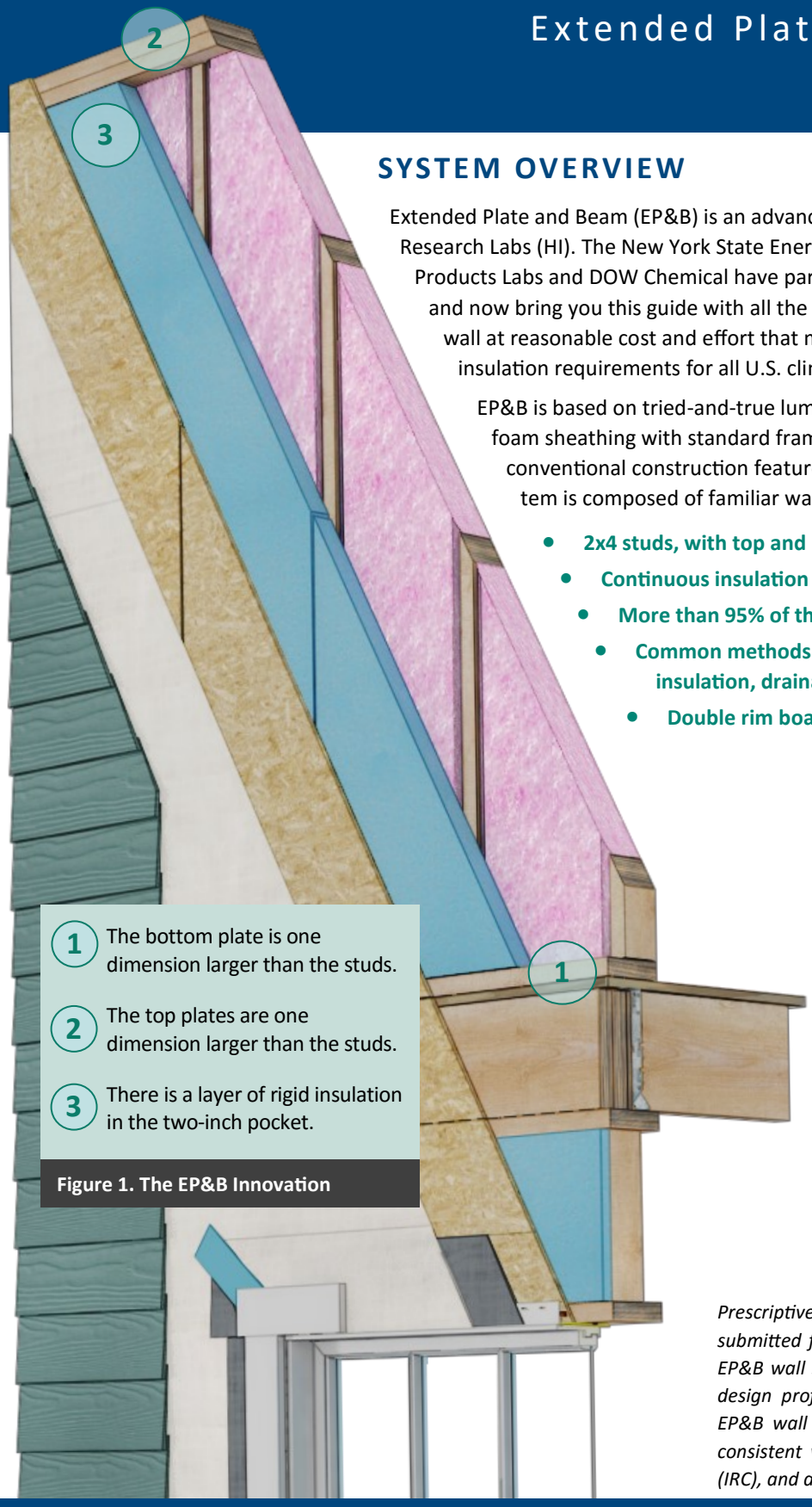
Home Innovation RESEARCH LABS™

A BUILDER'S GUIDE

Extended Plate & Beam Wall System

August 2016



1. The bottom plate is one dimension larger than the studs.
2. The top plates are one dimension larger than the studs.
3. There is a layer of rigid insulation in the two-inch pocket.

Figure 1. The EP&B Innovation

SYSTEM OVERVIEW

Extended Plate and Beam (EP&B) is an advanced wall system developed by Home Innovation Research Labs (HI). The New York State Energy Research & Development Authority, Forest Products Labs and DOW Chemical have partnered with HI to test and optimize the system, and now bring you this guide with all the information you need to build a high-performing wall at reasonable cost and effort that meets or exceeds Energy Code prescriptive insulation requirements for all U.S. climate zones.

EP&B is based on tried-and-true lumber construction methodologies, integrating rigid foam sheathing with standard framing practices into a system that preserves many conventional construction features and minimizes builder risk. The EP&B wall system is composed of familiar wall materials but in a different configuration:

- **2x4 studs, with top and bottom plate extensions of 2x6**
- **Continuous insulation exterior to the wall cavity, interior to the WSP**
- **More than 95% of the wall area free of thermal bridging**
- **Common methods and materials for framing, air sealing, insulation, drainage plane and siding attachment**
- **Double rim board (beam) that is also a header**

CONTENTS

Prescriptive requirements for the EP&B wall system will be submitted for inclusion into building codes soon. The use of the EP&B wall system in a specific project must be approved by the design professional for that project. The specifications for the EP&B wall system provided in this Guide are intended for use consistent with the scope of the International Residential Code (IRC), and are not approved for high-seismic or high-wind areas.

Wood Sheathing over the Foam Layer Allows for Standard Installation Approaches

The EP&B system locates the structural sheathing exterior to the foam sheathing (**Figure 2**). Windows, doors, the drainage plane, and the Water Resistant Barrier (WRB) are located as in standard frame wall systems with well-known installation methods. Always install the structural sheathing with vertical joints for proper rigidity. Foam sheathing joints should also be aligned with studs, but staggered with OSB joints as a first-line-of-defense air sealing measure.

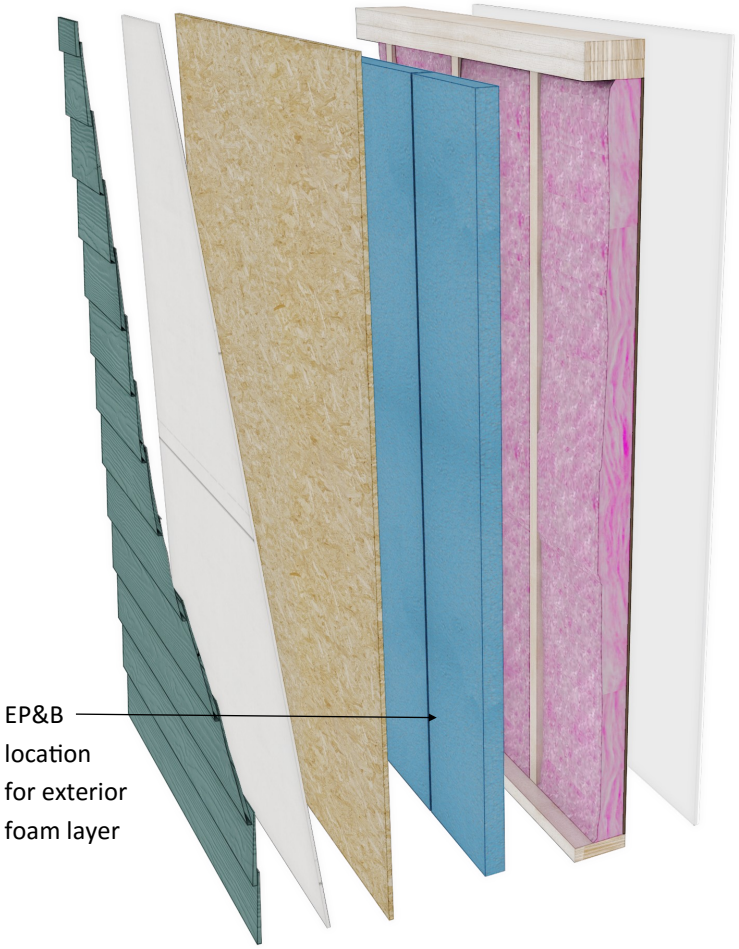
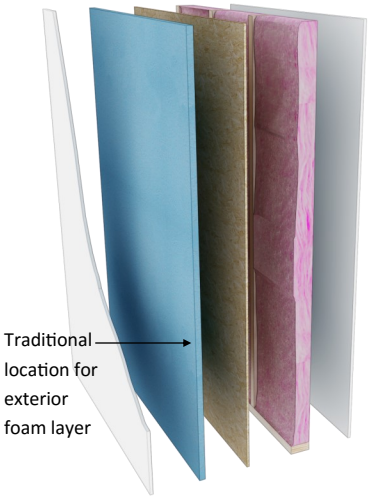


Figure 2. EP&B Material Layering *An EP&B wall has structural sheathing outboard of the rigid foam, where it provides a drainage plane surface for a separate WRB, a nailing surface for cladding, and rigid support for windows and doors, similar to SIP panels.*



Problem Solver

Typically, foam sheathing located to the exterior of the structural sheathing requires special attachment of windows, doors, and siding. Thickness in excess of 1 in. may require additional furring and support for windows and doors, as well. Depending on the type of cladding, the IRC may require continuous backing, which would necessitate a 1/2 in. foam fill layer between furring strips. This ordering also complicates decisions about the location of the drainage plane and WRB – complications that are avoided with the EP&B system.

