Outboard Insulation

Basement and Wall Strategies for Southern Ontario

Dave Petersen and Miyoko Oikawa

ABSTRACT

The necessity of a 10” foundation as a standard construction measure is a cost barrier for most production builders; this could limit the opportunities for high performance wall assemblies utilizing outboard insulation. The default specification of brick or stone veneers on homes in southern Ontario further complicates the outboard insulation discussion.

This paper will examine alternate basement wall scenarios that may be applied in an 8” thickness while still allowing for outboard insulation of up to 4” thickness, combined with a brick veneer façade. The options provided were reviewed based on cost and constructability, and then compared to the 10” foundation wall serving the same function.

The 10” foundation wall is the most cost effective and constructible option in every case when applying a stone or brick veneer finish, except when adding finished basements to the mix. This is a growing trend and a viable marketing approach at both adding value to the home and allowing the builder to recoup the added cost of construction and materials.

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Introduction

With the popularity of brick and stone veneer claddings in the Southern Ontario new construction housing market, the code-driven trend of outboard insulation strategies creates some challenges for builders. Builders have grown accustomed to the ease of construction and costs associated with 8" cast-in-place foundation walls. Outboard insulation strategies, while efficient from a thermal perspective in our climate zone, can create foundation wall depth issues, e.g. maintaining bearing for heavyweight veneers, and the 1" drainage gap required by these wall types to vent bulk water.

Through a series of residential design workshops sponsored by the Enbridge Gas Distributions Savings By Design™ (SBD) program, a clear link to cost as a primary objection has surfaced amongst most (80%) of builder proponents questioned. Over 120 builders have participated in the SBD program since 2012. The added value of the 10" foundation, e.g. ability to offer full ceiling heights in the basement are often not considered since many builders do not provide finished basement living space. Most builders suggest to prospective clients that basements be left to dry out for a period of no less than 18-24 months, prior to being finished. Some production builders have embraced basement space as highly valuable and marketable, providing multiple finishing options and comfort features for their clientele but this is the exception, rather than the norm.

This paper describes seven aboveground and basement wall strategies. These options rely on a typical 8" foundation pour (some requiring enhanced rebar schedules) and utilize outboard insulation between 2" to 4" thickness with masonry veneer claddings. This outboard insulation strategy, along with balanced interstitial insulation levels, meets the standard for net zero ready housing and will likely be code compliant construction by 2030 in Ontario.

Criteria for applying these building strategies included ease of construction, durability of wall systems, and thermal and structural performance (options provided have been reviewed by a licensed Ontario engineer – see Notes section). Order-of-magnitude pricing, including local labour factors, have been included for each system and may be compared and contrasted with the more typical 10" foundation strategy to determine which approach makes greater holistic sense.

Current State of Industry

With the Ontario Building Code (OBC) mandating net zero energy performance by 2030, builders are starting to explore methods of achieving enhanced performance, including changes to traditional construction practices. Issues surrounding cost, constructability, revised sequencing of construction activities, and trade expertise are areas that production homebuilders must give serious consideration.

The Canadian Homebuilders Association (CHBA) has introduced a Net Zero Home Labeling Program, along with a pilot project that incentivized builders to produce 26 such examples in 4 Canadian provinces. This association-based approach, along with industry partners and government has provided a look-ahead at what will be a code-built house in 2030.

Homes built as part of this program have some common traits:

1. Outboard insulation strategies (R-10) balanced with interstitial insulation
2. Higher levels of insulation in attic and basement, including basement under-slab insulation (R-10)
3. Substantially enhanced air tightness

4. Triple glazed windows and doors
5. Enhanced mechanical equipment (heat pump technology)

The development community will need to consider the products and systems used to achieve the anticipated increased levels of performance, while taking into account buyer wants and needs regarding materials/designs.

