The Enclosure

A beacon of building envelope excellence!

Site Address
Pemberton Heights,
North Vancouver BC

Design and Construction by:
SENWiEco Designs

Background

Sean Wiens, principal at SENWiEco designs, has had a keen interest in building science and energy efficiency for much of his adult life. He attended most building science and construction related seminars in his region prior to construction commencement, and has completed the Building Envelope Endurance and Building Envelope Laboratory at the BC Institute of Technology, under the teachings of Graham Finch and James Bourget. He is also regularly contributing commentary on building science topics in various LinkedIn groups and other web based forums. Sean has a passion for reducing human's footprint on this planet and hosted a blog at http://thepathtosustainableliving.blogspot.ca (on hiatus during construction), which discussed ways that we can all live a more sustainable lifestyle. This includes discussions on constructing our dwellings in ways that make them more durable and energy efficient, while at the same time using materials with a lower embodied energy. This blog still receives over 750 unique visitors a month.

Sean and his wife bought a 1954 rancher in Pemberton Heights, North Vancouver BC in 1998. The dwelling was original to construction without even the usual cosmetic updates. Many of the services had reached the end of their life span and required replacement. They debated the best course of action to allow them the benefit of a modern, efficient, and comfortable dwelling. Although a renovated rancher would be more than adequate for the two of them, market pressures in the region would dictate that a rancher would still be considered a 'tear down' resulting in a huge embodied energy penalty to renovate the existing structure.

As a result, they have made the decision to rebuild. With Sean's passion for energy reduction, the environment, and most importantly – Building Science Best Practices, they have made the decision to offer up the dwelling to the building science and engineering community for the purposes of studying high performance building assemblies that will be needed by BC's construction community if we are to reach the Province's goal of Net0 ready dwellings by 2030.

In this way, it is hoped that the new dwelling will resulting in a lasting legacy to the building science community and not liability to the planet.

The Design

The Enclosure will be a single-family dwelling to be constructed on a lot that Sean's current dwelling was located, in Pemberton Heights, BC. It will consist of a two storey plus basement structure with an attached garage. The main storey will comprise of the living areas and home office, and the upper floors will comprise of bedrooms. The basement will contain the HVAC and utility areas, Sauna, Exercise studio, and a wood and metal shop.

The design focus on *The Enclosure* will be to provide highly thermally resistant and air tight envelope assemblies that concentrate on reducing thermal bridging and ensuring that the effective values of any insulation are as close to the nominal values as possible.

With a hurricane proof WRB/AB details, and the benefits of a continuous mineral wool insulation thermal barrier, these assemblies are projected to meet the needs of the high performance build community for decades to come. Detail drawings of the assemblies are included at the end of this design brief.

Wall Assemblies

The wall assemblies will contain a primary thermal control layer consisting of six (6) inches of ROCKWOOL COMFORTBOARD™ 80 insulation installed as a continuous layer exterior to the sheathing in a manner free of thermal interruptions to all but eliminate thermal bridging. The predominately two (2) by four (4) stud bay structure would also be in-filled with ROCKWOOL COMFORTBATT ® to top-up the assembly for a total effective R40 (7 Rsi). This is roughly double the code minimum allowed at this time in BC, but is a level recommended to allow BC new building stock to easily become Net0 ready by 2030.

Roof Assemblies

The proposed roof assembly will employ parallel chord roof trusses with extended two (2) by six (6) top chords to support roof overhangs. Our attempt to design a roof without structural member penetration through the thermal envelope proved too complex, heavy, and costly. We will however be able to keep the truss spacing at 24" and with 18" deep trusses, will still be able to meet our R60 effective roof assembly goals.

To ensure an air tight assembly, we will 'hang' a two (2) by two (2) services raceway capped with plywood and a fully adhered AB/VB[2] to the underside of the truss assembly. This will house the electrical (pot lights) and radiant hydronic panels and eliminate the penetrations that would otherwise penetrate through the AB. This will also allow the truss assembly above to be vented providing a more durable and problem free roof assembly. Because of height concerns [1], this has been a delicate balance between an assembly deep enough to meet our structural and thermal requirements, and one that will comply with the neighbourhood zoning bylaw.

