



Home Innovation
RESEARCH LABS

CONSTRUCTION GUIDE: *ENERGY EFFICIENT, DURABLE WALLS*

February 12, 2015

Finding Innovation a Home

INTRODUCTION

- ❑ Low market penetration of energy efficient walls
- ❑ Construction Guide - energy efficient, durable walls that can be implemented in the field (focus on Climate Zones 3-5)
 - *Combine tried-and-true practices with the new*
 - *Pros and cons of various options*
 - *Potential conflicts with traditional installation practices*
 - *Enables builders to make informed design and material selections*
- ❑ 2x6 walls – Stakeholder Review Draft “Construction Guide to High Performance Walls”
(www.homeinnovation.com/wallguide)
- ❑ 2x4+1-1.5"foam Guide – later in 2015

OUTLINE

- ❑ Today's market – what walls builders are using right now?
- ❑ 2x6 wall construction and 2x4 walls with exterior rigid foam sheathing
- ❑ Implementation considerations for EE walls
 - *Framing*
 - *Sheathing*
 - *Interior vapor retarder*
 - *Drainage plane*
 - *Cladding*

2012/2015 IRC/IECC Prescriptive Wood Frame Wall R-value

CZ	2009	2012/2015	Example 2015 Walls
2	13	13	2x4
3	13	20 or 13+5	2x6 or 2x4+1"XPS
4	13	20 or 13+5	
5	20 or 13+5	20 or 13+5	
6	20 or 13+5	20+5 or 13+10	2x6+1" XPS or
7-8	21	20+5 or 13+10	2x4+2" XPS

Total UA alternative is permitted based on equivalent U-factors

A SYSTEM'S APPROACH TO MAKING A TRANSITION

- ❑ Don't just add the new to the old
- ❑ Find efficiencies in the new system
 - *Offset cost increases*
- ❑ Find a “sweet-spot” for combining tried-and-true with new
- ❑ Address potential unintended consequences

Result: Performance and added value

WALL MARKET TRENDS

New Home Starts – Wall Framing

FRAMING	2001	2006	2013
2x4 @ 16" o.c.	74%	73%	60%
2x4 @ 24" o.c.	2%	3%	1%
2x6 @ 16" o.c.	22%	22%	32%
2x6 @ 24" o.c.	2%	2%	6%
Other	1%	0%	1%
TOTAL	100%	100%	100%

WALL MARKET TRENDS

New Home Starts – Wall Sheathing

Wall Sheathing (primary)	2001	2006	2013
None (concrete, SIPs or others)	10%	12%	12%
WSP (Plywood, OSB, ZIP)	65%	68%	79%
1/2" fiberboard	3%	3%	2%
1/8" (Thermoply, EnergyBrace)	3%	2%	1%
SIS	n/a	n/a	1%
Foam (XPS, EPS, ISO)	17%	12%	4%
Other	3%	4%	1%
TOTAL	100%	100%	100%

WALL MARKET TRENDS

New Home Starts – Oversheathing

Oversheathing	2006	2012	2013
Shares of Homes with 2nd Layer of Foam Sheathing	7%	9%	10%

