Enclosing Timber Frames with Structural Insulated Panels

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Founder, Riverbend Timber Framing and Insulspan

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Outline

- What are SIPs?
- Structural advantage of SIPs for timber frames
- Energy performance of SIPs
- Life cycle analysis
- Speed of installation
- Building science and durability

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Structural Insulated Panel Association (SIPA)

SIPA is a nonprofit association representing manufacturers, suppliers, dealer/distributors, design professionals, and builders committed to providing quality structural insulated panels for all segments of the construction industry.

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Advantages of SIPs

- Energy savings
- Speed of installation
- Strength
- Sustainability
- Better indoor air quality
- Lifecycle cost savings

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The fastest way to
your energy-efficiency destination
2030 NOW
SIPs EXPRESSWAY
2020
CALIFORNIA
NET ZERO
ENERGY
2030 NOW
SIPs EXPRESSWAY
2012
IECC
30% INCREASE
2030 NOW
SIPs EXPRESSWAY
2011
LEED FOR HOMES
35% INCREASE
2030 NOW
SIPs EXPRESSWAY
2030
CHALLENGE
NET ZERO ENERGY
ZERO CARBON
2030 NOW
SIPs EXPRESSWAY
2016
BUILDING AMERICA
50% INCREASE
2030 NOW
SIPs EXPRESSWAY
2012
ENERGY STAR v3
35% INCREASE

Structural Advantages

SIPs add considerable lateral load strength to timber frames

- Rob Erikson and Dick Schmidt, University of Wyoming
- Published in Timber Framing Journal 2002

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Structural Advantages

- No such testing exists for stick frame
- Likely to have to sheath wall on both sides to equal strength of SIP
- Save on timber and labor

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Energy Performance

Two factors effect the energy efficiency of the building envelope:

- Convective losses (air gaps in insulation,)
- Conductive losses (thermal bridging)

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Air Infiltration

- Responsible for 30 – 50% of heating and cooling loss
- Blower door tests added to 2012 IECC
- Requirement for ENERGY STAR, Passive House, LEED for Homes

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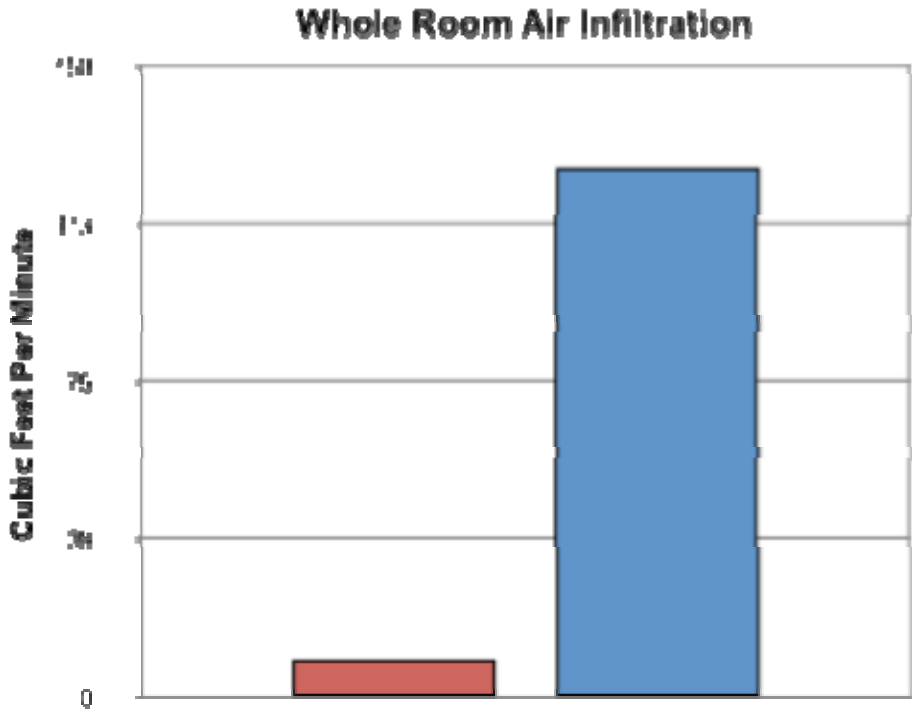
ORNL SIP Test Room

SIPs vs fiberglass insulation



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ORNL Research Homes

5 homes built in Oak Ridge, TN

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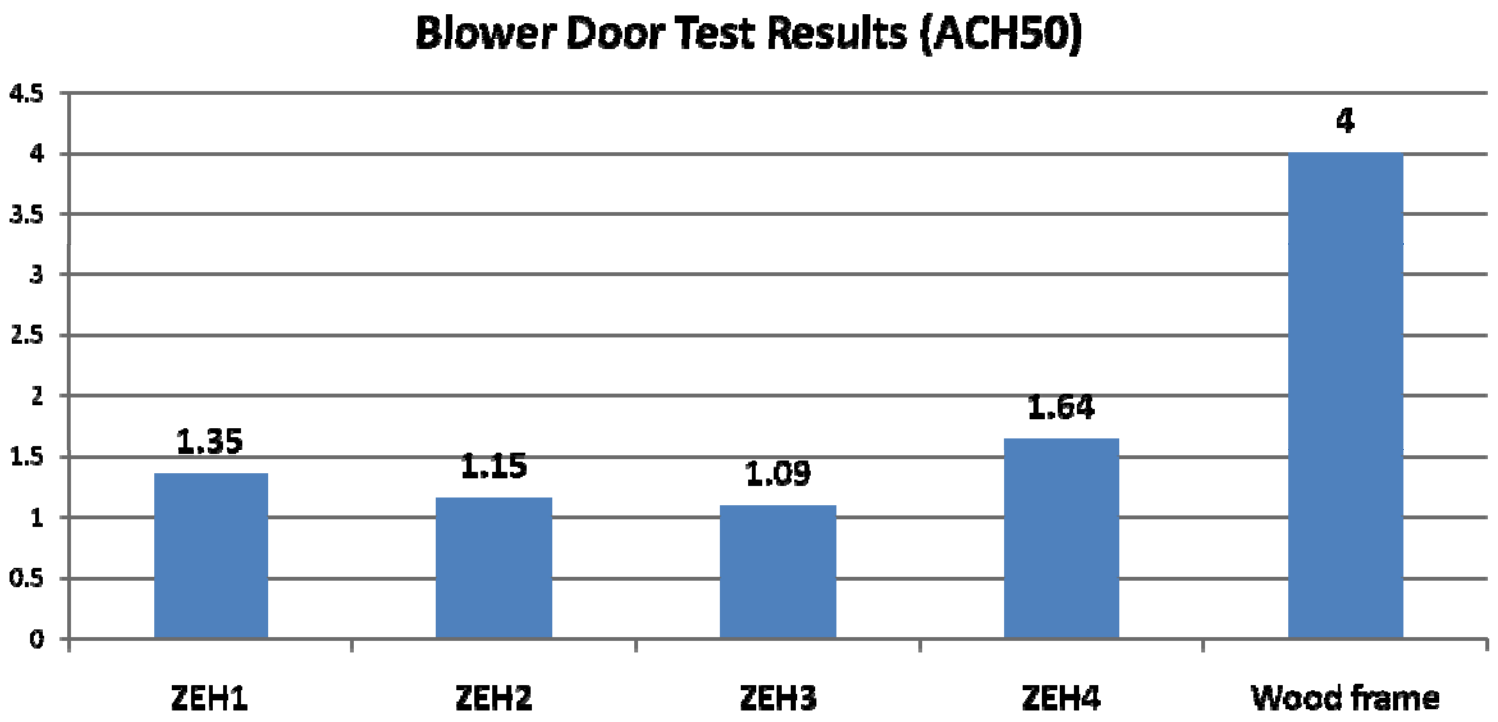

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ZEBRAlliance Research Homes

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ZEBRAlliance Research Homes

- Identical designs
- Built in 2009, 2009/10 was first heating season
- Houses controlled to simulate occupancy.
- Same windows, appliances, HVAC

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Zebralliance Insulation Spec.