Table 1. Light-Frame Wall Performance *Walls with a 2 in. layer of exterior c.i. provide improved performance.*

Light Frame Wall System[a]	Wall Width[b]	R-Value Calculated[c]	Wall Area % by Thermal Path			
			cavity	cavity/c.i.	Lumber/c.i.	Lumber (bridge)
2x4 Standard 16 in. o.c. R13	4 in.	11.9	75%	n/a	n/a	25%
2x6 Standard 16 in. o.c. R20	6 in.	16.8	75%	n/a	n/a	25%
2x6 Advanced 24 in. o.c. R20	6 in.	18.7	85%	n/a	n/a	15%
2x4 Std 16 in o.c. R13 + R10[d]	6 in.	21.8	0%	75%	25%	0%
2x4 EP&B R13 + R10 c.i.	6 in.	**21.7**	**0%**	**75%**	**20.6%**	**4.4%**

[a] Vinyl siding, house wrap, #2 SPF lumber, 1/2 in. OSB, 1/2 in. gypsum drywall
[b] Wall framing, sheathing, and furring
[c] R-value in hr·°F·ft^2/Btu; Includes all layers, interior/exterior finishes and film factors
[d] One layer of 1.5 in. rigid foam, with 1/2 in. foam layer alternating with 1/2 in. furring strips

Table 2. Calculated Thermal Resistance *Nominal and whole-wall assembly R-values of IECC prescriptive walls compared to EP&B.*

Climate Zone	2012/2015 IECC Prescriptive R-Value[a] for Above-Grade Walls (Calculated Assembly Value[b])	Nominal R-Value (Calculated Assembly Value[e])		
		EP&B 2x4/2x6 Standard Framing 16 in. o.c.	EP&B 2x6/2x8 Advanced Framing 24 in. o.c.	EP&B 2x6/2x7.5*[d] Advanced Framing 24 in. o.c.
1 & 2	13 (11.9)	13+10[c] (21.7) or 15+10[c] (22.8)	19+8.75[c] (26.6) or 21+8.75[c] (27.9)	19+10[c] (27.8) or 21+10[c] (29.1)
3, 4, 5	20 (16.8) or 13+5[c] (17.5)			
6, 7, 8	20+5 (20.8) or 13+10[c] (22.7)			

[a] R-value in hr·°F·ft^2 /Btu

[b] Configuration used to calculate assembly R-values for prescriptive above-grade walls include 25% framing factor (FF) for 16 in. o.c. standard 2x4 or 2x6 framing, and typical wall materials of gypsum drywall, SPF lumber, fiberglass batt insulation, XPS foam sheathing, OSB structural sheathing, WRB and vinyl siding

[c] First value is cavity insulation, second value is continuous insulation, so "13+5" means R-13 cavity insulation plus R-5 continuous insulation

[d] Plates designated 2x7.5* indicate the actual 7-1/2-in. plate width, to allow 2 full inches of rigid foam c.i.

[e] The calculated assembly value assumes typical wall materials of gypsum drywall, SPF lumber, fiberglass batt insulation, XPS foam sheathing, OSB structural sheathing, WRB and vinyl siding. 16 in. o.c. EP&B calculated assembly values assume 75%/20.6%/4.4% (cavity/framing/cantilevered plates); 24 in. o.c. EP&B calculated assembly values assume 85%/10.6%/4.4% for advanced framing

Meets or Exceeds Energy Code Requirements in All Climate Zones

The basic EP&B wall system using 2x4 studs and 2x6 plates ***meets or exceeds the most stringent IECC prescriptive insulation requirements for above-grade walls in all U.S. Climate Zones*** (Table 2 and Figure 3).

From a calculated whole-wall thermal performance standpoint, EP&B offers an 82% improvement in CZ 1 and 2, a 25% improvement in CZ 3, 4, and 5, and nearly the same whole-wall performance as the prescriptive wall in Climate Zones 6 through 8, with less cost and complexity.

The cantilever of the plates constitutes only a 4.4% thermal bridge. This reduces performance by about R-1 compared to 100% exterior continuous insulation, but with practical benefits that many builders find compelling.

For next-level performance, the EP&B configuration can be adapted to 2x6 stud framing, using a true 7.5 in. plate by ripping 2x10's to allow for the 2 inch layer of c.i. This configuration achieves nearly a 30% assembly R-value increase over the calculated performance of IECC prescriptive minimum walls in the coldest climates.

EP&B walls can contribute to whole-building thermal performance to help qualify for voluntary energy certification programs such as NGBS, LEED, and ENERGY STAR for Homes.

Moisture and Structural Testing

Home Innovation has confirmed EP&B's moisture performance with computer simulations, and by monitoring walls in controlled test buildings and demonstration homes. In Climate Zone 4, OSB moisture content (MC) never exceeded 14%, and studs in wall cavities measured steady states of less than 10% MC.

Laboratory testing using ASTM standard protocols confirms that the EP&B wall's vertical loading and shear performance equal or exceed IRC requirements.

EP&B is a straightforward, cost-effective, and long-term solution for all residential wall assembly performance requirements.

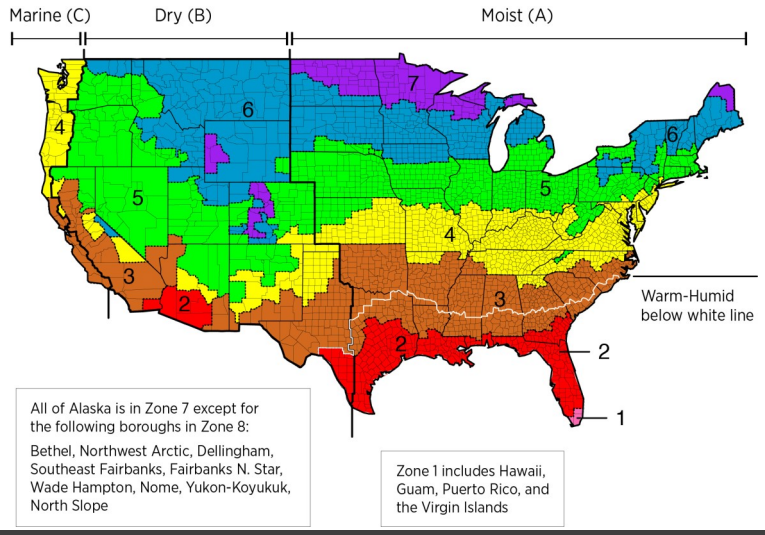


Figure 3. Climate Zone Map (Source: DOE)

Figure 4. Factory Panelization *Bundling and strapping panels.*

Competitive Cost

The EP&B system offers high value and reduced risk in transitioning to high-performing walls. The cost of the EP&B system compares favorably with other high-R wall systems and the transition is relatively straight-forward for contractors (Figure 6). The EP&B wall costs $0.55/SF LESS than an IECC prescriptive 2x4 wall with 2 in. of continuous insulation (second from top) with arguably less complexity. For a typical 1800 SF single-story home, that difference translates to over $800.

Flexibility

The EP&B method launches directly from the starting point most comfortable for residential builders today – 2x4 light framing. The technique is innovative, but the system is non-proprietary: builders can choose from a broad variety of sheathing, rigid foam, WRB and cavity insulation options, and the system is readily adaptable to field modifications.

Maintenance and Comfort

The EP&B wall's nearly continuous 2 in. layer of foam ensures a warm cavity and reduces the potential for condensation and resultant mold growth. Dryer wall assemblies also contribute to greater durability and longevity of materials, which reduces maintenance cost and effort. Additionally, higher R-value means a warmer interior surface in the occupied space, which improves occupant comfort.

Figure 5. Factory Panelization *Loading and shipping panelized wall sections from the factory.*

Can Be Panelized and Shipped

Often builders choose to have wall components factory-fabricated to streamline the construction process. Many high-performing walls do not lend themselves to factory panelization, either due to their complexity or to the risk of damage in shipping. The EP&B system design requires modest changes to the panelization process, but once employed, panels can be easily constructed and shipped from the factory to the worksite. The structural sheathing effectively protects the foam sheathing from damage during transport.

