

Comparison of Exterior Wall System Alternatives

“Designing & Building a Zero Annual Net Energy House” —
NESEA Building Energy Conference 2007

SYSTEM ONE: 12"-Thick framed wall – Larsen Truss System



Description: 2x4 stud frame and 1/2" sheathing providing lateral stiffness. A plastic membrane air/vapor barrier wrapped entirely around the outside of the sheathed frame. 8"-deep standoff "Larsen Truss" contractor-fabricated frames provide an exterior exoskeleton, which, when sheathed with an additional exterior sheathing, provides an 8" cavity, filled with dense pack cellulose. The 3 1/2"-deep interior stud cavity is also insulated, but independently. This cavity, being inside the air barrier, is readily available for electrical wiring, etc. without compromising the building air-tightness. Window and door rough openings extended through the thick wall using 3/4" plywood, to which the air barrier membrane is sealed.

Cost:

Thermal Performance:¹ 11.5" of cellulose x 3.5 = **R-value 40.25.**

Minimal thermal bridging.

Durable (well-protected) air barrier.

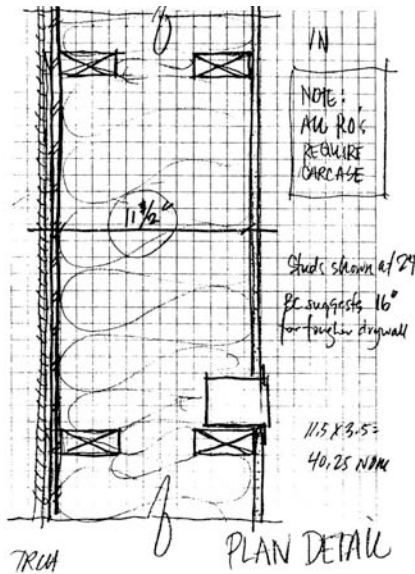
<i>Pro</i>	<i>Con</i>
<ol style="list-style-type: none"> 1. Air barrier secure for the life of the structure. 2. Interior plumbing and wiring chase inside air barrier. 3. Wall thickens to the exterior. 4. Uses cellulose insulation material, a non-fossil fuel-derived, recyclable product. 5. The dense pack cellulose and wood frame construction provides considerable moisture storage capacity as a resistance to the commencement of bio-degradation. 	<ol style="list-style-type: none"> 1. Involves an unconventional framing procedure after the initial 2x4 framed sheathed bearing wall: Stand-off trusses are custom fabrication; two layers of sheathing are involved, the second applied vertically after the wall is erected. 2. 12"-thick wall, involving approximately 80 S.F. of additional building area over an 8" wall. (± 3% gross building area)

¹ R values for all wall systems are calculated for comparative purposes considering only the insulation materials. Neither is the degradation due to thermal bridging included in the calculation — merely noted as either “minimal” or “none” in a typical location.

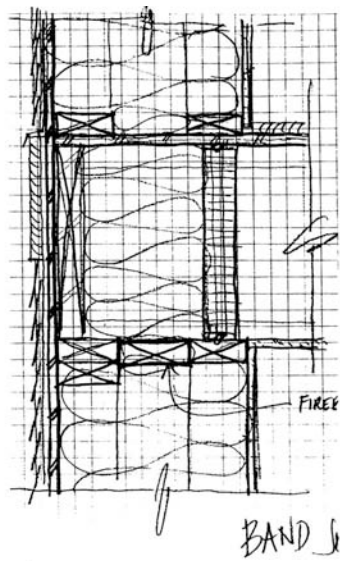
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SYSTEM TWO: 12"-Thick wall, double stud framed



Plan Detail



Section at Band Joist

Description: 2x4 stud wall with 1/2" sheathing, load bearing wall with second 2x4 stud wall constructed to the interior. 3/4" plywood window and door carcasses in tunnels with the 11 3/4" cavity filled with dense pack blown-in cellulose. Conventional air barrier.

