

Overview of Solid Panel Structure (SPS) System



- Patrick Huelman & Tom Schirber
 - Cold Climate Housing Program
 - Bioproducts & Biosystems Engineering
 - University of Minnesota

- An Novel Building Technology ...
 - “Studless” Wall System
 - Thin-wall / Monocoque / Plate / Tilt-Up
 - SEP (Structural Engineered Panel)

Short History on Solid Panel Houses in MN



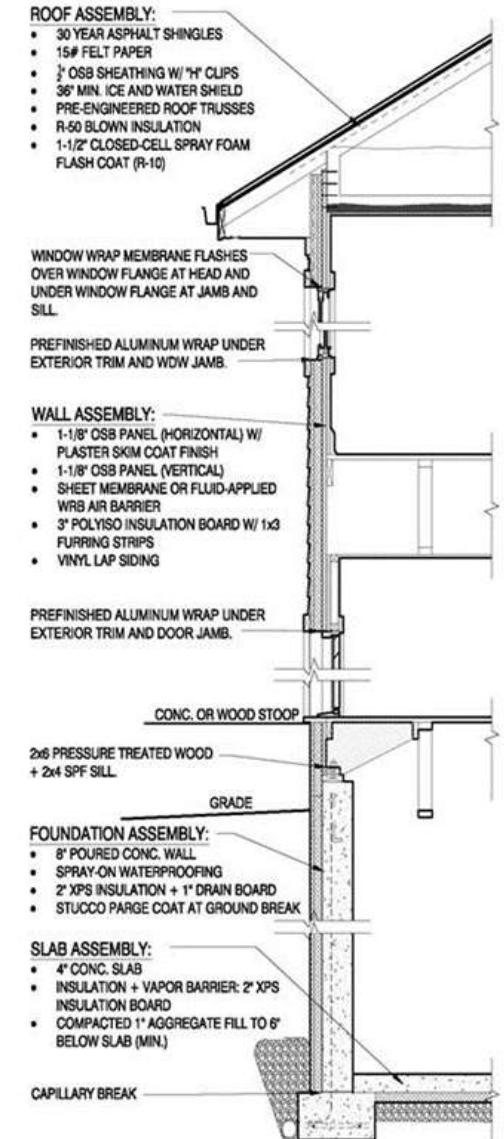
- Pre-UMN: Rob Leslie develop 3-ply panel using 1/2" OSB
- House 1 (2002): 2-ply panel using 3/4" OSB
- House 2 (2003): 1-ply vertical panel using 1-1/8" OSB w/ battens at seams
- House 3 (2004): 1-ply vertical panel using 1-1/8" OSB w/ battens, shear wall & stair
- House 4 (2006): 2-ply cross-laminated panel using 1-1/8" OSB

MonoPath Solid Panel Houses (2014)



- Cedar 2.0
- Two story
- 3 bedroom
- 24' x 32'
- Full basement
- 7 houses completed

- Builder: MonoPath
- Architects: CSI
- Developer: Spero
- Engineers: MMY



MonoPath Video Time Lapse



“Affordable Solid Panel “Perfect Wall” System”

- Funding from DOE Building America program in 2016
- Real world validation of cost and performance with focus on affordable housing
 - completed five SPS houses and two stud-frame comparison houses
- Preliminary structural testing at Home Innovation Research Labs



DOE High-Performance Home Challenge

Context: For decades, the “perfect wall” has been recognized as an optimal path to robust, high-performance, moisture managed, and energy-efficient walls.

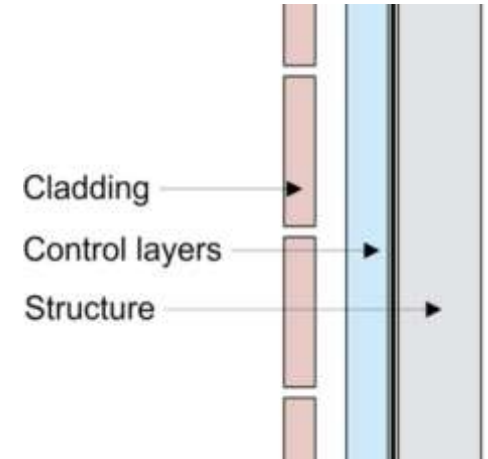
- Critical control layers (water, air, vapor, thermal)
- Placed on the exterior of the structural system
- The same wall system can work in all climate zones

Problem: Adoption of the “perfect wall” by the home building industry has been incredibly slow due to:

- Perceived complexity
- Trades and labor challenges
- Higher initial construction costs

Solution: An innovative building system and delivery approach based on “perfect wall” principles that is quicker and less expensive to build.

