Practical, Residential Wall Systems: R-30 and Beyond

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Introduction

Criteria for R-30+ wall systems, authors’ experience wrt:

• Practical and “buildable”
• Replicable
• Potential for wider acceptance
• Cost-competitive
Introduction

Wall Systems Selected:

- Double Walls
- Exterior Rigid Foam
- Structural Insulated Panels (SIPs)
Double Walls
Double Walls
Double Walls
Double Walls
## Double Walls: R-Value

<table>
<thead>
<tr>
<th>Space Between</th>
<th>Total Insul.</th>
<th>R-values [$ft^2hr\circ F/Btu$]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x4 Walls</td>
<td>Depth</td>
<td>Nominal Whole-Wall</td>
</tr>
<tr>
<td>1 in</td>
<td>8 in</td>
<td>30</td>
</tr>
<tr>
<td>2 in</td>
<td>9 in</td>
<td>33</td>
</tr>
<tr>
<td>3 in</td>
<td>10 in</td>
<td>37</td>
</tr>
<tr>
<td>5 in</td>
<td>12 in</td>
<td>44</td>
</tr>
</tbody>
</table>

20% framing factor; cavity insulation at 3.7 $ft^2hr$ F/Btu-inch
Similar to Conventional Framing

Exterior:
• Exterior wall framing
• Sheathing
• Windows
• House Wrap
• Siding

Interior
• Electrical
• Drywall
Double Walls: Key Differences

Second frame wall:

At least as much time as exterior wall.

2x4 vs. 2x6

Advanced framing
Double Walls: Key Differences

Insulation:

• Much more material
• Not much more time
• 30% cost increase (12” cavity) compared to 2x6 wall
Double Wall: Penetrations
# Double Walls: Lumber Costs

<table>
<thead>
<tr>
<th></th>
<th>Length of 8' Wall</th>
<th>Framing Factor</th>
<th>Framing Needed</th>
<th>Framing Cost per Foot</th>
<th>Framing Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single 2x6 Wall</td>
<td>100 feet</td>
<td>20%</td>
<td>1280 feet</td>
<td>$0.40</td>
<td>$512</td>
</tr>
<tr>
<td>Double 2x4 Wall</td>
<td>100 feet</td>
<td>20%</td>
<td>2560 feet</td>
<td>$0.25</td>
<td>$640</td>
</tr>
</tbody>
</table>

Net increase for Double Wall: $128
Double Walls: Cost Example

12” Double Wall, Incremental costs
100 linear feet, 8’ tall

<table>
<thead>
<tr>
<th></th>
<th>Approx. Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Framing Labor</td>
<td>$1,260</td>
</tr>
<tr>
<td>Framing Lumber</td>
<td>$128</td>
</tr>
<tr>
<td>Insulation</td>
<td>$500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$1,888</strong></td>
</tr>
</tbody>
</table>

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Double Walls: Simple Form
Exterior Foam

- Interior drywall
- Wall framing with cavity insulation
- Structural sheathing
- Drainage plane/house paper
- 4" XPS rigid foam board (2 layers)
- Window exterior trim
- Window flashing wrapped over window buck
- Framing jamb extension
- Interior jamb extensions
- Exterior mount window
- Window sill
- Framing sill extension
- Window flashing wrapped over window buck
- 1X furring strips in line with studs, attached with screws to framing
- Exterior siding
## Exterior Foam: R-values

<table>
<thead>
<tr>
<th>Wall Studs</th>
<th>Dim [in]</th>
<th>XPS</th>
<th>Cavity</th>
<th>Whole-Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15% FF</td>
</tr>
<tr>
<td>2x4</td>
<td>3.5</td>
<td>20</td>
<td>13</td>
<td>34</td>
</tr>
<tr>
<td>2x6</td>
<td>5.5</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
</tbody>
</table>
Similar to Conventional Framing