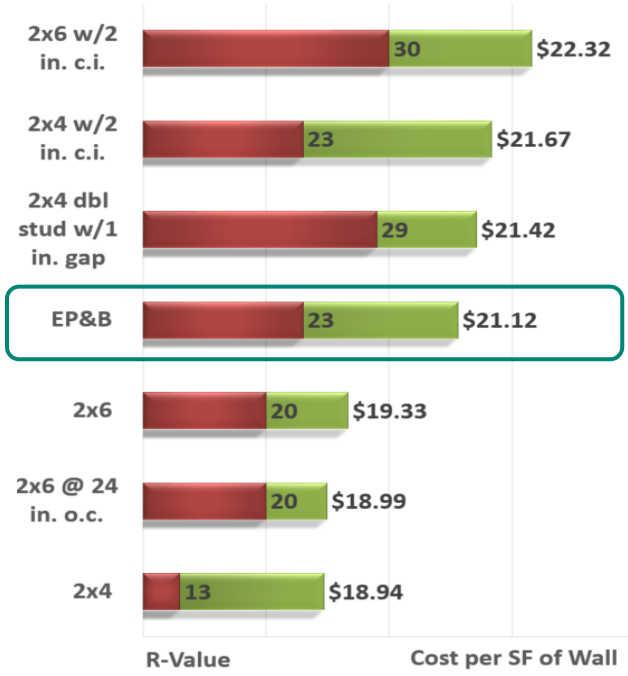


Figure 6. Cost Comparison *Relative cost and nominal R-value of various wall systems (16 in. o.c. framing unless otherwise noted.)*

Note: The comparison cost estimates for 2x4 and 2x6 walls with 2 in. of continuous insulation exterior foam include taped foam panel joints to perform as the WRB. The EP&B wall cost estimate includes a separate WRB.

EP&B COMPARED TO TYPICAL LIGHT-FRAME CONSTRUCTION

Table 3. EP&B Changes to Standard Light Frame Wall Construction

Design	Standard 2x4 Frame Wall	Extended Plate and Beam
Wall plates	Bottom and top plates all 2x4	Bottom and top plates all 2x6
Wall studs	2x4	2x4
Structural Wood Sheathing	Exterior to the studs. Horizontal breaks in the wall plane require blocking.	Exterior to the plates and foam sheathing. Continuous sheathing method required—no horizontal breaks are allowed in the wall plane between the top and bottom plates.
Insulating sheathing	Optional, exterior to (or in place of) the structural sheathing	Standard, exterior to the 2x4 studs, interior to the structural wood sheathing. Install vertically, staggering foam board joints with OSB joints
Drainage plane	WRB over the wood structural sheathing. If foam plastic insulating sheathing (FPIS) is used, either exterior or interior to the FPIS.	WRB over the wood structural sheathing
Sheathing Attachment	Standard, 2.5 in. nails Panel Edge: 6 in. spacing Studs: 12 in. spacing	Modified, 3.5 in. nails Panel Edge: 3 in. spacing Studs: 6 in. spacing
Rim Board, foundation	Standard rim	Standard; can also be inset 1 in. for c.i. or 2 in. if WSP is installed continuously from top plate to sill plate, lapping the rim, and fastened to the sill plate per the schedule.
Rim board between floors	Standard rim	Standard; can also use a double rim to act as a beam header, eliminating separate headers and allowing for additional insulation. Use joist hangers above openings with this option. Single rims require traditional window and door headers per the IRC.

Figure 7. Interior View of EP&B System

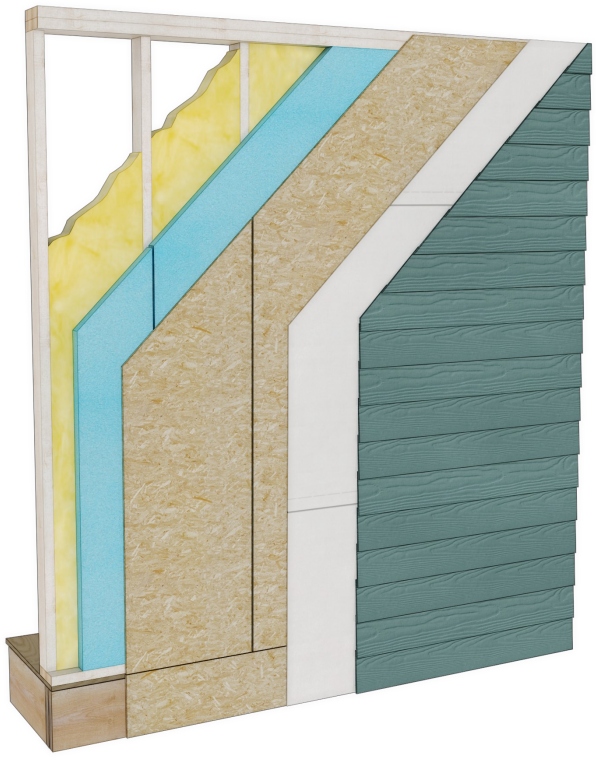


Figure 8. Exterior View of EP&B System

The Advantages of Continuous Exterior Insulation (c.i.)

For decades, high-performance builders have used rigid insulation installed to the exterior of the wall sheathing (and sometimes replacing the sheathing) to increase thermal performance. This method reduces the effects of thermal bypass (or short circuits) caused by the framing – essentially covering nearly 100% of the framing geometry with a continuous layer of insulation.

In addition to improving thermal performance, the rigid foam c.i. can potentially reduce air infiltration and improve moisture performance. But rigid foam as the exterior layer of a wall also impacts installation details, including window load transfer and flashing, and drainage plane and vapor barrier considerations.

Although there is a long history of exterior insulation use, material selection and design alternatives can still be challenging for many builders. The EP&B system provides a straightforward approach to incorporating continuous insulation, especially compared with wall systems that require additional furring for siding installation.

Table 4. Temperature Profile *Calculated temperatures in the wall when outdoors is 15°F.*

Interface/Wall Assembly	EP&B, R13/10	2x4, R13	2x6, R20
Indoor Temperature	68.0	68.0	68.0
Gypsum/cavity interface	65.7	64.2	65.2
Cavity/rigid foam interface	**38.7**	**(20)**	**(18.6)**
OSB Interior plane	18.0	20.0	18.6
OSB Exterior plane	16.6	17.7	16.9
Outdoor Temperature	15.0	15.0	15.0

The EP&B wall system achieves more than 95% continuous insulation without adding complexity or risk, to yield the following advantages :

- **Has a clearly identified location for the drainage plane and uses standard WRB installation**
- **Allows windows and doors to be installed as in typical framing**
- **Keeps the cavity warmer due to the foam's relative thickness and its location in the assembly**
- **Slows moisture movement to the OSB or other structural sheathing**
- **Promotes cavity drying to the interior and wood sheathing drying to the exterior**

EP&B Moisture Performance

Table 4 lists the calculated temperatures at important locations within the wall for various assemblies. The EP&B wall system uses foam sheathing to keep the wall cavity warmer, reducing the potential for condensation. Note that for typically-framed walls, the OSB interior plane is coincident with the cavity's exterior plane. In the winter, the vapor drive is outward, due to warmer, moister air inside. An interior vapor retarder is especially important in this case, since moisture that reaches this location is very likely to condense.

Test data of light-framed north-facing walls with OSB sheathing and vinyl siding in Climate Zone 4 shows stable moisture content for the EP&B wall system (Figure 9, blue lines). Compare the EP&B performance to the acceptable but cyclic performance of a standard wall without a continuous insulation layer (Figure 9, green lines).

Note that reduced framing, continuous insulation, and low air infiltration are characteristics common to many high-performance wall systems. To control airborne moisture migration, always use air sealing best practices. Rigid foam joints should be butted firmly to each other, and to the framing members they touch, to ensure uniform coverage with no gaps. These foam joints should also be taped from the outside, or sprayed with insulating foam on the inside of the cavity (air seal). See pages 12 and 13 of this guide for recommendations for weather resistive barriers (WRBs) and interior vapor retarders.

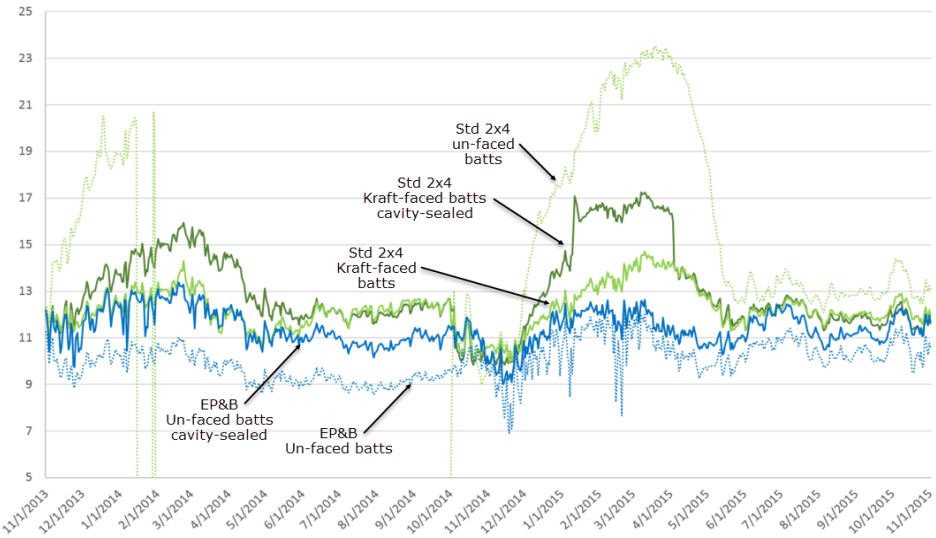


Figure 9. Moisture Content *MC% of the wood structural sheathing (OSB) in the EP&B system (CZ 4); controlled laboratory tests conducted by Home Innovation Research Labs.*

Note: Despite the gap in data for the 2x4 wall with un-faced batts from 2/1/2014 to 10/1/2014, the data collected on the remaining dates corroborates the trend.