Key Concerns

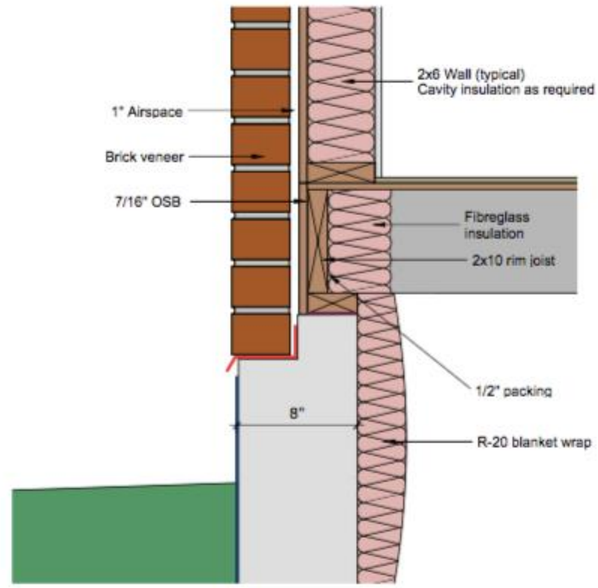
Through an internal study of the comments provided by builders participating in the Savings By Design™ program, a recurring list of concerns were brought up by the proponents, when asked to discuss barriers to high performance wall assemblies:

1. Architectural demands and design constraints
2. Cost premiums for high performance assemblies
3. Cost premium to install outboard insulation (union fees)
4. Increased wall thickness adds complexity/cost to windows and doors (increased extension depth and sill extensions on doors)
5. Condensation within basement assemblies and the assumed risk of "finished basements"
6. New sequencing requirements of trades
7. Constructability and adoption curve

Outboard Insulation Assemblies

Base Wall Assembly

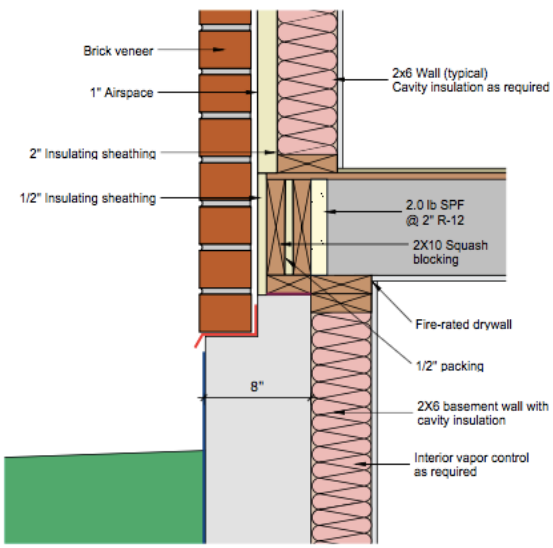
The base wall package consists of an 8" foundation wall with 3" masonry veneer, 1" airspace, spun bonded polyolefin WRB, 7/16" OSB, 2x6 stud assembly @ 16" O.C., R-22 batt insulation (nominal), 6 mil PE vapour retarder (detailed as air barrier) and ½" drywall with latex paint finish.



Base wall (Package A-1, 2017 SB-12)

Alternative Assemblies

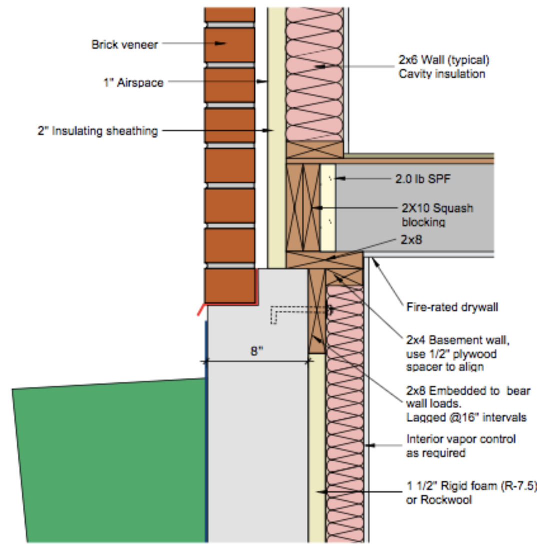
Assembly 1 combines an 8" foundation wall with masonry veneer and 2" of outboard insulation with an offset rim joist (1/2" insulation over rim joist) with an R-20 continuous blanket insulation wrap meeting 2017 SB12.