Cost:

Thermal Performance: 11.75" of cellulose x 3.5 = R-value 41.1

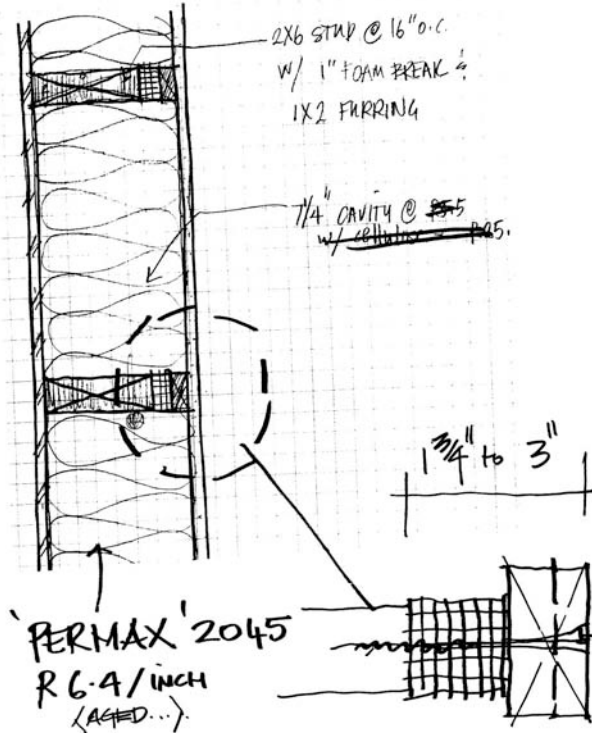
No thermal bridging.

Pro	Con
<ol style="list-style-type: none"> 1. Uses cellulose insulation material, a non-fossil fuel-derived, recyclable product. 2. The dense pack cellulose and wood frame construction provides considerable moisture storage capacity as a resistance to the commencement of bio-degradation. 	<ol style="list-style-type: none"> 1. Involves an unconventional framing procedure after the initial 2x4 framed sheathed bearing wall, though less so than required for the Larsen Truss system. 2. 12"-thick wall, involving approximately 80 S.F. of additional building area over an 8" wall. ($\pm 3\%$ gross building area) 3. Air sealing is the most challenging of the set, (even though it involves standard air sealing practices).

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SYSTEM THREE: 2x6 Frame strapped to the interior with in-situ spray foam



Description: Conventional 2x6 stud load bearing wall framing with 1/2" sheathing. Studs extended to the interior with a sandwich of XPS foam and wood furring applied vertically to the studs. In-situ spray polyurethane insulation, zero ozone depleting, into the stud cavity. (Note: the procedure leaves one inch of un-filled cavity to avoid trimming — which adds considerable cost)

Cost: \$0.60± per face sq. ft. per inch of depth in cavity (to be verified by Steve H)

Thermal Performance: Assuming an aged R-value of 6.2 per inch. With 1 1/2" XPS at R 5 per inch, and 2x3 batten = $(5.5 + 3 - 1) \times 6.2$ less thermal bridging of the studs = **R-value 35.6²**. Excellent air sealing.

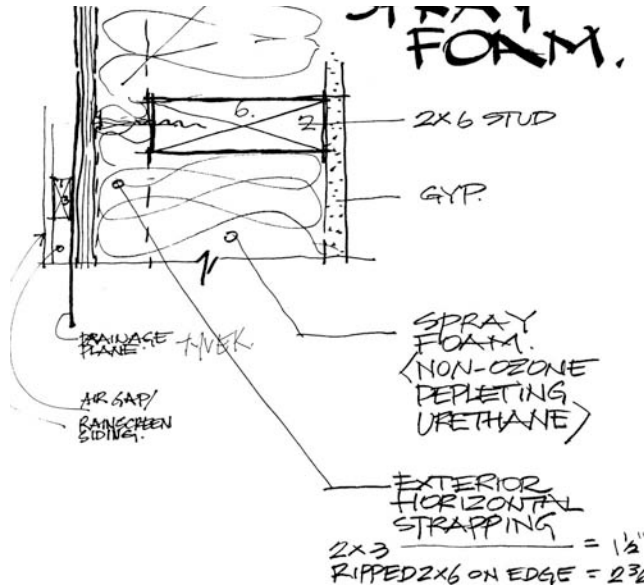
Pro	Con
<ol style="list-style-type: none"> 1. Most similar to conventional construction practice. Assemble 2x6 frame, apply sheathing, tip-up the wall, secure / attach sheathing, nail sheathing to rim joist and mudsill to achieve lateral stiffness. 2. Excellent air sealing ("automatically") — as a consequence of this in-situ spray foaming process, this form of air sealing resists casual degradation during construction. 3. "Thinner" (8"-thick) wall. 4. The thermal performance is adjustable, depending on the thickness of the XPS and wood stud thickening strips. 	<ol style="list-style-type: none"> 1. Whilst the foam product would use blowing agents that are non-ozone depleting, the foam material is a fossil fuel-derived product. (Note: We should confirm that this need be necessarily be considered a disadvantage. The petroleum stock used to produce this insulation material is apparently a by-product of the refinement of petroleum and, so long as petroleum is produced, it might reasonably be argued that productive uses be found for these by-products.)