- Labor savings gained from the building system and its delivery approach
- Provides savings to pay for high-performing control layers
- To deliver a more efficient, robust, and resilient home



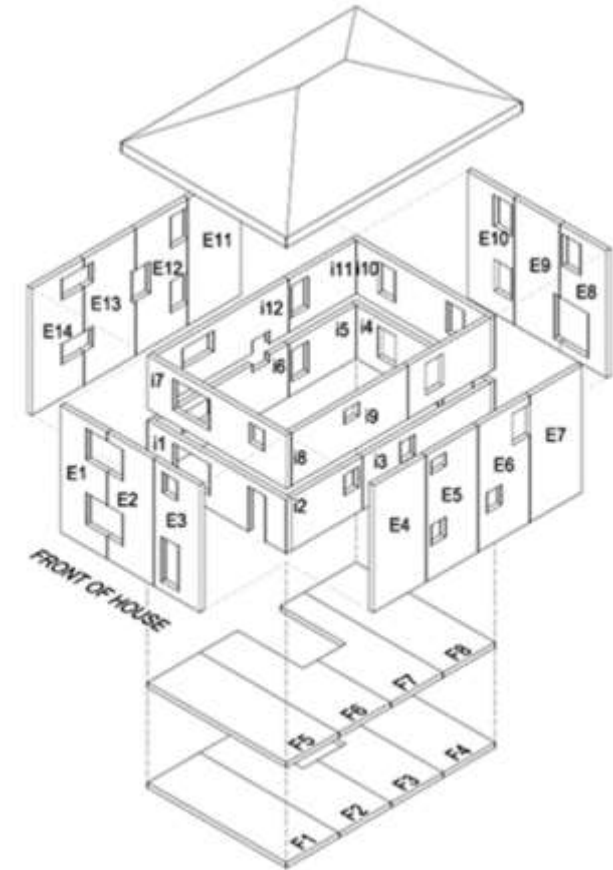
Can the SPS system provide better performance at lower cost?

Research Hypotheses: This solid panel system ...

