Sustainable Housing: Reconstruction in the Gulf Coast



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Outline

- Background
- Materials evaluation sheets
- Panels
- Testing
- Building codes
- Building details
- Future work

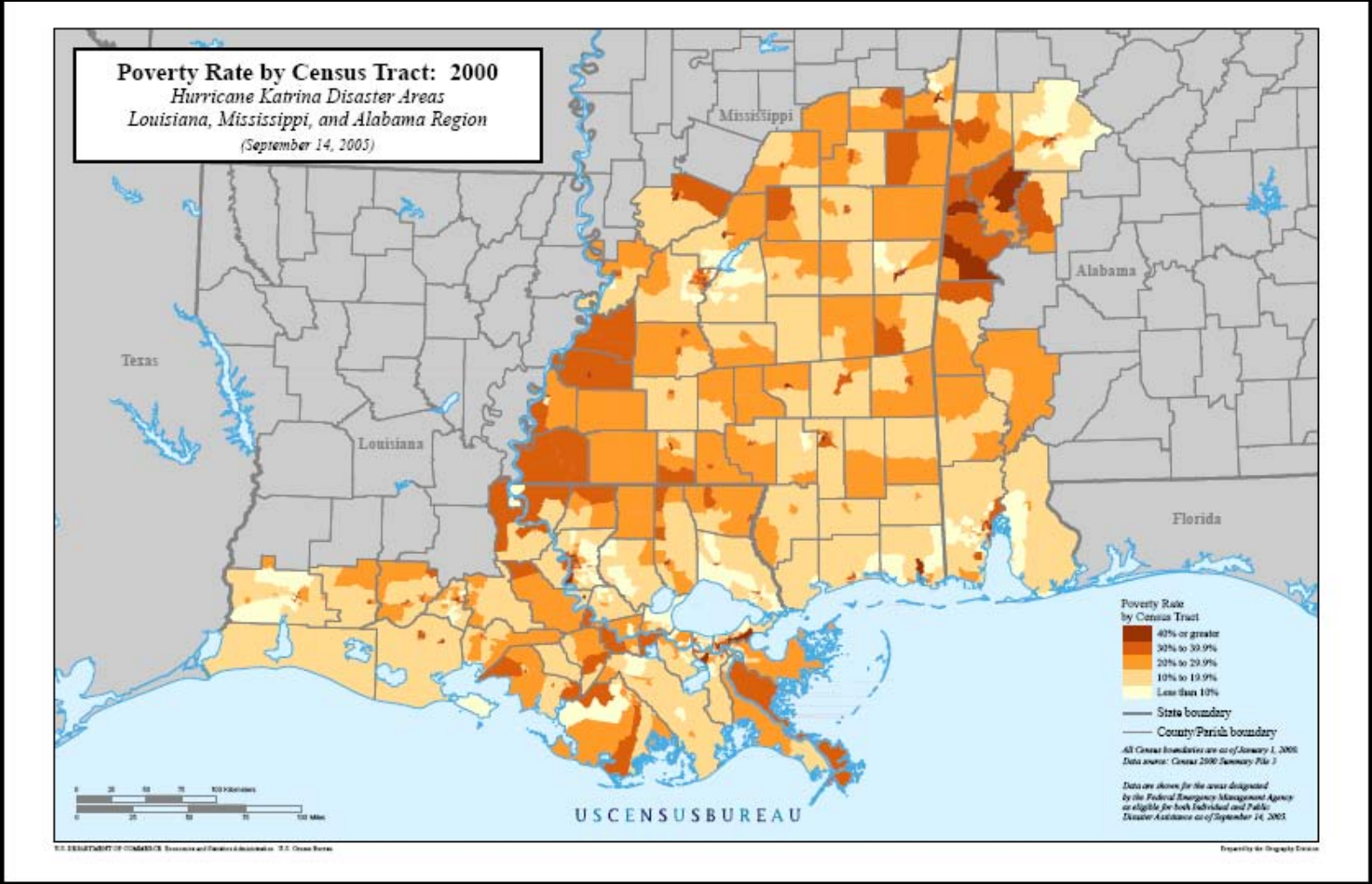
Hurricanes Katrina and Rita

High winds
Rain
Flooding
Lowlands experienced extreme damage

The Community

Constraints
- -Money
- -Knowledge
- -Resources

Assets
- -Time
- -Community



What do individuals rebuilding need to know?

Building Concerns

- Water issues
- Health
- Durability
- Cost and construction
- Regional issues
- How to prevent future damage

Slidell and Lower Ninth Ward
www.davidmetraux.com

When do they need to know it?

