation of multi-unit Passive House in B.C.

→ Simple shapes cost less
→ Exterior insulation can take the weight
→ Big buildings bring big thermal bridges
→ Why Passive House is growing in B.C.

BC Passive House factory in Pemberton
Lesson #1:

Simple shapes cost less

Bernhardt Contracting, Victoria
Bernhardt Contracting

First Certified Passive House in Victoria

Photo: Bernhardt Construction
North Park Passive House: First multi-unit PH building in B.C.
Bernhardt Contracting

North Park Passive House: Strata units sold above-market rate.
North Park Enclosure Monitoring Study

- 1/2" Gypsum board with latex paint
- 2x4 with R-13 mineral fiber batt insulation
- Air/vapor barrier
- 2x10 with R-37 dense-packed cellulose insulation
- 1/2" Plywood sheathing
- Vapor permeable sheathing membrane
- 1x4 Wood strapping
- Fiber cement siding

Sensor Legend
- ● RH and Temp Sensor
- △ Temperature Sensor
- □ MC and Temp Sensor
Complicated back-framing in the dormers

Photo: Bernhardt Contracting
10 kWh / m²a

+0.5 kWh

2/3 of labor costs

1/3 of labor costs

10 kWh / m²a

Graphic courtesy Mark Bernhardt
Why shape matters

Six units of surface.
One unit of floor.
(One person.)
6:1 surface/floor ratio.
(Or, 6 walls, 1 body.)
The two-storey building is twice as efficient

Two units of floor.
3:1 surface/floor ratio.
(Three walls/body.)
Multi-storey buildings are far more efficient

Three units of floor.
2:1 surface/floor ratio.
(Two walls per body.)
303 Pender = 1:1 surface/floor
1:1 surf/floor ratio

Increase of 10%
Mary Street duplexes: Simple shapes.
“It’s all about the shape. Both for performance and cost.

Decorate the envelope, don’t decorate with the envelope.”

~ Mark Bernhardt
Bernhardt Contracting
Lesson #2:
Exterior insulation can take the weight
Britco, Langley
A sweater so thick you don’t need a furnace
The Sweater: Six inches of Exterior Mineral Wool
Bella Bella Passive House: Canada’s first modular Passive House building
Huh? Nothing but screws?

Long screws through vertical strapping and rigid insulation creates a ladder truss.
What about really long screws?
What about really long screws?
How does this compare to nail-on strapping?

Displacement (mm)

0.00 0.13 0.25 0.38 0.51 0.64 0.76

Load (kg)

0 5 10 15 20 25 30

Load (lb)

0 5 10 15 20 25 30

Displacement (1/1000")

- Long Screw through 3/4" strapping and 9" of Mineral Wood into Stud
- 8d Nail through 3/4" Rainscreen Strapping No Exterior Insulation

Vinyl, Metal, Wood Siding

Stucco

Thin Stone Veneer

Thick Stone Veneer, Very Heavy Cladding
What happens if you miss a stud?
Wrap Weather/air barrier over bottom
Structural Engineer to review dim

3/4"x6 continuous plate
Wrap Weather/air barrier over plate

2 1/2" (minimum) EPS insulation
fill all joints with foam

2 1/2" (minimum) EPS insulation
fill all joints with foam

FACTORY
Scale: 3"=1"
UniverCity at Simon Fraser University
Fifty large apartments in a northern climate zone
Exterior rockwool: 12- to 15-inches deep
Lesson #3:

Big buildings bring big thermal bridges

Evaluating a 10-story concrete residential tower
Ten-story concrete building on infill site
Passive House is feasible

→ Target insulation values:
  → Above Grade Walls: R-25 to R-30
  → Below Grade Walls: R-20 to R-30
  → Below slab: R-20 to R-30
  → Windows U-0.14
Passive House is feasible

→ Target insulation values:
  → Above Grade Walls: R-25 to R-30
  → Below Grade Walls: R-20 to R-30
  → Below slab: R-20 to R-30
  → Windows U-0.14

→ Structure is critical strategic choice
  → Core & column vs perimeter
  → Decision drives TB strategy
Exposed slab edges are thermal bridges
Exposed slab edges are thermal bridges

→ Psi values of greater than 1 one W/mK are common
Eliminating exposed slab edges critical to affordability

→ More than a kilometer of slab edge in 10-story bldg
Eliminating exposed slab edges critical to affordability

→ More than a kilometer of slab edge in 10-story bldg

→ If exposed, slab edges would more than double the heat demand
Order of magnitude in difference
Above Grade wall options (R-25 to R-30 eff.)