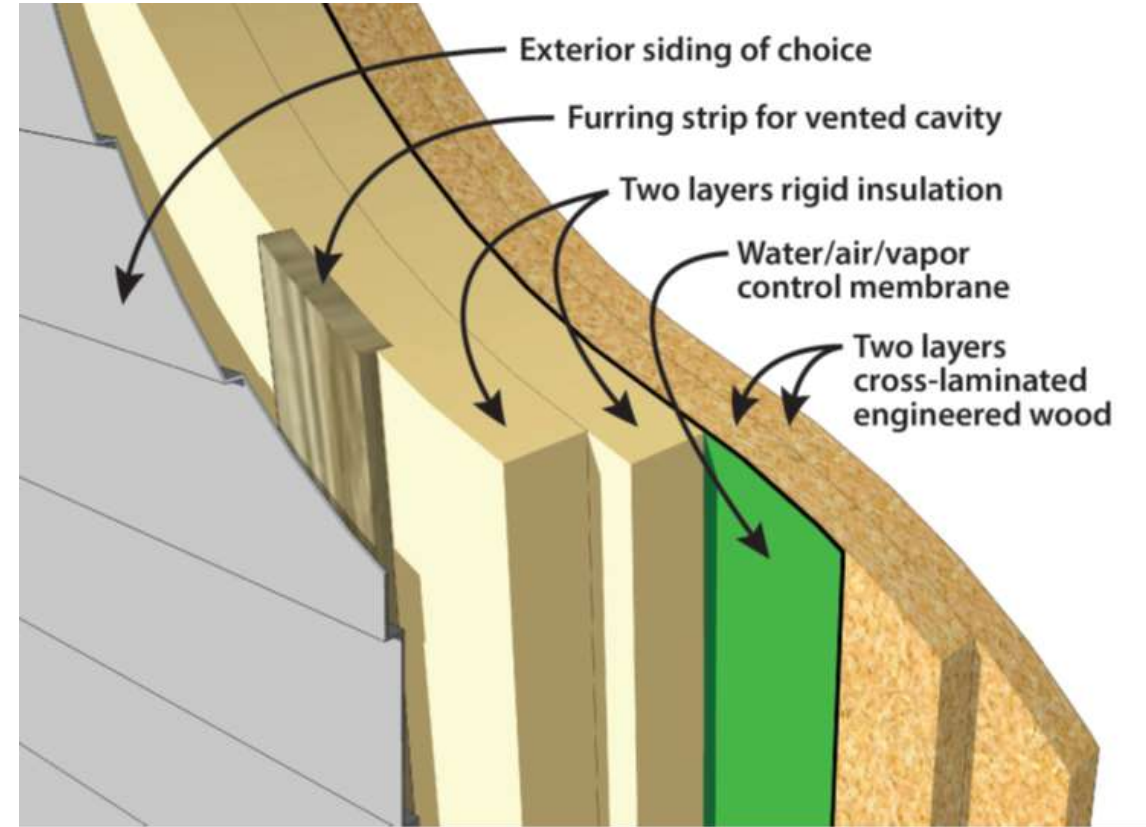
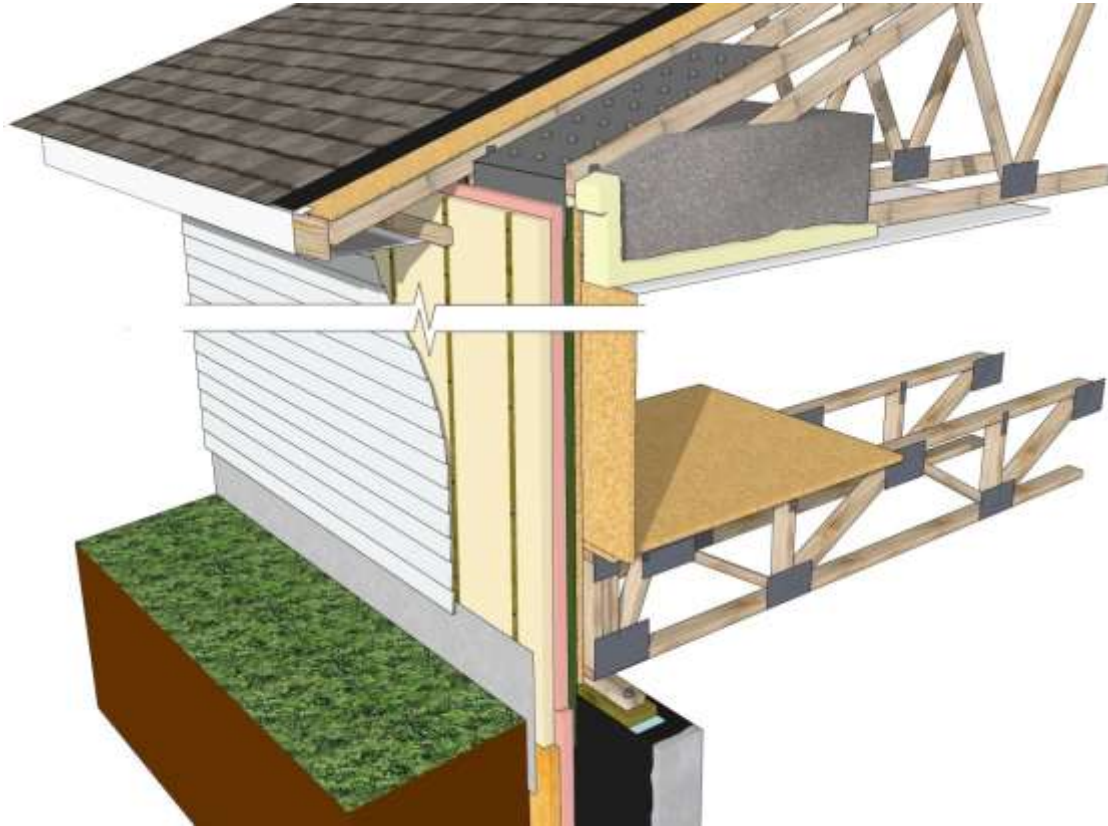
- Will outperform conventional wood-frame construction at a lower cost,
- Will ensure better QA/QC and lower builder risk, and
- Can deliver cost-effective Zero Energy Ready Homes for affordable housing.

