High Performance Walls

Agenda

• Introduction
• Where to start – Design goals
• Thermal control
• Air control
• Moisture control
Introduction
High Performance Walls

Role of the building assembly

• Provide for structural needs
• Separate the inside from outside environment
  o Air control
  o Thermal control
  o Moisture control
  o Vapor control
High Performance Walls

“God is in the details.” – Ludwig Mies van der Rohe
High Performance Walls

High performance building assemblies enhance the performance (control) of one or more aspect, without compromising the others

• Provide for structural needs
• Separate the inside from outside environment – maintain the integrity of all control layers
  o Air control
  o Thermal control
  o Moisture control
  o Vapor control
High Performance Walls

Why build a higher performance wall?

• Largest areas of opportunity for improving shell efficiency:
  o Infiltration
  o Wall/window U-value

• Successfully improving walls accomplishes both of the above

• Can enhance comfort, efficiency, and reduce equipment costs
High Performance Walls

Why create a training on higher performance walls?

• Improving walls represents significant process changes from current practice
  o Change framing practices
  o Change cladding practices
  o Cascading changes to structural, fenestration, air sealing, and cladding attachment practices/systems
High Performance Walls

Key design considerations

• Interaction of thermal, air, and moisture transmittance
  o Control layers
• Cascading changes to other building systems
  o Structural systems
  o Fenestration
  o Cladding
• Integration with adjacent surfaces
• Impact on home’s overall energy and comfort performance
High Performance Walls

Design Goals
High Performance Walls

What is your design goal?

• Meet a target U-value
• Obtain a certification
• Improve current wall design
• Find a more cost-effective wall design
• Mark of quality/product differentiation
Thermal Control
Thermal Control

Overall U-value

• Determined with “path layer analysis”
  o Typically completed by engineer, energy consultant, Rater, building science team

• Only indicative of thermal performance, not other control aspects of the wall
  o More on this later
Thermal Control

Typical Overall U-value Ranges

- Optimized 2x6 wall, no rigid: U- .050-.051
- Optimized 2x6 wall, 1” rigid: U- .040-.045

Getting U-values under .040 will usually require one of the following

- Framing changes – double wall, etc.
- More than 1” of rigid
- Thicker SIPs or ICFs
Thermal Control

Thermal Bridging

• Address by using insulation that “breaks” thermal bridges created by structural wall elements:
  o Rigid exterior insulation
  o SIPs or ICFs
  o Staggered stud/double wall
  o Interior strapping
Thermal Control

Impacts of window selection Nominal R-30 wall (U-0.035)

Overall Wall R-Value

20% window-to-wall  15% window-to-wall  10% window-to-wall

U-0.30 window
U-0.25 window
U-0.19 window
Thermal Control

Impacts of window selection Nominal R-23 wall (U-0.051)

Difference can account for >800-1,800 kWh/year Heating energy impact.
Air Control
Air Control

Sheathing as the primary air barrier

• Resilient means of providing air control with walls
• Can be resource efficient – Sheathing/WRB/rigid insulation can serve as air control layer… if properly detailed.
Air Control

OSB/CDX or similar sealed with tapes, foam, or proprietary sealant systems
Air Control

Liquid-applied and “Peel & stick” WRBs
Air Control

Rigid foam with taped seams
Air Control

Detailing a primary air barrier at the wall exterior
Flexible Air Barrier material spans from wall exterior sheathing onto ceiling plane, forming a continuous air barrier.

Air Seal at each break in wall exterior sheathing. Tapes provide added security when installed under mechanically fastened wall components.

Air Seal all penetrations in interior finish/wallboard. Air seal wallboard to top plate at all attic/wall intersections with durable tapes, gaskets, and sealants.
Rigid air barrier material spans from wall exterior sheathing onto ceiling plane, forming a continuous air barrier.

Air Seal at each break in wall exterior sheathing. Tapes provide added security when installed under mechanically fastened wall components.

If used as an electrical chase, a furred-down ceiling assembly preserves the integrity of the air barrier by minimizing penetrations.

Rigid air barrier material spans from wall exterior sheathing onto ceiling plane, forming a continuous air barrier.
Seal wall sheathing at bottom plate, sill plate, and rim/band joist connections.

Seal the sill plate to stem wall connection with gasket material.

Wall designed to dry to the inside.
Air Control

Adding redundant air control
Moisture Control
Moisture Control

Dewpoint

• The temperature to which air must be cooled at constant pressure and water content to reach saturation

• “Frost point” is the dew point when temperatures are below freezing
Moisture Control

Dewpoint

- Cold sheathing or framing material can become a “condensing surface of interest” when below dewpoint
Moisture Control

Dewpoint

- Adding insulation to the **interior** of the sheathing plane keeps sheathing colder
- Adding insulation to the **exterior** of the sheathing plane keeps sheathing warmer
Moisture Control

Dewpoint

- In thick walls without rigid insulation, the sheathing temperature stays close to the outdoor temperature
Moisture Control – Vapor

Keep vapor moisture out of walls

• Regulate interior Rh with effective ventilation
• Avoid positively pressurizing the building
• Air seal at the sheetrock plane
• Vapor barrier at the sheetrock plane
Moisture Control – Vapor

Avoid vapor issues inside walls

- Protect sheathing and framing from the cold (keeps condensation away from mold-prone materials)

Or

- Install sheathing, WRB, and cladding systems that allow drying to the outside
Moisture Control – Bulk

Consider the merits of the WRB system

• Permeance
• Cost/ease of installation
• Can it serve multiple purposes?
  o Air control
  o Thermal control
• Impact on flashing and fenestration details
Moisture Control – Bulk

Planning for windows—innies or outties?

• Outties
  o Familiar flashing details and install process
  o Require interior sill/trim extension
  o Creates a ledge for cats

• Innies
  o Less familiar install and detailing
  o Requires both interior sill/trim and buck extension, with more intricate flashing details
  o Creates some additional weather protection
  o Creates a ledge for squirrels
Moisture Control – Bulk

Outtie window with 2” rigid
Moisture Control – Bulk

Innie window with 2” rigid – Head

- Blocking, Salvaged
- 2x15 Rafters, Salvaged
- Joist Hangers @ Window Opening
- Lus 210-2
- Water Resistant Barrier
- Header/Rim Board
- Metal Siding, Typ.
- Metal Flashing
- Barn Door Track
- Low Expanding Foam, Typ.
- Rigid Insulation
- Gws Casing, Latex Paint
- Window Per Sched.
Moisture Control – Bulk

Innie window with 2” rigid – Sill
Conclusion

Does my high performance wall:

• Provide for structural needs?
• Control against bulk water intrusion?
• Control for water vapor and allow for drying?
• Provide redundant air control?
• Incorporate feasible flashing and trim details?
• Add thermal control without sacrificing any of the above?
• Present a cost-effective means of improving overall performance?
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