New Home Starts – Housewrap

Housewrap	2006	2012	2013
Homes with Housewrap	54%	74%	74%

WALL MARKET TRENDS

New Home Starts – Cavity Insulation

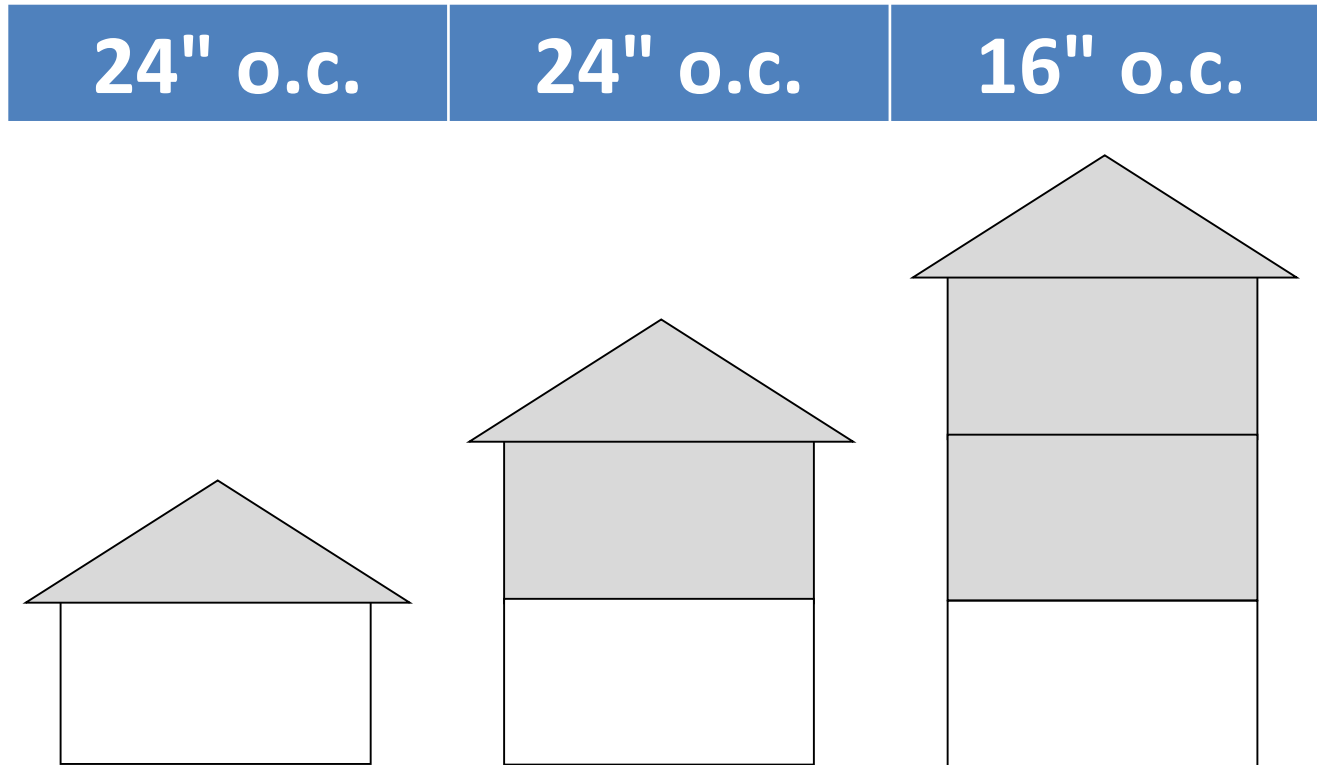
Cavity Insulation	2006	2011	2013
Fiberglass batt	76%	68%	68%
Fiberglass blown	7%	8%	8%
Spray foam	3%	11%	10%
Cellulose	11%	8%	9%
Other or none	3%	5%	5%
TOTAL	100%	100%	100%

2X6 WALLS (W/O EXT. INSULATION)

- ❑ Straightforward transition from conventional 2x4
- ❑ “Tried and True”
- ❑ 2x6 studs are stronger
 - 24" OC, fewer studs at openings
- ❑ Optimized framing:
 - Advanced framing techniques
 - NextGen framing options
- ❑ Potential for reduced labor
- ❑ Guide at www.homeinnovation.com/wallguide



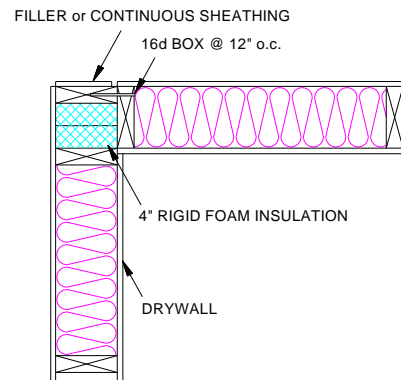
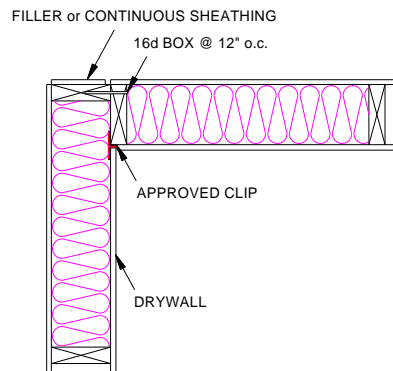
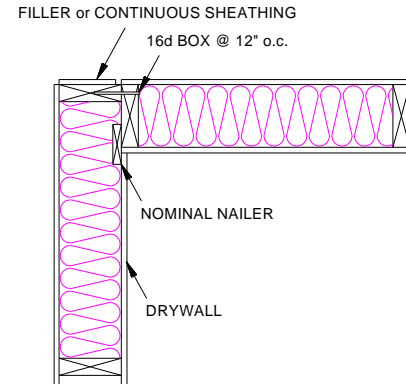
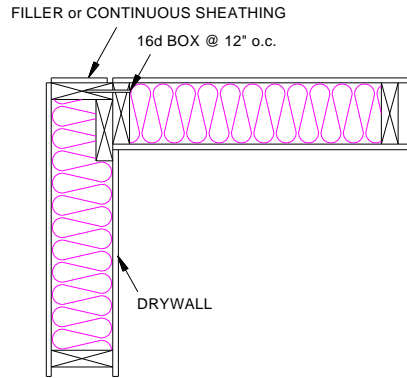
2X6 WALLS - NUMBER OF STORIES



Story-to-story alignment:

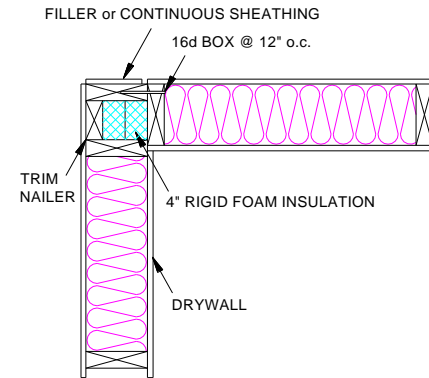
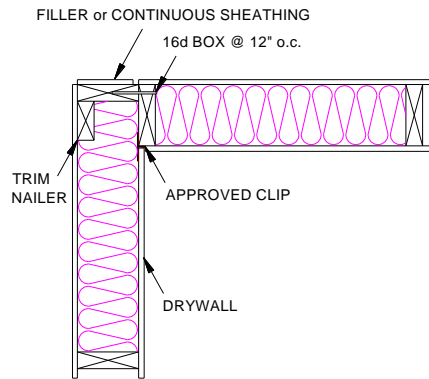
- for 2x6 walls with studs at 24" oc in-line framing is not required if a double top plate is installed

2X6 WALLS - CORNERS



Framing Details for Cladding Systems That Do Not Require Additional Framing for Trim

2X6 WALLS - CORNERS

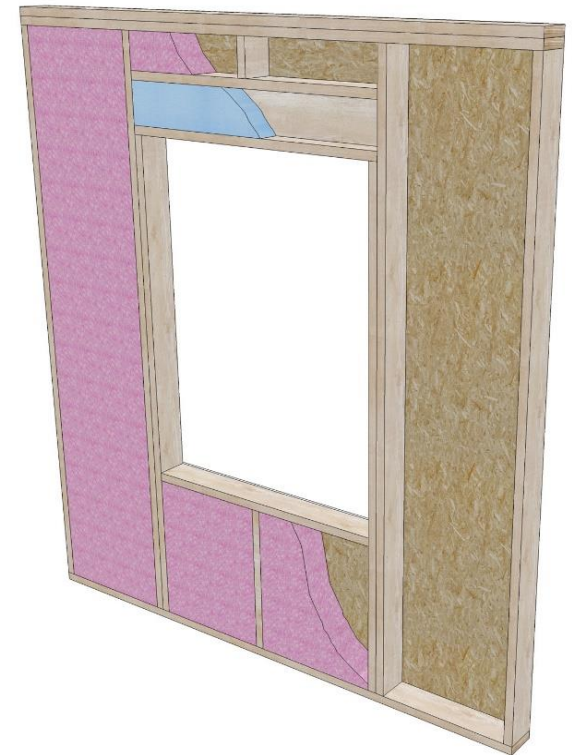


Framing Details for Cladding Systems That Require Additional Framing for Trim

2X6 WALLS - FRAMING AT OPENINGS

SINGLE HEADER

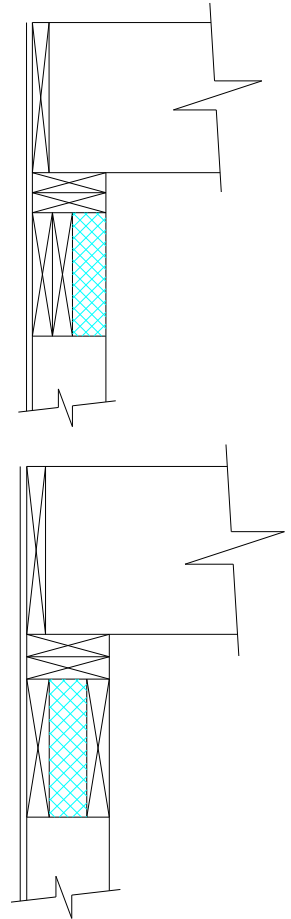
- 4" of insulation: R20 XPS
- Single story homes
- Top story in a multi-story building
- Openings up to 6' for solid lumber
- Openings up to 7' for SCL
- Refer to IRC for spans