Overhangs on the south exposure have been optimized to provide full shading of our top floor windows at noon June 21 (summer solstice). We have modeled the assembly with an effective R60 which is again well above current building code requirements but believed to represent where we should be going to easily achieve a Net0 ready home by 2030.

Foundation Assembly

Our foundation assembly will comprise of Durisol 10" foamless ICF block [3] made from mineralized wood fibre and cement slurry. These blocks have a 30 year track record for durability in below grade applications as highway noise walls and were tested by SENWiEco for resistance to capillary movement [4]. While uncommon in BC, this product has been expanding their market share for both below and above grade single family ICF installations in Ontario.

These blocks will provide a base R8 assembly, which will be boosted with the addition of 3" of ROCKWOOL COMFORTBOARD™ 80 mineral wool insulation mounted as a continuous layer on the exterior of the ICF block and stud infill with ROCKWOOL's COMFORTBATT ® mineral wool insulation to provide a phenomenal effective R35 assembly. This is above our targets and we may choose to forgo the stud infill should we have budgetary constraints, which would bring the assembly down to just over $R20_{eff}$ which would fulfill our target.

Air and Water Control Layer

SENWiEco are proponents of an air control layer that is separated in function and location from the vapour barrier. In our region, Poly is typically used on the walls interior surface, below the drywall, as both a vapour control layer AND an air control barrier. While the poly performs flawlessly as a vapour barrier, the difficulty in sealing the poly around numerous penetrations has led to its absolute failure as an air barrier in our opinion. Instead, we promote an exterior air control layer detailed outboard of the main sheathing. This provides a firm surface for the barrier (the sheathing) that is durable and rigid. There are also significantly fewer penetrations at this location and those penetrations are typically straight sided and easily detailed. Our preferred method of creating an exterior air barrier consists of a self adhered DELTA®-VENT SA membrane, with all mechanical penetrations detailed using the PROSOCO R-Guard® Joint & Seam Filler. Window and door penetrations will be detailed with the field membrane on the jambs and head, a foil faced non-permeable membrane on the sills, and air sealed on their interior side with PROSOCO R-Guard® AirDam® These combination of products provides the strengths of sheathing membrane, including its high permeance, and ease of application, combined with a highly waterproof and air tight detailing of penetrations. SENWiEco has tested the RGuard system in a mock-up wall assembly including a Cascadia window, parapet wall, electrical and water penetrations, and a vent termination. We were able to take the assembly up to – 4500 Pa without significant water leakage (http://goo.gl/kNYvoy).

Building Lab

To ensure the planned dwelling provides a lasting legacy to the building enclosure and construction community, SENWiEco will sponsor and include building science labs to be built right into the dwelling. The main above grade wall assembly testing lab will include a 10ft wide by 8ft tall rough opening in the lower storey of the north elevation. This is a location that will be protected from predominant winds and wind driven rain and will allow testing conditions that represent the general ambient exterior conditions for the site.

A series of 18" wide wall panels, representing various high performance assemblies, will be tested for thermal and moisture transfer through the assembly over time in real world conditions. A total of 6 panels will be tested at any one time. These panels will be outfitted with instrumentation to measure humidity, moisture content, temperatures, and thermal flux through the assemblies at various locations. It is expected that the test panels would stay in place for one (1) years time, when they would be subjected to a purposeful injection of liquid water to test the panel's performance in a WRB or an AB failure. At the end of the test, the panels would be removed and replace with another 6 panels of different design. This cycle would continue for as long as a need/interest in the resulting data was present, and ownership of the dwelling was retained by Sean.

Similar instrumentation would also be installed within the main dwelling, in the wall, basement slab and foundation assemblies, to provide a base line of conditions and provide additional data points for other building science research. It is expected that these base line results, utilizing ROCKWOOL mineral wool insulation, would reflect many of the strengths of ROCKWOOL in comparison with other insulation strategies.