² Calculation by Marc Rosenbaum — see email Jan 14th 2005

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SYSTEM FOUR: 2x6 Frame, exterior horizontal strapping and in-situ sprayed foam



Description: 2x6 stud frame, diagonally braced (??) with 2x2± horizontal strapping applied to the exterior, then 1/2" sheathing, which may or may not provide sufficient lateral resistance depending on the sill plate design. In-situ spray polyurethane insulation, zero ozone depleting, into the stud cavity. (Note: the procedure leaves one inch of un-filled cavity to avoid trimming — trimming adds considerable cost)

Cost: \$0.60± per face sq. ft. per inch of depth in cavity (to be verified by Steve H) .

Thermal Performance: Assuming an aged R-value of 6.2. x (5.5 + 1.5- 1) less thermal bridging of the studs = **R-value 32³**. Performance can be slightly enhanced by thickening the strapping to 2.75 inches.

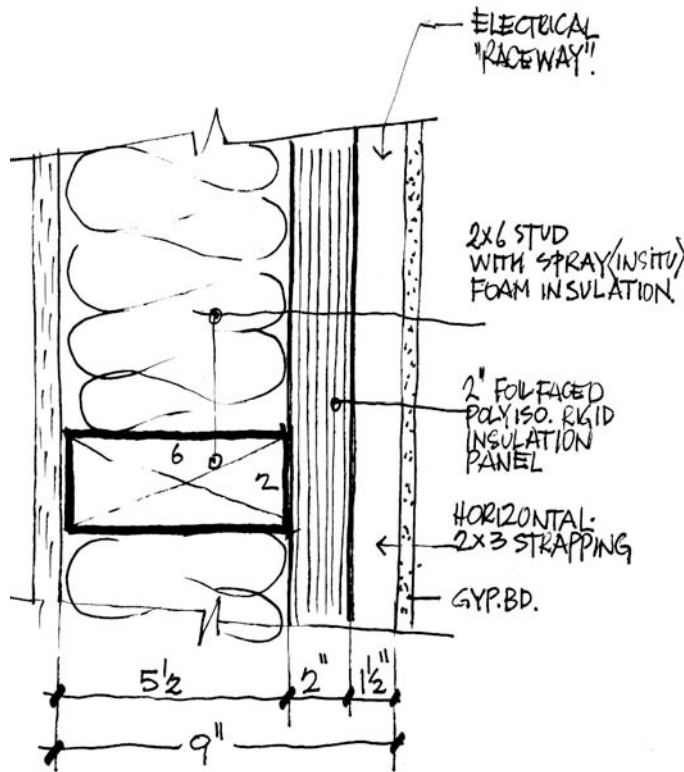
Pro	Con
<ol style="list-style-type: none"> 1. Excellent air sealing ("automatically") — as a consequence of this in-situ spray foaming process, this form of air sealing resists casual degradation during construction. 2. "Thinner" (8"-thick) wall. 3. The thermal performance is adjustable, depending on the thickness of the XPS and wood stud thickening strips. 	<ol style="list-style-type: none"> 1. Unconventional construction in that the exterior sheathing is applied after the frame is erected and diagonal bracing may be required. 2. Additional vertical furring is required if clapboard siding is intended. (However, its use will create the siding as an effective rain screen.) 3. Whilst the foam product would use blowing agents that are non-ozone depleting, the foam material is a fossil fuel-derived product. (Note: We should confirm that this need be necessarily be considered a disadvantage. The petroleum stock used to produce this insulation material is apparently a by-product of the refinement of petroleum and, so long as petroleum is produced, it might reasonably be argued that productive uses be found for these by-products.)