2X6 WALLS - FRAMING AT OPENINGS

INSULATED DOUBLE HEADER

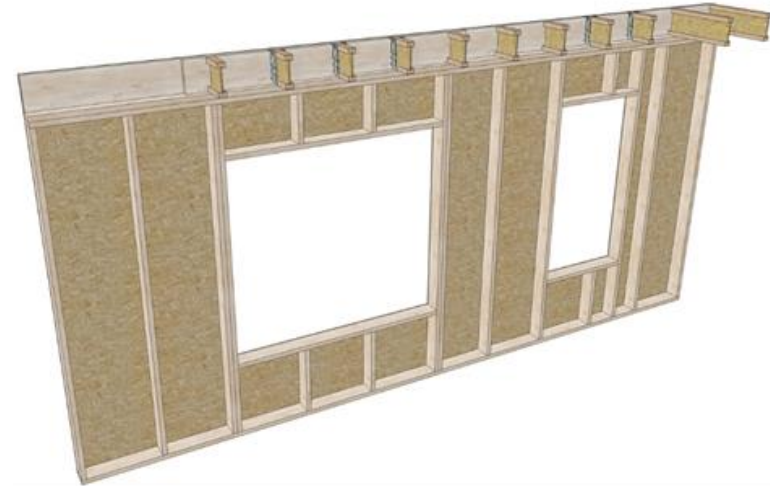
- 2.5-3" of insulation: **R13-19 (rigid foam)**
- Most openings in a house
- Prefabricated or site-built
- Must be capped, if foam sandwiched between the double members



2X6 WALLS - FRAMING AT OPENINGS

INSULATED RIM HEADER

- Full wall insulation value
- All openings except top floor
- Part of 2x6 package
- Joist hangers at opening
- Reduced number of window studs
- 2015 IRC listed for solid sawn
- Engineered lumber – manufacturers' specs



2X6 WALLS - FRAMING AT OPENINGS

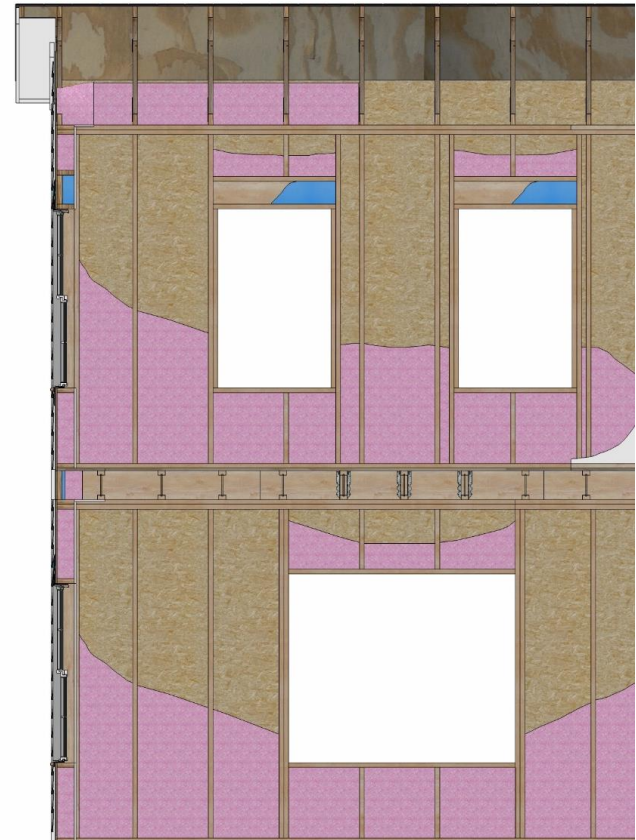
INSULATED RIM HEADER



2X6 WALLS - FRAMING AT OPENINGS

EXAMPLE

- Rim headers first floor
- Single headers top floor

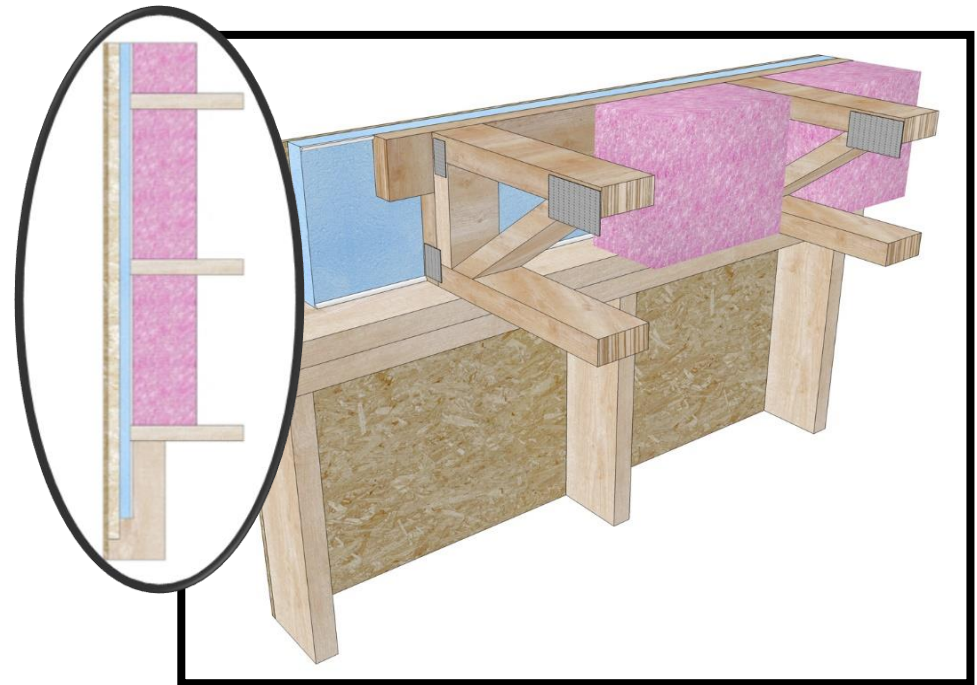


2X6 WALLS - RIM JOIST INSULATION

More bearing area –
continuous insulation options (2.0"-2.5")



