



Learning to Breathe Again

ICAA


Orlando, FL

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Learning Objectives

- Examine the relationship between heat flow, air flow and moisture flow
 - Discuss how the building code addresses each of the above and how recent changes to the code could potentially reduce building durability
 - Review the four key mechanisms of moisture flow in buildings in order to explain how things get wet and how things dry
 - Describe some of the properties of building materials that play an important role in moisture management
 - Explain the concept of safe moisture storage
 - Discuss how insulation assemblies can help prevent wetting while promoting drying
- 



AGENDA

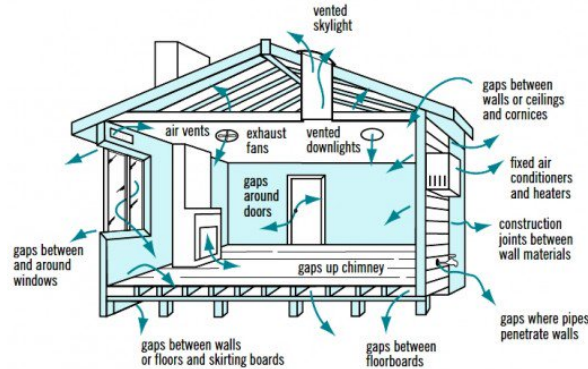


1. Review the three basic “physics flows” that drive the movement of heat, air, and moisture through building assemblies
2. The residential building code is challenged to find a balance of these flows amid the increasing demands of “the energy code” (IECC)
3. You must consider a building materials heat, air, and moisture resistance properties in concert or you could get wet
4. Most building materials can accommodate some moisture- how much and how to predict
5. Applied knowledge: how insulation is like beer- both the cause and solution to all our problems?
6. Conclusions

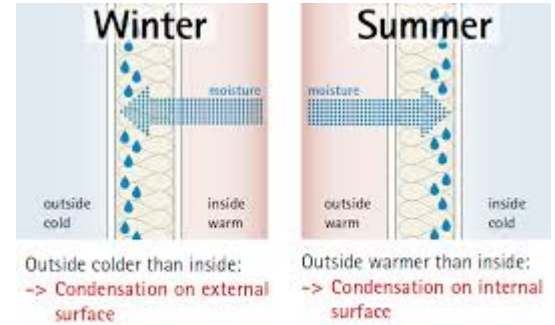
Reviewing the three flows:



Heat Flow



Air Flow



Moisture Flow

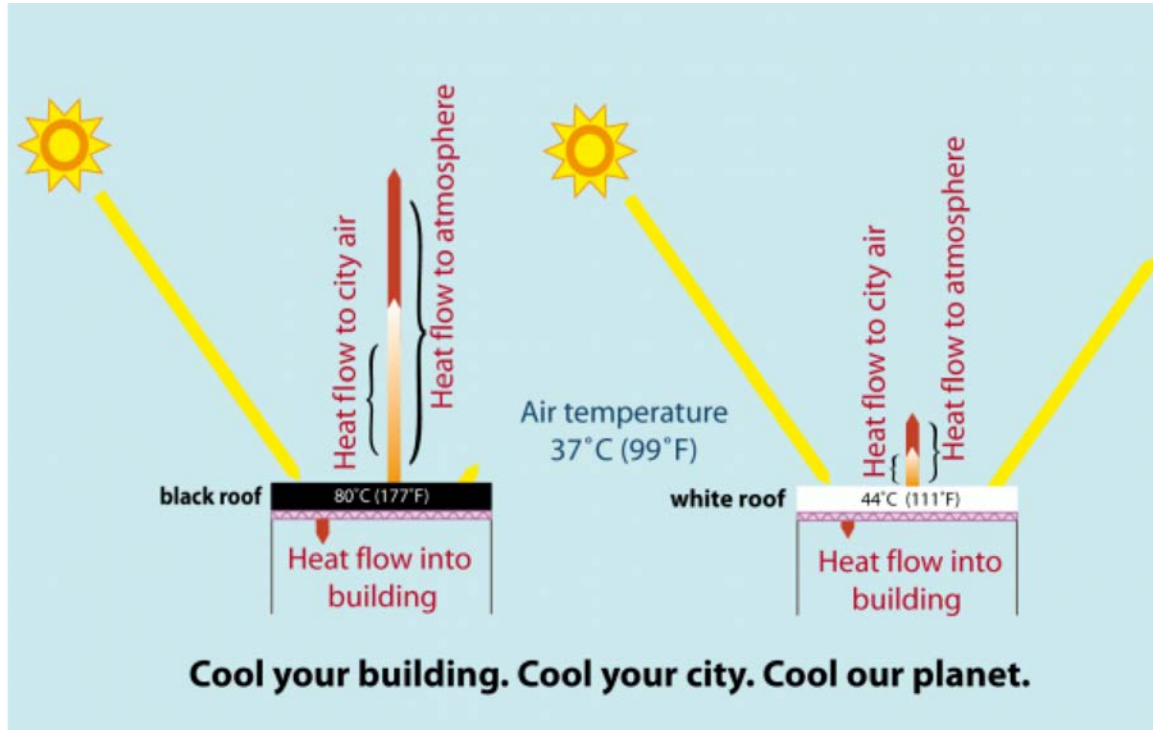
Reviewing heat flow



Reviewing heat flow



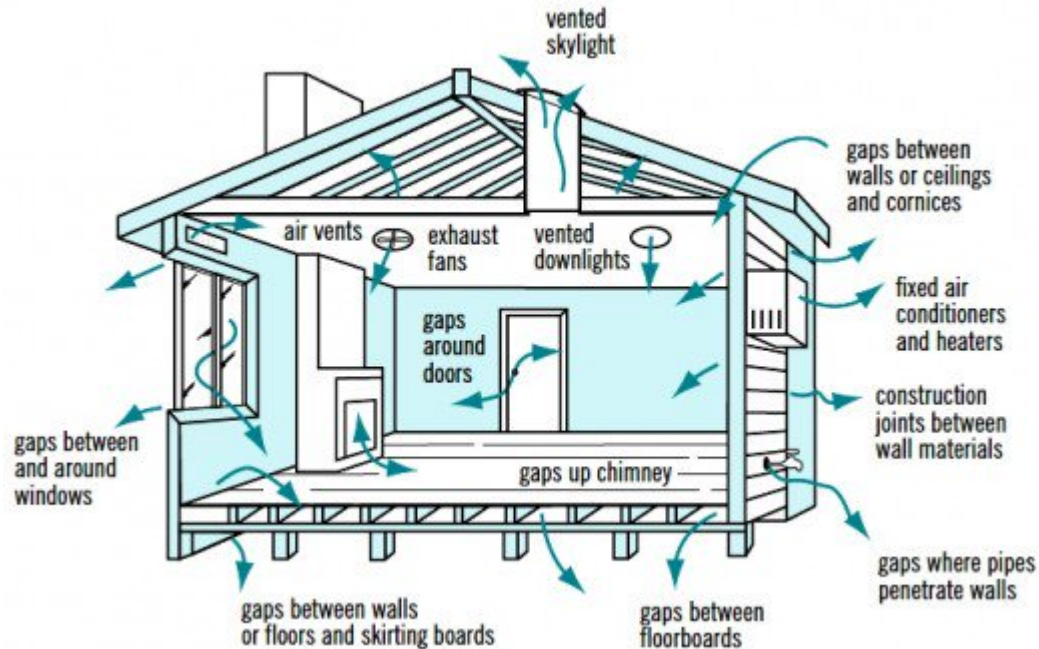
Reviewing heat flow



Reviewing heat flow



Reviewing air flow



Reviewing air flow



Stack Effect



**Flue and Ventilation
Effects**

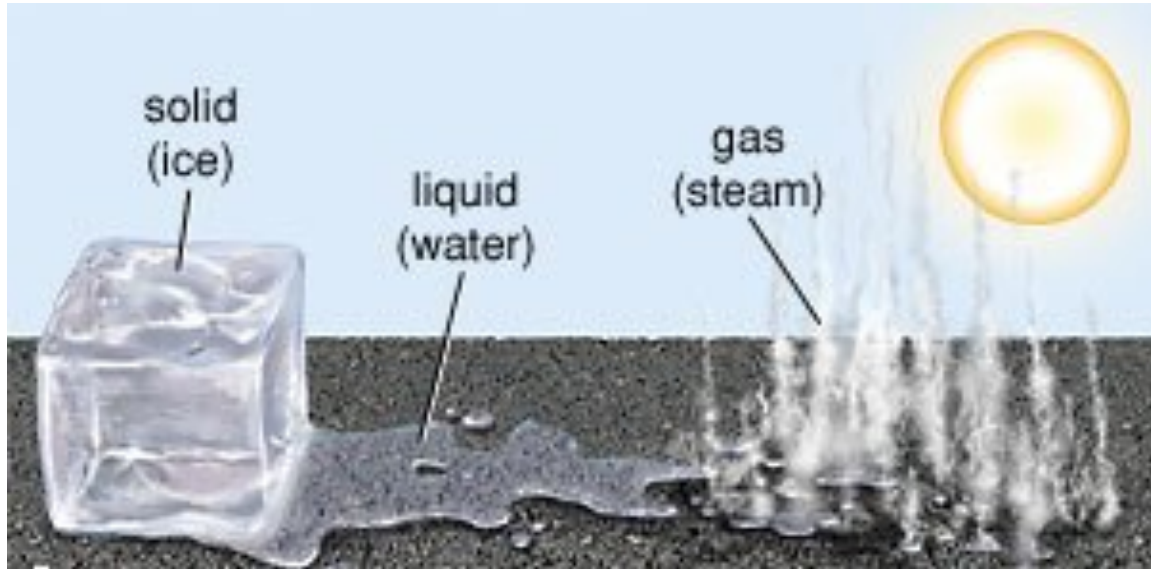


