ADVANCED ENERGY
EFFICIENT ROOF SYSTEM

Agreement Number (DE-FC26-04NT42114)
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December 6, 2007
A Better Performing Roof

- Mechanical system and ducts located in unconditioned attic
- Up to 3 days erection time requiring skilled labor
- Loose fill insulation has gaps and thermal bridges
- Construction waste

- Mechanical equipment in conditioned attic saves 30-35% of energy for space conditioning*
- Off-site manufacture and ½ day field installation
- Open attic space
- Reduced on-site construction waste
Down-selected Panel Concepts

**Truss Core Panel**
- Structure does not depend on plastic foam insulation
- Well understood structural component
- Joints don’t affect R value
- Low risk for long life

**Foam-integrated Panel**
- Integrates structural and thermal components
- Similar in manufacture to a SIP
- May provide easier installation
- Reliance on plastic foam for structural integrity carries more risk
Stiffened Plate Roof Panel Design Options

A

PUR

Top face sheet

Steel deck structure

Steel face sheet

B

C
Created Design Tools

Models to predict …

Structural Performance

Thermal and Moisture Performance

$\Delta R/R = 56\%$

Buckling
Investigated Many Options

Roof geometry and Loads

- Snow load > 3350 N/m² (70 psf)
- Live load based on wind load

Materials

- Insulation: PUR, EPS, XPS
- Structural materials: metal, fiber reinforced plastic, wood

Web configurations

Developed Detailed Panel Designs
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Cooling dominated climate, truss core

TOP FACESHEET: 14 GAGE (2.0MM) GALVANIZED STEEL

WEB: 22 GAGE (0.85MM) GALVANIZED STEEL

BOTTOM FACESHEET: 22 GAGE (0.85MM) GALVANIZED STEEL

DETAIL A
SCALE 3 : 20

NOTES:
1. THIS DIMENSION REFERS TO THE HEIGHT OF THE WEB FROM THE TOP OF ONE FLAT TO THE BOTTOM OF THE OTHER FLAT.
2. CONTINUOUS WELD WEB TO FACESHEET

Truss Core
Structural Component
PUR Foam Insulation
Gypsum Board Interior Finish

268.80 (22 FT 0 INCH)

96.00 (8 FT)
Architectural Details
cooling dominated climate

Ridge

Soffit
Prototyping and Testing

Lab scale testing

Full scale testing to failure, >20,000 lbs sand
Summary of Test Results

<table>
<thead>
<tr>
<th>Design Criteria</th>
<th>Model</th>
<th>Measured</th>
<th>Measured/Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection Stiffness (kip-in(^2))</td>
<td>656E3</td>
<td>671E3</td>
<td>1.02</td>
</tr>
<tr>
<td>Face Sheet Wrinkling Moment Capacity (k-in)</td>
<td>Pinned</td>
<td>107</td>
<td>1.75</td>
</tr>
<tr>
<td>Web Buckling at Support Reaction (lbs)</td>
<td>770</td>
<td>1268</td>
<td>1.65</td>
</tr>
</tbody>
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Conservative modeling assumptions lead to safe panel design.
Project Status

- Created design tools
- Applied tools to various scenarios to develop panel designs
- Architectural details for heating and cooling dominated climates
- Identified possible manufacturing partners
- Prototyped and completed testing (validated models)
- Developed a new prototype with emphasis on foam integrated designs
- Cost modeling and market analysis