Pre-fabricated Insulated Rim



Ribbon Board/Truss

2X6 WALLS - RIM JOIST INSULATION

Exterior insulation with a recessed rim –
UNDER EVALUATION



- 1" exterior foam at rim
- No apparent reduction in capacity observed for a standard capacity wall (IRC)
- Further testing is needed
- Not a code option

Rim recessed by 1"

2X6 WALLS - EXTERIOR WALL SHEATHING

WOOD STRUCTURAL PANEL SHEATHING

- ❑ 16" or 24" o.c. studs
- ❑ Check nail sizes and panel thickness/rating based on wind speed and wind exposure (e.g., 100 mph Exp. B – 100B)
 - *See IRC or Guide for specific details*
- ❑ 3/8 WSP not permitted in Exposure C for 24" o.c. studs
- ❑ Panels can be installed vertically or horizontally

2X6 WALLS - INTERIOR VAPOR RETARDER

- ❑ Requirements vary by Climate Zone, type of insulation, cladding system
 - *Must consider the entire assembly and site location*
- ❑ CZ 3-5 – vapor retarder (if used) always on the INSIDE
 - *Minimizes the movement of interior humidity into the cavity*

2X6 WALLS (W/O EXTERIOR INSULATION) – INTERIOR VAPOR RETARDER

- ❑ **CZ 3** – VR not required; Class I VR discouraged
- ❑ **CZ 4** – VR not required; Class II (Kraft paper) or III recommended
- ❑ **CZ 4C and 5** – a VR is required; Class II is recommended
- ❑ **Class I VR** is always discouraged with non-vented claddings (stucco, wood composite with flat install, etc.)
- ❑ **Air sealing** is always encouraged as an added moisture control measure

2X6 WALLS – CLADDINGS

- ❑ Type of cladding
 - *Vented* (e.g., lap vinyl, brick veneer with an air gap)
 - *Partially Vented* (e.g., solid siding clapboard install)
 - *Non-vented* (solid cladding w/o air gap)
- ❑ Drainage plane
- ❑ Attachment | Framing spacing
- ❑ Code compliance with wind loads

2X6 WALLS – CLADDINGS (GUIDE)

VINYL SIDING INSTALLATION		
Air Gap	Integral with cladding (i.e., vented cladding).	
WRB	Any WRB material in Table 20 can be used in a single layer application.	
Attachment	16 in. on center studs	24 in. on center studs
	Most standard vinyl siding products are rated for 16 in. on center applications and installed directly over exterior sheathing with fasteners (nails or staples) required to penetrate framing.	<p>Options:</p> <ol style="list-style-type: none"> Vinyl siding rated for 24 in. on center applications with fasteners penetrating framing (typically thicker plastic material used to fabricate siding). Standard vinyl siding attached to WSP sheathing only (framing penetration not required) in accordance with Table 27. <p>Manufacturers' recommendations for specific product (e.g., attached to studs at 24 in. on center and one fastener into WSP between studs).</p>
Code Compliance	IRC R703.4 and R703.11, ASTM D 3679. Install siding in accordance with Code Evaluation Report and/or Manufacturers Installation Instructions.	
Wind Resistance	Verify wind load compliance in accordance with manufacturer's installation instructions based on siding rating and fastening schedule. Vinyl siding should not be attached to furring strips unless the space between the furring strip is filled with a rigid material.	

2X6 WALLS – CLADDINGS (GUIDE)

ANCHORED VENEER		
Air Gap	One inch minimum air gap.	
WRB	Any WRB material in Table 20 can be used in a single layer application	
Attachment	16 in. on center studs	24 in. on center studs
	Metals ties spaced 16 in. horizontally and 24 in. vertically and attached to framing with one 8d common nail. In SDC D0 and higher (SDC C for townhouses) or where wind pressure exceeds 30 psf, vertical spacing is reduced to 18 in.	Metals ties spaced 24 in. horizontally and 16 in. vertically and attached to framing with one 8d common nail. In SDC D0 and higher (SDC C for townhouses) or where wind pressure exceeds 30 psf, vertical spacing is reduced to 12 in.
Code Compliance	IRC R703.4 and R703.7	
Wind Resistance	The code compliance is achieved through the prescriptive IRC code provisions for wind speeds below 110 mph (2012 IRC). For higher wind speeds, engineered design is required.	