- Walls
  - 2x6 15% Framing Factor, Flash & batt – ½” spray foam + R-19 fiberglass batts
  - 6” SIP with EPS core
- Attic
  - R-35 Cathedral (SIPs 10-in)
  - R-50 Cathedral (aged phenolic) 2 X 12, 24in O.C.

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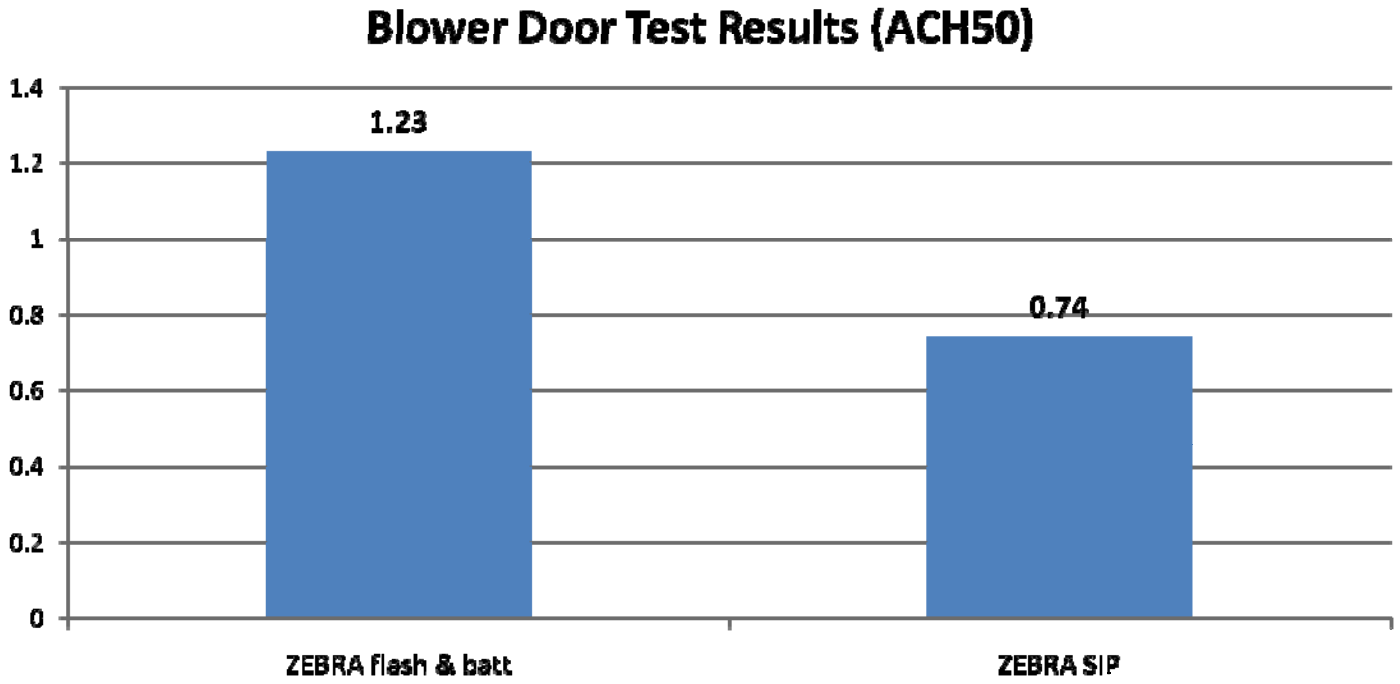
ZEBRAlliance Research Homes



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Summary

- SIPs saved 21% more space heating energy than OVF
- SIPs scored a higher HERs Rating than OFV
  - SIPs attained 40% greater air tightness than OVF even though it was the Framing crews first SIP job.
  - Crew went to SIP school, then built same house with OVF.
- SIPS envelope went up in only 5 days compared to 15 for the OVF

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Why the large difference in performance?

- Air leakage
- Thermal bridging
- FTC R-Value Myth, is it really R-19?
- ASTM Guarded Hot Box vs Whole Wall R-Value.
  - 75F test temp vs real world.
  - Tightly sealed box not a wall.

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Benefits of Airtight Homes

- Better IAQ
- No cavity mold growth
- Smaller HVAC systems – cost savings
- Shorter duct runs
- Energy savings

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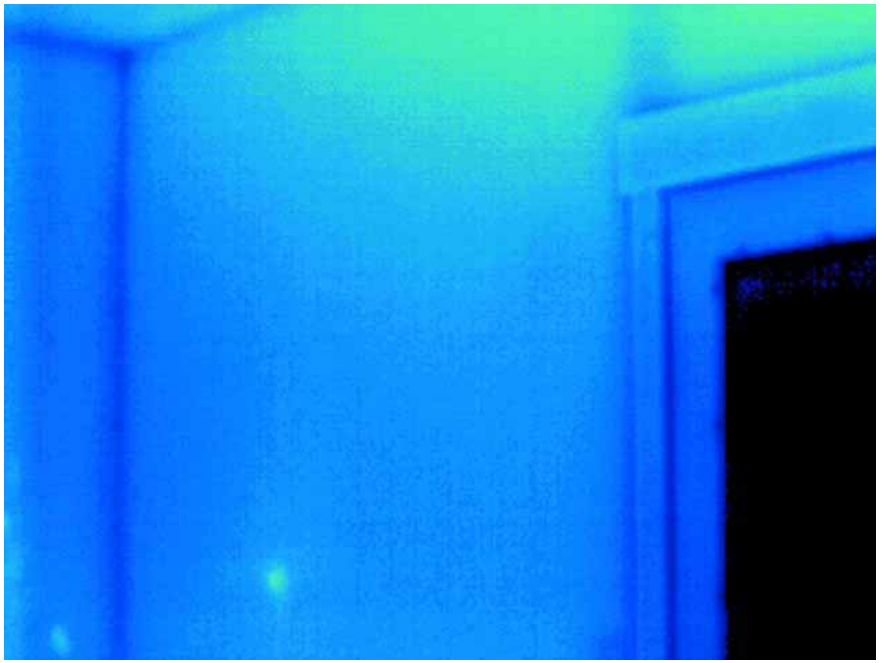
Thermal Bridging

