White Paper on 2x8 R30 Woodframe Wall Design

Dec 2020

Introduction

As our society looks for ways to reduce our utilization of energy, which even in British Columbia comes chiefly from petroleum products, we find that a quarter to a third of that energy is used to heat buildings: our homes and places of work. While new, lower carbon heat sources, such as heat pumps running on hydroelectricity, will play a big roll, these systems are challenged especially in colder regions and when buildings are poorly-insulated. And no matter how efficient a heating system may be, it is all for nothing if building envelopes are not built to match.

Jurisdictions in Canada are reluctant to improve building code requirements, in part due to pushback on cost from the construction industry and their customers. Training is also needed to enable adoption of newer techniques and technologies. As an example, structural insulated panels (SIPs) took 30 years to see wide adoption in Europe, and costs remain high despite continued innovation. Building with SIPs in Canada nearly doubles the material costs of a home and cannot be done except under BC Building Code (BCBC) Part 4 and the direction of a structural engineer.

What if western framing techniques using standard dimensional lumber and “Advanced Framing”, such as three-stud corners and single top plates, were used in a new way to build walls under BCBC Part 9 with near zero thermal bridging?

A Solution

It is well-known that a standard 16” OC 2x6 wall filled with R-19 insulation, the current standard and minimum insulation requirement, will yield a wall section average insulation value of under R-14. This is due to the 20% of the wall where no insulation is present due to the studs and plates of 2x6 which have an R-value of 6.6. Double walls, often separated by hard foam insulation, have been tried, but the costs are very high due both to double the lumber requirements and double the labour time to erect. There are also significant problems with the introduction of a second vapour barrier in some of these systems and more problems introduced when installing the plumbing and electrical systems.

We propose here a wall system which utilizes standard dimensional lumber in a relatively simple, single wall plate construction to achieve more than double the thermal efficiency of a typical 2x6 wall and with only slightly more board feet of material. As a side benefit, this solution also vastly speeds, simplifies, and renders safer the electric wiring in the exterior wall.

Building with 2x8 Exterior Wall Plates

When the building code adopted 2x6 construction as the new more energy-efficient standard, the insulation gains were barely 30%. An opportunity was missed to deal with the thermal bridging of the lumber in the wall. While 2x6 plates could be filled with staggered 2x4s 12” OC and still comply with the new code, the R19 insulation would be compressed by the opposite stud and the insulation gains would thus be at most 10% more.

Move to a 2x8 bottom and top plate and those same staggered 2x4s 12” OC could be filled with two

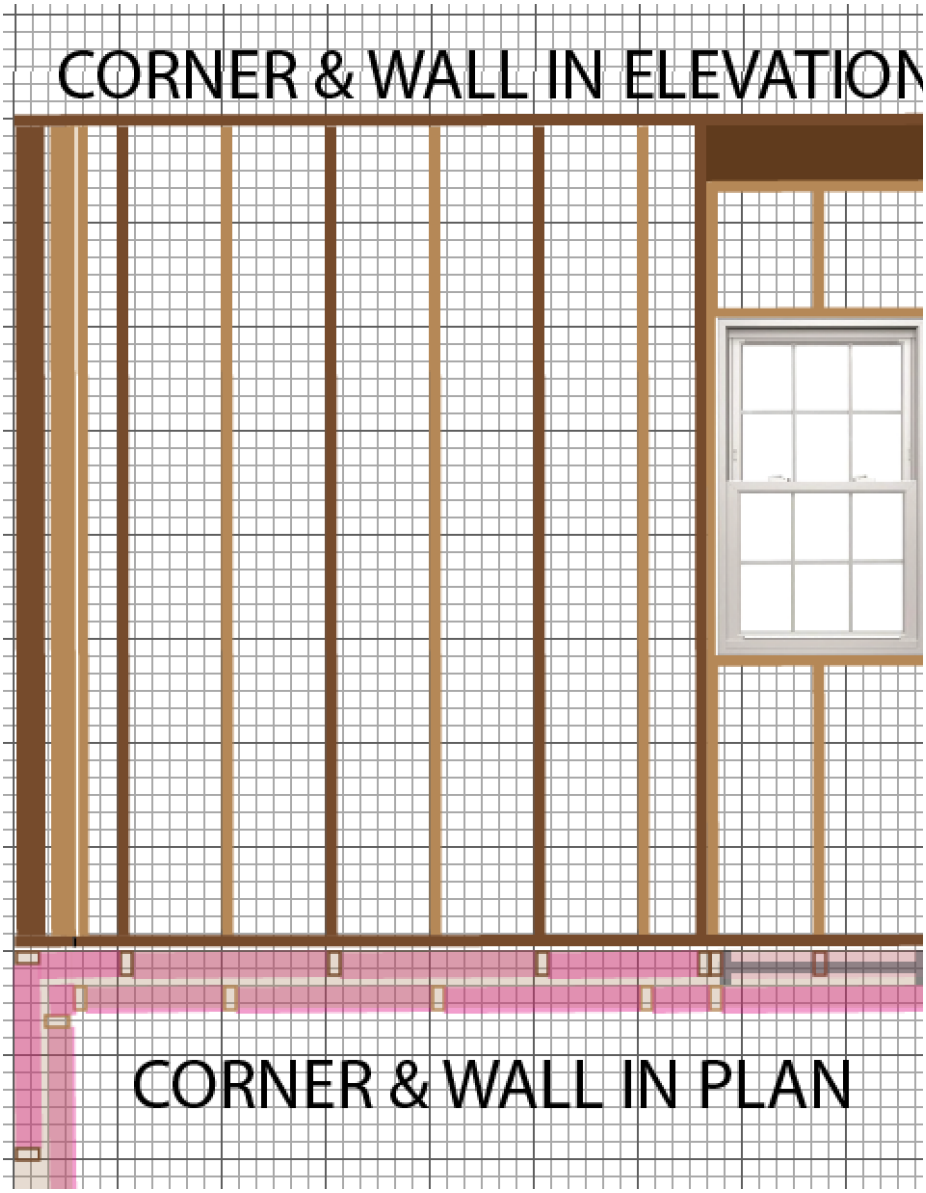

Figure 1: 8" wall section and plan

layers of standard R-14 insulation. A 1/4” air space between the offset batts becomes not just an additional insulation gap but is also the perfect channel for electrical wiring with no need to drill through studs.