Assembly 1

The above grade wall of Assembly 1 is similar to that of the CHBA net zero energy building pilot program and will function well in climate zones 5/6 as 50% of the insulation is outside of the wall assembly (mitigating condensation risks associated with air leakage)

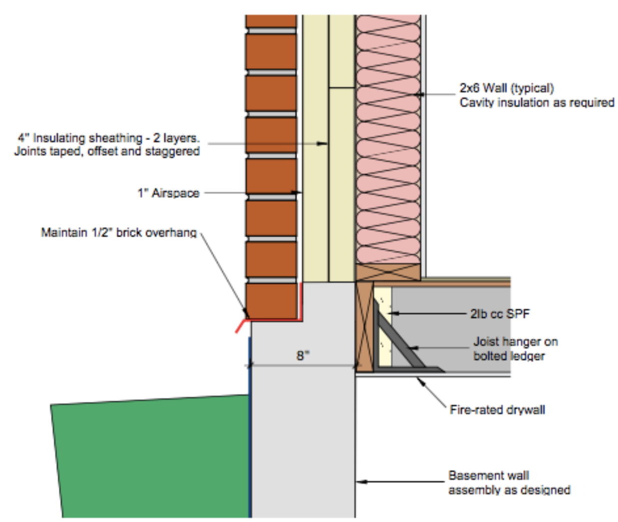
Assembly 2 consists of an 8” CIP foundation with masonry veneer and a continuous 2” outboard insulation layer. A lagged-in 2x8 interior plate supports the wall loading above and is combined with foam or rock wool layer (ci) against the foundation wall with R-13 batt back up layer in a 2x4 stud assembly in the basement (R-20.5 to R-23, nominal).



Assembly 2

Assembly 2 combines the higher levels of above-grade insulation (see Assembly 1) with a high performance basement insulation strategy – mitigating the risk of moisture issues below grade while enhancing comfort and livability in this space (finished basement).

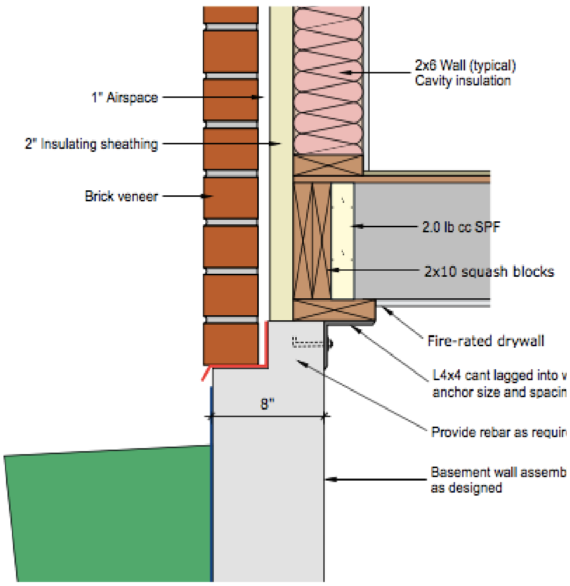
Assembly 3 shows a masonry veneer wall with 4” of ci outboard of the wall assembly (staggered joints). No basement insulation shown in this example but a metal joist hanger and 2x8 wood ledger board bearing the weight of the wall above.



Assembly 3

The hung joist detail is used on many tall-wood (6-storey) buildings, and accommodates up to 4" of rigid foam insulation to be placed above grade while still supporting the wall system from a structural perspective. The balance of inboard and outboard insulation (R-40 nominal) is moisture safe in climate zones 5-7.

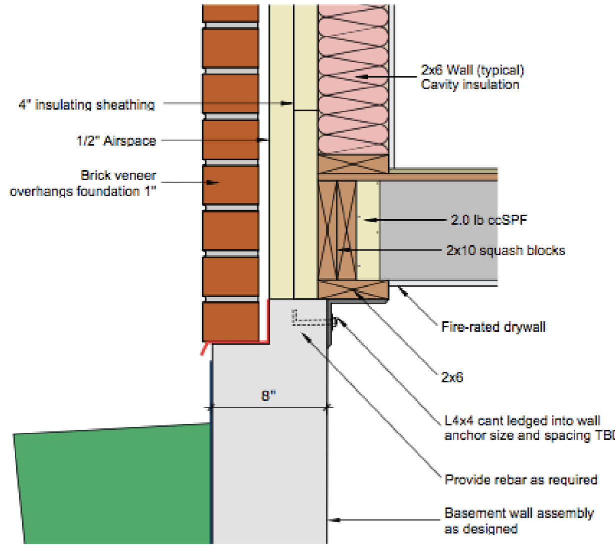
Assembly 4 shows an 8" foundation wall with additional rebar added, masonry veneer with 2" of continuous outboard foam insulation and a 4" x 4" metal 'L' angle lagged into the foundation wall (no basement insulation shown) carrying the weight of the framing above.