2X6 WALLS – CLADDINGS (GUIDE)

ENGINEERED WOOD SIDING^A (LAP, HORIZONTAL)

Air Gap	Standard installation (flat installation) permitted by siding manufacturers provides no air gap. Installation over furring or housewrap with built-in drainage promotes drying and drainage. Installation in a clapboard fashion promotes drying by providing partial venting between courses.	
WRB	For flat installations, follow siding manufacturer’s instructions for selection of WRB. Where such recommendations are not available, it is recommended to use a more permeable WRB product to allow drying to the inside. Where furring is used, any WRB material in Table 20 can be used in a single layer application. Note that permeability of various types of engineered wood siding can vary and is always less than solid wood siding.	
Attachment	<p style="text-align: center;">16 in. on center studs</p> <p>Standard products rated for 16 in. on center installation.</p>	<p style="text-align: center;">24 in. on center studs</p> <p>Manufacturers provide a thicker siding product (e.g., 7/16 vs. 3/8) or permit the use of alternate fastening schedules (e.g., 24 in. on center nailing with an additional ring-shank nail into WSP sheathing between studs).</p>
Code Compliance	CPA/ANSI A135.6, IRC Section 703.4	
Wind Resistance	Verify wind load compliance in accordance with manufacturer’s installation instructions.	

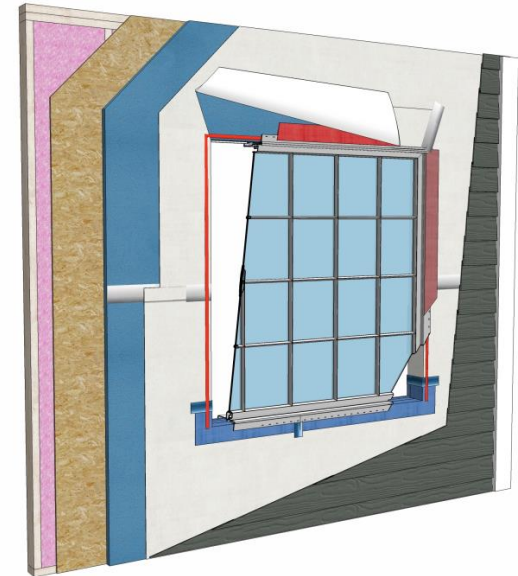
2X6 WALLS – SUMMARY

- ❑ R20 or higher
- ❑ Optimized Framing Factor
 - 24" o.c. framing
 - Rim Header option
 - Advanced framing
- ❑ System efficiencies
- ❑ Select vapor retarders based on
 - Climate zone
 - Cladding
 - Insulation type
- ❑ Guide at www.homeinnovation.com/wallguide



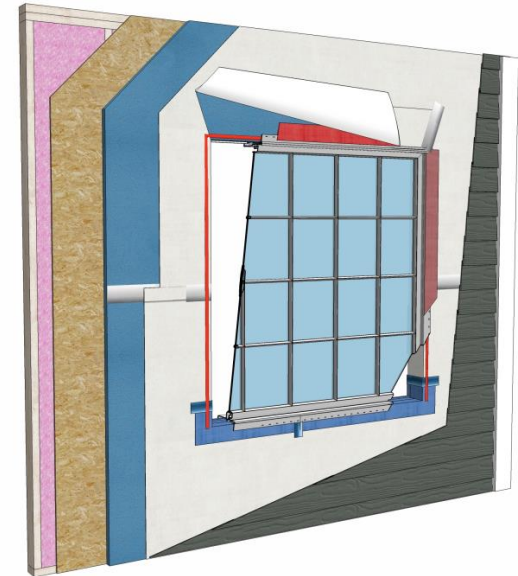
2X4+1-1.5" EXTERIOR INSULATION

- ❑ R13+5 (or greater)
- ❑ XPS, EPS, Polyiso, mineral wool, other
- ❑ Minimized effect of thermal bridging
- ❑ Different moisture dynamics
 - *Interior and exterior moisture*
- ❑ For thicknesses 1.0"-1.5" over WSP, only minimal changes to standard detailing and cladding attachments