Wind Effect



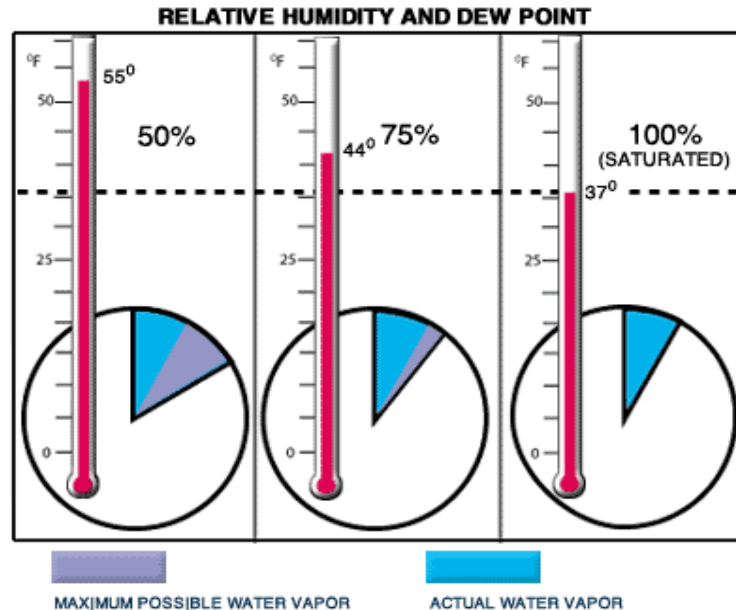
System Effect

Reviewing moisture flow



Reviewing moisture flow

Dew Point: In base terms, it is the temperature at which a given mass of water in the air will form condensation or “dew”. It’s like being at 100%RH and then dropping the temperature 1 degree