- FEMA maps
  - Final maps to be released August 2006
  - Maps dictate insurance and rebuilding funding
- Building permits in New Orleans
  - No adherence to New Urbanist redevelopment plan

FEMA trailers Biloxi
www.fema.gov

Rebuilding Update

- FEMA decisions, April 2006
  - Katrina was a “one-time” event
  - Houses must be built 3 feet above ground

Original Project Goal

- Fill knowledge gap
  - Provide easily accessible information for decision making
- Target audience
  - Builders
  - Individuals
  - Non-profits

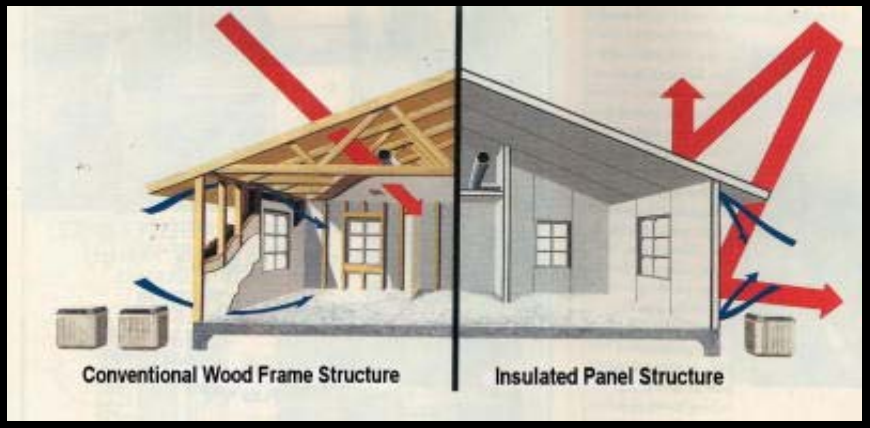
Refining the Project Context

- Collaborations and Conversations
  - Federation of American Scientists
    - Baton Rouge demonstration house
    - Home Depot Foundation grant
  - Building inspection department, Baton Rouge
  - Home Depot, Baton Rouge
  - New Orleans Housing Resource Center
- Daily news articles
  - Permitting, flood insurance

FAS housing technology project

- Baton Rouge House
  - Demonstration house
  - Funding for envelope
- Houston House
  - Demonstration 2000 sf house
  - Fully funded
- Turkey, Afghanistan
  - Planning stages

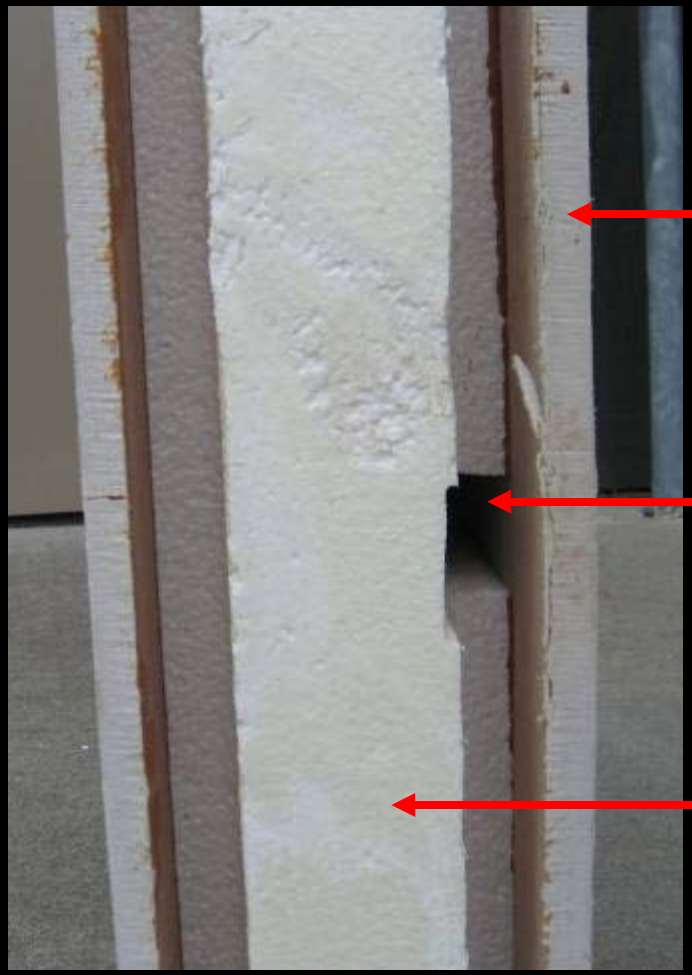
www.thermasave.com



www.cleanhouston.org

ThermaSAVE Panels

- Made from:
  - EPS foam core
  - (coffee cups)
  - Cementitious outer skin
- Sustainability?
  - EPS Foam issues
  - Cement issues
  - Assembly issues