2X4+1-1.5" EXTERIOR INSULATION

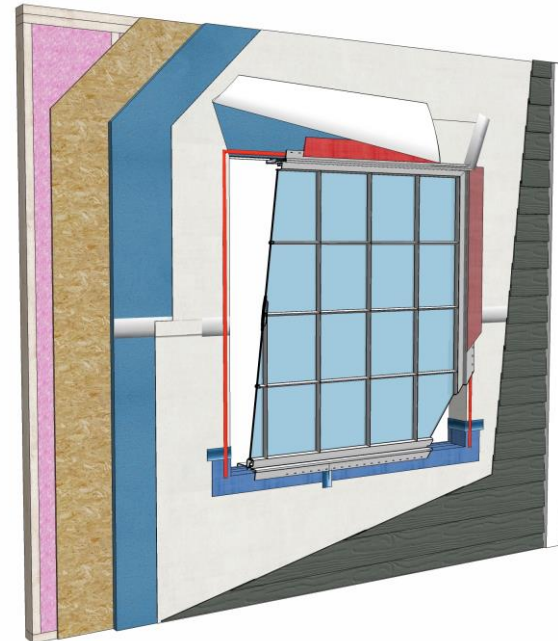
Insulation Type	Per inch R-value	Minimum Density (pcf)	R5 thickness, inch
EPS Type I	3.6	0.90	1.39
EPS Type VIII	3.8	1.15	1.32
EPS Type II	4.0	1.35	1.25
EPS IX	4.2	1.80	1.19
XPS Type X	5.0	1.30	1.00
XPS Type IV	5.0	1.55	1.00
PIC	6.5	1.70	0.77
Mineral Wool	4.0	8.00	1.25



2X4+1-1.5" EXT. INS. – WRB

Option 1: Primary drainage plane outboard

- **Taped Foam** (XPS or PIC; tested to meet ICC-ES AC71)
- **House wrap** installed over foam



2X4+1-1.5" EXT. INS. – WRB

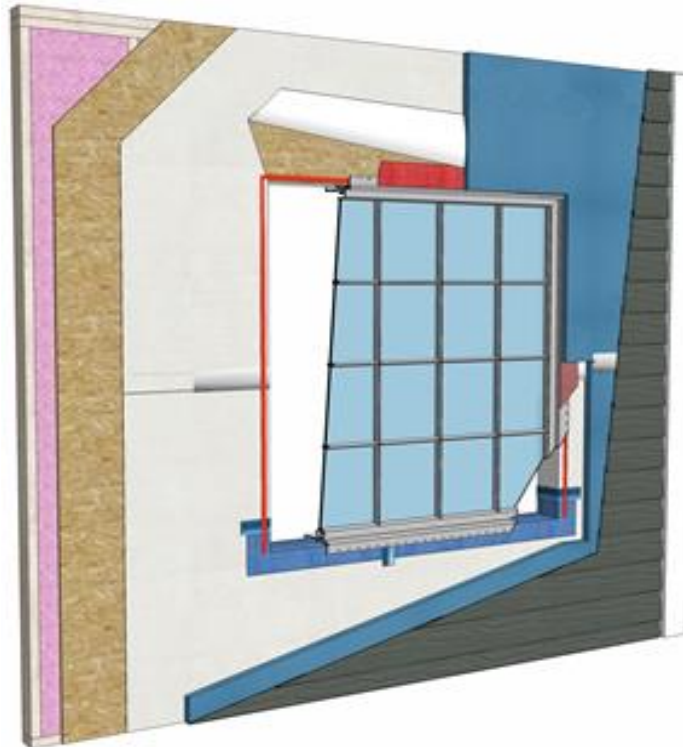
Option 1: Primary drainage plane outboard



2X4+1-1.5" EXT. INS. – WRB

Option 2: Primary drainage plane inboard

- *House wrap installed behind foam*



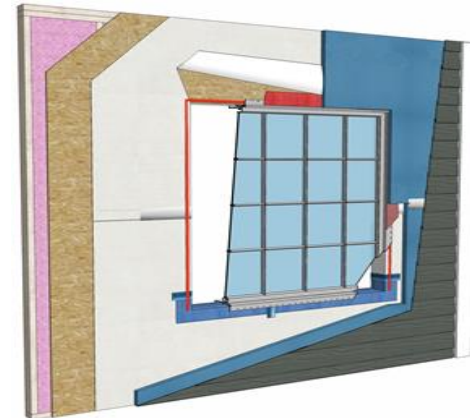
2X4+1-1.5" EXT. INS. – CLADDING

- ❑ Fastened to framing or to furring
- ❑ IRC Section 703
- ❑ Rigid foam sheathing – 15 psi compress. strength min
- ❑ Furring strips vertical or horizontal
- ❑ For horizontal furring strips:
 - *Preservative treated wood*
 - *Corrosion resistance fasteners*
 - *Best practice: drainable house wrap*

2X4+1-1.5" EXT. INS. – CLADDING

Cladding (or furring) attachment depends on:

- *Nail size*
- *Framing spacing*
- *Insulation thickness*
- *Cladding weight*



1-1/4" minimum nail penetration into the framing

- *Wood structural panel thickness can be included in the minimum penetration*

2X4+1-1.5" EXT. INS. – CLADDING

2015 IRC: 1-inch-thick rigid foam sheathing attachment to wood studs

Nail D	Max Stud Spacing	Max Vertical Nail Spacing	Max Cladding weight	Example Cladding
0.113"	16"	8"	11 psf	Fiber cement
		12"	3 psf	Vinyl
	24"	8"	3 psf	Vinyl
		12"	3 psf	Vinyl