Assembly 4

The 'L' angle support and added reinforcing in the 8" wall supports the framing above and is similar to the joist hanger strategy, but in a continuous fashion. Basement insulation strategies remain flexible with this detail, allowing the homeowner to finish this space at a later date, by removing the blanket wrap required by code and applying a similar solution as shown in Assembly 2.

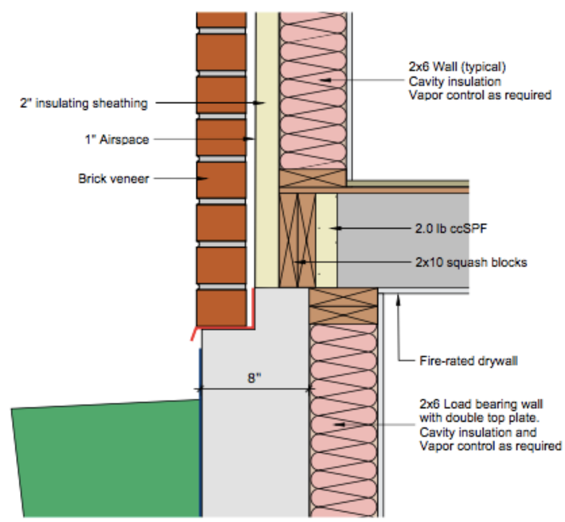
Assembly 5 is identical to Assembly 4, but shows 4" of continuous outboard rigid insulation for a nominal R-20 outboard. This foundation wall will require additional rebar as well to support the metal shelf angle upon which the above-grade wall bears.



Assembly 5

Benefits are as similar to those in Assembly 4, but with an above-grade wall layout that is durable and extremely energy efficient.

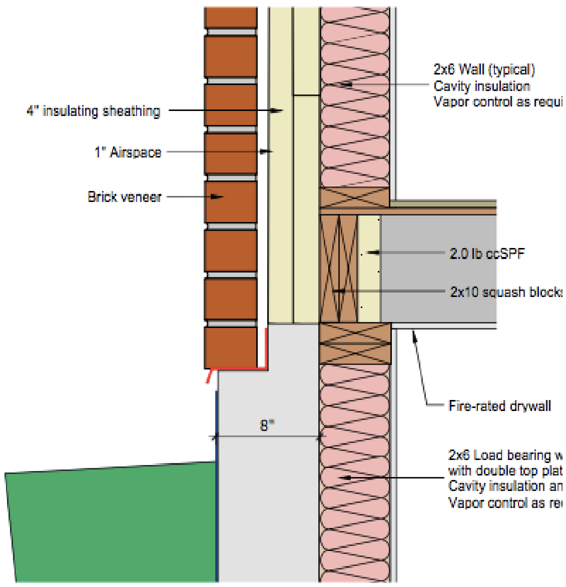
Assembly 6 details an 8" foundation wall with masonry veneer and 2" of insulated sheathing. A structural 2x6 basement wall assembly with nominal R-22 supports the above grade wall assembly with the addition of squash blocks at the rim joist.



Assembly 6

Assembly 6 is a simple and inexpensive assembly to construct, especially if the builder is providing a finished basement. It allows for both high performance above-grade and below-grade insulation packages without substantially changing construction practices.

