The Enclosure

A beacon of building envelope excellence!

Site Address
North Vancouver BC

Design and Construction by:
SENWiEco Designs
A division of SENWI Services Inc.

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 attends most building science and construction related seminars in his region, 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 also has a passion for reducing human's footprint on this planet and hosts a blog at http://thepathtosustainableliving.blogspot.ca, which discusses 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 currently receives over 500 hits 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 have now reached the end of their life span and require replacement. They have 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 2020.

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 is now 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 a 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 Roxul ComfortBoard IS 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 Roxul ComfortBatt to top-up the assembly for a total effective R40. This is roughly double the code minimum allowed at this time in BC, but is a level recommended to allow BC building stock to easily become Net0 ready by 2020.

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 six (6) 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 exist 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 2020.

Foundation Assembly

Our proposed foundation assembly will comprise of Durisol 10" foamless ICF block [3] made from mineralized wood fibre and cement powder. These blocks have a 30 year track record for durability in below grade applications as highway noise walls and are currently being 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 2.38" of ROXUL's DrainBoard mineral wool insulation mounted as a continuous layer on the exterior of the ICF block and stud infill with ROXUL'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 sealed Tyvek sheathing paper in the field of the wall, with all penetrations detailed using the Prosoco three (3) part RGuard air barrier system. This combination provides the strengths of sheathing membrane, including its high permeance, low cost and ease of application, combined with a highly waterproof detailing of all penetrations. SENWiEco has tested the RGuard system in a mock-up wall assembly including a Cascadia window, parapet wall, electrical and water penetration, and a vent termination, and was 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 a building lab to be built right into the dwelling and 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.

It is proposed that a series of 24" wide wall panels, representing various high performance assemblies, be tested for thermal and moisture transfer through the assembly over time in real world conditions. A total of 5 panels can 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 5 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, roof, and foundation assemblies described above, 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 ROXUL mineral wool insulation, would reflect many of the strengths of ROXUL 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 reduce our need for the purchase of all new instrumentation. Structural Monitoring Technology will also be providing the ability to monitoring instrument readings online at no additional charge.

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 - BCIT Building Science Master's Program Graduate

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 [(6)]. 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 will also sponsor a project website that will provide live video and time lapsed photos of the build, short documentaries on various aspects of the build, component descriptions and manufacturer promotion, and post construction live monitoring of instrument data.

Footnotes:

1) Pemberton Heights has a strict 22ft eave height. To accommodate this we needed to utilize a higher R value per inch material for the thermal control layer base to allow us to stay within the total height allowance and still meet our thermal resistance goals. The use of PolyIso base also lowers the overall weight when compared to a 100% mineral wool system, which reduces the structural requirements of the TGI's.
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) http://www.naima.org/publications/GREEN.PDF
6) BCIT Building Science Masters Program http://www.bcit.ca/study/programs/buildingscience

