Passive House

An introduction to Western Technical College's wood built high performance building envelope project

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STRUCTURES with INTEGRATED PASSIVE HOUSE TECHNOLOGY

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In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

"This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1.5 hours** of credit toward **Building Officials and Residential Contractors** continuing education requirements."

For additional continuing education approvals, please see your credit tracking card.

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Todays Learning Objectives

- Examine the history of the Passive House movement
- List the standards for Passive House building
- Identify components of a Passive House envelope system
- Understand the importance of analysis and testing
- Explore energy consumption in residential buildings
- Examine the building materials of a passive house mock up
- Compare energy modeling to actual energy consumption

What is Passive House?

- Heard of it?
- What do you already know?
    1. Very little—just heard about it today
    2. Some knowledge, but have some gaps
    3. Feel comfortable with the Passive House Standard
    4. I know more than this Bozo, wish someone else was presenting

Passive House History

- 1973 oil crisis
- Increased transportation costs
- Residential heating costs also soar

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Illinois Lo-Cal House

- Wayne Schick’s team @ Urbana
- Small footprint
- Utilize sun’s energy for heating
- High insulation levels
- Passive Solar Movement

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Passive House Europe

Darmstadt-Kranichstein House

- Dr. Wolfgang Feist
- Early 1990s
- 60-70% total energy savings
- 80-90% total heating savings
- Passive House Institute (**PHI**) established 1996

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Passive House United States

- Katrin Klingenberg, Urbana, Illinois in 2003
- Stephan Tanner, BioHaus @ Concordia Language Village, 2006
- PHIUS 2007!
- Western Technical College starts 1st project: 2012

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Passive House Design

- Robust, continuous thermal insulation
- Air Tight
- Moisture management
- High performance windows
- Constant (low volume) fresh air supply

A new standard for building

- Passive House
  - R-values:
    - Slab:39
    - Basement wall: 39
    - Walls: 58
    - Roof: 89
  - 0.6 ACH_{50}
  - 4.75KBTU/ft^2/yr
  - Energy/moisture analysis: WUFI passive
  - Air exchange: Balanced using ERV/HRV

- MN Code Built
  - R-values:
    - Slab: 10
    - basement wall: 15
    - Walls: 20
    - Roof: 49
  - 3 ACH_{50}
  - 38 KBTU/ft^2/yr
  - Energy/moisture analysis: none
  - Air exchange: Balanced

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A new standard for building

- Passive House
  - R-values:
    - Slab:39
    - Basement wall: 39
    - Walls: 58
    - Roof: 89
  - 0.6 ACH_{50}
  - 4.75KBTU/ft^2/yr
  - Energy/moisture analysis: WUFI passive
  - Air exchange: Balanced using ERV/HRV

- WI Code Built
  - R-values:
    - Slab: 0
    - basement wall: 10
    - Walls: 20
    - Roof: 39
  - 3 ACH_{50}
  - 48 KBTU/ft^2/yr
  - Energy/moisture analysis: none
  - Air exchange: Exhaust only…

Why Passive House Standard?

- Resource management
- Energy security
- Extremely low carbon footprint

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Why Passive House Standard?

- Comfort
  - Thermal performance
  - Terrific IAQ
  - Quiet
  - Draft free
- Durability
  - Vapor open assemblies
  - Air tight
  - Tested and verified
- Affordability
  - 80% total energy savings
  - 90% Heating/cooling savings

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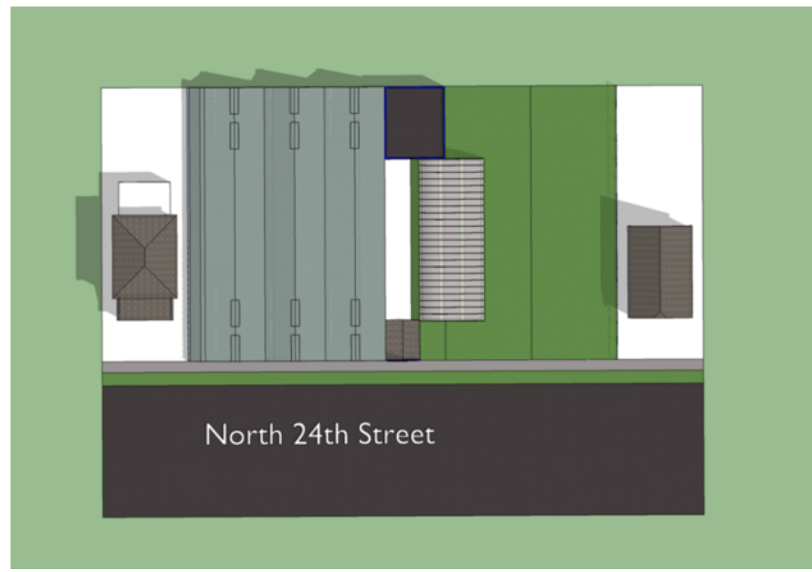
Western's SWiPHT Project

- Existing Greenhouses
- 3 lots, requiring re-zoning
- Chimney swifts
- Neighborhood near Western Technical College and UW-La Crosse