EP&B Wall Layers

An EP&B wall assembly is composed of common wall framing materials:

1. **Exterior siding (or other cladding)**
2. **Water Resistant Barrier**
3. **Wood structural sheathing**
4. **Rigid foam insulation**
5. **Framing and cavity insulation (with interior vapor retarder, if required)**
6. **Interior gypsum drywall**

The rigid foam insulation is laid to fit between the extended 2x6 bottom and top plates. The remainder of the wall framing is standard 2x4 construction.

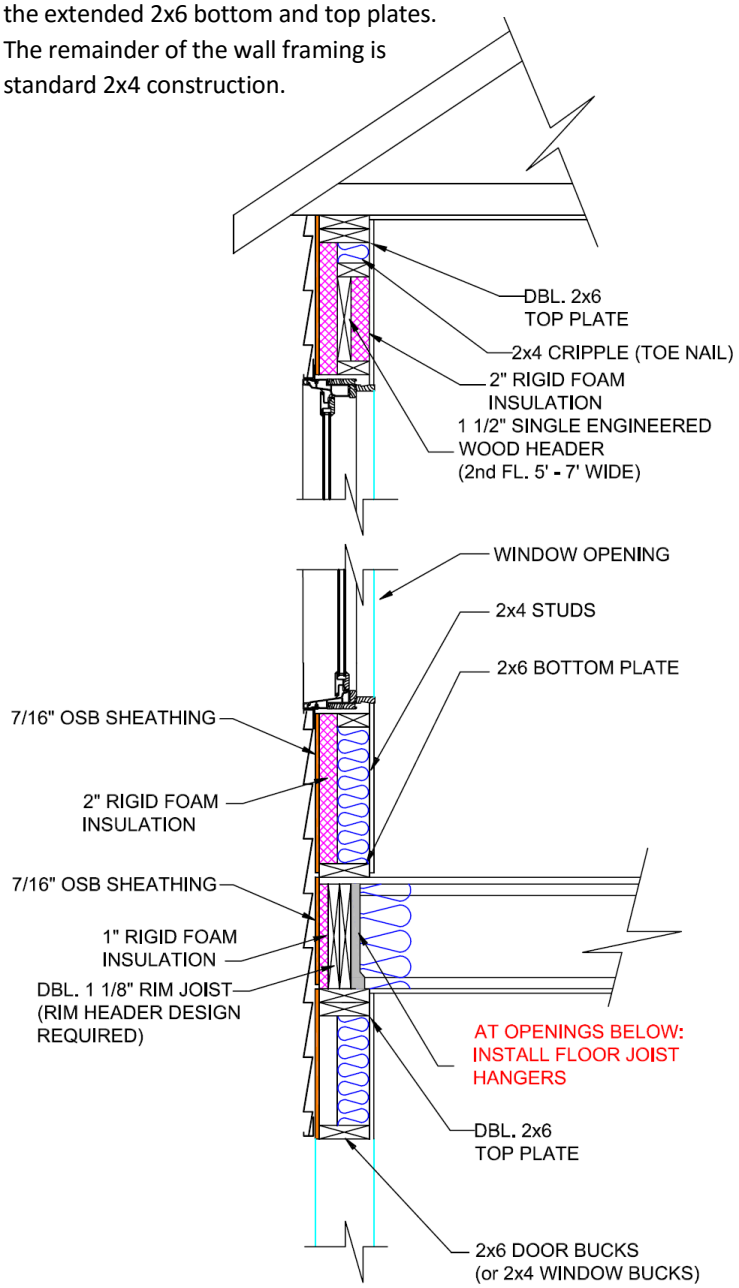


Figure 10. EP&B Wall Detail *First floor bottom plate detail not shown.*

Figure 11. EP&B Component View *Rim beam not shown.*

The EP&B wall system detail is summarized in Figure 10 for a 2-story house design (the WRB layer is not shown). EP&B unique characteristics include:

- Extended plates provide a 2-in. pocket for rigid foam insulation placement
- Windows are framed with 2x4 framing
- Doors are framed with either 2x4's (typical) or 2x6's (sliders or heavy-duty)
- Structural wood sheathing is attached directly to the extended plates, for shear resistance
- Double rim provides load transfer between floors
- Double rim can act as a header for the openings below (joist hangers required)
- Double rim can be inset 1 in. to accommodate rigid foam sheathing
- A single header is used for many openings in the second floor to maximize insulation

Lab tests confirm good structural performance with the double rim located at the exterior plane.

Insetting a double or single rim by 1 in. also meets IRC performance targets in lab tests, and improves thermal performance by making room for a continuous insulation layer of exterior rigid foam. A final option allows a 2 in. inset if the WSP spans the entire wall/rim assembly, and the scheduled fasteners connect to the sill plate.

Note that a single rim board is not sufficiently strong to perform the duty of a header. In these cases, utilize typical headers of solid or manufactured lumber. See Figure 15 on page 9 for illustrations of the rim joist options.

Figure 12. EP&B Wall *Factory Fabrication*

Figure 13. EP&B Wall *Field-Framing. Note Top Plate End Gap to Tie into the Neighboring Panel.*

Table 5. EP&B Connection Schedule *Note: Staples are NOT an acceptable substitution for nails in the EP&B wall system.*

Connection	Fasteners	Schedule
Perimeter of Sheathing	3.5 in. x 0.131 in.	3 in. o.c.
Field of Sheathing	3.5 in. x 0.131 in.	6 in. o.c.
Top Plate to Top Plate (face-nail)	10d or 3 in. x 0.131 in.	12 in. o.c.
Top/Bottom Plate to Stud (end-nail)	(3) 10d or 3 in. x 0.131 in.	
Stud-to-Stud with Spacer (face-nail)	3-16d (D = 0.131 in., L = 3.25 in.)	3 nails per spacer (9 total)
Corner studs in contact with each other	16d or 3 in. x 0.131 in. nails	12 in. o.c.
Corners: WSP from both intersecting walls nailed directly to a common 2x framing member	2.5 in. x 0.131 in. nails	6 in. o.c.
Corner studs separated by up to 2 in. of rigid foam sheathing insulation, 2 options	5 in. x 0.135 in. nails	6 in. o.c.
	6 in. x 0.190 in. SIP screws	12 in. o.c.

Build Your First Extended Plate and Beam Wall:

1. Lay out your walls on the deck as usual, with 2x4 studs and 2x6 bottom and 1st top plates. End-nail each stud to the bottom and top plates with two nails per connection. You can use a spacer to ensure a 2 in. gap for the foam.
2. Add the 2nd top plate, leaving an end extension (or gap) to tie into an adjacent wall section where needed, or use steel ties per IRC Section R602.3.2.
3. Lay foam sheathing in the pocket atop the stud layer, snug to the bottom plate. Cut excess foam sheathing along the inside face of the top plate with a skilsaw or sawzall. Tap foam into place. If desired, tape joints, and/or caulk or spray foam along both sides of the stud at foam panel joints.
4. Rip OSB so that wood sheathing joints alternate with foam joints. Place a bead of caulk along face of the top and bottom plates to airseal. Lay in OSB and nail per Table 5.

Tip up your EP&B wall and fasten it in place.

Figure 14. Nails *EP&B Walls require modified nailing patterns.*

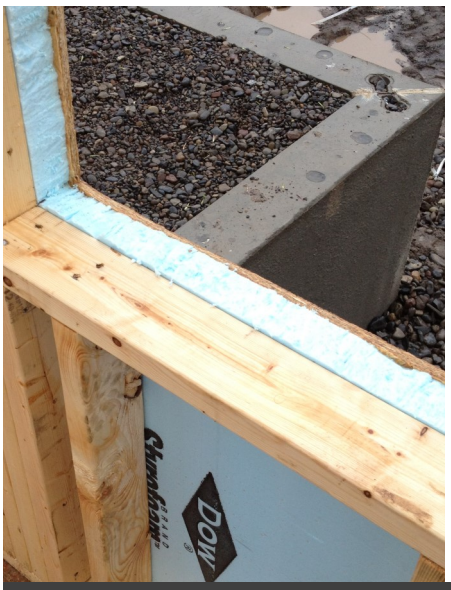


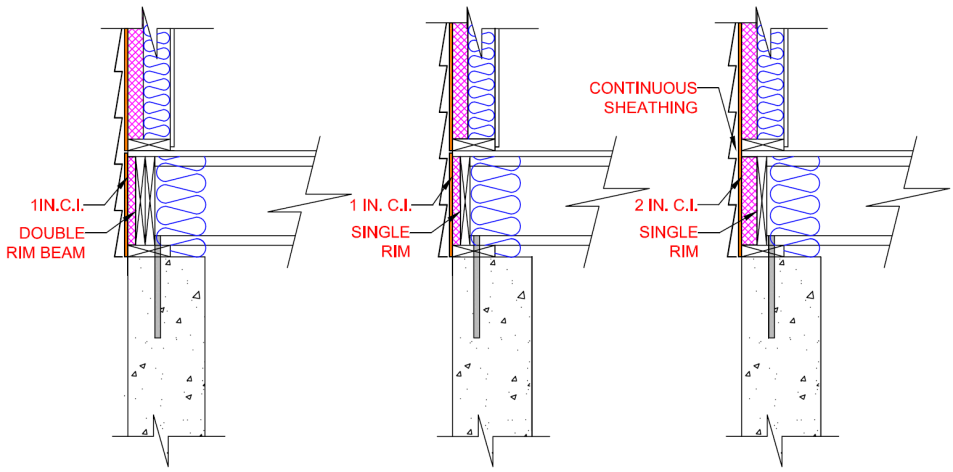
Figure 15. Openings *Frame window openings with 2x4 lumber to maximize continuous insulation. Door openings for sliders can use full-depth framing for stability.*