Project Goals

Materials evaluation

Panel testing

Building code study

Building details study

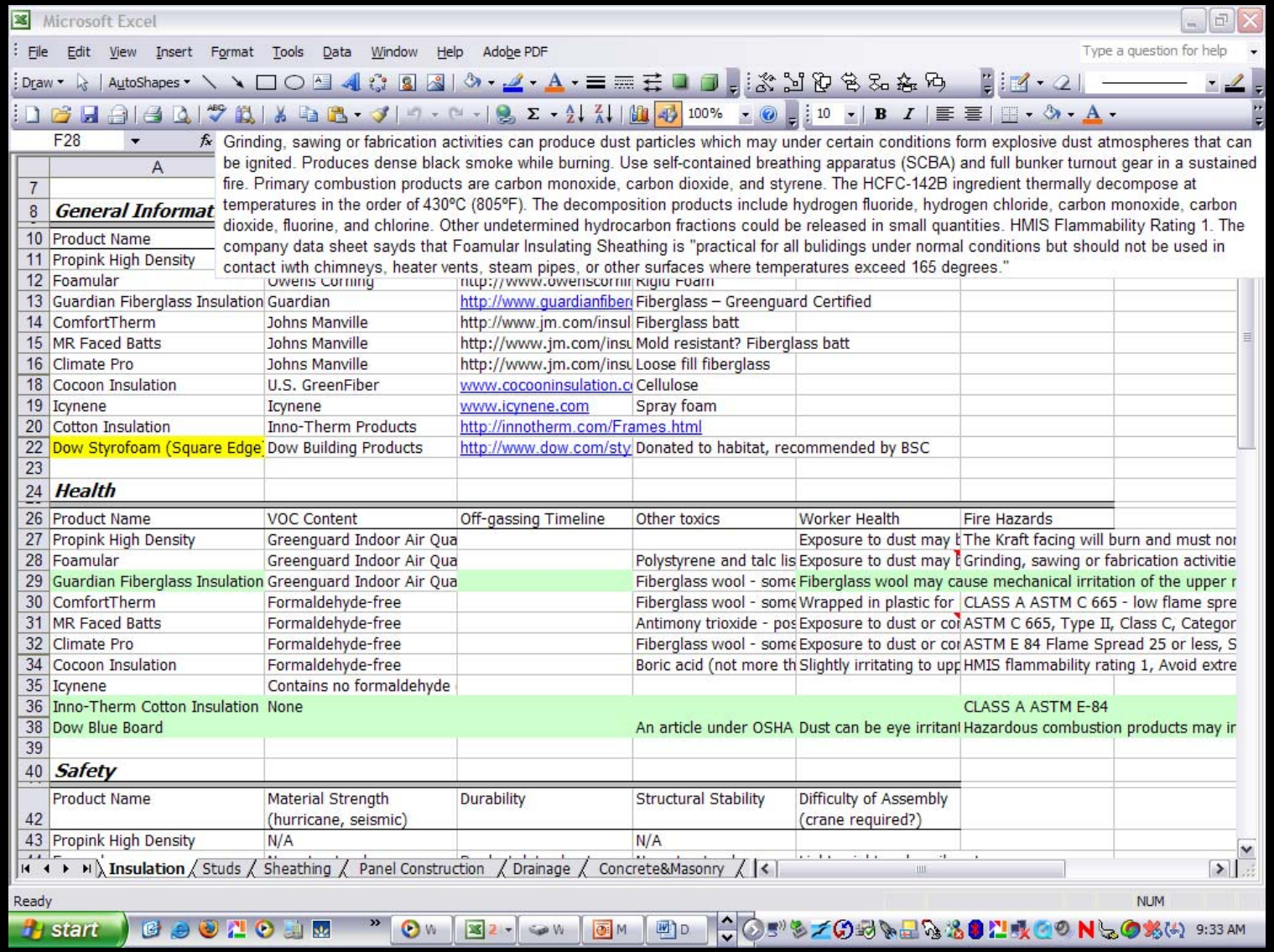
Materials Evaluation

- Objective
  - To provide information to help homeowners and builders prioritize material purchase
- Main criteria: health, safety, cost, locally appropriate, green
- Rating System
- References
  - Company product websites
  - PATH, NAHBRC
  - Environmental Building News
  - Others

Materials Evaluation

- "Consumer Reports" style
  - Use existing information to evaluate building materials
  - User-friendly format for help with decision-making
  - Criteria to cover wide array of concerns
  - Analyze commonly used and alternative materials for structure, skin and foundation (no interiors)

Preliminary Materials Evaluation



Microsoft Excel

File Edit View Insert Format Tools Data Window Help Adobe PDF

F28: Grinding, sawing or fabrication activities can produce dust particles which may under certain conditions form explosive dust atmospheres that can be ignited. Produces dense black smoke while burning. Use self-contained breathing apparatus (SCBA) and full bunker turnout gear in a sustained fire. Primary combustion products are carbon monoxide, carbon dioxide, and styrene. The HCFC-142B ingredient thermally decompose at temperatures in the order of 430°C (805°F). The decomposition products include hydrogen fluoride, hydrogen chloride, carbon monoxide, carbon dioxide, fluorine, and chlorine. Other undetermined hydrocarbon fractions could be released in small quantities. HMIS Flammability Rating 1. The company data sheet sayds that Foamular Insulating Sheathing is "practical for all bulidings under normal conditions but should not be used in contact iwth chimneys, heater vents, steam pipes, or other surfaces where temperatures exceed 165 degrees."