Figure 1 shows an elevation and plan view of this system, a 7 1/4” wall with the dark brown 2x4 studs aligned with the building exterior and light brown studs on the inside. The plan view shows standard R-14 fibreglass or rock wool batts in 22 1/2” widths filling the cavities between the 2x4s. The window is 24”-wide (23 1/2” rough opening) in a load-bearing wall with a 2x6 header in the outer portion of the wall with king and jack studs supporting it. Even the space inside the header above the window can be insulated to at least R-20. With a roof system (trusses) or a floor system above with 12” OC or 24” OC joists, a single top plate may be employed under established Advanced Framing techniques. Note also the 3-stud corner with no thermal bridging.

This simple wall section utilizing a single top plate needs less than 10% more board feet of lumber than a standard 2x6 wall, but its insulation value in the wall (leaving out the window area) approaches R-30, or better than double that of a 2x6 wall. Not only is there an additional 1 3/4" of insulated cavity, but the cross-sectional area of thermal bridging drops from 20% to just 3%, representing the area of the top and bottom plates only.

In practice and with a jig system made for aligning 2x4s between the 2x8 plates, the differential labour costs of making these wall sections in comparison with standard 2x6 framing is insignificant. The framing of studs 12" OC also greatly simplifies calculations and avoids mistakes that often occur using 16" OC grids.

Figure 2 is a typical cross-section of such a wall system on a ground floor with a concrete foundation wall. Note how an in-floor radiant heating system and raised finished floor effectively eliminates thermal bridging in the bottom plate. This increases the R-value of the wall by at least another point.

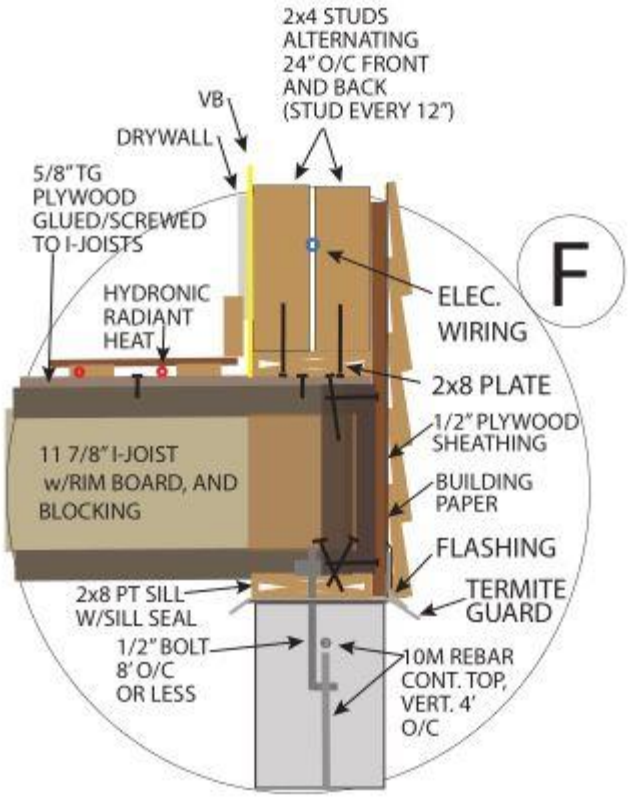

Figure 2: Cross-sectional detail of wall system on foundation wall.

Note that the drywall, inner vapour barrier, sheeting, housewrap, and cladding also add insulation value. The air-tightness of the whole system is also critical to a high level of efficiency. Because these elements are familiar to builders, no additional training is required to ensure the entire envelope is assembled optimally.

A typical full wall assembly (leaving out window and door penetrations) should exceed R-32.

A Place for Wiring

Nestled easily between and stapled to the exposed stud edges fully 4" from either the inside or outside of the finished wall, what easier and safer place is there to install electrical wiring? A side benefit of this design halves the cost of running wire and greatly improves the safety. And no stud will ever be compromised structurally by improper drilling.

Made in BC for BC

BC's Wood First initiative and Wood First Program recognize the importance of the lumber industry to BC's economy. Western stick framing is by far the most common method of residential construction in Canada, and also widely used for both residential and commercial buildings as high as six stories. This system is founded on a wood frame and entirely covered under Part 9 of the BCBC, thus ensuring low cost and wide adoption very quickly.

Lumber, used in such an optimal way, becomes not just a solution to the energy and climate crises, but also becomes the engine of job creation, rural development, and innovation for the BC economy. A highly efficient building envelope married to a heat pump system fueled by hydroelectricity will sip nearly carbon-free energy even on the coldest of days in the coldest regions of BC.

BC lumber has the potential to cut provincial energy use for housing in half and the carbon footprint of that housing by at least three quarters.

The time is right to demonstrate how new framing techniques can be integrated with the newest heating technologies to make BC a leader in building efficiency and the supplier of both materials and know-how to the world.