Framing Windows and Doors

Window openings are framed with 2 x 4's similar to standard framing or SIPs construction. Trim the foam sheathing flush to the WSP opening (Figure 15, left.) The OSB provides ample support, but some framers prefer to add a 1x6 sill on top of the 2x4 framing of the window opening. Most exterior doors can use 2x4 framing. Sliding doors can benefit from the stability of 2x6 framing instead of 2x4.

Rim Joist Considerations

Several configurations of Rim Joist can work with the EP&B wall. Doubled joists act as a Rim Beam and can replace traditional headers, reducing framing short circuits. Joist hangers above window and door openings are required if the Rim Beam replaces headers. Single rim joists are adequate for non-load-bearing walls with no openings.



NOTE: Insetting the rim by 2 in. is allowed only if the full-length of the WSP spans the entire rim height and is fastened to sill plate per the EP&B nailing schedule.

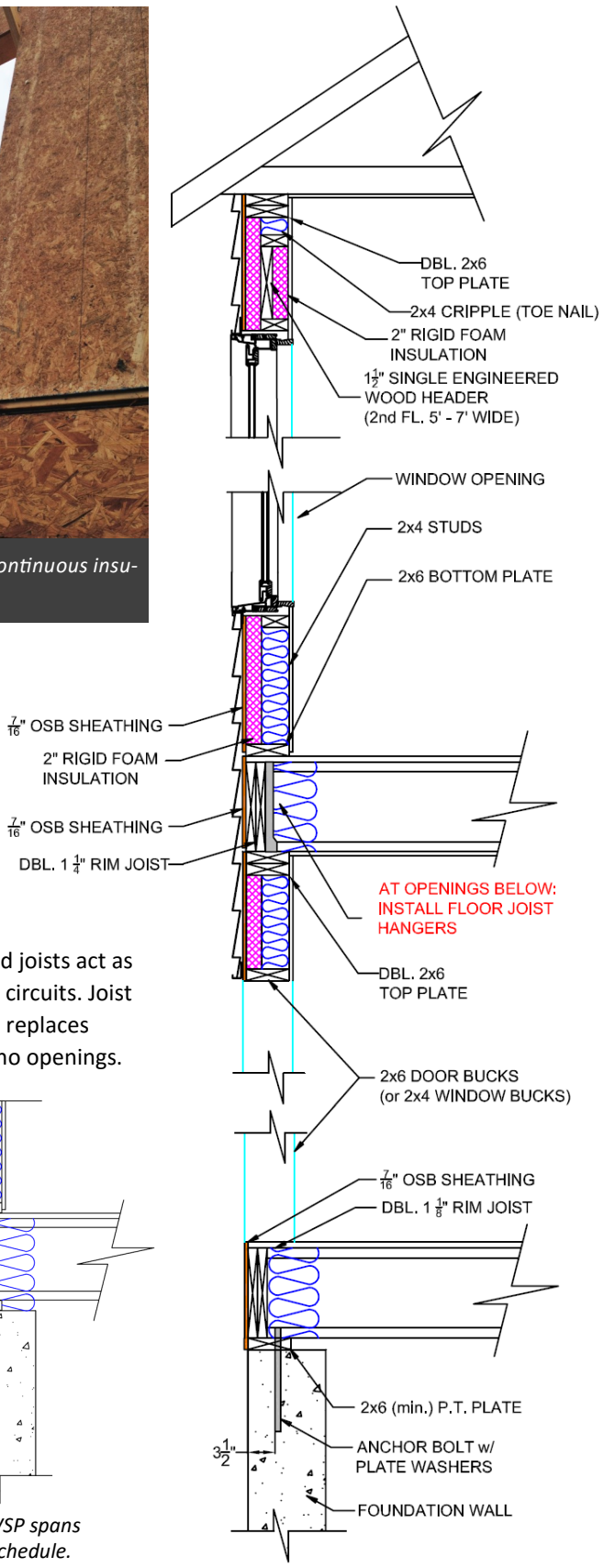


Figure 16. Rim Band Options *Rim joists may be flush to the exterior of the wall or inset to accommodate rigid foam continuous insulation.*

EP&B Sill Plates and Rim Headers

The EP&B wall design can use a double rim to support the extended plate configuration. In many cases, the double rim can act as the header for openings below and provide ample bearing for the floor joists. The floor joists above the opening will require joist hangers.

Use of double rim headers can streamline the wall installation and allow the continuous insulation to span more wall area. It can also be very cost-effective. See **Figures 10, 15, 17, and 18** for illustration.

Figure 17. Double Rim Beam *A rim beam configuration replaces window headers, leaving more room for insulation. Note joist hangers above opening and caulk to seal between plates.*

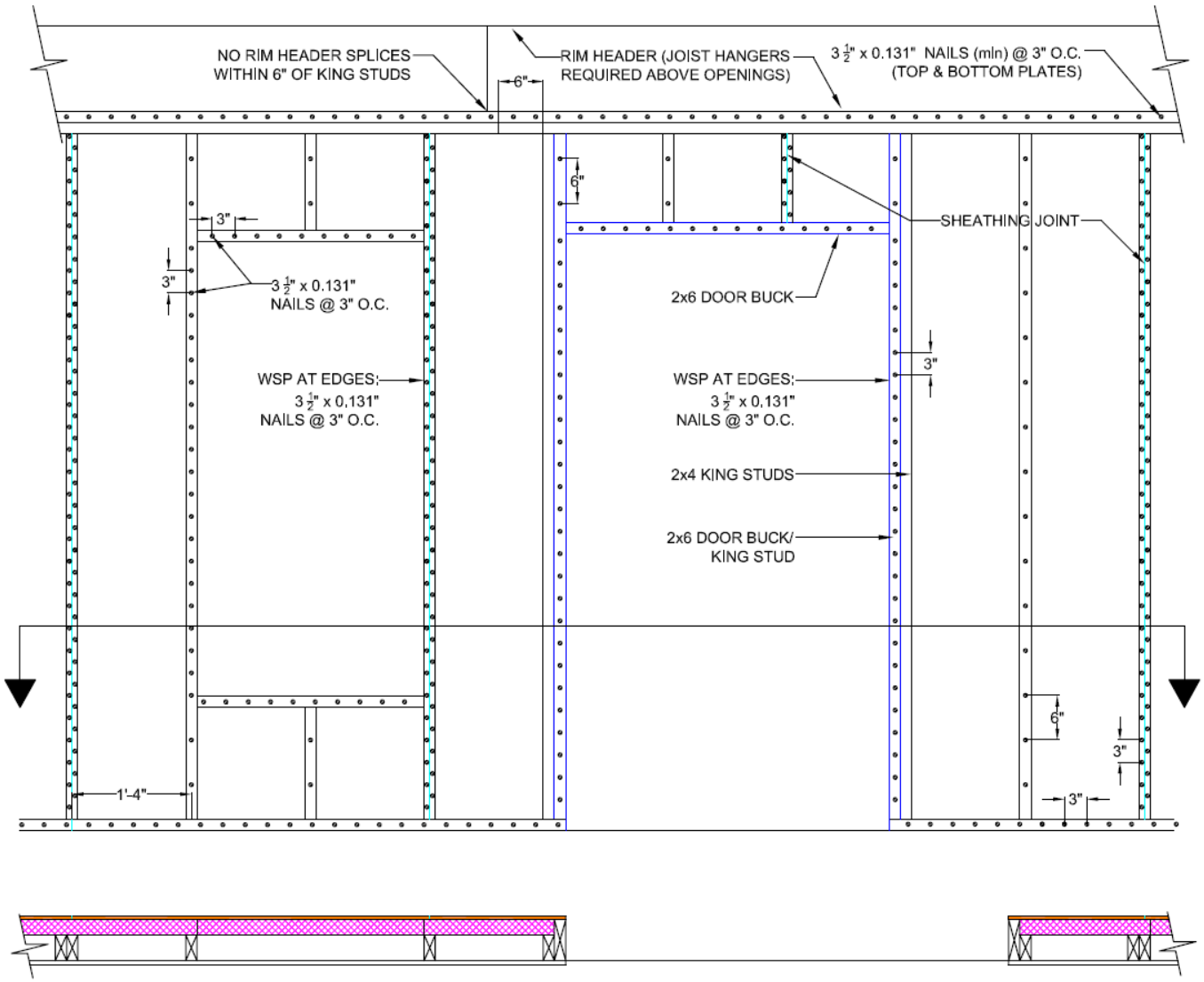
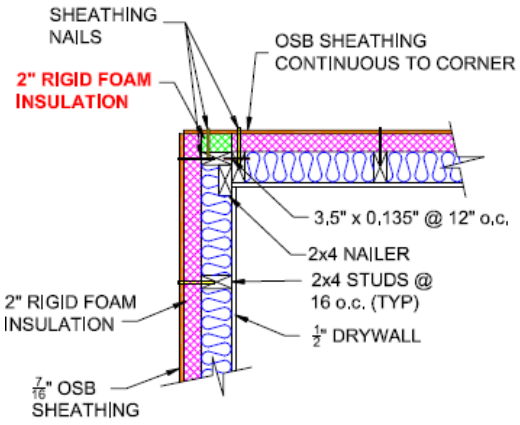