The cost of materials, instrumentation, and labour to construct these test panels will primarily be borne by SENWiEco. RDH Building Science Consultants have offered to offset some of these costs by providing a small selection of used instrumentation to supplement the purchase of all new instrumentation. Structural Monitoring Technology will also be providing the ability to monitoring instrument readings online at no additional charge and the instrumentation at a discounted cost.

Scientific and Engineering assistance will be provided by the following Building Lab Team Members:

- Graham Finch – RDH
- Murray Frank - Constructive Home Solutions
- Fitsum Tariku - Director of Building Science Centre of Excellence
- Jason Teetaert - Structure Monitoring Technology
- Loveleen Atwal - Morrison Hershfield

These team members will also work to distribute the resulting data to the engineering and build community. It is expected that additional assistance and monitoring support would be provided by current students in the BCIT Building Science Masters program [(5)]. The instrument data points will be made available online via a secure website to any interested parties involved with building science research or envelope design. This data and research should assist code officials across Canada during the process of creating prescriptive code language for high performance walls.

SENWiEco has also sponsored a project website (theEnclosure.ca) that will provide live video and time lapsed photos of the build, a construction journal, component descriptions, and post construction live monitoring of instrument data.

Footnotes:

1) Pemberton Heights has a strict 22ft eave height.
2) For full details of our VB, AB, and WRB layer designs, please see the roofing details drawing (fig2 below)
3) http://durisolbuild.com
4) SENWiEco tests the Durisol ICF Block http://goo.gl/dSnoNN
5) BCIT Building Science Masters Program http://www.bcit.ca/study/programs/buildingscience

Design Detail Drawings

Wall Assemblies

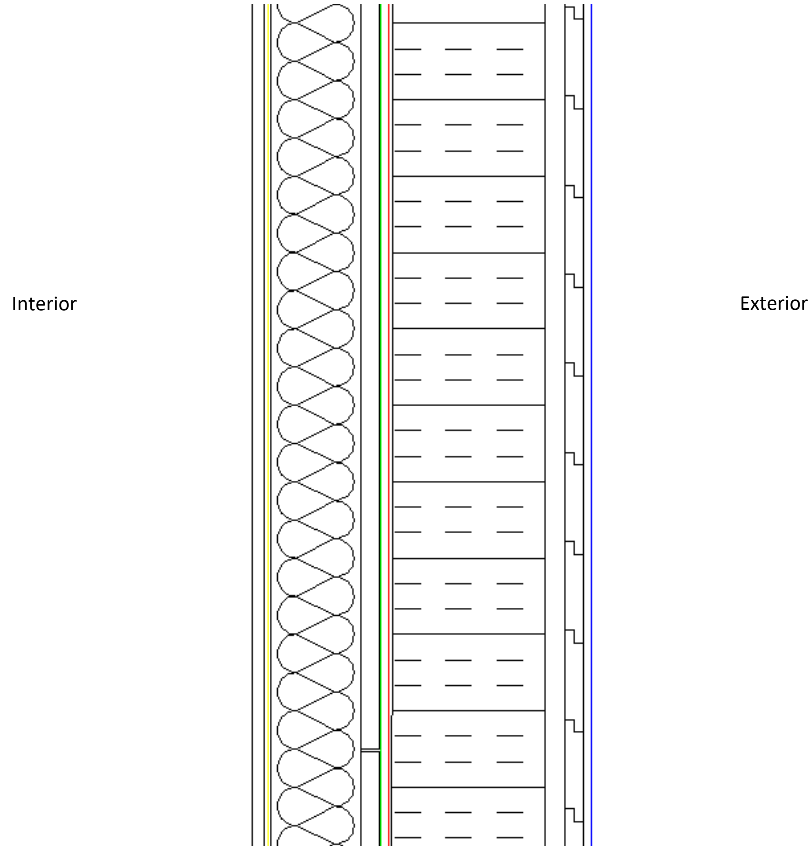

Figure 1 – The Enclosure Wall Assembly (R40 eff.)