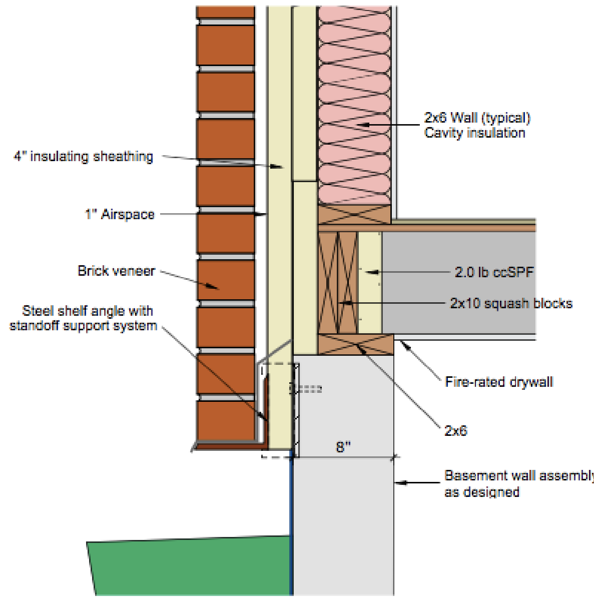
Assembly 7 is identical to Assembly 6, except the ci is 4” vs. 2” for a nominal R-20, outside of the wall cavity.



Assembly 7

This wall is especially suited to climate zone 7 and provides a durable, moisture-managed assembly that includes the basement as comfortable living space.

Assembly 8 utilizes a galvanized brick shelf with knife-edge brackets, offsetting the shelf angle to allow for 2” of continuous insulation to be applied. The assembly bolts onto the rim joist and allows for a similar wall make-up re: Assemblies 4/5.

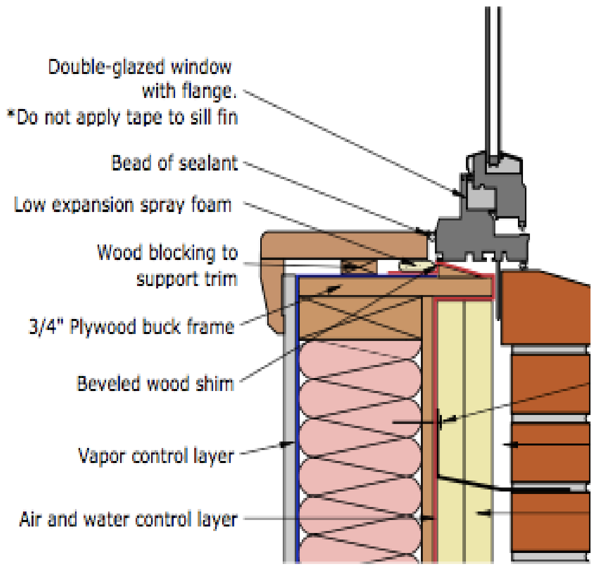


Assembly 8

This assembly is typical of Part 3 structures but may easily be combined with brick veneer construction on Part 9 buildings. The knife edge detail decreases thermal bridging, allowing the insulation to run in a continuous manner. Cost and constructability are both barriers that are real for the production builder. Custom homebuilders may be more apt to apply this detail, especially if considering infill designs at 3-storeys or above.

Window and door installation details change when applying outboard insulation in thicknesses greater than 1 ½”. The drawing below illustrates an ‘outie’ install designed for enhanced water management. This requires a cantilevered plywood buck frame (3/4”) to support the weight of the window. Ideally, a flanged window will allow the use of ice and water shield tape systems to connect the frame to the drainage plane of the wall while providing for a sill pan under the window sill that is designed to deal with water ingress past the caulking barrier.

Connecting the window to the air/vapour barrier assembly is key – continuous low expansion foam may be applied but careful attention to trimming of shim blocks is required for this to be an effective tool. Window extensions are rarely structural and never air sealed. These should not be used to fasten the window into the opening. Any air sealing strategies must be connected to the window frame, not the extension material.



Punched Window – Typical Installation Section @ Sill

Sloped material in the drainage plane under the window will provide a gravity assist of any water penetrating the secondary tape barrier – the sill fin must not be sealed to allow this water to drain effectively.

Note that pushing the window out to provide better water management may create a misalignment of the insulation plane of the wall assembly (the I.G.U of the window not aligning with wall insulation layer(s), creating a flanking path for energy to bypass these two key elements, derating the entire assembly considerably)

Assembly Considerations

Challenges for production builders exist where new materials or construction methodologies are proposed or mandated by Building Code.