Design Detail Drawings

Wall Assemblies

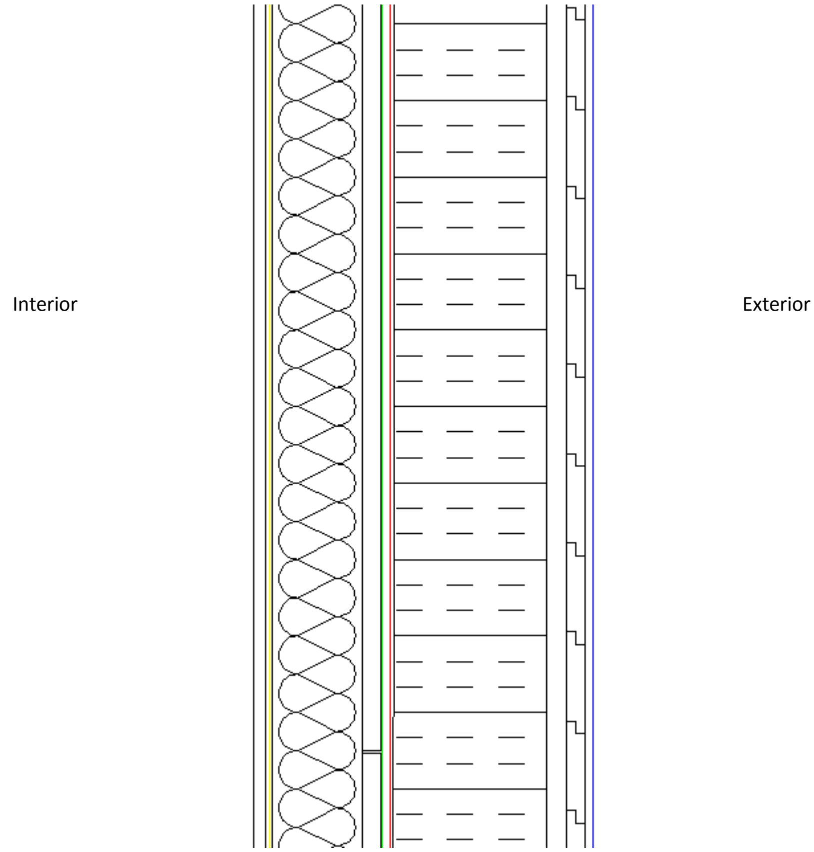

Figure 1 – The Enclosure Wall Assembly (R40 eff.)

- Drywall with VB Paint
- 2x4 Stud Wall filled with R14 ROXUL Comfortbatt
- ¾" Plywood
- Tyvek WRB/AB detailed with Prosoco RGuard 6" around all penetrations.
- 6" of R24 ROXUL ComfortBoardIS
- ¾" PTP furring strips for capillary break and siding support (4" wide)
- Cladding: Horizontal ship lapped cedar strip

Roof Assemblies

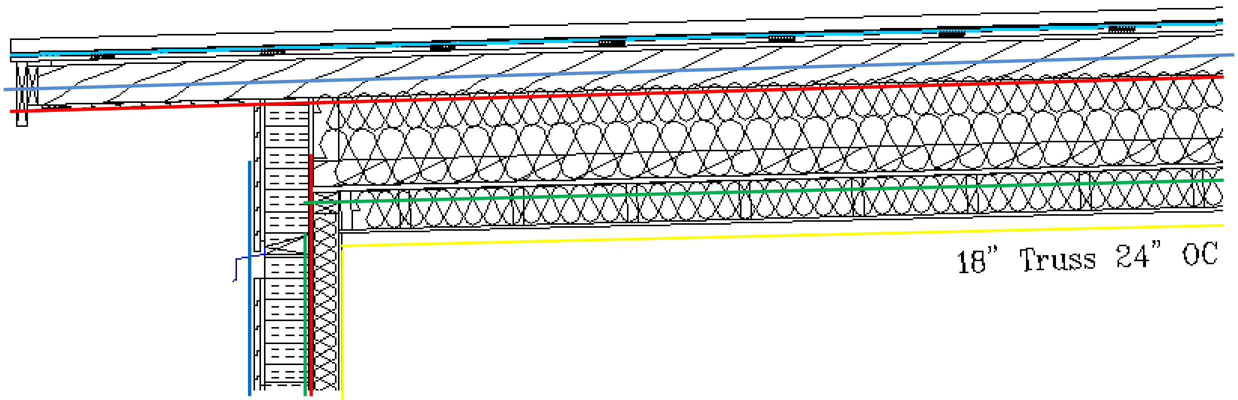

Figure 2 – The Enclosure Roof Assembly (R61 eff.)

- Drywall (with VB retarding paint primer)
- 2x6 Services Raceway (filled with ROXUL ComfortBatt)
- 1/2” Plywood (G&S)
- Fully adhered VB/AB (SopravapR). Wrapped over Tyvek on exterior wall sheathing.
- 18” Roof truss with extended 2x6 Top Chord to form overhangs
- Truss cavity filled with 1 layer of 8” ROXUL ComfortBatt and 1 layer of 5.5” ComfortBatt
- 1x4 strapping to create ventilation gap between truss bays
- 5/8” Plywood (Glued and Screwed)
- Fully adhered WRB (SopravapR)
- Ventilation and Drainage Matt (Enkadrain 3611R)
- Metal Roof (Min 1.5" Standing Seams)