	A					
7						
8	***General Informat***					
10	Product Name					
11	Propink High Density					
12	Foamular	Owens Corning	http://www.owenscorni	Rigid Foam		
13	Guardian Fiberglass Insulation	Guardian	http://www.guardianfiber	Fiberglass – Greenguard Certified		
14	ComfortTherm	Johns Manville	http://www.jm.com/insul	Fiberglass batt		
15	MR Faced Batts	Johns Manville	http://www.jm.com/insu	Mold resistant? Fiberglass batt		
16	Climate Pro	Johns Manville	http://www.jm.com/insu	Loose fill fiberglass		
18	Cocoon Insulation	U.S. GreenFiber	www.cocooninsulation.c	Cellulose		
19	Icynene	Icynene	www.icynene.com	Spray foam		
20	Cotton Insulation	Inno-Therm Products	http://innotherm.com/Frames.html			
22	Dow Styrofoam (Square Edge	Dow Building Products	http://www.dow.com/sty	Donated to habitat, recommended by BSC		
23						
24	***Health***					
26	Product Name	VOC Content	Off-gassing Timeline	Other toxics	Worker Health	Fire Hazards
27	Propink High Density	Greenguard Indoor Air Qua			Exposure to dust may b	The Kraft facing will burn and must no
28	Foamular	Greenguard Indoor Air Qua		Polystyrene and talc lis	Exposure to dust may b	Grinding, sawing or fabrication activitie
29	Guardian Fiberglass Insulation	Greenguard Indoor Air Qua		Fiberglass wool - some	Fiberglass wool may cause mechanical irritation of the upper r	
30	ComfortTherm	Formaldehyde-free		Fiberglass wool - some	Wrapped in plastic for	CLASS A ASTM C 665 - low flame spre
31	MR Faced Batts	Formaldehyde-free		Antimony trioxide - pos	Exposure to dust or cor	ASTM C 665, Type II, Class C, Categor
32	Climate Pro	Formaldehyde-free		Fiberglass wool - some	Exposure to dust or cor	ASTM E 84 Flame Spread 25 or less, S
34	Cocoon Insulation	Formaldehyde-free		Boric acid (not more th	Slightly irritating to upp	HMIS flammability rating 1, Avoid extre
35	Icynene	Contains no formaldehyde				
36	Inno-Therm Cotton Insulation	None				CLASS A ASTM E-84
38	Dow Blue Board			An article under OSHA	Dust can be eye irritant	Hazardous combustion products may ir
39						
40	***Safety***					
42	Product Name	Material Strength (hurricane, seismic)	Durability	Structural Stability	Difficulty of Assembly (crane required?)	
43	Propink High Density	N/A		N/A		

Insulation / Studs / Sheathing / Panel Construction / Drainage / Concrete&Masonry

Ready NUM

start 9:33 AM

Final Materials Evaluation Format

Insulation	HEALTH	VOC Content	Non-Toxic	Worker Health	Fire Safety	SAFETY	Material Strength	Durability	Structural Stability	Ease of Disposal	COST	Unit Cost	Do it Yourself?	Easy to Use?	Equipment?	Contractor?	Maintenance	Thermal Performance	LOCAL	Performance After Flood	Permits Drying	Mold Resistance	Termite Resistance	Local Acceptance	GREEN	Recycled Content	Renewable Material?	Resource-Efficiency Potential	Locally Manufactured?
Propink High Density	□	◘	?	□	※	?		?		□	□	?	Y	Y	N	N		◘	□	□		□		□	□	◘	N		
Foamular	□	◘	□	□	×	◘		◘		□	◘	$	Y	Y	N	N		■	□	◘	※	◘		□	□	◘	N	Y	
Guardian Fiberglass Insulation	□	◘	□	□	?	?		?		□	□		Y	Y	N	N		□	?	?		?		□	□	□	N	Y	N
ComfortTherm	◘	◘	□	◘	□	□		□		□	□	?	Y	Y	N	N		□	□	□		◘		□	□	◘	N	Y	
MR Faced Batts	□	◘	※	□	□	□		□		□	?		?	?	?	?		?	□	□	□	◘		□	□	◘	N	Y	
Climate Pro	◘	◘	□	□	□	□		□		□	※		N	N	Y	Y		※	□	□		?		□	□	◘	N	?	
Cocoon Insulation	□	◘	□	□	※	□		□		□	※	$	Y	N	Y	N		□	※	×		□		※	◘	■	Y	Y	
Icynene	?	◘	?	?	?	◘		◘		□	※	$	N	N	Y	Y		□	◘	□	◘	◘	◘	?	□	□	N	Y	
Cotton Insulation	■	■	?	■	□	?		?		□	□		Y	Y	N	N		□	?	?		?		※	◘	■	Y	Y	
Dow Blue Board	※	?	※	※	×	◘		◘		□	?		?	?	?	?		◘	□	?		◘		□	?	□	N	?	

LEGEND	
■	Excellent
◘	Above Average
□	Standard
◊	Below Average
×	Poor
$	Low to Average Cost
$$	High to Average Cost
?	Inconclusive Information
{Blank}	Undetermined

Materials Evaluation Discussion

Lessons learned

- Moisture-resistant materials are not warrantied for flood conditions (drywall example)
- Toxicity of some materials increases in flood conditions (cellulose with boric acid)
- More expensive materials do not necessarily perform better (felt vs. housewrap)
- Some unexpected materials were very appealing for certain reasons (aluminum)

Joints and Assembly Tests

- Existing ThermaSAVE panels
- Existing OSB panels
- Assembly
- Conduit routing test
- Water test

ThermaSAVE Panels

- General
- Delamination
- Cracks
- Conduit




OSB Panels

General

Corner

Conduit

Assembly

Routs are often too wide on both types of panels

Routs are often not deep enough on either

Panels are hard to square, even on 2’ lengths

ThermaSAVE cracks easily

ThermaSAVE

OSB SIP

Conduit Routing Test

Where do you put the electrical wiring in SIPs?

