

Kohta Ueno

Historic Preservation Meets Building Science: The Mallett Deep Energy Retrofit



BUILDINGENERGY 13
CONFERENCE + TRADE SHOW FOR RENEWABLE ENERGY AND GREEN BUILDING PROFESSIONALS

Overview



The Mallett Deep Energy Retrofit

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The Mallett Deep Energy Retrofit

- The design decision process for how the team chose assemblies and details
- Energy efficiency, durability, constructability



Image c/o Energy Circle



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R-Value Targets

Climate Zone	Wall	Vented Attic	Compact Roof	Basement Wall	Exposed floor	Slab edge ¹	Windows (U/SHGC)	Sub-slab ²
1	10	40	35	5	10	none	yes	none
2	15	50	40	10	20	5	0.35/<.25	none
3	20	50	45	10	20	7.5	0.30/<.3	5
4	25	60	45	15	30	7.5	0.30/<.35	7.5
5	30	65	50	15	30	10	0.24/<.50	7.5
6	35	75	60	20	40	10	0.18/--	10
7	40	90	65	25	45	15	0.15/--	15
8	50	100	75	35	50	20	0.15/--	20

Table 2: Current Recommended "True" Minimum R-value (+/-) ³ including thermal bridging
Source: RR-1005: High R-Value Enclosures for High Performance Residential Buildings in All Climate Zones

- "True" R value: R-13 2x4 wall ≈ **R-8**
R-19 2x6 wall ≈ **R-12**
- Estimated targets—will vary with local construction costs, energy costs, client targets



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Enclosure Design

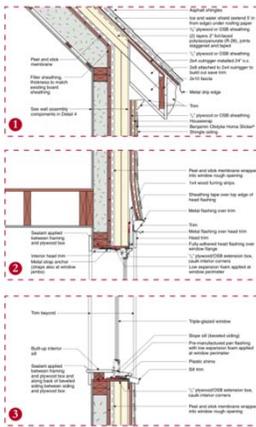


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Enclosure Design (1 of 2)

- R-40 Walls (existing 2x4 framing filled with cellulose insulation and (2) ~~X~~ layers foil-faced polyisocyanurate insulating sheathing on wall sheathing)
- R-50 Roof Insulation (existing 2x7 framing filled with cellulose insulation and (2) 2" layers foil-faced polyisocyanurate insulating sheathing on roof sheathing)
- Windows (Low-E triple pane krypton filled, U = 0.20 & SHGC = 0.44)



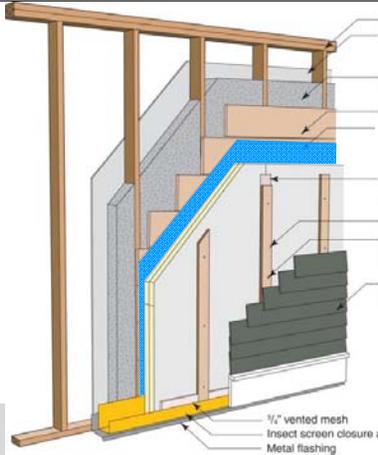
Enlarged Details



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4" Polyisocyanurate Foam



- Existing wood framing
- Interior finish as per project (existing horsehair plaster, replacement gypsum board)
- Existing board sheathing
- 4" Polyisocyanurate Foam
- 1/4" vented mesh
- Insect screen closure at base of wall
- Metal flashing



Foam Sheathing Cladding Attachment



250 lbs/113 kg load (7.8 psf): <math><0.003''</math> deflection

Wood siding ~2 psf
Fiber cement 2-3 psf
Stucco 8-10 psf

Image c/o Petersen Engineering



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Foam Sheathing Cladding Attachment

Rotational resistance provided by tension in fastener and compression of the insulation

See: Exterior Cladding Attachment Research, Peter Baker, EEBA 2012: <http://www.buildingscienceconsulting.com/presentations/documents/2012-09-26%20EEBA%20Baker%20Cladding%20Attachment.pdf>

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Enlarged Details

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Vented and Unvented Roofs

(Conventional) Ventilated Attic Unvented Cathedralized Attic

- Vented roofs good solution for low cost, durable, high-R assembly, IF:
 - No mechanicals in vented roof AND
 - Good air barrier at attic floor

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Unvented Roof: How?

- 2006 IRC: R806.4 Unvented attic assemblies
- Minimum R-value of "air impermeable insulation"
- Nail base needed with rigid foam on roof deck
- Air barrier on interior side of "roof sandwich"

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Enlarged Details

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Water Control: Pan Flashings

- Deep energy retrofits (addition of insulation at existing wall) can make the wall more vulnerable to water leakage
- Previously "survivable" leaks may no longer be able to dry out.