Stick



SIP

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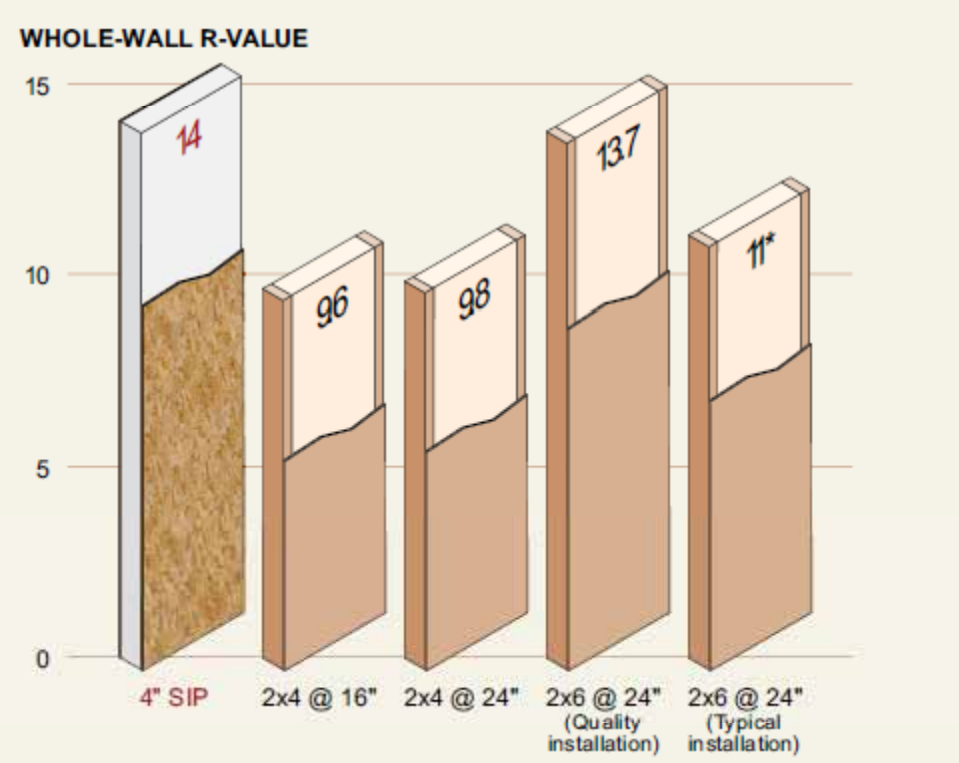
ORNL Whole Wall R-Value Testing



* Tests show that in the “worst case commonly found of procedures for installing batt insulation” the performance drops to R-11

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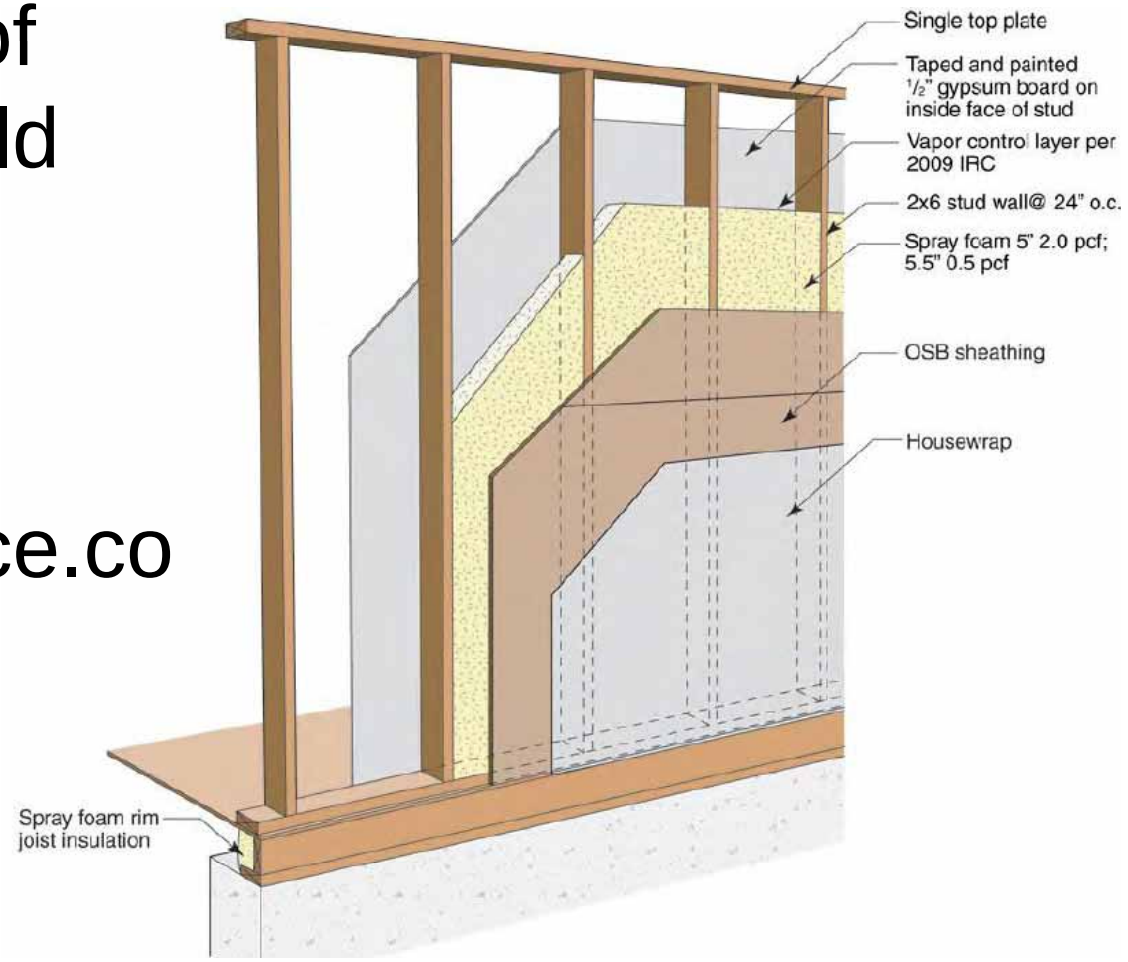
Building Science Corp. Wall Study