Foundation Assembly

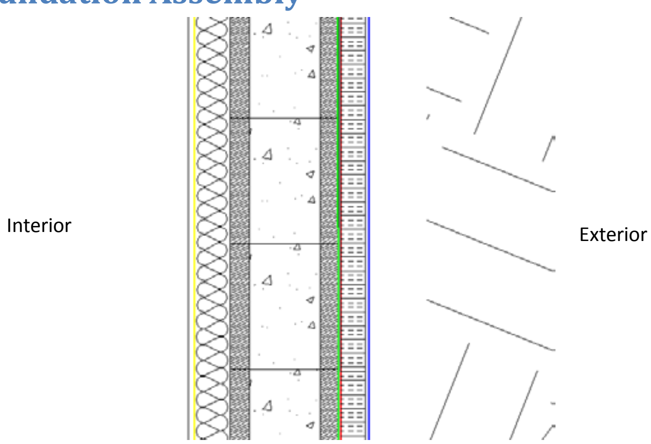

Figure 3 – The Enclosure Foundation Assembly (R20 eff. or R35 eff. with option stud bay insulation)

- Drywall with VB Paint
- 2x4 Stud Wall filled with R14 ROXUL Comfortbatt (Optional)
- 10” R8 Durisol ICF with 6.5” Concrete Core
- Fully Adhered (Torch-ON) WRB/AB
- 2.38” of R10 ROXUL DrainBoard
- Waterproof Dimpled Foundation Membrane
- 4” – 6” Granular Fill
- Backfill

Thermal Bridge Reduction

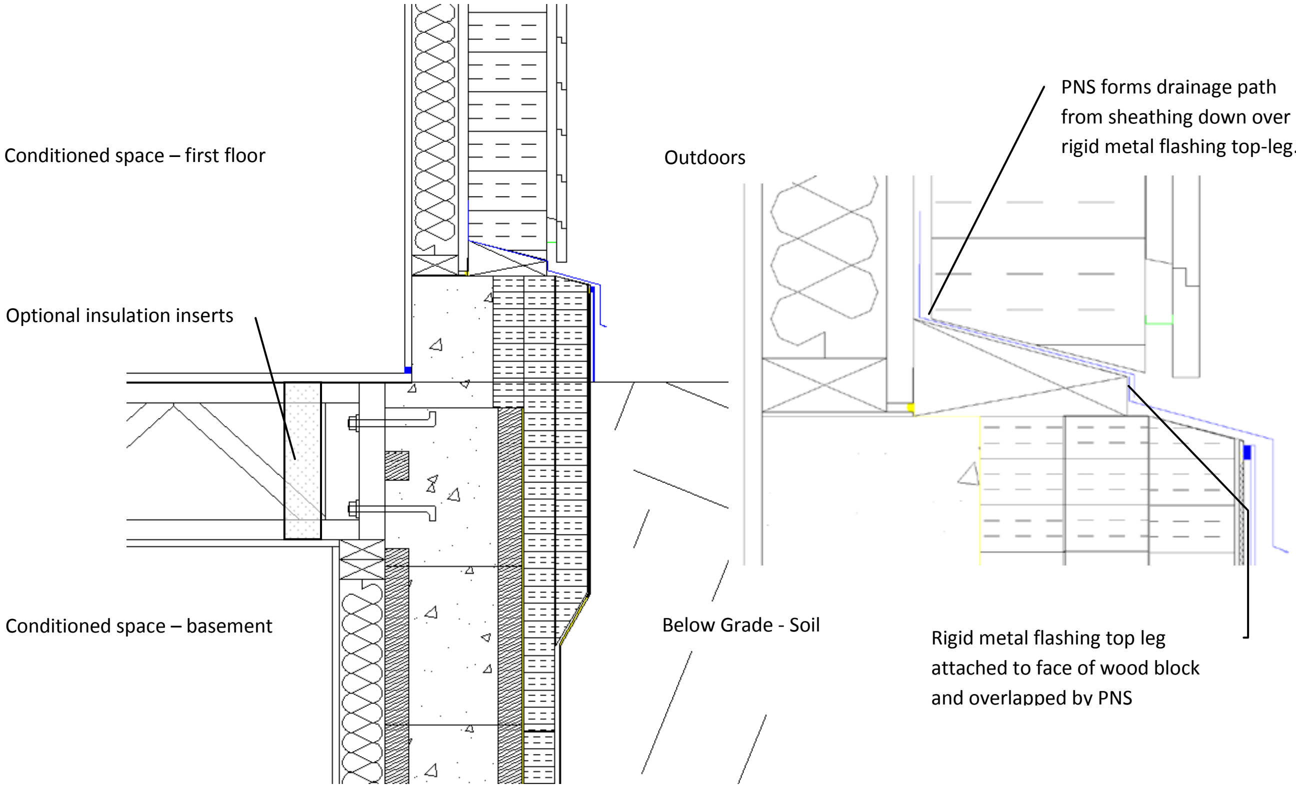

Figure 4 - Conditioned Space to Outdoors - First storey floor detail.