- Drywall with VB Paint
- 2x4 Stud Wall filled with R14 ROCKWOOL COMFORTBATT ®
- ¾" Plywood
- Self Adhered DELTA®-VENT SA membrane (WRB/AB)
- 6" (R24) ROCKWOOL COMFORTBOARD™ 80
- ¾" PTP furring strips for capillary break and siding support (4" wide)
- Cladding: Horizontal T&G COULSON Engineered Cedar (WSS)

Roof Assemblies

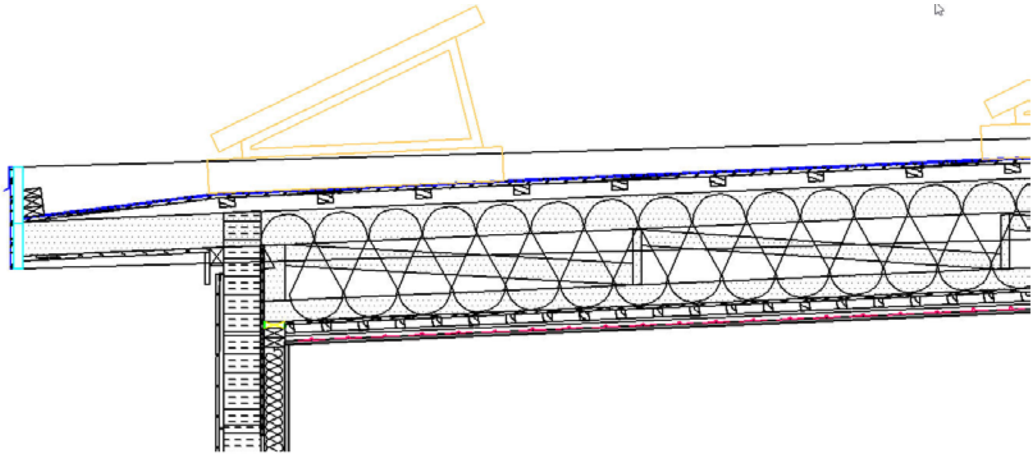

Figure 2 – The Enclosure Roof Assembly (R61 eff.)

- Drywall
- Hydronic Heating/Cooling Panels incorporated into ¾" Foil Faced PolyIso insulation
- ½" Hydronic Panel Plywood Base
- 2x2 Services Raceway
- 1/2" OSB (seams and holes sealed with R-Guard® Joint & Seam Filler) provides Air and Vapour Barrier
- 18" Roof truss with extended 2x6 Top Chord to form overhangs
- Truss cavity with 2 layers of 5.5" ROCKWOOL COMFORTBATT ®, 2 layers of 3.5" COMFORTBATT ®
- 2x3 strapping on 1" plywood blocks to provide cross ventilation between truss bays
- 5/8" Plywood (Screwed)
- SOPRABOARD Roof Protection Board (Seams taped)
- SOPRALENE FLAM 180 2-ply SBS modified Roofing WRB and RSS

Foundation Assembly

Figure 3 – The Enclosure Foundation Assembly (R20 eff. or R35 eff. with option stud bay insulation)

- Drywall (No internal VB)
- 2x4 Stud Wall filled with R14 ROCKWOOL COMFORTBATT ® (Optional)
- 10" R8 Durisol ICF with 6.5" Concrete Core
- Fully Adhered (Torch-ON) COLPHENE TORCH'N STICK (WRB/AB/VB)
- 3" of R10 ROCKWOOL COMFORTBOARD™ 80
- Waterproof Dimpled Foundation Membrane
- 4" – 6" Vertical Granular Fill Column
- Geotextile with compacted Backfill