2X4+1-1.5" EXT. INS. – CLADDING

2015 IRC: 1.5-inch-thick rigid foam sheathing attachment to wood studs

Nail D	Max Stud Spacing	Max Vertical Nail Spacing	Max Cladding weight	Example Cladding
0.113"	16"	8"	3 psf	Vinyl
		12"	3 psf	Vinyl
	24"	8"	3 psf	Vinyl
		12"	3 psf	Vinyl

2X4+1-1.5" EXT. INS. – CLADDING

2015 IRC: 1.5-inch-thick rigid foam sheathing attachment to wood studs

Nail D	Max Stud Spacing	Max Vertical Nail Spacing	Max Cladding weight	Example Cladding
0.131"	16"	8"	11 psf	Fiber Cement
		12"	3 psf	Vinyl
	24"	8"	3 psf	Vinyl
		12"	3 psf	Vinyl

2X4+1-1.5" EXT. INS. – CLADDING

2015 IRC: 1-inch-thick rigid foam sheathing attachment to wood studs

Nail D	Max Stud Spacing	Max Vertical Nail Spacing	Max Cladding weight	Example Cladding
0.162"	16"	8"	25 psf	Stucco
		12"	11 psf	Fiber Cement
	24"	8"	11 psf	Fiber Cement
		12"	11 psf	Fiber Cement

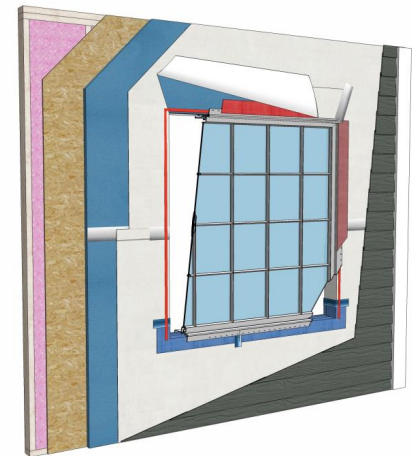
2X4+1-1.5" EXT. INS. – CLADDING



2X4+1-1.5" EXT. INS. – INTERIOR VAPOR RETARDER

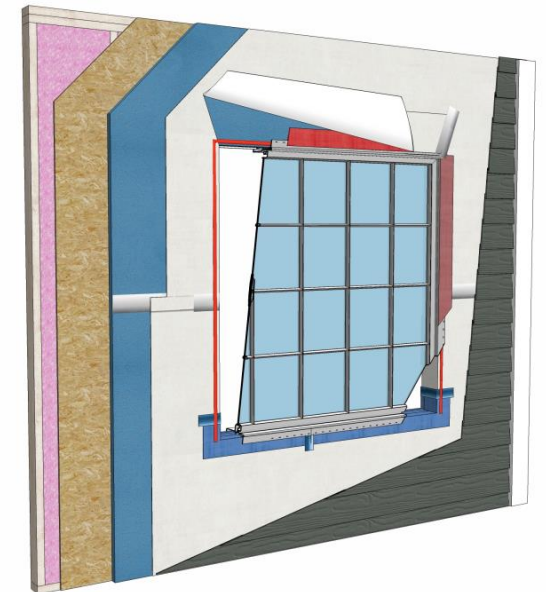
- Sheathing is warmer
- Wall cavity RH is lower
- Rigid foam sheathing – reduced drying rate to the outside

Exterior Insulation	Perm
EPS	~ 2.8
PolyISO	~ 0.03
XPS	~ 1.0
RockWool	~ 30



2X4+1-1.5" EXT. INS. – INTERIOR VAPOR RETARDER

- Class III vapor retarder permitted for CZ 3-5 for R13+5
- Class III – latex or enamel paint
- 2x6 walls in CZ 5: +7.5R
- 2x4 walls in CZ 6: +7.5R



2X4+1-1.5" EXT. INS. – INTERIOR VAPOR RETARDER

- **Class I** vapor retarder is discouraged with less permeable exterior foam sheathing (XPS, PIC)
- **Air sealing** is always encouraged as an added moisture control measure
- **Paint**, unless specifically rated as a VR, can be 40 perm or higher (Class III – 10 perm)
- Kraft facing or a **smart vapor retarder** can be considered CZ 4 and 5

DETAILS - DO NOTS



Summary

- ❑ 2x6 walls or 2x4 walls with 1.0-1.5" exterior insulation are “ready-to-go” options for CZ 3-5
- ❑ Understand all transition considerations:
 - *Framing*
 - *Drainage plane*
 - *Cladding attachment*
 - *Interior vapor retarder*
 - *Details*
 - *Other*