- Code says 1.25” from nailing surface

User adaptation test (unapproved routing method)

Conduit Routing Test


ThermaSAVE



OSB SIP

Water Joint Test

Results

- No water leaked through
- Water soaked into OSB panel, beaded on ThermaSAVE

ThermaSAVE

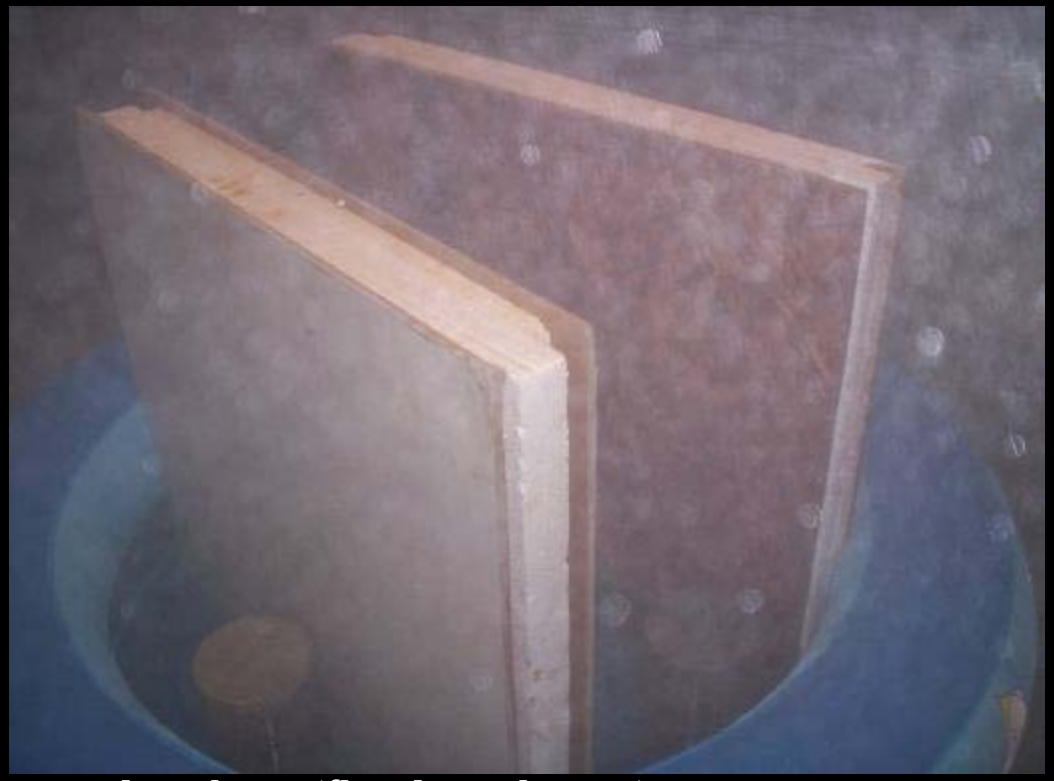
OSB SIP

Diagonal Load Test

- Compare the strengths of panels exposed to humidity and bulk moisture
- Six total panels
  - Three OSB, three ThermaSAVE
    - Panel 1: Control, left dry
    - Panel 2: Moisture chamber (95% humidity)
    - Panel 3: Partially submerged in pool, also in moisture chamber

Diagonal Load Test

Panel preparation (day 4)



Partial soaking (flood conditions)

ThermaSAVE (95% humidity)

OSB SIP (95% humidity)

Diagonal Load Test

Initial observations:

- Panels float (OSB more easily)
- Panels grow mold
- OSB expands when wet
- Both panels wick moisture

Diagonal Load Test

After 35 days:






Diagonal Load Test

Step 1: Inspect the panel

Step 1a: Cut down ThermaSAVE panels

Diagonal Load Test

Step 2: Drill holes for bolts

Step 3: Attach steel loading shoes with hydrostone

Diagonal Load Test

Step 4: Attach gauges to measure vertical and horizontal deflection

Vertical gauges measure vertical shortening

Horizontal gauges measure elongation due to shearing

Diagonal Load Test

Step 5: Apply load until the panel fails



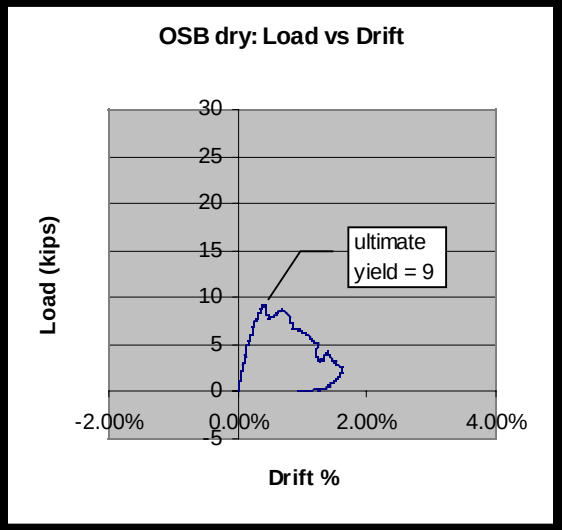


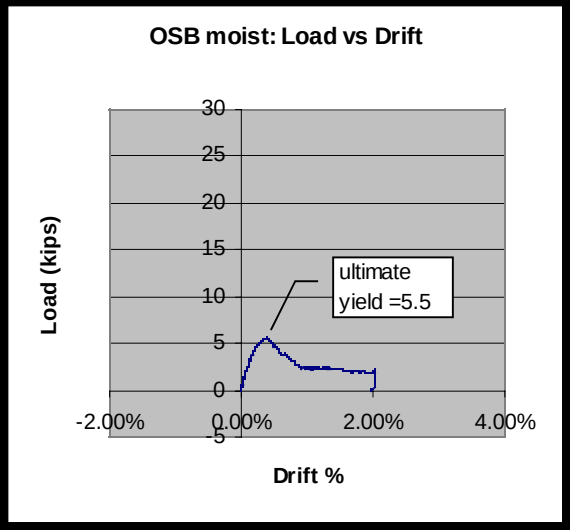

Diagonal Load Test

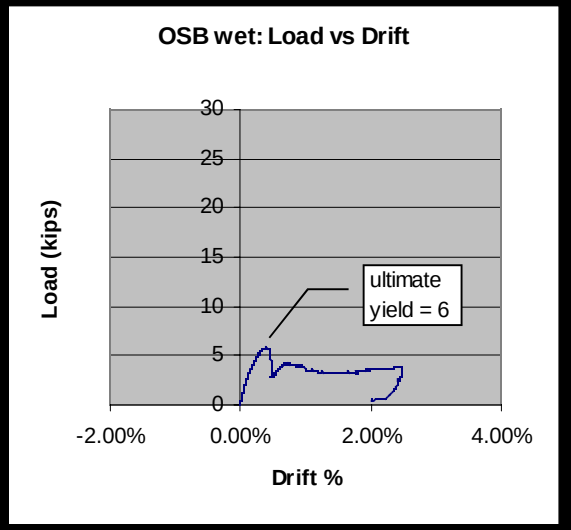
Recorded load, time, horizontal, and vertical displacement data for each panel test

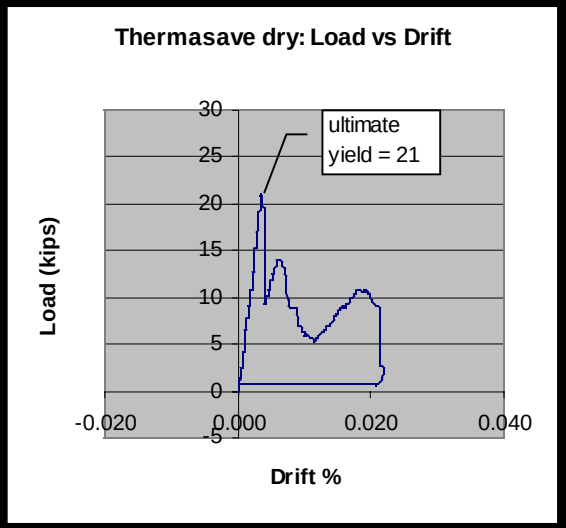
Calculated percentage drift, an approximation of each panel's shear deformation

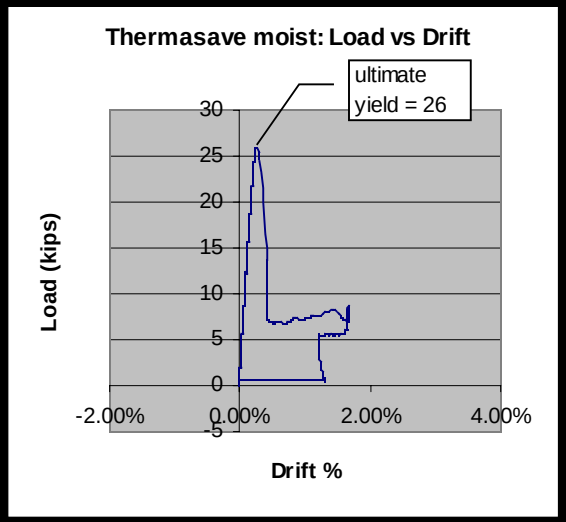
Diagonal Load Test

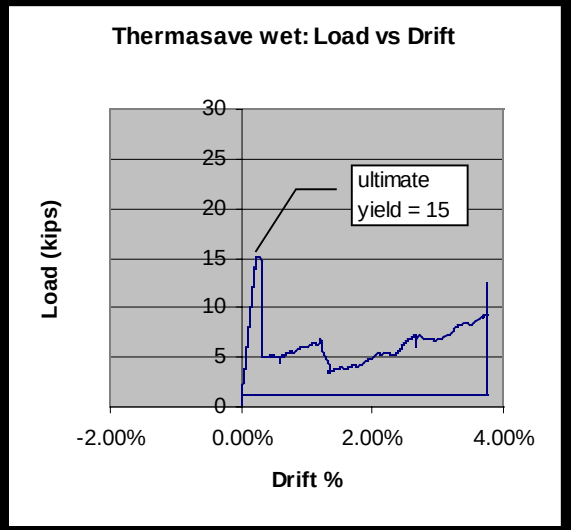












Diagonal Load Test

ThermaSAVE panels yielded at loads 2 to 4 times greater than the yield points for the comparable OSB panels

Diagonal Load Test

It is reasonable to assume that moisture and saturation decrease strength in the OSB panels by separating bonds within the material.