Thermal Bridge Reduction

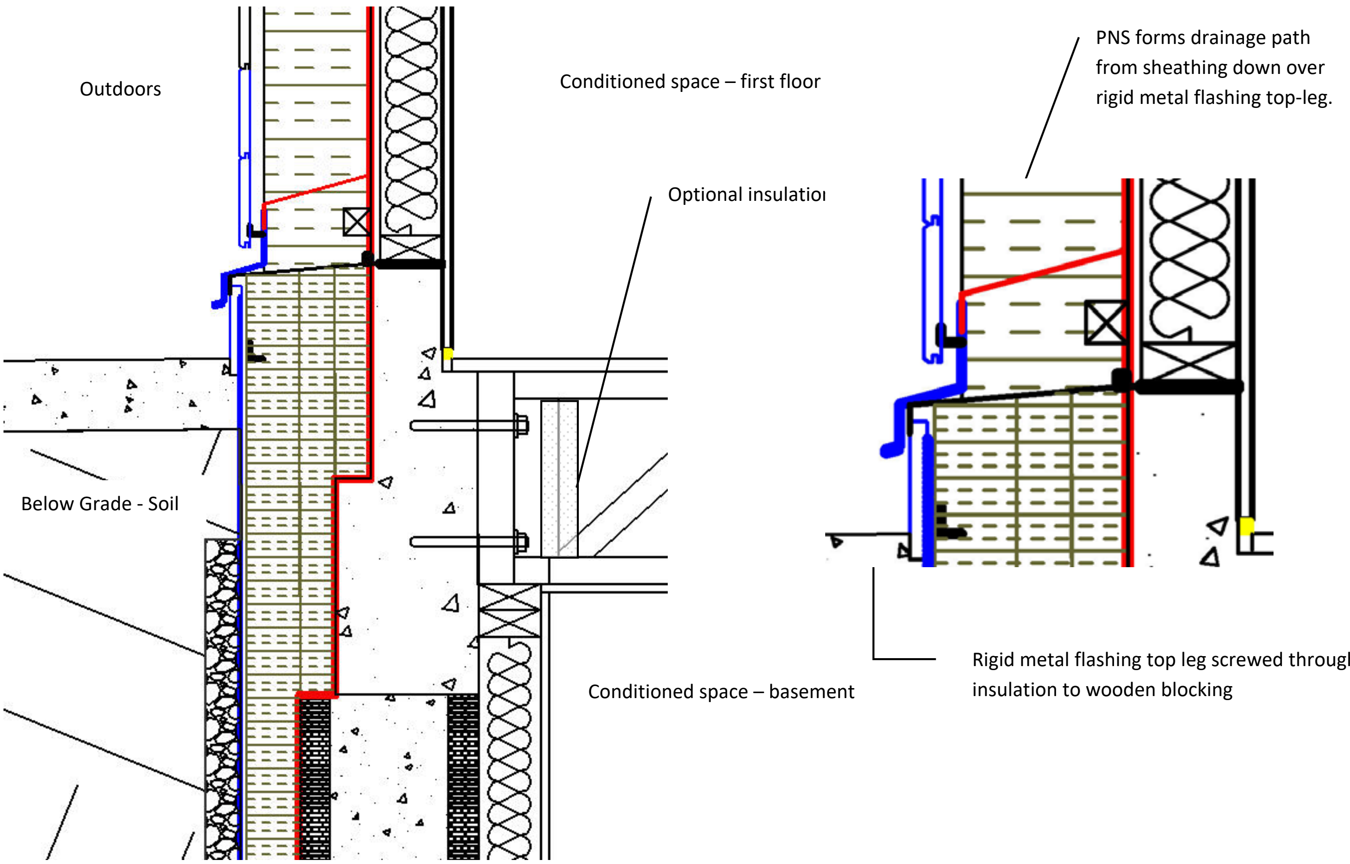

Figure 4 - Conditioned Space to Outdoors - First storey floor detail.

- Thermal control layer continuous along exterior of foundation and wall assembly.
- Thermal control layer increased for top 48" of foundation to reduce slab edge thermal bridging and transition to the higher resistance needed above grade due to the higher temperature differential conditions.
- Rigid metal flashing only utilized in UV exposed areas. Interstitial flashing created with Foil Faces peal and stick membrane reducing thermal bridging of flashing assembly (see inset).
- If warranted after THERM modeling, infill of semi-rigid mineral wool may be added between the floor truss bays against the inside surface of the rim boards.