Software analysis of wall systems for cold climates

Available at www.buildingscience.com



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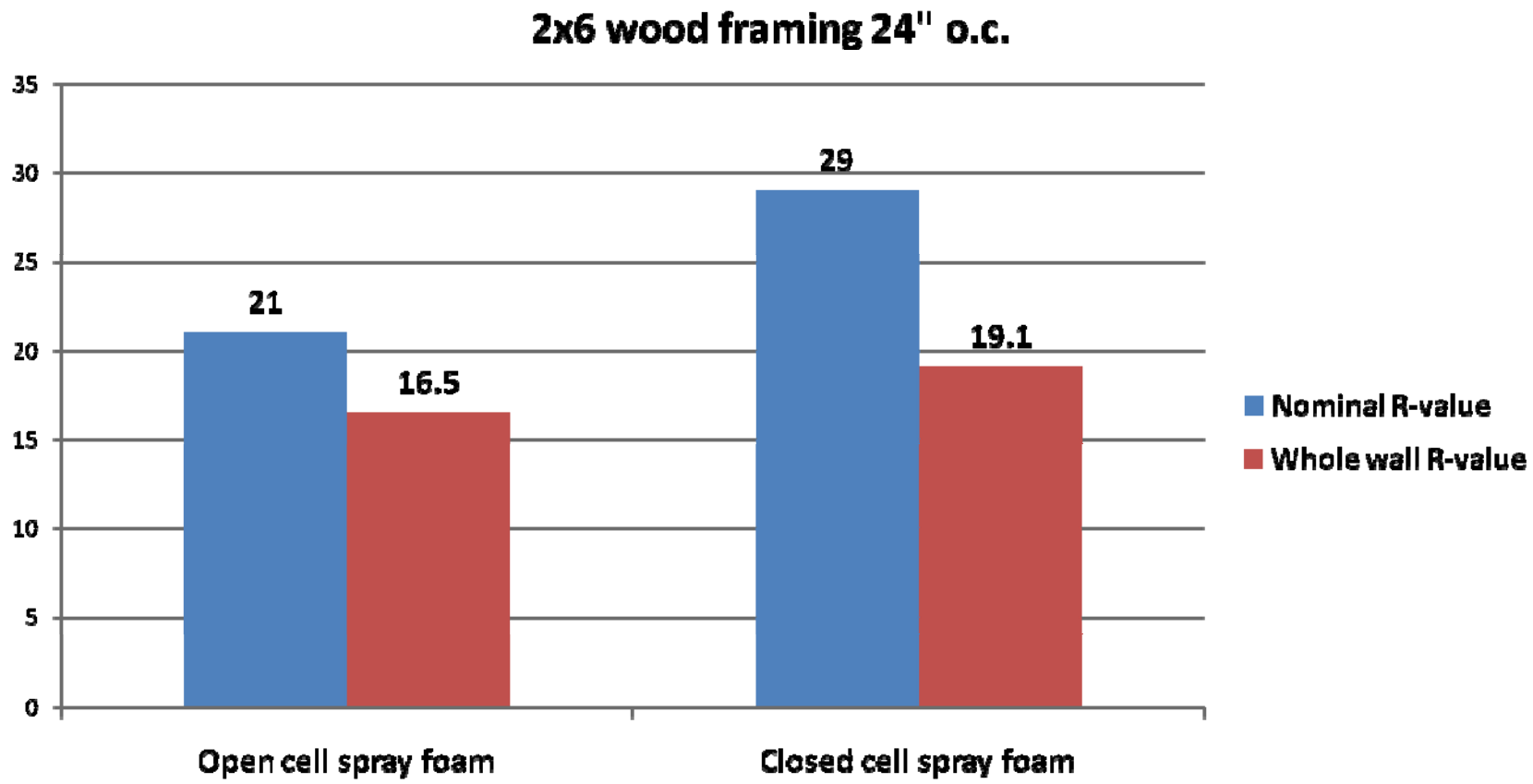
Building Science Corp. Wall Study



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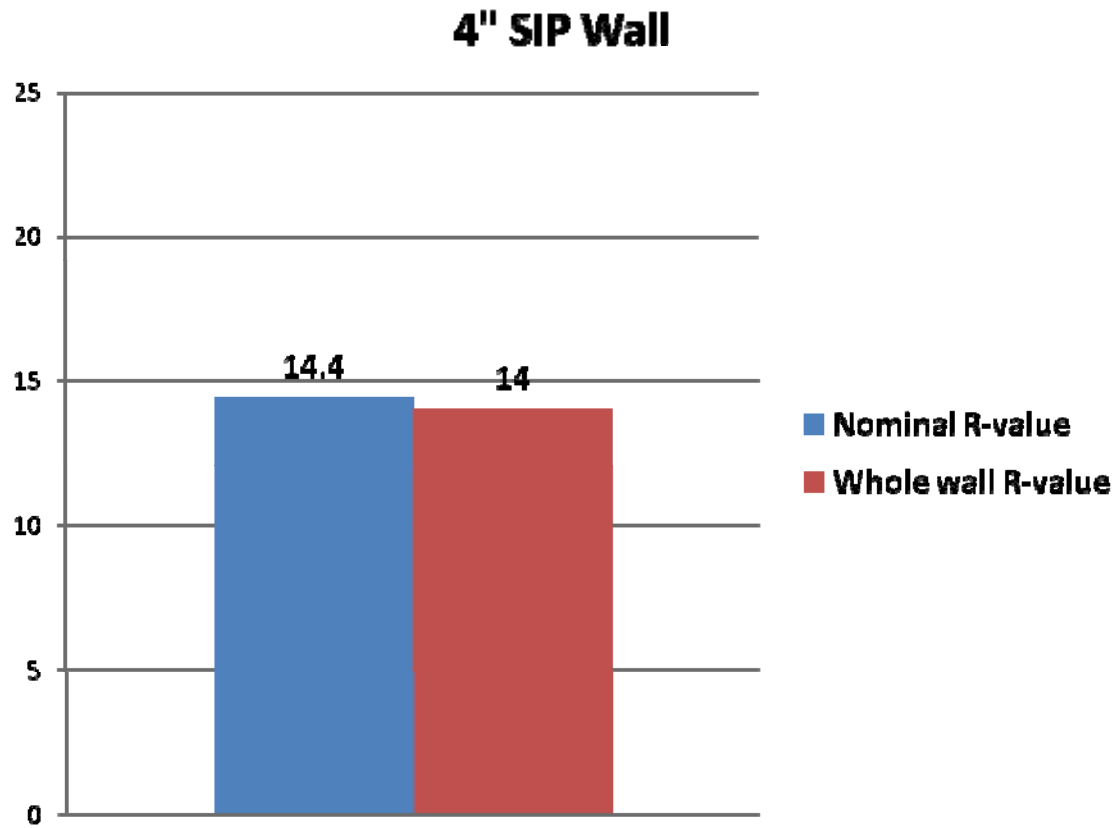
ORNL Whole Wall R-Value Testing



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ORNL Whole Wall R-Value Testing

Wall Type	Wall Cavity	R Value Face to Face		Insulation	Notes
	Dimension"	**10/75F**	**50/100F**		
Straw Bale	19		26.97	Straw	
SIP 6"	5.675	22.26	21.72	EPS Core	
Stud 2x6 Cellulose	5.5		15.3	Includes Drywall/OSB	Studs 16" OC
SIP 4"	3.675	13.52	14.59	EPS Core	
Stud 2x6	5.5		14.4	FG Batt R 19, incl OSB/DW	Studs 16" OC
Stud 2X6	5.5		13.74	Fiberglass Batt R 19	Studs 24" OC
Stud 2x4 Cellulose	3.5		10.4	Includes Drywall/OSB	Studs 16" OC
Stud 2x4	3.5		9.9	FG Batt R11, Incl OSB DW	Studs 16" OC
Stud 2x4 25% FF	3.5		9.8	2" Soy Foam/Cotton Batt	Studs 16" OC
Stud 2x4 25% FF	3.5		9.65	1.59" Soy Foam	Studs 16" OC
NOTES					
None of the tests include air leakage in the heat loss.					

