Introduction

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Building Science Approach to SIPs

- Building science background for recommendations made in the Builder’s Guide
- Recommendations for Enclosure Design
  - Claddings, drainage planes and drainage gaps
  - Vapor open assembles
- Recommendations for Mechanical Design
  - Combustion safety, mechanical ventilation, and effective distribution
- Top Ten Lists for SIPs

The Five Fundamental Changes to Buildings

1. Increased thermal resistance,
2. A changing of the permeability of the linings that we put on the inside and outside of the building enclosures,
3. The water and mold sensitivity for building materials has been going up,
4. The ability for the building enclosure to store and redistribute moisture is going down, and
5. We now have complex three dimensional airflow networks that inadvertently couple the building enclosure to the breathing zone of the occupied space.

The building enclosure must:

- Hold the building up
- Keep the rain water out
- Keep the ground water out
- Keep the wind out
- Keep the water vapor out
- Let the water and vapor out if they get in
- Keep the soil gas out
- Keep the heat in during the winter
- Keep the heat out during the summer
- Keep the noise out

Introductions
An Irish Church from 1000 AD composed of just dry-stacked rock. Simple and durable, but hardly comfortable.

Solid masonry with generous window area. Durable, functional with moderate R-value.

Light-weight Building 1.0 – The first frame building in Ellicottville, NY (1817) with balloon framing, non-standard wood elements and irregular spacings, fastened with both wood pegs and hand forged iron nails.

Lightweight Building 2.0 – Structural insulated panels form walls and roof, enclosing full volume within thermal envelope. (photo: Al Cobb, SIP School)

Functions of the Enclosure

1. Support
2. Control
   - Rain water
   - Air
   - Water vapor
   - Heat
   - Sound
   - Light
3. Finish

Builder’s Guide to Structural Insulated Panels (SiPs)

RAIN WATER CONTROL
“3-D” Water Management

- Drainage
- Deflection
- Drying

“3-D” approach to rain water management

- Deflection
- Drainage/Storage/Exclusion
- Drying

Layering Materials to Shed Water

The Moisture Balance

Reservoir Cladding and Solar Driven Moisture

Brick Veneer Walls – “A Big Reservoir”
Cedar Shingles, Traditional Stucco and Manufactured Stone Veneer Walls

Provide Drainage Plane and Drainage Gap

All claddings should be drained and back-ventilated where annual rainfall exceeds 20 inches

For Cedar Shingles, Traditional Stucco, and Manufactured Stone Veneer:
- Install over 3/8-inch (9mm) drainage mat over a water resistive barrier

Wood or Fiber Cement-clad Walls

Provide Drainage Plane and Drainage Gap

All claddings should be drained and back-ventilated where annual rainfall exceeds 20 inches

For Wood and Fiber Cement Siding:
- Install over a 1/4-inch (6mm) spacer strip over a water resistive barrier

Drained and Back-ventilated Siding

Vinyl or Aluminum Clad Walls

Provide Drainage Plane and Drainage Gap

Can be used in all regions

Vinyl or Aluminum Siding is inherently back-ventilated

Builder’s Guide to Structural Insulated Panels (SIPs)

AIRTIGHTNESS AND THERMAL CONTROL
Convective Loops in Air-permeable Insulation

A: Air Loops Around Insulation
B: Air Loops Through Insulation

Wind-washing of Air-permeable Insulation

Airflow into enclosure through porous materials or unintentional openings

Airflow out of enclosure through porous materials or unintentional openings

Frame Wall vs. SIP Wall

Frame Wall
- OSB
- Fiberglass cavity insulator
- Foam core
- Interior gypsum board
- Exterior finish
- Condensation location due to air leakage and connection in cold Climate

SIP Wall
- Core is "cold" and "homogenous" and "air impermeable"
- Connection and air leakage is not possible versus SIP
- Condensation due to connect hip and leakages within SIP is not possible

Thermal Control with SIPS

- SIP panels are air impermeable, solid and homogenous insulation
- As with any panel system, joints are important