- 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.
- Wood blocking reduces thermal resistance but allows a composite flashing of both peel and stick and rigid metal which will more than offset the thermal resistance loss by preventing bridging from the sheathing through a metal flashing (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.

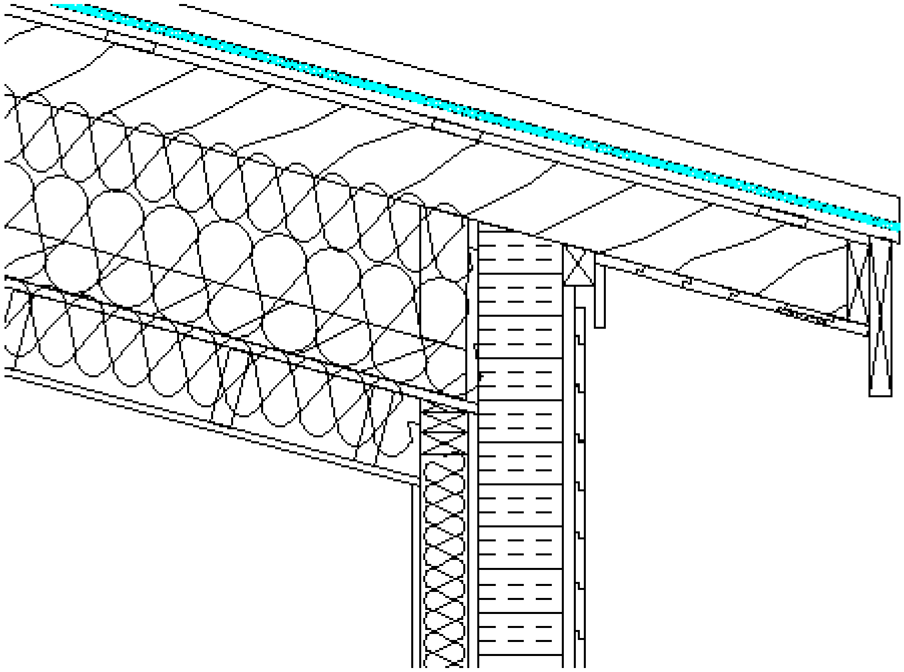

Figure 5 - Roof to Wall Interface

- Wall thermal control layer is continuous up to roof truss top chord.
- Service raceway preserves integrity of air barrier.
- Truss assembly is vented
- Vent space and WRP below metal roofing