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Foam vs Fuzz

- Fiberglass and other types of fibrous insulation performance **decreases** as the Delta T increases.
- Foam insulation performance **increases** as the Delta T increases. EPS at 75F is 3.85, at 25 is 4.25. Over 10% increase.
- Yet the FTC labeling is fixed to the 75F standard.

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Environmental Benefits

- Reduced energy use = less GHG emissions
- Reduced construction waste
- Fewer natural resources
- Indoor environmental quality
- Points in LEED, National Green Building Standard

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Green Building

National Green Building Standard Certified.

Performance starts with the building envelope.

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Green Building

LEED Platinum, EVHA Winner

0.86 ACH50

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Life Cycle Analysis

EPS Molders Association
SIPs Work Group and
Franklin Associates

STRUCTURAL INSULATED PANELS
REDUCE GLOBAL WARMING

LIFE CYCLE BENEFITS OF SIPS

The basic design concept for SIPs is elegant in its simplicity, and offers several advantages for constructing walls and roofs. There is general agreement that SIPs provide better overall air tightness and practical thermal performance than conventionally framed walls.
- NAHB Research Center

SIPS ENVIRONMENTAL ADVANTAGE

By providing substantial energy savings and critical reductions in greenhouse gas emissions, the energy invested in the production and delivery of SIPs yields an exponential benefit to the environment, when compared to traditional stick framing.

The exceptional performance of SIPs as an insulator coupled with low air leakage for the built environment offers the construction industry the tools and technology needed to achieve superior thermal performance while making a significant and restorative contribution to the reduction of global warming.

This Environmental Profile summarizes a life cycle analysis conducted by Franklin Associates for the EPS Molders Association SIPs Work Group. The study was to quantify the energy savings and greenhouse gas reductions provided by the use of SIPs walls as an alternative to traditional stick construction.

Study results present a powerful case for the significant contributions SIPs provide in making homes more efficient, comfortable and environmentally sustainable.

PERFORMANCE MODEL

A representative single-family home was the model used to illustrate the properties and performance of SIPs with EPS insulation compared to stick-framed construction. The total insulated wall area of the home modeled was 1,791 sq. ft.

The stick-framed home was constructed with 2x6 dimensional lumber 24 in. on center, R-19 fiberglass insulation, vapor barrier, and 7/16" OSB sheathing. The SIP home was constructed with 6-1/2" SIPs with an EPS core and dimensional lumber plating.

Both homes were clad with wood siding on the exterior and finished with 1/2" gypsum drywall on the interior. The study evaluated the environmental effects of using SIPs as an alternative to the stick-framed wall.

PREMIER BUILDING SYSTEMS
Stronger. Straighter. Greener.
SIPS: STRUCTURAL INSULATED PANELS

Plymouth Foam

R CONTROL SIPs

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Life Cycle Analysis

Technique to assess each and every impact associated with all the stages of a process from-cradle-to-grave

(i.e., from raw materials through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling)

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Life Cycle Analysis

Goal and Scope:

- Model Structure - 1,791 sq. ft. wall area
- Walls SIPs vs 2x6 framing, R-19 fiberglass and vapor retarder
- Calculate Energy and GWP Impact
  - Whole wall R-Value
  - Heating/Cooling
  - Air Leakage

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Life Cycle Analysis

- Additional energy investment recouped 10x over life of a home
- Energy payback in 5.1 years
- Global Warming Potential (GWP) payback in 3.8 years

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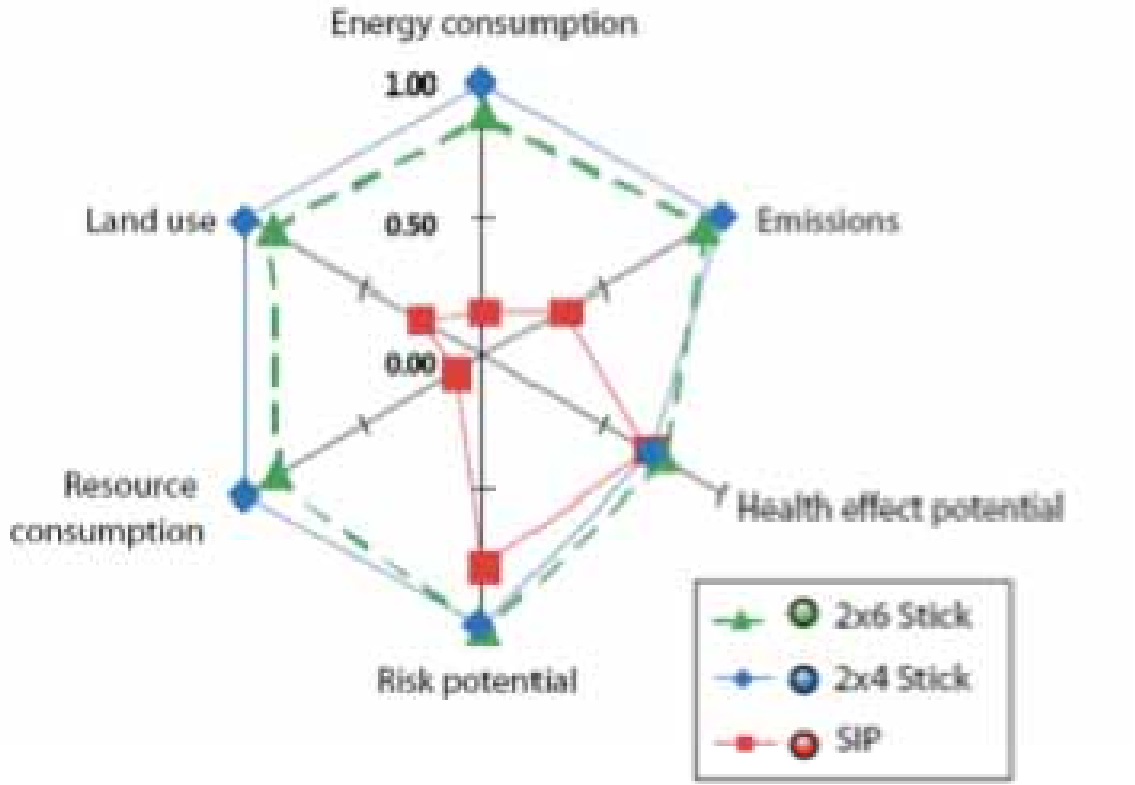
BASF Eco Efficiency Analysis

Resource efficiency - LCA



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Speed of Construction

- Independent R.S. Means study shows 55% labor savings over stick frame in residential construction

- 11% savings on electrical rough-in

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Speed of construction

Labor savings – 8’ x 24’ panels

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Speed of Construction

Labor savings – CNC fabrication

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Speed of Construction

Labor savings – dormers and preassembly

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Cost Savings

- Trim installation
- Waste disposal
- Shortened duct runs
- Smaller HVAC
- Less skilled labor needed
- Overhead/construction loan

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Economics of SIPs

What are you comparing it to?