Enclosure Design (2 of 2)

- R-24 Basement Walls (2" closed cell spray foam with 2x4 stud wall filled with cellulose)
- R-13 Rim Joist Area (2" closed cell spray foam with 2x4 stud wall filled with cellulose)
- R-10 Basement Slab (2" XPS below slab)

Enlarged Details

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Basement Insulation Location

Building Enclosure Components:

1. Base Floor System(s)
2. Foundation Wall System(s)
3. Above Grade Wall System(s)
4. Windows and Doors
5. Roof System(s)

Building Enclosure Components:
- Building Enclosure
- Interior Spatial Separators

Basement Insulation Location

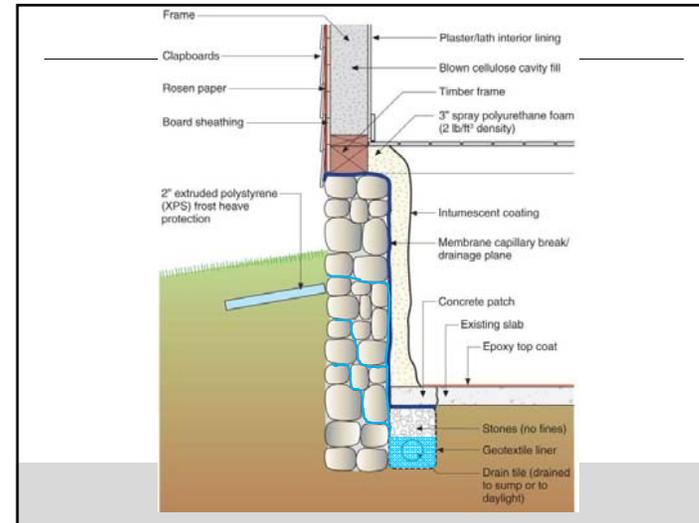


- 4.6 ACH50; 2129 CFM 50 total; 1100 CFM 50 through floor
- 8.5 ACH50; 3590 CFM 50 total; 1740 CFM 50 through floor



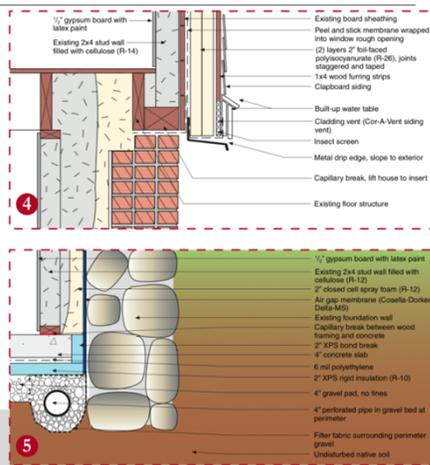
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Foundation Insulation Details

- Stud wall and cellulose insulation for additional R-value
- 2" XPS sub-slab insulation



Air Barriers



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Roof-to-Wall Air Barrier Connection

INSULATE OVER AND UNDER THE ROOF DECK

To get the most insulation into the shallow 2-in. rafters, we used closed-cell foam. On top of the roof, we added 4 in. of polyurethane foam boards, which has the highest R-value per inch of the rigid foam boards. This provided an R-60 roof without sheathing.

We didn't want to damage the interior plaster to spray foam into the wall cavities, so we filled the walls with cellulose and covered them with rigid foam.

"Chainsaw" Retrofits (Roof-to-Wall)

Asphalt shingles
Top and water shield (attached 6" from edge) under roofing paper
1/2" plywood or OSB sheathing
2" layers 2" foil-faced polyurethane foam (R-20), joints staggered and taped
1/2" plywood or OSB sheathing
2x4 outrigger (attached 24" o.c. 2x4 attached to 2x4 outrigger to build out eave line)
2x10 fascia
Metal drip edge
Timber
1/2" plywood or OSB sheathing
Housewrap
Benjamin Obdyke Home Slicker
Single siding

See "The History of the Chainsaw Retrofit" (Green Building Advisor)
<http://www.greenbuildingadvisor.com/blogs/dept/musings/history-chainsaw-retrofit>

Wall Retrofit Air Barrier Options

Self-adhered Membrane as Air Barrier

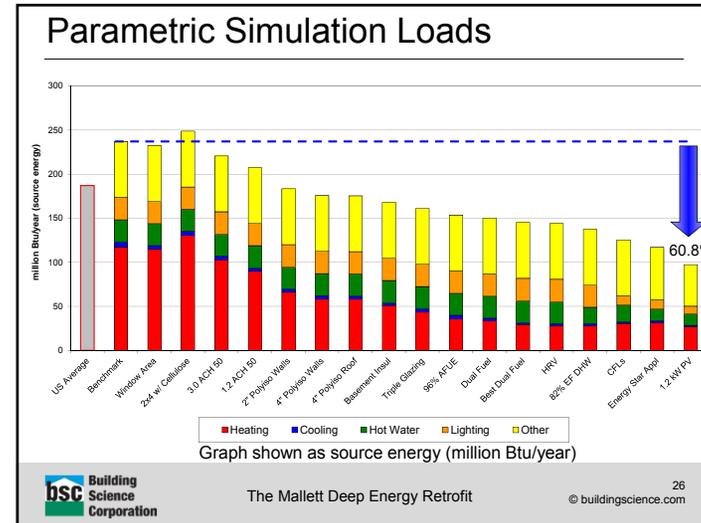
- 69 CFM 50 (0.09 ACH 50) w. blanked off openings
- 337 CFM 50 (0.4 ACH 50) pre-drywall

Energy Performance



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Infrared Images



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Infrared Images

23.4°F $\epsilon=0.90$ 21.2°F $\epsilon=0.90$ FLIR

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Snow Melt Patterns

- One of these things is not like the other...

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Questions?

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