³ Calculation by Marc Rosenbaum — see email Jan 14th 2005

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SYSTEM FIVE: 2x6 Frame wall, in-situ sprayed cavity with additional rigid foam sheathing to interior



Description: Conventional 2x6 stud frame with 1/2" sheathing secured to foundation, providing lateral stiffness. In-situ spray polyurethane insulation, zero ozone depleting, into the stud cavity. In lieu of thickening or strapping the studs, a 2" thickness of rigid faced insulation board is secured to the inside face of the studs after the curing of the spray foam in the stud cavities. Horizontal 2x3 furring secures the rigid insulation panel in place and provides a wiring chase to the interior. (Note: the procedure leaves one inch of un-filled cavity to avoid trimming — which adds considerable cost).

Cost: \$0.60± per sq. ft. per inch of depth in cavity (to be verified by Steve H) ... plus cost of foil-faced rigid insulation panel.

Thermal Performance: Assuming an aged R-value of 6.2. x (5.5 – 1 + 2) less thermal bridging of the studs = **R-value 40.3⁴**.

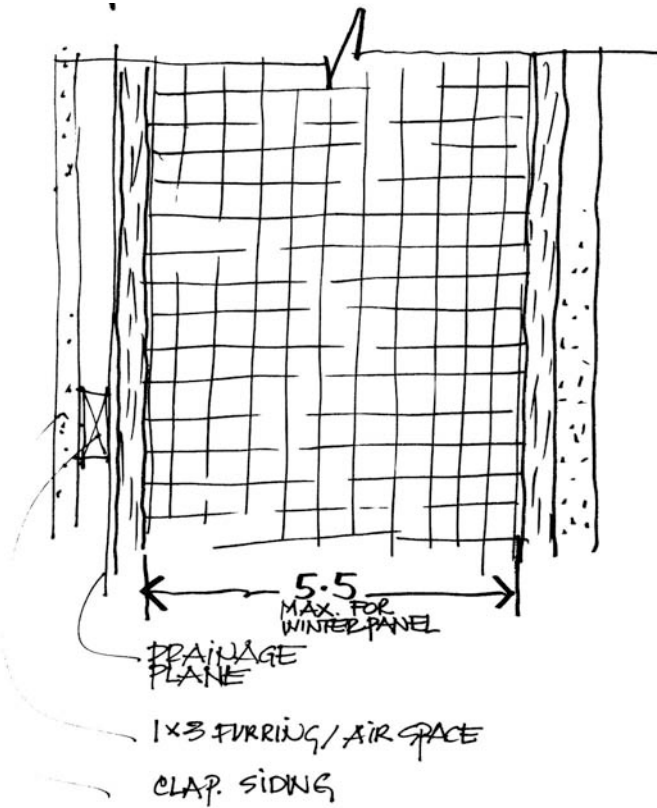
Pro	Con
<ol style="list-style-type: none"> 1. Excellent air sealing (“automatically”— as a consequence of this in-situ spray foaming process). 2. All the exterior thermal insulation is performed before the mechanical/electrical rough-in commences. 3. The interior wiring chase involves less stud drilling for the electrical sub-contractor and the possibility of “fishing” additional cable in the future. 	<ol style="list-style-type: none"> 1. Whilst the foam product uses blowing agents that are non-ozone depleting, the foam material is a fossil fuel derived product (Note: we should confirm that this is necessarily a disadvantage since the petro stock apparently used is a by-product and so long as petroleum is produced it might reasonably be argued that productive uses should be found for these by-products). 2. Slight increase in wall thickness from 8” to 9 1/2”.

⁴ Calculation by Marc Rosenbaum — see email Jan 14th 2005

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SYSTEM SIX: Structural Insulated Panels (SIPs)



Description: Factory-produced wall panels, designed, fabricated and erected by the panel manufacturer, who also attends to the air sealing using spray sealant during erection along all panel joints.

Cost:

Thermal Performance: Winter Panel claim an aged R-value (12 months) of 7.1 which, with the 5.6" of insulation in their thickest panel noted on their website, yields R-value = 40. (Though it is possible that thicker panels with higher R-values can be achieved though special orders — Murus, Winter, Foard.)

Pro	Con
<ol style="list-style-type: none"> 1. Very rapid on-site construction once the shop drawing and panel pre-fabrication is complete. 	<ol style="list-style-type: none"> 1. SIPs are vulnerable to degradation if moisture enters the system because they have so very little moisture storage capacity. The OSB is particularly susceptible to degradation. 2. Dealing with the fabricator, making sure that the overall design intent is not compromised by a panel manufacturer who typically is more concerned with their process than with ours. 3. Handling electrical wiring in these walls is non-conventional, though most panel manufacturers have some proprietary means of achieving it.