- What will be required to reach low level of air infiltration?
- Eliminating thermal bridging?

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Economics of SIPs

Material costs vs installed costs

Upfront costs vs lifecycle costs

- Energy efficiency
- Durability
- Higher value for green buildings

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Building Science

By Joe Lstiburek, Building Science Corporation

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Building Science – Airtight Homes

- Low levels of air infiltration demand mechanical ventilation
- Work with qualified HVAC professional
- Sealed combustion appliances

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Building Science – Airtight Homes

- Ventilation options climate specific:
  - ERV/HRV
  - Fan cycler
- Exhaust moisture-laden air and supply fresh air
  - Filtered system removes allergens
  - Superior IAQ

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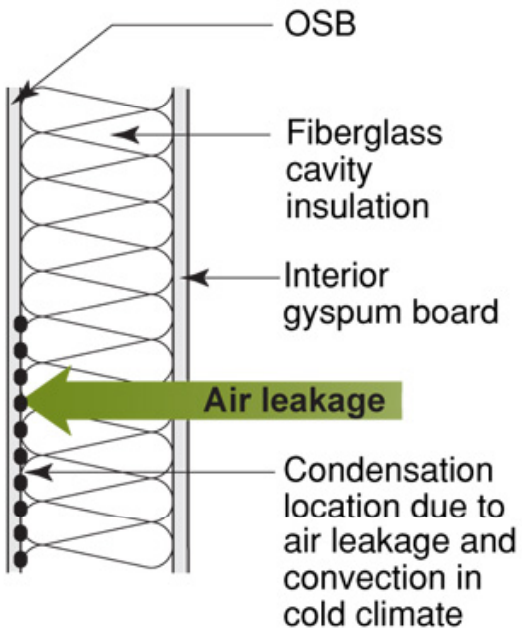
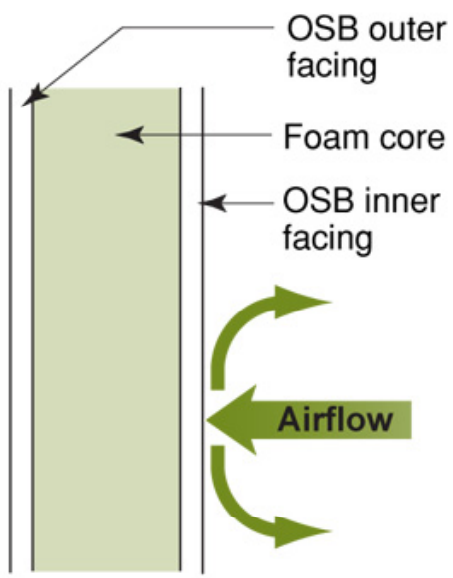
Building Science – Air Sealing



Typical Stick Frame Wall

- Cavity within typical frame wall is prone to airflow and convection
- Condensation can occur at exterior sheathing in cold climates



SIP Wall

- Core is “solid” and “homogenous” and “air impermeable”
- Convection and air leakage is not possible within SIP
- Condensation due to convection and air leakage within SIP is not possible

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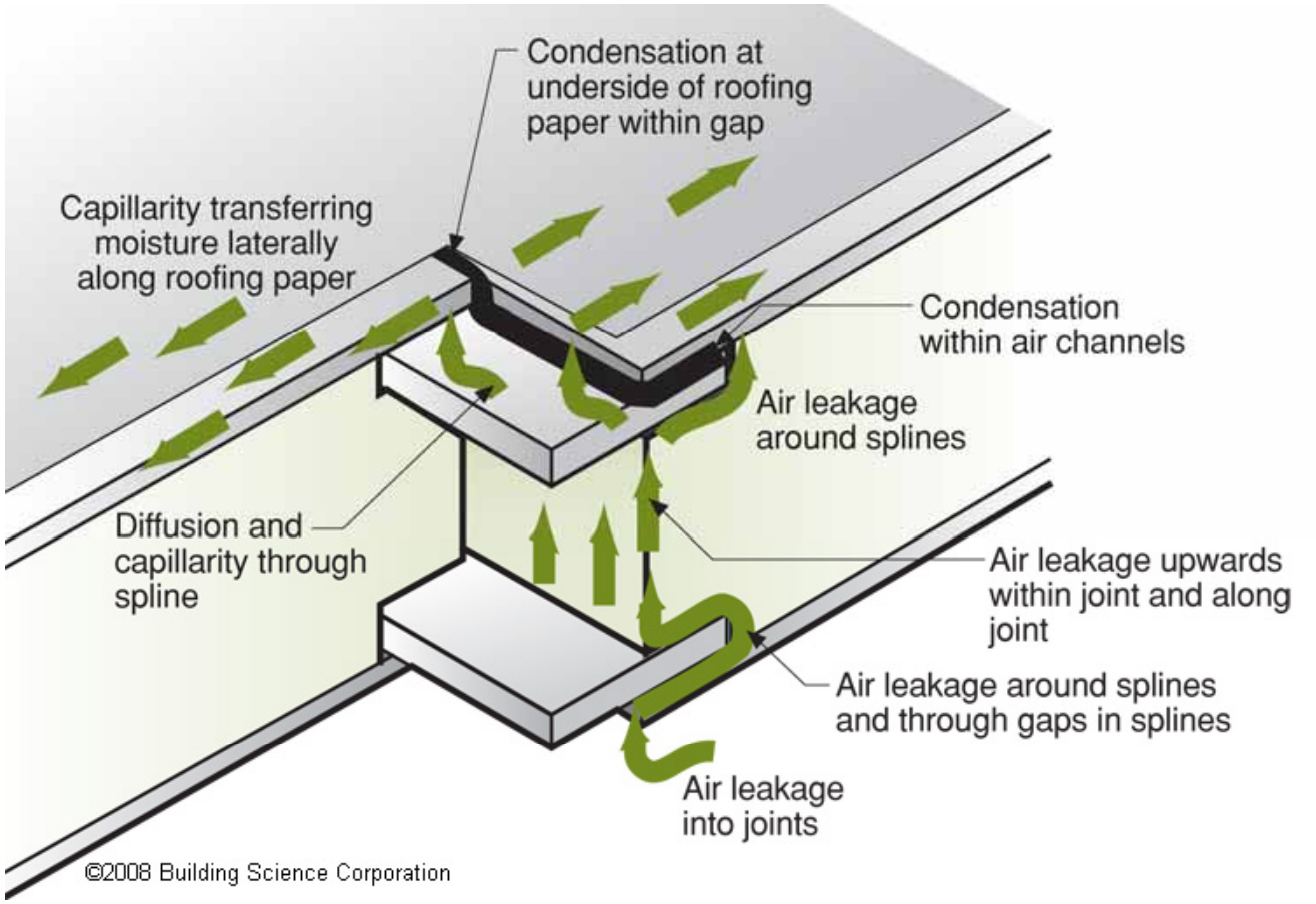
Building Science – Air Sealing