Outcomes: Validation of this innovative enclosure and delivery system

- Project to model, measure, and compare the SPS system to stud frame for:
 - performance (energy, moisture, air)
 - constructability and quality control
 - costs (materials, labor, etc.)
- Demonstrate market acceptance of the SPS system with a focus on affordable housing.



Solid Panel Structure (SPS) System



Foundation with Exterior Control Layers



Receiver Plate and First Floor Joisted Installed



Framing Day 1

First Floor Sheathing Installed



Framing Day 2
Crane Arrives

Exterior Vertical Panel Corners are Installed (plumb, level, & square)



Framing Day 2

First Floor Interior Horizontal Panels Installed



Framing Day 2

Second Floor Trusses and Sheathing Installed



Framing Day 2

Second Floor Interior Horizontal Panels Installed



Framing Day 2

Remainder of Exterior Vertical Panels are Installed



Framing Day 2

Roof Truss Installed (inside of exterior panel)



Framing Day 2
Crane Leaves

Roof Sheathing and Building Paper On (dried in)



Framing Day 2

Windows and Door Openings Cut



Framing Day 2

All Wall Penetrations are Pre-located and Cut



Framing Day 2

Fully-Adhered Membrane is Installed (as the water, air, and vapor control layer)



Control Layers 1

Windows Installed and Integrated w/ Membrane



Control Layers 2

Exterior Insulation Installed (2 layers w/ Furring)



Control Layers 3

Exterior Finishes are Completed



Interior Finishes & Electrical



Innovative SPS System Supports Outstanding Air/Energy/Moisture Performance

House	Builder	Enclosure Type	Blower Door Test Results			HERS	Conditioned Shell Area - sf
			ACH@50	cfm@50	cfm@50Pa per sf shell		
2313 James	TC-Habitat for Humanity	Solid Panel System	0.26	88	0.019	41	4563
3015 Thomas	TC-Habitat for Humanity	Solid Panel System	0.41	140	0.031	39	4563
2954 Morgan	TC-Habitat for Humanity	Solid Panel System	0.44	146	0.032	39	4563
952 Farrington	Urban Homeworks	Solid Panel System	1.01	404	0.089	43	4563
1317 Thomas	Urban Homeworks	Solid Panel System	1.11	379	0.083	38	4563
115 Magnolia	Spero Builders	Solid panel	1.16	368	0.081	42	4547
433 Sherburne	Spero Builders	Solid panel	1.25	428	0.094	42	4547
582 York	Spero Builders	Solid panel	1.30	445	0.098	47	4547
587 Reaney	Spero Builders	Solid panel	0.64	203	0.045	41	4547
687 Edmund	Spero Builders	Solid panel	1.03	318	0.070	47	4547
706 Charles	Spero Builders	Solid panel	1.60	250	0.056	47	4547
706 Thomas	Spero Builders	Solid panel	1.16	231	0.051	47	4547
736 Desota	Spero Builders	Solid panel	0.65	207	0.050	41	4547
762 Lafond	Spero Builders	Solid panel	1.16	292	0.050	46	4457
904 Geranium	Spero Builders	Solid panel	1.00	317	0.070	42	4547
687 Edmund	Spero Builders	Solid panel	1.03	318	0.070	47	4457

“Accelerating the Adoption of the SPS System”

- Second round of funding from DOE Building America program in 2019
- Primary focus on structural testing at Home Innovation Research Labs that will:
 - support code acceptance
 - facilitate widespread adoption
- Develop simplified engineering calcs and prepare the way for ICC-ES approval
- Preliminary investigation of the SPS system for use in multifamily buildings



SPS Testing Plan

Developed by Jay Crandell, ARES, for the University of Minnesota and to be executed at the Home Innovation Research Labs.

- OSB Material Properties – 30 (small specimen) tests
- In-Plane Shear (Racking) Load Resistance – 8 full-scale tests
- Bending & Axial
 - 2-Ply Bending Stiffness & End Moment Fixity – 37 tests
 - 2-Ply Axial Point Load Buckling Interaction – 5 tests
 - SPS Header Beam Behavior – 24 tests (lack sufficient funds)
 - SPS Header End Reaction and Buckling Interaction – 24 tests (lack sufficient funds)
- Whole Building Tests (on hold; requires additional funding)

Wrap-Up

SPS is an innovative “building & delivery system” for the future of high-performance houses in the U.S.!

- Questions & Discussion
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