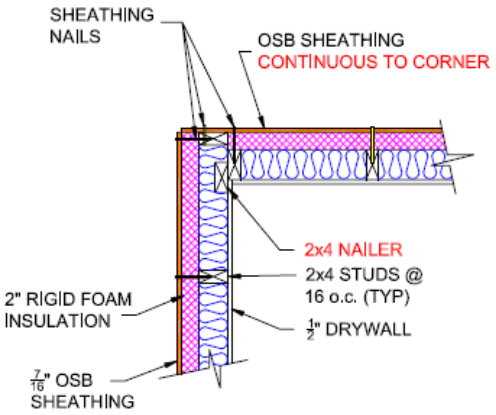
Figure 18. EP&B Wall Elevation *Joists attached to the double rim beam above wall openings require joist hangers. Use 3" nail spacing for all edges of wood sheathing panels, including at openings. No rim header splices are allowed within 6 in. of king studs.*

Field-Made or Pre-Built Corners

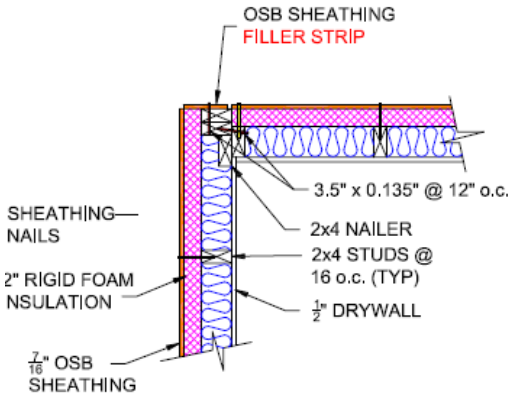
Top plates at corners may be connected using standard framing methods. Numerous manufacturers offer insulated structural components, including insulated corners for frame walls and insulated rim boards, consisting of wood structural members laminated to rigid foam. Use of these preassembled components may reduce installation time and thermal bridging.



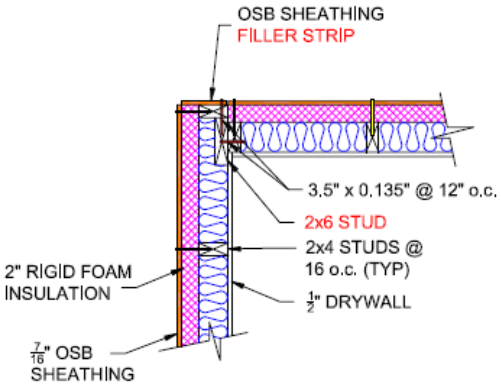
OPTION 1: CONTINUOUS EXTERIOR FOAM



OPTION 3: 2x4 STUDS AND CONTINUOUS OSB



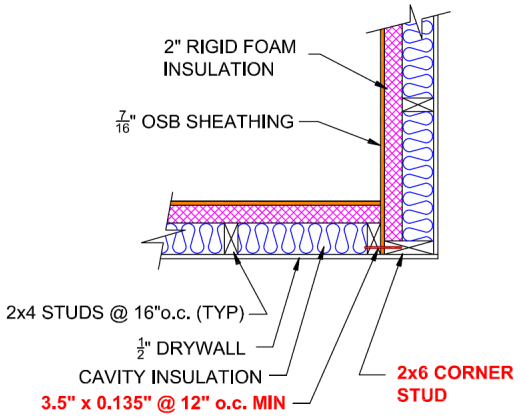
OPTION 2: 2x4 STUDS & OSB FILLER



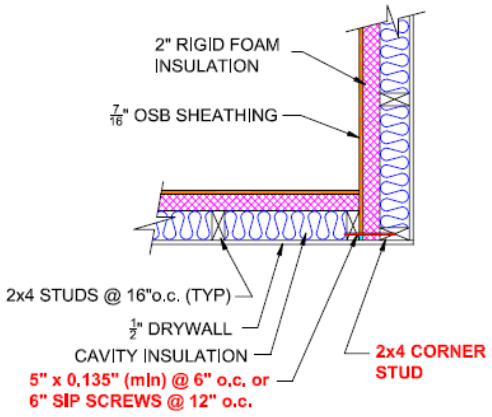
OPTION 4: 2x6 STUD AND OSB FILLER

NOTE: Gypsum nailers can be substituted with approved corner clips.

Figure 19. Outside Corners



OPTION 1: 2x6 END STUD



OPTION 2: 2x4 END STUD

Figure 20. Inside Corners

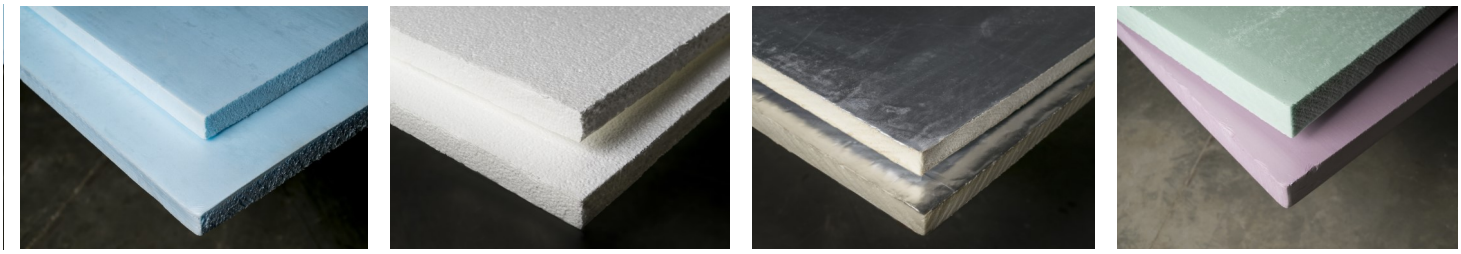


Figure 21. Rigid Insulation Board *Several types of continuous insulation are suitable for use in EP&B Walls. From left: XPS, EPS, PIC, XPS*

Choose the Insulation that Meets Your Needs

Insulation choices for an EP&B wall are similar to the options for standard framed walls. Mix and match cavity fill and rigid continuous insulation to achieve the IECC prescriptive minimums (or greater) for your climate zone (see **Table 1**).

Also consider the moisture characteristics of these choices; see the following section on Interior Vapor Retarders.

Rigid foam board is recommended for the area of the extended plates due to its compressive strength and lower level of moisture permeance compared to non-rigid foam boards.

Due to its high perm rating, EPS is recommended ONLY if it has a film facing. For any rigid, insulating sheathing, if only a single side is faced, the film must be installed facing the cavity, not towards the sheathing. Because mineral wool board is not faced and not sufficiently rigid, it is not suitable for the continuous insulation layer of an EP&B wall. The following rigid foam sheathing products are recommended for use in an EP&B wall system:

- XPS (Extruded Polystyrene—blue, pink, yellow, or green)
- EPS (Expanded Polystyrene—typically white with a characteristic beaded appearance; use faced only)
- PIC/Polyiso (Polyisocyanurate—yellow or tan with a foil facing)

Table 7. Typical Insulation Thermal Performance Values[a, b, c]

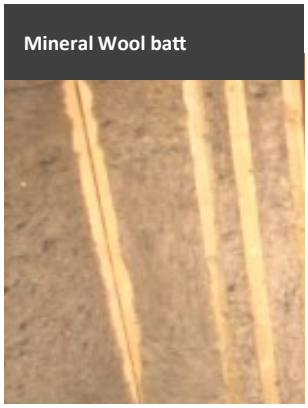
Rigid Insulation: Nominal R-Value per 2 in. layer	
EPS – Expanded Polystyrene	8
XPS – Extruded Polystyrene	10
XPS, blown with low GWP blowing agent[d]	8
PIC – Polyisocyanurate	12-13
Cavity Insulation: Nominal R-Value per 3.5 in. layer	
Fiberglass Batt (3-1/2, 3-5/8, hi-density)	11, 13, 15
Cellulose (dense-pack wall or blown)	12.5
Blown Fiberglass (loose, dense)	12.5, 14
Mineral Wool Batt (standard, hi-density)	12.5, 14

a. Values shown are typical; check manufacturer's specifications for actual performance

b. Thermal Resistance is measured in the unit R = (hour x ft x °F)/Btu

c. Refer to **Table 1** and **Figure 2** to ensure your chosen combination meets IECC prescriptive insulation requirements for frame walls

d. The Global Warming Potential (GWP) of CO_2 = 1. Some low-GWP blowing agents with GWP <5 have been tested to produce R per inch performance that is 20% or more below XPS produced by standard methods. Check manufacturer's specifications.