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SWiPHT House

- Pre-design: Fall 2012
- Design: Spring 2013
- Site Prep: Fall 2013
- Main Structure: Spring 2014
- Finishes: Summer 2014

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Western Technical College Goals

- Sustainability is one of our *values*
- Build three Passive Houses
- Student involvement
- Curriculum integration
- Broad Community Partnerships

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Envelope Elements: Slab

- All envelope elements must reflect:
  - Air tightness
  - Robust thermal performance
  - Continuity of both

Slab details, continued

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Basement Walls

- Thermal layer is connected to under slab thermal layer
- Air tight layer is connected to the under slab polyethylene

Basement Walls, continued

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Basement walls, continued

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Above grade, wood frame

- 2x6 interior load bearing wall
- Advanced Framing techniques
- OSB sheathing for air tight layer (taped and sealed)
- Exterior balloon frame with 14" i-joists
- Fiber board exterior sheathing
- Dense pack cellulose
- Arguably the most challenging assembly…

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Some more wall details: air sealing strategies

Top and bottom plates receive a continuous bead of sealant, as do all openings and penetrations

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More Wall details

Foundation/wall connection

14” i-joists, balloon framed--exterior

Above Grade Walls, continued

14” I-joist balloon frame

Dense Pack Cellulose, fiberboard and Tyvek (note the furring strips for air gap)

Above grade walls, continued

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Roof System

- 12/12 pitch for optimum PV
- 24” energy heel
- ¾” plywood
- Ice and water shield
- Zinc standing seam roof

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More roof details

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Roof Details Continued

- Sheeting the “A” truss

- Peel and stick ice and water shield

Roof/wall connection

- OSB is also the air tight layer for the roof system (taped and sealed)
- 24” of loose fill cellulose for thermal performance

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Roof/wall connection

- 2x6 framing chase to run HVAC, electricity
- Dense packed
- 5/8" sheet rock to finish

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Windows and doors

- Low U-values: 0.125
- SHGC: 55 (requires shading in summer months)
- Triple pane
- Robust weather stripping
- Tilt/turn
- Integrated installation
- Wrapped insulation
- Exterior roll-down shutters

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Windows and doors, cont.

- Take advantage of southern exposure
- Some doors are actually large tilt/turn windows
- Mounted in center of wall assembly:
  - Better thermal performance and comfort—always within 7.2 degrees F of interior air temp.

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Air tightness

- Rough-in blower door test
- Target:
    - 109 CFM_{50} or .3ACH_{50}
- Achieved:
    - **117 CFM_{50} or .32 ACH_{50}**
- Theater smoke and IR cameras to find leaks
- Tape and sealant to tighten the envelope

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Smoke Test/IR

After interior finishes are complete, the final blower door test is completed by a HERS rater

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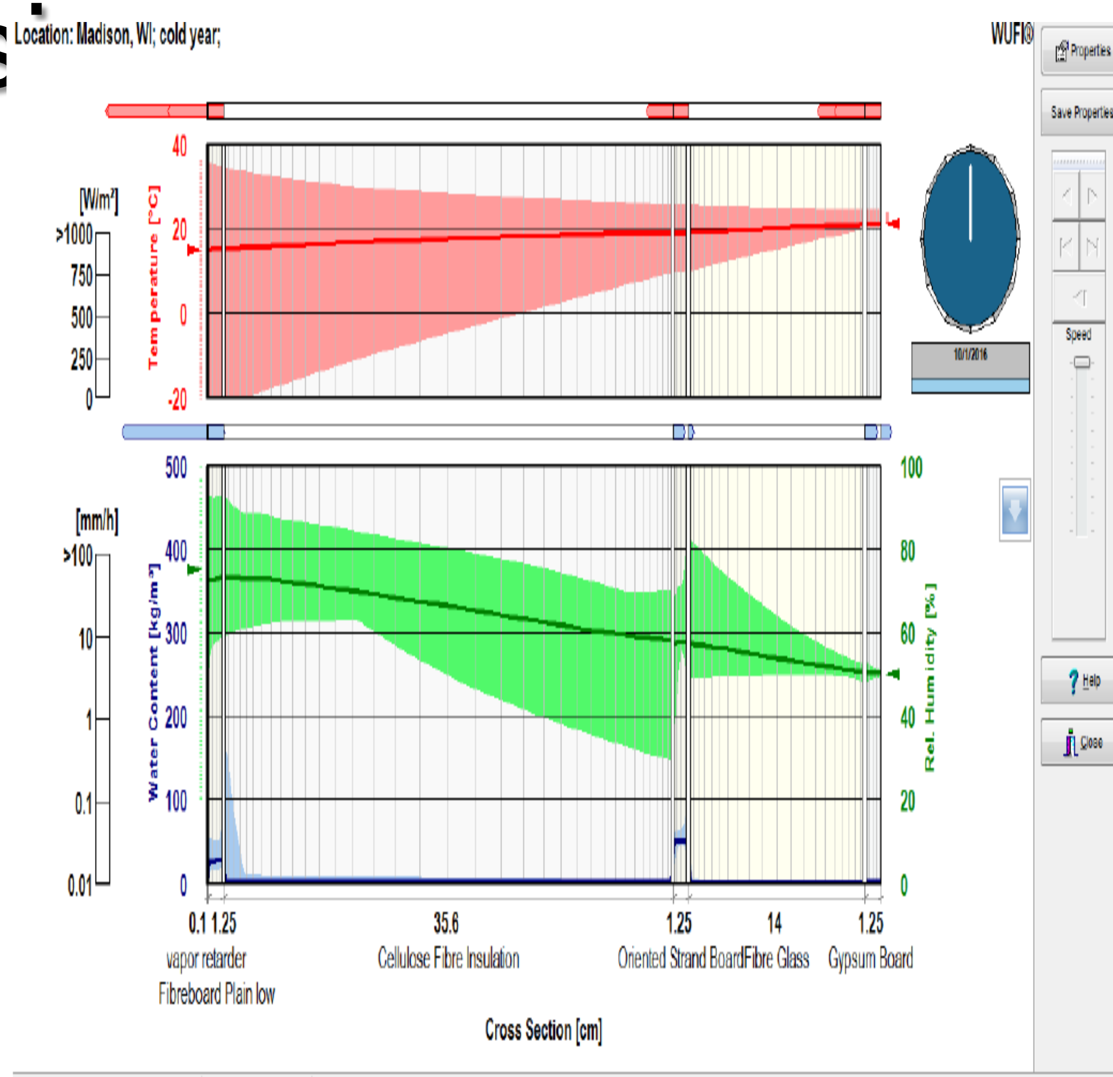
Durability Checks