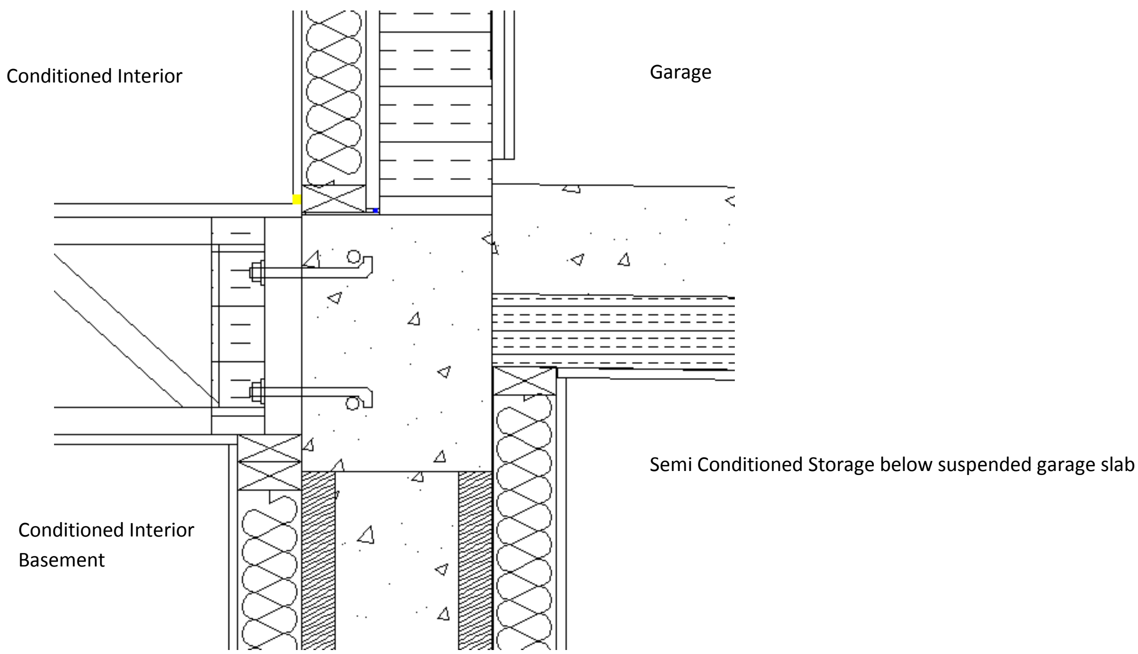

Figure 6 - First Storey Floor Interface at Garage

- Main thermal control layer on exterior of assemblies continuous above grade and stud infill below grade.
- Basement wall to utilize stud infill mineral wool
- Insulation inserts between truss bays against inside face of rim boards
- Suspended slab to be insulated on bottom surface.
- Possible incorporation of Isokorb® thermal break in suspended slab

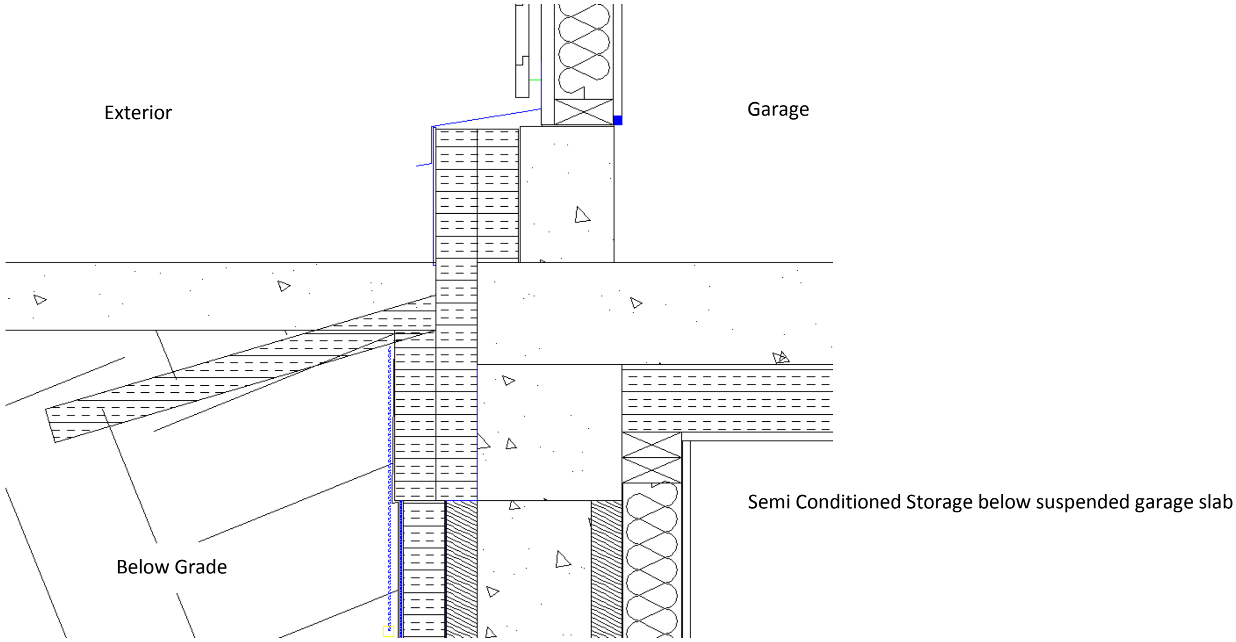

Figure 7 - Garage Side Wall interface to Exterior

- Semi Conditioned room below garage to have stud infill insulation and continuous ceiling insulation.
- Continuous insulation on exterior of ICF foundation thickened near grade to combat slab edge losses
- Insulation skirt around perimeter of garage to further combat losses from semi conditioned room below garage
- Garage walls insulated to provide slightly conditioned spaced within garage. Garage vehicle door will also be fitted with air tight 'wipe' seals.