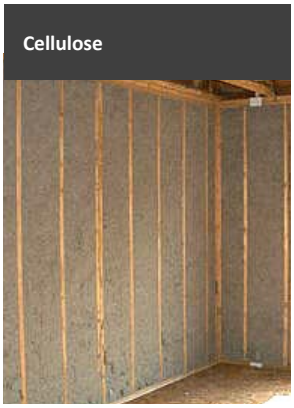
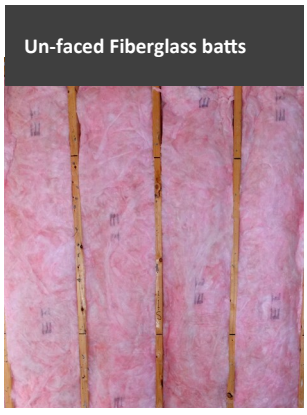


Figure 22 (a-c). *Typical cavity fill insulation products suitable for use in Extended Plate and Beam walls*



INTERIOR VAPOR RETARDERS

According to IRC Section R702.7 and Table R702.7.1, Climate Zones 1-4 do not require vapor retarders. Climate Zones 5-8 and Marine 4 require a Class I or II vapor retarder on above-grade walls unless certain conditions regarding vented cladding or continuous insulation are met.

Because an EP&B wall includes a 2-in. layer of continuous insulation, in most cases a Class III vapor retarder may be used. See **Table 8** for direction. If the configuration you've chosen does not qualify for Class III interior vapor retarder, then Home Innovation recommends a Class II vapor retarder, such as Kraft facing on batt insulation. Proprietary "Smart" vapor retarder products have perm ratings that rise with increasing relative humidity from 1 perm or less at normal conditions (Class II) up to 35+ perms (vapor permeable) in high humidity, and represent a "belt and suspenders" approach.

Home Innovation discourages the use of polyethylene sheeting as an interior vapor retarder as it may create a double-vapor barrier condition, trapping incidental moisture and limiting drying.

Table 8. Vapor Retarders *Adapted from IRC Table R702.7.1 Class III Vapor Retarders*

	Climate Zone	Class III Vapor Retarders Permitted For...
Refer to Table 7 in this guide for typical continuous insulation R-values; Kraft-faced batts qualify as a Class II vapor retarder	CZ 1, 2, 3, 4	No vapor retarder is required; in CZ 4 KFB or a "smart" vapor retarder is recommended for EP&B walls for interior conditions with high humidity during winter
	CZ Marine 4	Continuous Insulation with R-value ≥ 2.5 over 2x4 wall Continuous Insulation with R-value ≥ 3.75 over 2x6 wall
	CZ 5	Continuous Insulation with R-value ≥ 5 over 2x4 wall Continuous Insulation with R-value ≥ 7.5 over 2x6 wall
	CZ 6	Continuous Insulation with R-value ≥ 7.5 over 2x4 wall Continuous Insulation with R-value ≥ 11.25 over 2x6 wall
	CZ 7 and CZ 8	Continuous Insulation with R-value ≥ 10 over 2x4 wall Continuous Insulation with R-value ≥ 15 over 2x6 wall

WATER RESISTANT BARRIERS AND PAN-ADHERED FLASHING

For long-term durability, any wall system must be detailed to avoid bulk water intrusion. When properly installed over the wood structural sheathing, a Water Resistant Barrier (WRB) provides protection against rain water entering the wall cavity from the outside, but still allows drying of incidental moisture. Look for a housewrap that resists tearing and always layer in step fashion.

Due to the low-permeability of the foam sheathing directly behind the OSB, drying of the wood sheathing must be outwards. A high-perm WRB is recommended (≥40 perms) and one with texturing or vertical channels to provide a physical drainage plane behind the cladding is also worth considering.

Installation of the WRB at windows is the same as over wood sheathing in typically-framed homes – use standard best practices for all openings and penetrations, including pan flashing installed in a shingled fashion.

Figure 23. WRB and Window Flashing for EP&B *Install adhesive flashing by shingling from bottom to top. Replace WRB flap and seal at top.*

CLADDING INSTALLATION FOR EP&B WALL SYSTEMS

Cladding application using the EP&B wall system is similar to installing siding over Structural Insulated Panels (SIPs). The IRC has included a table specifying attachment of siding weighing 3 psf or less (most fiber cement siding qualifies) to wood structural sheathing (see below).

Alternately, siding or other types of exterior finishes may use nails or screws of sufficient length to attach through both the wood structural sheathing and 2-in. foam layer to the studs with penetration to the depth required by IRC Section R703.3.3, at the prescribed frequency.

Table 9. Fastening Exterior Finishes *the IRC provides an alternate schedule for fastening directly to structural sheathing.*

Exterior wall covering (weighing 3 psf or less) attachment to wood structural panel sheathing, either direct or over foam sheathing a maximum of 2 in. thick.[a] Note: Does not apply to vertical siding.	Adapted from 2015 IRC TABLE R703.3.2 OPTIONAL SIDING ATTACHMENT SCHEDULE FOR FASTENERS WHERE NO STUD PENETRATION NECESSARY	
	NUMBER AND TYPE OF FASTENER	SPACING OF FASTENERS[b]
	Ring shank roofing nail (0.120" min dia.)	12 in. o.c.
	Ring shank nail (0.148" min dia.)	15 in. o.c.
	#6 screw (0.138" min dia.)	12 in. o.c.
	#8 screw (0.164" min dia.)	16 in. o.c.

a. Fastener length shall be sufficient to penetrate back side of the wood structural panel sheathing by at least 1/4 in. The wood structural panel sheathing shall be not less than 7/16 in. in thickness.

b. Spacing of fasteners is per 12 in. of siding width. For other siding widths, multiply "Spacing of Fasteners" above by a factor of 12/s, where "s" is the siding width in inches. Faster spacing shall never be greater that the manufacturer's minimum recommendations.

FIELD FRAMING OF EXTENDED PLATE AND BEAM WALLS

Example Scope of Work: 2x4 Studs with 2x6 Plates

1. Introduction

1.1. This scope of work addresses the construction procedure for field-framed EP&B walls in a two-story building with a basement or a crawlspace.

1.2. This scope of work addresses the EP&B configuration constructed using 2x4 stud and 2x6 plates (an option for 2x6 studs and either 2x8 or 2x7.5 in. plates is similar).

1.3. The construction procedure addresses framing and sheathing (including structural and foam sheathing).

1.4. The primary focus is on the methods and materials that are unique to the EP&B system or impacted by the EP&B system design. Where framing practices are not altered by the EP&B design, typical construction methods and material shall be followed/used.

1.5. All headers shall be in accordance with building code or an approved, engineered design.

1.6. With the exception of the wall structural sheathing nailing schedule that is unique to the EP&B system, all fastening requirements are consistent with building code requirements for light-frame wood walls as applicable. Approved alternatives shall be permitted.

1.7. For additional information, refer to construction details provided with the Scope of Work.

2. Materials List

2.1. Dimension lumber: Stud grade or higher

2.2. Wall sheathing: wood structural panels (WSP) – ply-wood or oriented strand board (OSB) with minimum 7/16 in. thickness

2.3. Engineered or solid wood rim board

2.4. Metal joist hangers (at first-floor openings only – rim header application) per engineered design

2.5. Structural composite lumber (second-floor headers and rim joist application at first floor)

2.6. Insulating rigid board foam sheathing (EPS, XPS or PIC; see page 12—consider the climate characteristics and the FPIS moisture performance carefully when choosing materials combinations)

2.7. Fasteners per construction details

2.8. WSP floor sheathing and engineered floor joists per building plans

Other EP&B Configurations:

The EP&B wall system can be adapted to 2x6 stud framing, using a true 7.5 in. plate and 2 in. of c.i. or with nominal 2x8 plates and 1-3/4 in. c.i. (see **Table 2** on page 3).

3. Field-Framing Guidelines

3.1. Sill plate and First Floor Construction

3.1.1. Verify sill plate anchor bolt size and spacing is in accordance with the house plans. The anchor bolt edge distance from exterior edge of the foundation wall should be approximately 3.5 in. to allow for the double rim joist installation, modified appropriately for other rim joist solutions.