Diagonal Load Test

A possible “fuzzy” explanation for ThermaSAVE is that the water in the moist panel reacted with the cement material, producing hydration products which increased its strength. Too much water decreased bonding within the material.



Building Code Study

- Phone calls
- Florida code changes after hurricanes
  - Impact of poor construction
- Informs building details study
  - Fire, wind, rain, flood, termites, and moisture

Building Details

Defined detail categories

- Roof to wall connections
- Window flashing
- Sill termite flashing
- Foundation drainage and insulation

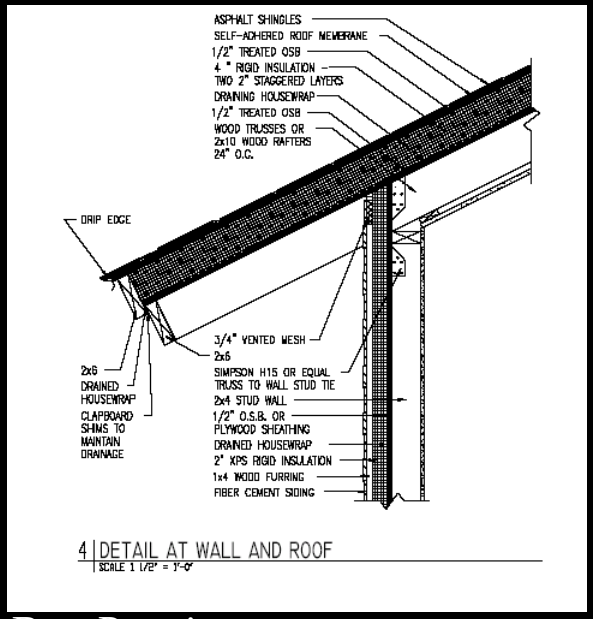
Evaluated building details

- Fire, wind, rain, flood, termites, and moisture

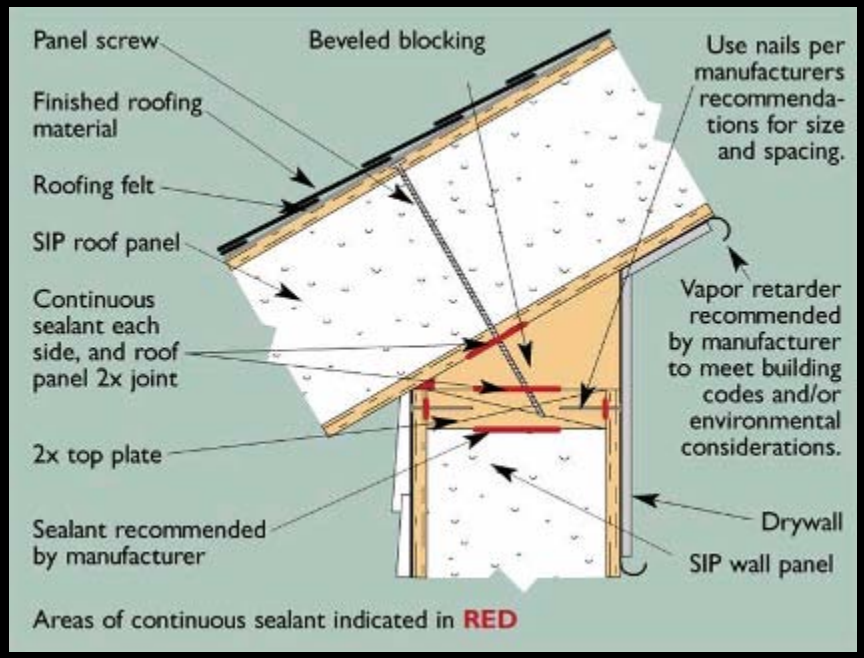
Building Details

Evaluated advantages and disadvantages for all

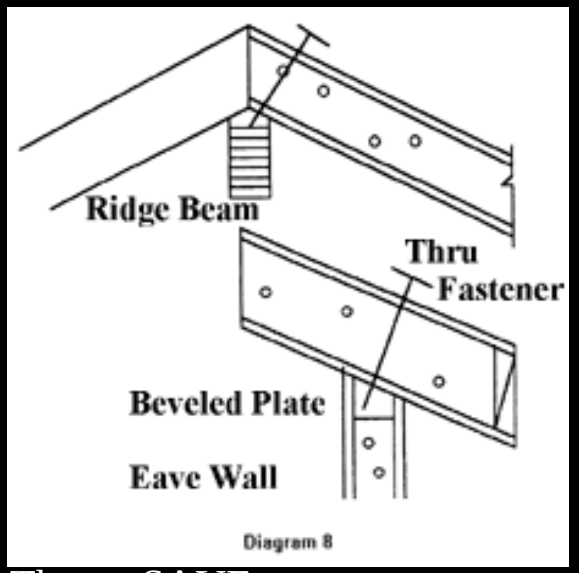
Made specific recommendations for use of ThermaSAVE panels



Best Practice
Building Science Corp.