The chart below outlines some of the pushback that builders in the SBD program have shared with the authors, regarding adoption of our recommendations.

Unfortunately, code officials may interpret some of these assemblies differently. This may require the builder to work with engineers and suppliers to have these methodologies vetted – a cost and timeline consideration that most are adverse to.

Assembly	Possible Construction Challenges	Possible Code Challenges
Assembly #1	Fully finished basement stud wall and drywall – moisture issues regarding encapsulating CIP foundation wall before fully dried out (+/- 50% free water). Possible call-backs for builder Cost of adding studs and drywall (could be negated if finished basement option offered) Cost of 2" insulated sheathing Extra cost of window extensions and door sill extensions for 2" of outboard insulation	Poly vapour barrier on interior – still sealed? (drying issues based on type of OB insulation).This may be an issue for any of the walls featuring 2"+ of outboard ci
Assembly #2	As Assembly 1, plus: Engineering review (cost) for using a lagged ledger board Trades unfamiliar with detail	No Code Issues Identified
Assembly #3	Engineers stamp required (cost and revised drawings) Trades ability to provide – not typical of a Part 9 building Protection (thermal) of 2.0 lb SPF Cost of 4" insulation – also vapour barrier issues, drying issues Window and door extensions, sill details, etc. Brick ties through OB insulation (thickness of OB insulation)	No Code Issues Identified
Assembly #4	Same as Assembly 3 Added rebar in foundation to allow for lagged "L" angle and associated material and installation costs	No Code Issues Identified
Assembly #5	Same as Assembly 3 Added rebar in foundation to allow for lagged "L" angle and associated material and installation costs	No Code Issues Identified
Assembly #6	Same issues as Assembly 1	No Code Issues Identified
Assembly #7	Same issues as Assembly 1	Detail 7 is a balloon-framed wall, with the wall assemblies inset from the foundation completely. Fire separation of floors may become an issue
Assembly #8	Same issues as per Assembly 1	No Code Issues Identified

Costing

A typical single-family production home model was selected from a design layout and gross floor area that would be considered typical by most production homebuilders in Ontario.

The home design consists of a 2-storey detached single-family unit with a gross floor area (above grade) of 2900 s.f., with an unfinished basement, built to SB-12 Prescriptive Package "A-1". This is consistent with the Baseline wall assembly shown on Page 3.

Costs shown include labour, with union premiums included. Efficiencies and possible savings associated with larger scale application of the measures shown have not been taken into account – all costing is based on an individual home meeting the design parameters called-out.

Assembly	Description	Cost: Below Grade Wall	Cost: Above Grade Wall	Constructability	Complexity (1= standard construction, 5= highly technical)
Baseline (A-1)	Code-built to Package A-1	Baseline	Baseline	Standard Details and Practices	1
Assembly #1	2" O.B ci with R-20 Basement	$6,601.00 (+28%)	$10,270.00	Studded basement wall, offset blocking at rim joist	2
Assembly #2	2" O.B, ci with R-23 basement ci + stud wall	$9,554.00 (+41%)	$11,288.00	Added ledger board to bear structural loads, ci in basement against foundation wall	3
Assembly #3	4" O.B. ci, joist hanger, no basement insulation shown	-$518.00 (-2%)	$5,013.00	Joist hanger on lagged rim board, 4" ci OB insulation	3
Assembly #4	2" c.i. OB with 'L' angle support and no basement insulation	$4,874.00 (+21%)	$6,608.00	2" ci OB, "L" angle supports loads from above, rebar in 8" pour	4
Assembly #5	Same as #4 but with 4" c.i. OB	+$5,101.00 (+22%)	$10,164.00	Same as above, 4" ci	4
Assembly #6	2" c.i. OB w/ structural 2x6 basement wall (R-22)	+$5,974.00 (+25%)	$7,708.00	2" ci OB, 2x6 stud wall in basement supports load from above	2
Assembly #7	As above, but with 4" OB ci	+$6,285.00 (+27%)	$11,506.00		
Assembly #8	2" OB ci, offset shelf angle	+$8,361.00 (+36%)	$13,892.00	Offset shelf angle, 2" ci	5
Baseline w/ 10" Foundation wall Package A-1	10" pour, reinforced	+$6,556.00 (+28%)	Same	Standard – 10" foundation pour, reinforced	1

Findings

The complexity of changing current best practices, especially in a unionized trade environment, lead to a construction industry that is conservative and risk-adverse. Changes to the Energy Component (SB12) of the OBC will require hoses to become better insulated and more airtight to save energy. These changes are pushing the limits of structural considerations (foundation thickness), cost paradigms (union labour and historical construction practices) and material applications, thus reshaping the landscape for this industry.