3.1.2. Install minimum 2x6 pressure treated sill plate and secure using nuts over an appropriately-sized washer.

3.1.3. Install a double 1.25 in. engineered wood rim joist faced-nailed at a nominal spacing of 24 in. on center at top and bottom edges and toe-nailed to sill plate on the exterior face with 8d nails (2-1/2 in. x 0.113 in.) at 6 in. on center.

3.1.4. Inset the double rim 1 in. in from the sill exterior to accommodate 1 in. thickness of rigid foam insulation board.

3.1.5. Install engineered floor joists and floor sheathing in accordance with the building plans.

3.2. Wall construction

3.2.1. Layout 2x6 bottom (sole) plate.

3.2.2. Layout 2x4 studs @ 16 in. on center.

3.2.3. Layout 2 x 6 first top plate (or 2x4).

3.2.4. Attach bottom plate to studs and first top plate to studs using (2) 3-1/2 in. x 0.135 in. nails at each connection, keeping the interior face of the studs and plates flush.

3.2.5. Attach 2 x 6 second top plate to the first top plate using 10d nails (3 in. x 0.128 in.) at 24 in. on center. End joints in double top plates shall be offset at least 24 in. and a minimum of eight (8) 10d nails (3 in. x 0.128 in.) shall be installed in the lapped area. In lieu of the offset, double top plates may be fastened to each other with an approved metal plate connector.

3.2.6. Mark the plates with the location of studs (needed for attaching WSP sheathing after foam sheathing is installed).

3.2.7. Install 2-in.-thick rigid foam sheathing over 2x4 studs between 2x6 top and bottom plates. The foam sheathing shall be oriented vertically and all vertical edges shall occur over studs. The foam sheathing can consist of two layers of 1-in.-thick panels or a single 2-in.-thick layer. If two layers are used, stagger the joints. Rigid foam sheathing shall fill the entire space between the 2x6 top and bottom plates except at openings (see Sections 3.3 and 3.5 for framing at openings). The edge/end joints of foam sheathing panels shall be tight against each other and against 2x6 plate framing members.

3.2.8. For increased air tightness of the wall, the foam board seams may be taped using manufacturer-approved adhesive tape. Alternatively, once the wall is tipped into place a bead of chemically-compatible caulk or spray foam may be applied from the cavity side to each edge of the studs where foam joints occur.

3.2.9. Install WSP sheathing over the insulating rigid foam sheathing. Avoid coincident vertical joints of FPIS and WSP by staggering the sheathing course to align on different studs. The WSP sheathing shall be oriented vertically and shall be continuous between top and bottom 2x6 plates. Horizontal WSP orientation or horizontal joints in WSP sheathing shall not be permitted (blocked or unblocked). WSP sheathing shall overlap top and bottom plates by a minimum of 1 in. to allow installation of sheathing nails. All vertical edges shall occur over studs. Use of elongated WSP panels that extend over the rim joists below and/or above the wall is permitted, and is required if the rim joist is inset by 2 in. instead of 1 in.

3.2.10. Allow 1/8-in. gap at all WSP edges (or in accordance with WSP manufacturer's recommendations).

3.2.11. Attach WSP sheathing to 2x6 top and bottom plates and to 2x4 studs using nails in accordance with the following schedule:

- At perimeter of sheathing: a minimum 3.5 in. x 0.131 in. at maximum 3 in. on center.
- At 2x4 studs in field of foam sheathing: a minimum 3.5 in. x 0.131 in. at maximum 6 in. on center to allow 1.5-in. penetration into the framing

3.3. First Floor Openings

3.3.1. Window bucks are framed using 2x4 studs.

3.3.2. Door bucks are framed using 2x4 studs, or 2x6 studs to provide for direct attachment of WSP sheathing to achieve a greater stiffness of the door frame.

3.3.3. The space above all openings is framed as for a non-bearing wall (rim header design – see Section 3.4).

3.3.4. Horizontal door/window buck at the top of the opening shall be a continuous member and shall be attached to the exterior WSP sheathing using sheathing nails at 3 in. on center (to provide support for the horizontal buck member).

3.3.5. The number of king studs shall be determined based on the size of the opening in accordance with Table 10 or approved engineered design. (Note: a window or door buck continuous from bottom to top plate is a king stud.)

3.3.6. WSP sheathing is connected to window or door bucks using 3.5 in. x 0.131 in. nails at 6 in. on center.

3.4. Rim Headers and Second Floor Construction

3.4.1. Install double 1.25 in. engineered wood rim joist along the entire perimeter of the wall, inset 1 in. to accommodate 1 in. rigid foam sheathing to the exterior of the rim.

3.4.2. Rim joists shall not have splice joints over an opening and the first splice joint to each side of the opening shall occur a minimum of 6 in. away from the opening edge and past the outermost king studs (rim header application).

3.4.3. Double rim joist shall be faced-nailed at top and bottom edges at a nominal spacing of 24 in. on center and at 16 in. on center over openings with minimum 2.5 in.x0.131 in. nails. The

exterior rim shall be toe-nailed to top plate with 8d nails (2.5 in. x 0.113 in.) at 6 in. on center.

3.4.4. The maximum rim joist span shall be verified by a licensed professional. (Note: A double 1.25x11.875 structural composite lumber member is sufficient for most openings up to 8 ft wide).

3.4.5. Install engineered wood floor joists in accordance with the floor plans.

3.4.6. If using Rim Beam design, floor joists located above an opening shall be supported by a metal joist hanger selected by a licensed professional based on design loads.

3.4.7. Install WSP floor sheathing in accordance with the building plans.

3.5. Top Floor Openings

3.5.1. Top floor openings are conventionally framed using single 1.25 in. to 1.5-in.-thick engineered or solid wood headers (up to 5-7 ft) or double engineered or solid wood headers (for larger openings).

3.5.2. Where single header is used, it is insulated with 2-in. rigid foam sheathing on the interior face of the header.

3.5.3. Headers are supported by jack studs. The number of jack studs and king studs is determined based on standard practice in accordance with building code or engineered design.

3.6. Corner Details (Exterior Walls)

3.6.1. Construct wall corners at intersecting exterior walls using one of the details provided in this Construction Guide.

GLOSSARY OF TERMS

CI (c.i.)	Continuous insulation—generally a rigid or semi-rigid foam sheathing material installed exterior to the wall cavity.
CZ	Climate Zone, as defined by the International Energy Conservation Code
FPIS	Foam Plastic Insulating Sheathing, typically made from extruded polystyrene (XPS), expanded polystyrene (EPS) or Polyisocyanurate (PIC)
High-R	Building America program reference to wall systems with high thermal resistance exceeding energy code minimum requirements
IECC	International Energy Conservation Code
IRC	International Residential Code for One- and Two-Family Dwellings
R-value	Quantitative measure of resistance to conductive heat flow ($hr \cdot °F \cdot ft^2/Btu$)
WSP	Wood Structural Sheathing—the layer of wood sheeting (plywood or OSB) that provides shear and racking strength when properly attached to wall framing
WRB	Water Resistive Barrier—used to protect the building envelope from liquid water, while allowing the diffusion of water vapor back out

3.6.2. Framing members at the corners are arranged in a manner to minimize thermal bridging and allow for increased quality and level of insulation installation. Rigid foam sheathing insulation is installed at the corners as provided in the details.

3.6.3. The intersecting walls shall be connected to each other at the corner using one of the following options:

- Adjacent framing members are nailed directly to each other using 3.5 in. x 0.135 in. nails at 12 in. on center.
- Adjacent framing members that are separated by up to 2 in. of rigid foam sheathing insulation are nailed to each other using 5 in. x 0.135 in. nails at 6 in. on center or using 6 in. x 0.190 in. SIP screws at 12 in. on center.
- Exterior WSP sheathing from both intersecting walls is nailed directly to a common 2x framing member using minimum 2.5 in. x 0.131 in. nails spaced a maximum of 6 in. on center (for each wall).
- Other approved fastening methods.

3.6.4. Double top plates are overlapped at corners and intersections, and two (2) 3 in. x 0.128 in. nails are installed at each lap (face-nailed). Alternatively, the intersecting walls are fastened to each other with an approved metal plate connector, per IRC Section R602.3.2.

Table 10. King Studs at 1st Floor Openings *With rim header*[a]

Opening Width, ft	# At Window	# At Door[b]
3	1	1
4	2	1
6	3	2
8	3	2
10	4	3
12	5	4

a. The number of 2x4 king studs at each side of the opening.

b. Number of king studs is reduced at door opening only if the first stud (buck) is a 2x6 member.

Equipment

Rigid foam sheathing can be cut with a table saw, circular saw or reciprocating saw. New toothless saw blades are available in 7-1/4 in. and 10 in diameters for nearly dust-free cutting. Use eye and breathing protection per manufacturer's instructions.

Many standard framing nail guns will accommodate the 3.5 in. nails required to fasten the WSP to the studs through the 2 in. foam sheathing. The fastener pattern of 3 in. o.c. at the WSP perimeter and 6 in. o.c. in the field will be familiar from traditional stapling schedules. Note that staples are not an acceptable substitute for nails in the EP&B wall system.