Moisture in improperly sealed joint

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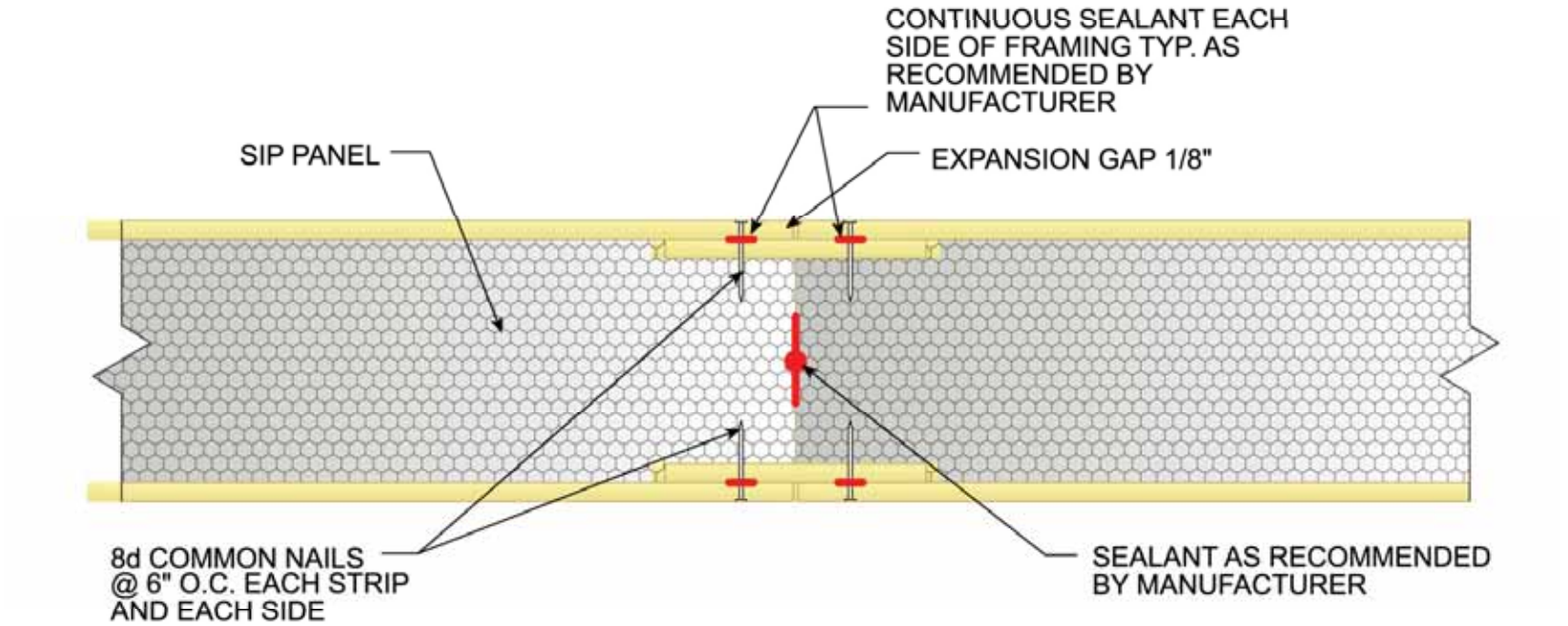
Building Science – Air Sealing



Follow manufacturer details

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Air infiltration – sealing methods

Mastic

Expanding Foam

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Air sealing – SIP tape

Draped over ridge beam

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Building Science – Detailing

- Prevent vapor intrusion – sealing
- Protect from bulk water – WRB
- Create a way for assemblies to dry
  - Drainage plane in wet climates
  - Cool roof in wet climates

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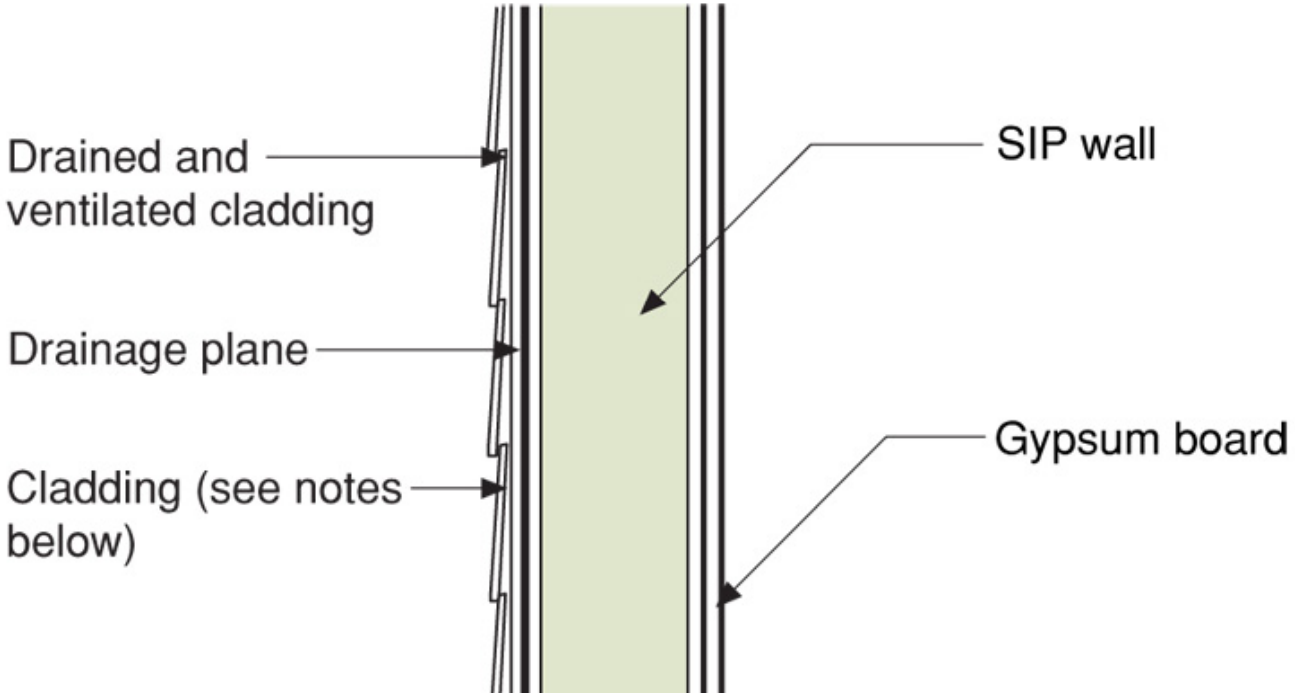
Wall Cladding



Siding should be back-ventilated in areas with annual rainfall greater than 20”