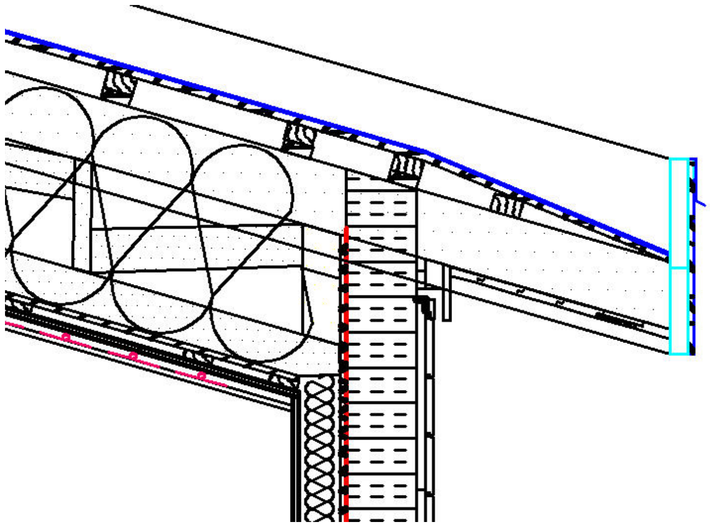

Figure 5 - Roof to Wall Interface

- Wall thermal control layer is continuous to top of roof truss.
- Service raceway preserves integrity of air barrier.
- Roof assembly vented above truss
- Hidden Gutter behind raised Fascia
- Top of wall rainscreen ventilation

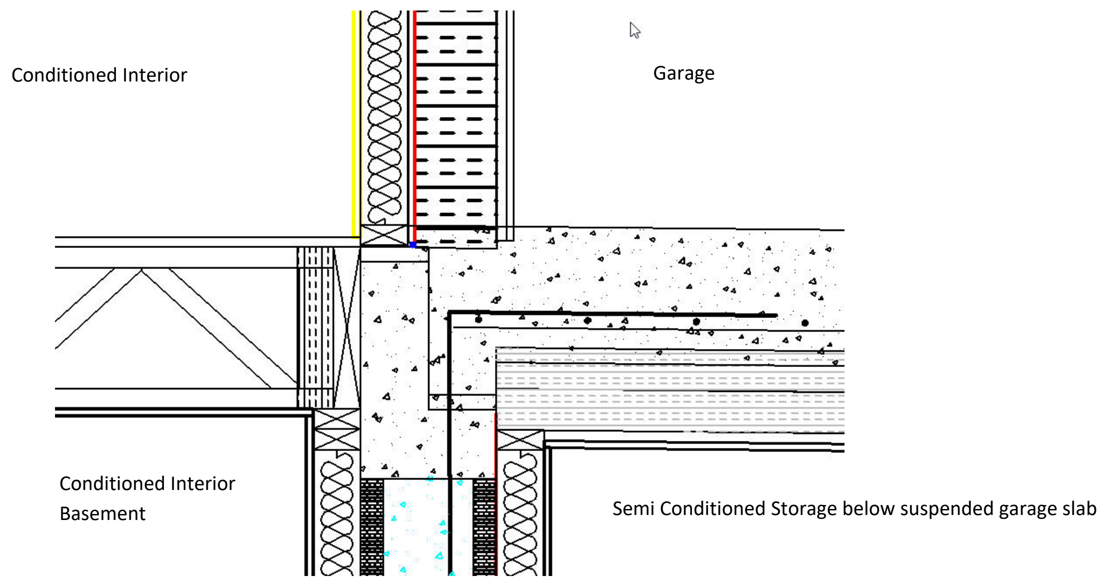

Figure 6 - First Storey Floor Interface at Garage

- Main thermal control layer on exterior of dwelling continues on above grade separation wall between garage and house with inboard stud infill.
- Basement wall to utilize stud infill mineral wool both side of ICF separation wall.
- Insulation inserts between truss bays against inside face of rim boards
- Suspended slab to be insulated on bottom surface.