Builder’s Guide to Structural Insulated Panels (SIPs)

CONDITIONED ATTICS
Conditioned Attic Design

Either vented (“cold roof”) or unvented (“hot roof”)

Why vent?
- Cold climates: cold roof surface to control ice dams, vent moisture
- Hot climates: expel solar heated air to reduce cooling

Other considerations:
- Attic needed for living space
- Roof complexity makes venting difficult
- Locating HVAC system components

Unvented, Conditioned Attic allows HVAC inside conditioned space

Telegraphing of Panel Joints

SIP Roof – Simple Cold Deck

Applicable Code Sections

2006 International Residential Code for One- and Two-Family Dwellings
- R806.1 Ventilation required
- R806.2 Minimum area
- R806.3 Vent and insulation clearance
- R806.4 Conditioned attic assemblies

2007 Supplement to the International Residential Code
- R806.4 Unvented attic assemblies
- Table R806.4 Insulation for condensation control
WATER VAPOR CONTROL AND DRYING

Air Pressure and Vapor Pressure

Diffusion vs. Air Leakage

SIPs - Bilateral Symmetry

Design for Outward and Inward Drying
Outward: Housewraps and Building Papers

Inward: Painted Gypsum Board

Applicable Code Sections

2006 International Residential Code for One and Two-Family Dwellings
- R202 Vapor Retarder
- N1102.5 Moisture Control

2007 Supplement to the 2006 International Residential Code for One and Two-Family Dwellings
- R202 Vapor retarder Class
- N1102.5 Vapor retarders
- N1102.5.1 Class III vapor retarders
- N1102.5.2 Material vapor retarder class

Combustion Safety

In an airtight SIPS house, all combustion sources must be considered:
- Gas boiler, furnace or water heater
- Cooktop, oven or dryer
- Unvented gas fireplaces

Provide combustion air to each appliance and ensure that combustion gases do not interact with breathing space

Use sealed combustion, direct or power-vented appliances
Do not use unvented gas or wood fireplaces

Air pressure driving forces

HVAC FOR AIRTIGHT, ENERGY-EFFICIENT BUILDINGS

Builder’s Guide to Structural Insulated Panels (SIPS)
Use Sealed-Combustion, Power-Vented Equipment

Provide mechanical ventilation

- SIP construction greatly reduces unintended infiltration and exfiltration
- Controlled mechanical ventilation is needed regardless of mechanical design

Our recommended approach:
- Design system to meet ASHRAE 62.2 with controls to provide continuous ventilation at about half that rate.
- Many options

Mechanical Ventilation System Options

Consider Heat Recovery in Cold Climates

Heat-loss Recovery Ventilator

Effective ventilation air distribution

Unsealed ductwork can cause unintended air pressure interactions inside the building enclosure

- Seal ductwork with mastic (preferred) or tape, especially returns
- Provide continuous return pathways using transfer grilles and jump ducts
- Do not use interior wall or floor cavities as ducts
Air handler closet depressurization

Backdrafting in mechanical room

Effective Distribution and Return Pathways for the Whole House

Builder's Guide to Structural Insulated Panels (SIPs)

**TOP TEN LISTS**

Top Ten Reasons Building Scientists Like SIPs
1. Panels are airtight and can be assembled into structures with little unintentional infiltration or exfiltration

Common Leakage Points
Top Ten Reasons Building Scientists Like SIPS

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2. No wall cavities
3. Air impermeable, solid and homogenous insulation
4. Far fewer thermal bridges
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6. Easy to create conditioned attics (even with complex roof geometry)
7. Supports construction for extreme climate enclosures
Extreme Cold Enclosure

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SIP Roof – Vented-Unvented Hybrid

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9. Hard to put plumbing and ductwork in exterior walls
10. Control of heat and air is easily done leaving more time to get the water and water vapor control done right.

Top Ten Things that Building Scientists Worry About with SIPs
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6. . . . okay, so maybe we can’t get ten.
Online Resources

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