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Wall Cladding

Drainage plane with ventilated cladding

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Wall Cladding

Ventilated cladding with ¼” thick strips of foam sheathing

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Wall Cladding

Ventilated cladding with drainage mat

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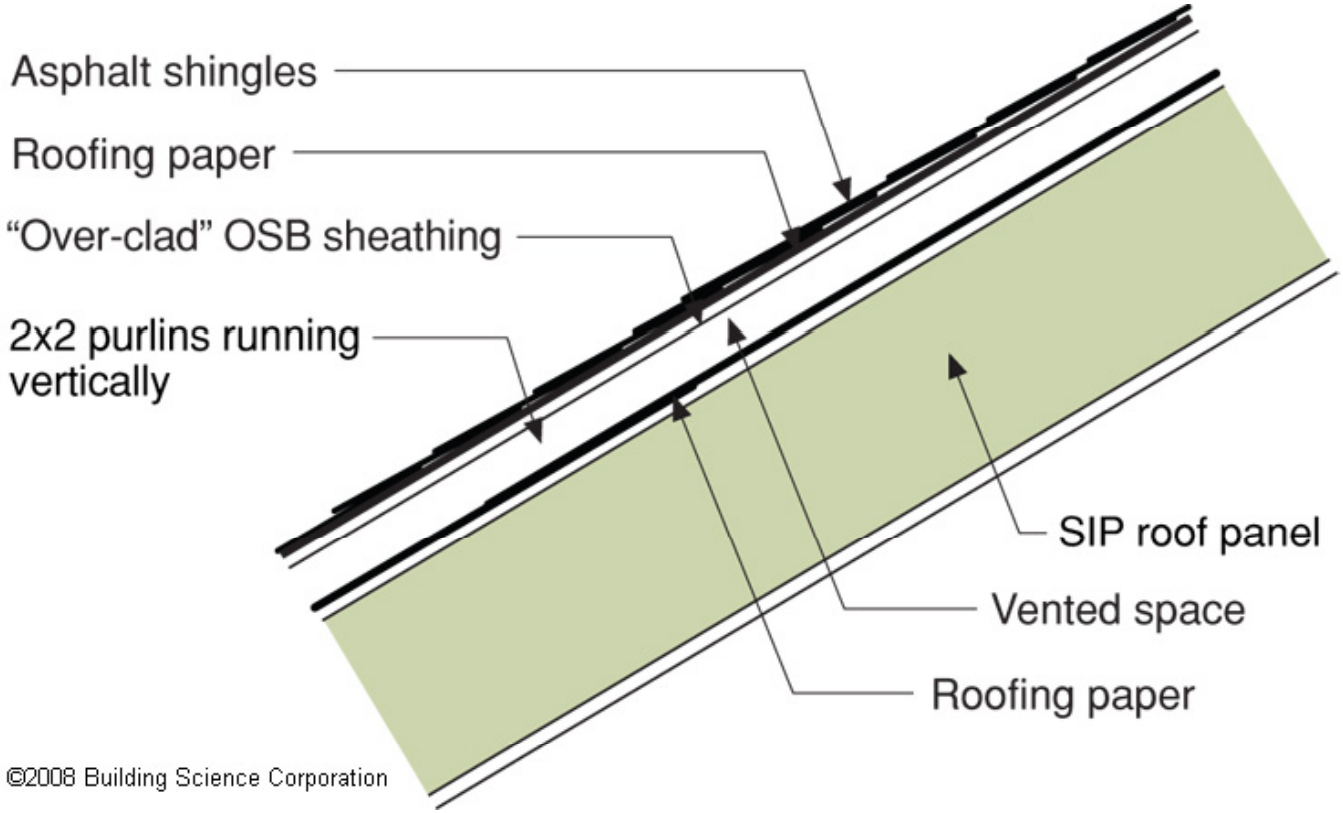
Roofing



Roofing should be ventilated (cool roof) in areas with annual rainfall greater than 20"

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Roofing

Diagonal lath under metal roofing

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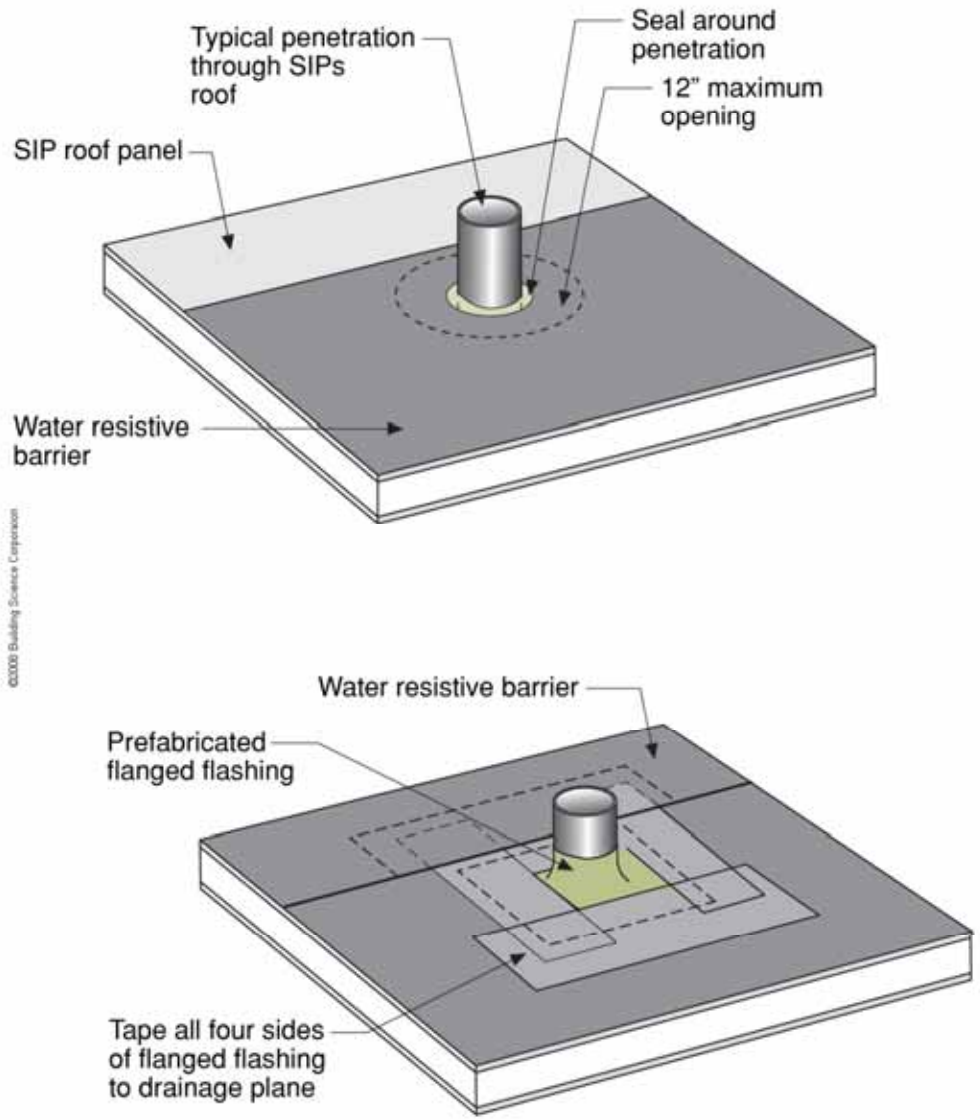
Penetrations

- Prevent vapor intrusion:
  - Expanding foam
  - Caulking
- Protect from bulk water:
  - Flashing



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Questions?

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