OSB SIPS
Detail from SIP Association



ThermaSAVE
Company website

ThermaSAVE Discussion

Joints

Air and moisture sealing

An air sealing detail with intentional ventilation is needed

The leakage for a standard panel assembly, with and without caulking, should be determined

Can ThermaSAVE panels be reused if the structure has been air-sealed?

ThermaSAVE Discussion

Joints

Splines

The depth and width of the panel routs were significantly different than the dimensions of the supplied splines

The stated reason for this is that the panels should be pulled together tightly; it would be difficult to do this while keeping panels square and not cracking the edges

Workers may need tools on site to melt out deeper routs

ThermaSAVE Discussion

Joints

Splines

The splines are supposed to be the same fiber cement material as the panel skin

If OSB splines are used on site out of convenience, will the swelling of OSB due to moisture cause the edge of the panel to crack?

ThermaSAVE Discussion

Joints

Splines

There is concern about an Oak Ridge National Laboratory study rumored to show that expansion on contraction of panels wears down the fiber cement around screws

ThermaSAVE Discussion

Moisture Management

Panels as structure and skin

The structural integrity of ThermaSAVE does not seem to be compromised by prolonged exposure to humidity or standing water

ThermaSAVE panels do mold in humid conditions – this implies that cladding with a drainage plane is necessary

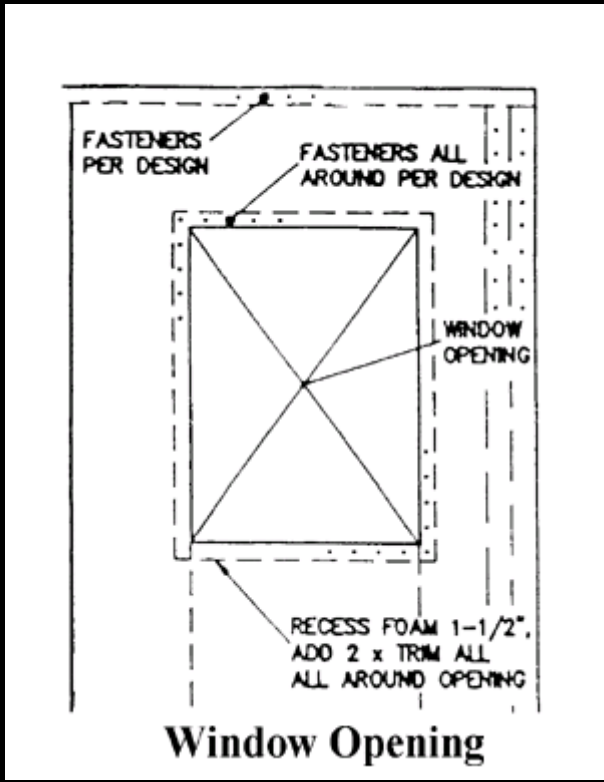
ThermaSAVE Discussion

Moisture Management

Window flashing

A set of window flashing details needs to be developed to avoid pouring water into the window frame

Window installation instructions should be developed that address air sealing of the rough opening around a window



Window Opening

ThermaSAVE Discussion

Moisture Management

Sill Detail

Even if no drainage plane is used, a termite flashing detail is still necessary

ThermaSAVE Discussion

Electrical Conduit

Electrical runs must be either 1 ¼” from a nailing surface or covered with 16 gauge metal

The routs on the ThermaSAVE panel were only ½” from the nailing surface

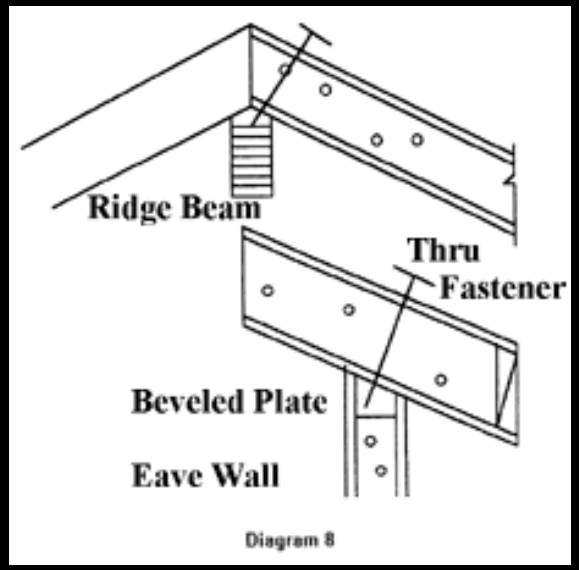
ThermaSAVE Discussion

Structure

Ridge (roof)

A ridge beam is visible in ThermaSAVE details – is this beam necessary? How are the panels joined and sealed at the ridge?

What material is used in the routs at ridge and eave? Are there expansion and contraction issues?



Recommendations for Future Work

- Joint ponding test
- Effects of spline expansion and contraction
- Wind uplift on roof to wall connection
- Window flashing details
- Further evaluation of panel connections
- Monitoring of test houses

Acknowledgments

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Building Codes Office, Baton Rouge

UC Berkeley Engineers for a Sustainable World

Lawrence Berkeley National Laboratory

US Department of Energy

Questions?

The New York Times, January 26, 2006

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