- Exterior Insulated Steel Stud or Concrete
- Integrally insulated, precast sandwich or ICF
Optimization of Enclosure Performance

Weighted overall effective R-value for entire enclosure (including windows)
Window-Wall Ratio impact on cooling

→ WWR for the residential floors:

Uw-0.13

\[ g-0.3 \]
Vancouver High Rise Feasibility

→ 60-storey residential tower
→ 30,000 m² of TFA
→ 10,000 m² glazing
  › Triple-paned curtain wall
  › Target R-6 (+/-)
→ 12,000 m² opaque wall
  › Target R-27 (+/-)
→ Modified balcony design required
→ Glass elevator lobby discussed
→ Ventilation penetrations an issue
Vancouver High Rise Feasibility

→ Primary Energy Renewable has been the defining challenge on larger projects

→ Strategies include:
  → Negotiate ventilation
  → Elevator efficiency
  → DHW efficiency
  → Reduce fan & pump loads
“If you simply must build something thermally stupid, for God’s sake, build it with wood.”

~ Scott Kennedy
Cornerstone Architecture
Why is Passive House growing so quickly?

When governments count carbon, priorities change
Last century, we counted energy efficiency
Last century, we counted energy efficiency

On the coldest night of the year, each unit in the Bella Bella Passive House will require a heat load equal to just six 100-watt lightbulbs
Last century...
This century, we count GHG emissions

- Buildings: 40%
- Industry: 32%
- Transportation: 28%

Data: Natural Resource Canada
Buildings: 55% of urban GHG emissions

Buildings are biggest source of greenhouse gases in Vancouver, staff report says
Detached houses are the worst culprits, followed by industrial buildings

BY BRUCE CONSTANTINEAU, VANCOUVER SUN  JUNE 23, 2014
Buildings: 77% of government GHG emissions
City of Vancouver now counts GHG emissions

→ Greenest City 2020
  → All buildings constructed from 2020 to be carbon neutral in operations

→ Renewable City Strategy
  → 100% of energy used is renewable by 2050
  → New buildings required to use 100% renewable energy by 2030 or earlier
Gas furnaces and boilers are the source of GHGs
The bigger the building, the bigger the boiler
Passive House buildings do not need boilers
Where there is no boiler, there are no emissions
Where there is no boiler, there are no emissions

This is why Passive House is growing
Passive House is the cheapest way to cut GHGs

→ VBBL 2014 CODE HOUSE

Source: City of Vancouver Passive House Costing Study
Passive House is the cheapest way to cut GHGs

→ VBBL 2014 CODE HOUSE
→ PASSIVE HOUSE
→ $25,000 more to build
→ 75% GHG reduction for lifetime of the building

Source: City of Vancouver Passive House Costing Study
Redistribution of cost of a six-story MURB

**LEED & ASHRAE+**
- Delete hydronic system
- Delete industrial boilers
- Delete concrete floors
- Realign consultants

**PASSIVE HOUSE**
- Upgrade windows/doors
- Increase insulation values
- Upgrade HRV systems
- Upgrade air barrier
- Electric baseboard heat

**Total redistribution = Est. $600,000**
**Net Passive House premium est. 3%**

*Estimates by Peak Construction, Summer 2016*
Vancouver Zero Emissions Building Plan

→ One- and two-family homes:
  → 2020: 70% GHG reduction
  → 2025: Zero Carbon & 30 kWh/m2/a

→ Four- to six-storey MURBs:
  → 2020: Passive House performance
  → 2025: Zero Carbon

→ High-rise:
  → 2020: Near Passive House
  → 2025: Zero Carbon
Passive House is cost-effective for “missing middle” housing, offices, schools.
North Vancouver: Up to 250 townhomes

Anthem Properties & Integra Architecture
North America’s largest Passive House district

Permit applications for more than 105 Passive House townhomes (Mar 2017)
B.C. climate plan points toward Passive House

Step 4 is not yet defined, but draft text looks a bit like Passive House.
Growth of Passive House in North America

Source: Pembina Institute
Growth of Passive House in North America

Vancouver

Source: Pembina Institute
“The number and size of certified Passive House projects has seen a rapid increase in North America in the last five years, and we expect this growth to accelerate.”

~ Pembina Institute
Discussion + Questions

FOR FURTHER INFORMATION PLEASE VISIT
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