Reviewing moisture flow

Water Flow

Gravity moves rainwater down the building's exterior surfaces

- Water will enter downward-sloped openings

- Storm water runoff can flow against buildings and seep in to basements

Minimize water flow against the building

Foundation drainage systems

Use shingles and flashings to keep rainwater out of joints

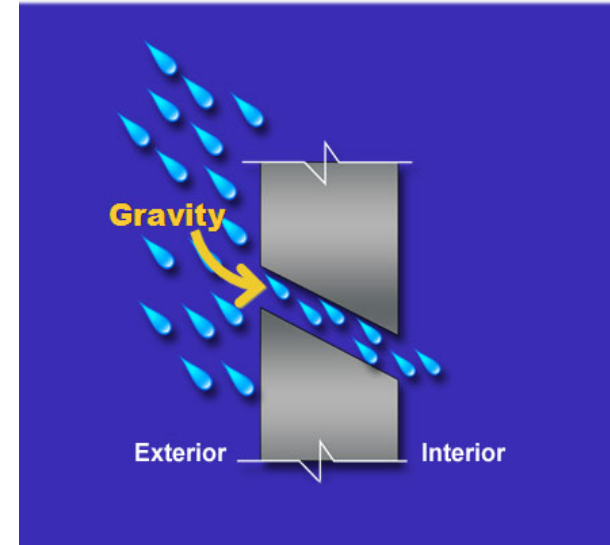
- Overlap the components

- No reversed laps

- Drainage holes

- Protect vertical joints

Illustration of Gravity Flow Through a Wall Opening



Reviewing moisture flow

Airborne Moisture Flow

Air flow carries moisture into buildings

Construction practices can prevent openings

The volume of moisture entering a building by air flow can be 100 times greater than by diffusion

Diffusion through a 4 x 8 sheet of painted gypsum board is about 1/3 quart of water over a heating season in a cold climate

Air flow through a 1-inch hole can add up to 30 quarts!

Airborne Moisture Transport Potential



Reviewing moisture flow

Capillary Suction

Caused by surface tension of water

Causes water to be drawn in through tiny pores in building materials

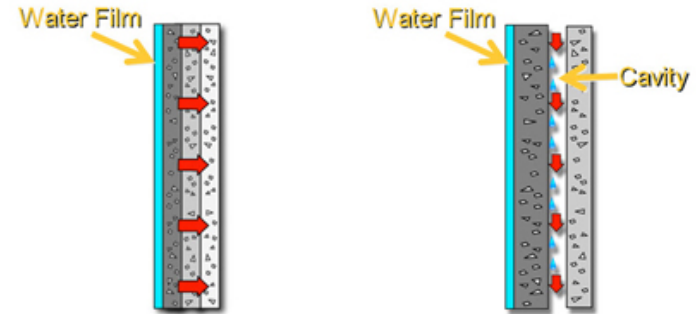
To prevent capillary flow, create breaks in the components

Even very narrow spaces work

Should drain and vent to the exterior so drying can occur

Moisture tolerant materials like concrete and masonry help prevent capillary flow

A Capillary Break Protects Building Materials From Absorbing Moisture



Capillary suction, caused by water surface tension, draws water into porous material and tiny cracks