Exterior:
- Wall framing
- Sheathing

Interior
- Electrical
- Drywall
Exterior Foam: Key Differences

- Installing Foam
- Window Installation
- Drainage Plane/Flashing Details
- Furring, siding
Exterior Foam: Windows

- Interior drywall
- Wall framing with cavity insulation
- Structural sheathing
- Drainage plane/ house paper
- 4" XPS rigid foam board (2 layers)
- Window exterior trim
- Window flashing wrapped over window buck
- Framing jamb extension
- Interior jamb extensions
- Exterior mount window
- Window sill
- Framing sill extension
- Window flashing wrapped over window buck
- 1X furring strips in line with studs, attached with screws to framing
- Exterior siding

- Interior drywall
- Wall framing with cavity insulation
- Structural sheathing
- Exterior membrane/ house paper
- 4" XPS rigid foam board (2 layers)
- Window exterior trim
- Window flashing wrapped over rough opening
- Framing jamb extension
- Attachment with 2x2" galvanized angle flashing
- Interior mount window
- Window sill
- Window flashing wrapped over rough opening
- 1X furring strips in line with studs, attached with screws to framing
- Exterior siding
### Exterior Foam: Cost Example

<table>
<thead>
<tr>
<th>Component</th>
<th>Qty</th>
<th>Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furring Strips</td>
<td>110</td>
<td>$3.00</td>
<td>$330</td>
</tr>
<tr>
<td>XPS (2’x8’x2”)</td>
<td>100</td>
<td>$15.00</td>
<td>$1,500</td>
</tr>
<tr>
<td>Fasteners</td>
<td>1000</td>
<td>$0.60</td>
<td>$600</td>
</tr>
<tr>
<td>2x4 (board-feet)</td>
<td>800</td>
<td>-$0.25</td>
<td>-$200</td>
</tr>
<tr>
<td>Blocking/jambs (board-feet)</td>
<td>200</td>
<td>$1.00</td>
<td>$200</td>
</tr>
</tbody>
</table>

**Incremental Material Costs:** $2,430

<table>
<thead>
<tr>
<th>Component</th>
<th>Qty</th>
<th>Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor hours</td>
<td>27</td>
<td>$35.00</td>
<td>$945</td>
</tr>
</tbody>
</table>

**Total Incremental Cost:** $3,375
### Structural Insulated Panels

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Nominal</th>
<th>Whole-Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5''</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>6.5''</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td>8.25''</td>
<td>31</td>
<td>28</td>
</tr>
<tr>
<td>10.25''</td>
<td>39</td>
<td>36</td>
</tr>
</tbody>
</table>

R-values [ft$^2$ hr°F/Btu]
Similar to Conventional Const.

Exterior:
- Siding
SIPs: Key Differences

- Panelized Construction
- Electrical
SIPs: Key Differences

- Panelized Construction
- Electrical
# EPS SIPs: Cost Example

<table>
<thead>
<tr>
<th>Wall System</th>
<th>Whole-Wall R-value [ft² hr°F/Btu]</th>
<th>Installed Cost</th>
<th>Incremental Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x6 Frame Wall</td>
<td>17</td>
<td>$3,662</td>
<td>-</td>
</tr>
<tr>
<td>8.25&quot; SIP</td>
<td>28</td>
<td>$5,120</td>
<td>$1,458</td>
</tr>
<tr>
<td>10.25&quot; SIP</td>
<td>36</td>
<td>$5,920</td>
<td>$2,258</td>
</tr>
</tbody>
</table>

Estimated costs for a reference wall, 100 linear feet, 8’ tall.
Summary

Double Walls
• Most similar to conventional framing;
• Framing labor dominates incremental costs.

Exterior Foam
• Similar to frame construction;
• Material costs dominate.

SIPs
• Very different from frame construction
• With experience, SIP construction is VERY fast.
Cost Summary

• $1,900 - $3,400 incremental cost range for 100’ wall (well along learning curve).

• Cost and practicality are very dependent on simplicity of design.

• Planning and details are key!
Thank You

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