Builders in Ontario will be required to adjust the way they build, not just based on code-related advancements, but regarding changes to demographics and buyer wants and needs. These changes will cost more to build, requiring a new approach when considering alternative strategies to meet buyer, code, and carbon-related mandates in the next 5-10 years (2 – 2 ½ code cycles)

1. The cost of Alternate Wall Assemblies on an 8" foundation will prove more expensive than moving to a 10" pour, in every case except one (Assembly 6). If builders added an option package of finished basements and marketed the comfort and space benefits of full ceiling heights provided by the 10" foundation wall, costs could be covered and additional margins would likely exist.
2. Builders already providing a finished basement option package to their clientele will find it easier and more cost effective to look at packages similar to Assembly 6. This would also simplify the application of additional outboard insulation requirements that we will see become code-minimums by 2030.
3. The inclusion of basement space as valuable living space will help offset construction costs related to thicker foundations. Code changes defining dwelling units within a home (pending) will add further fuel to finished basement demand already seen in areas where multi-generational living is being adopted.
4. With masonry veneer claddings being the norm in southern Ontario, builders will continue to have challenges related to bearing of brick/stone on the foundation wall, as walls become thicker due to outboard insulation being mandated in the Building Code. Applying some of the alternative assemblies shown can help balance cost and constructability issues – this is especially significant for carbon footprint considerations, as saving concrete by maintaining an 8" foundation wall will reduce the embodied carbon in these homes – an alternative factor in cost savings may be to switch away from heavier veneer cladding options with the application of lightweight claddings that look like brick or stone but are only 10-20mm thick.
5. Market demographics (ethnicity, multi-generational living, etc.) will require living space within the traditional single family home to be optimized for more than the default family assumption of 2 adults + 1 child. This living space may be more easily added in the basement vs. other areas on main or second floors (See Point 3, above)

Further Research:

1. Market research in both existing and new housing, relative to how density within homes will change and how communities will benefit/find challenges relative to this densification.
2. How can panelization or modular building provide efficiencies in producing a high-R value wall system, while allowing for a more typical foundation strategy (8")?
3. How can finished basements help builders sell more homes profitably while reducing callback issues due to moisture problems (Doug Tarry wall, or similar)

Legend

Ci – Continuous Insulation (rigid or semi-rigid) applied either outboard or inboard (basements) of the main wall assembly

OB – outboard (outside of wall)

Nominal R-Value – value of bare insulation only, no thermal bridging or framing factors taken into account

Effective R-Value – the value of the whole wall assembly, including thermal bridging

WRB – Weather Resistive Barrier (house wrap, felt or other system – installed outboard of the sheathing, primarily as a drainage plane)

PE – polyethylene, used as a vapour retarder but may be detailed as an interior air barrier

CIP foundation – cast in place concrete. Foundation is set with forms into which concrete and reinforcing is added to produce the foundation wall

Blanket Wrap – Combined insulation and Air/vapour retarder, attached to basement wall with nailing strip. Considered continuous Insulation (ci)

References

http://www.chba.ca/CHBA/HousingCanada/Net_Zero_Energy_Program/CHBA/Housing_in_Canada/Net_Zero_Energy_Program/NZE_Program_Landing_Page.aspx?hkey=4af3da17-b4da-42ef-bf20-261a9cfbe39f

https://argileresearchgbc.wordpress.com/doug-tarry-homes-basement-system/

Notes

The structural details of the foundation wall and superstructure described herein are schematic and indicative (Assembly 1 to 8). The details shall not be utilised without consulting a design professional to assess their suitability for your project.

Derek Tong, P. Eng. LEED AP
Principal
DT Engineering