- Thermal Bridge free
- Vapor open
- Tested and verified
  - Through energy modeling
  - WUFI: Dynamic hygrothermal modeling
  - THERM: thermal bridge analysis

WUFI Analys

- Hygrothermal analysis
  - Red= temperature
  - Green= relative humidity
  - Blue=water
- 2 years of weather and indoor conditions: dynamic modeling
- Durability checks—assures assemblies are able to dry



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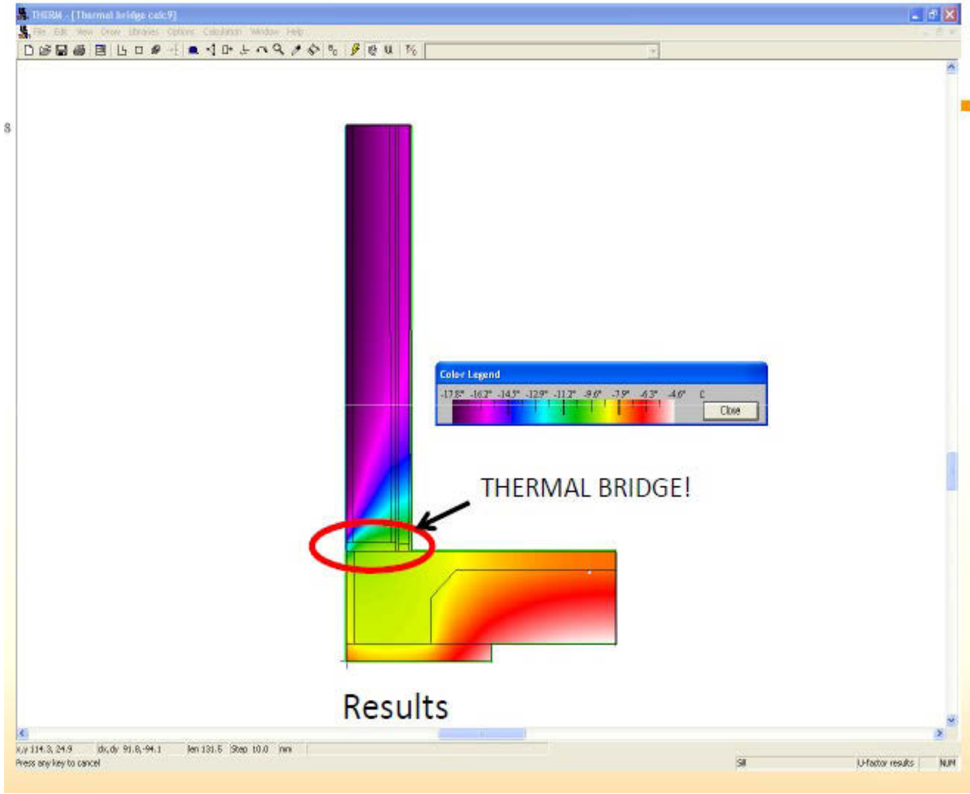
THERM Analysis

- Verify thermal bridge free envelope assemblies
- Required when thermal bridging is a concern and/or an unproven assembly
- Point and linear thermal bridge guidelines



More Passive House Information

- Western's SwiPHt website:
  - http://www.westerntc.edu/swipht/
- Western's SwiPHt Blog:
  - http://swiphthomes.wordpress.com/
- Passive House Institute United States:
  - http://www.passivehouse.us/passiveHouse/PHIUSHome.html
- Passiv Haus Institute:
  - http://passiv.de/en/