Create capillary breaks to protect building materials from absorbing moisture

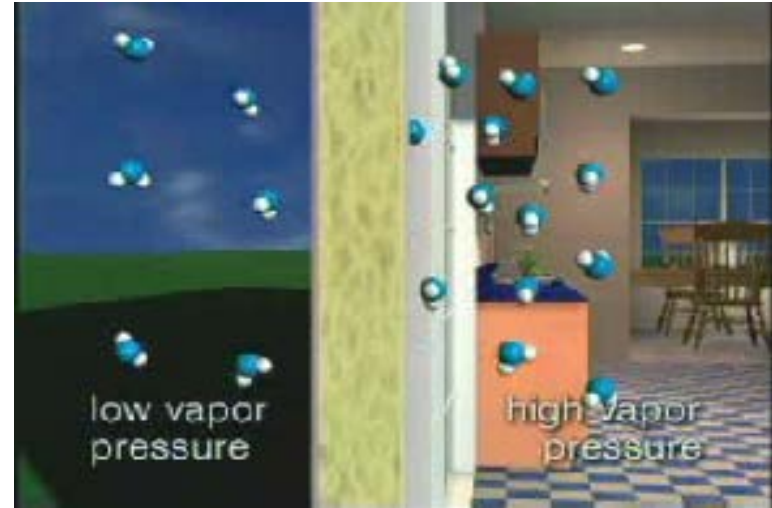
Reviewing moisture flow

Diffusion

The movement of moisture through a substance

This kind of moisture movement due to difference in vapor pressure

Moisture diffuses through a wall to equalize differences in vapor pressure



The building code challenge:

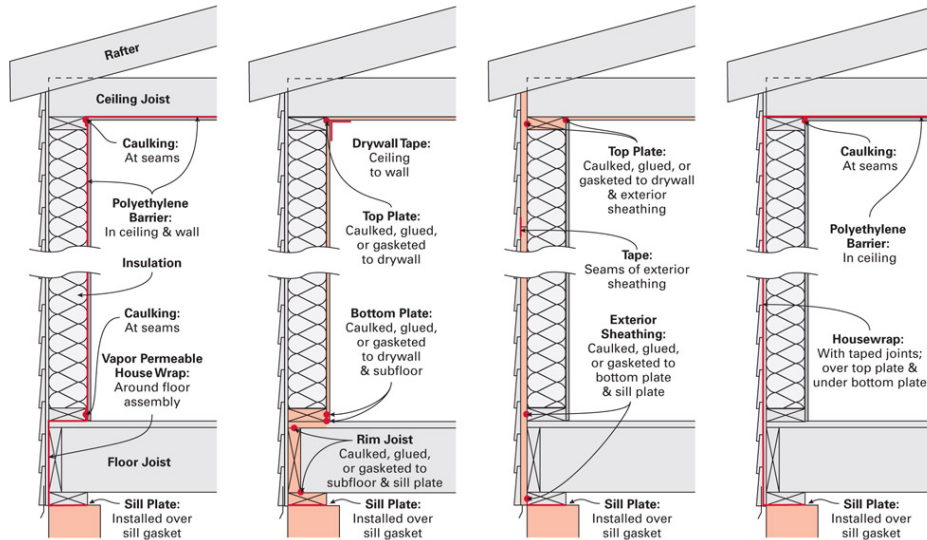
Change occurs and consequences are learned then we adjust
Example: Add insulation to attics and now we need ventilation



The building code challenge:

In what ways do air barriers and continuous insulation upset the traditional balance?

Common Approaches to Air Barriers



Recommended for Very Cold Climates Only: No air conditioning

Source: *Builder's Guide to Cold Climates* by Joseph Lstiburek



The building code challenge:

Example R20 w/o VR in climate zone 4 (2015 IRC chapter 1405.3 is a sketchy idea)

IECC Residential Requirements		IECC	IECC	IECC	IECC	IECC	IECC
		2003	2006	2009	2012	2012	2015
Ceiling	1	19	30	30	30	30	30
	2	26	30	30	38	38	38
	3	30	30	30	38	38	38
	4 except marine	30	38	38	49	49	49
	Marine 4 and 5	38	38	38	49	49	49
	6	38	49	49	49	49	49
	7 and 8	49	49	49	49	49	49
Wood-Frame Wall	1	11	13	13	13	13	13
	2	11	13	13	13	13	13
	3	13	13	13	20 or 13+5	20 or 13+5	20 or 13+5
	4 except marine	13	13	13	20 or 13+5	20 or 13+5	20 or 13+5
	Marine 4 and 5	18	19 or 13+5	20 or 13+5	20 or 13+5	20 or 13+5	20 or 13+5
	6	18	19 or 13+5	20 or 13+5	20 or 13+10	20 or 13+10	20 or 13+10
	7 and 8	21	21	21	20+5 or 13+10	20+5 or 13+10	20+5 or 13+10

The building code challenge:

Predicting performance using modeling programs such as WUFI

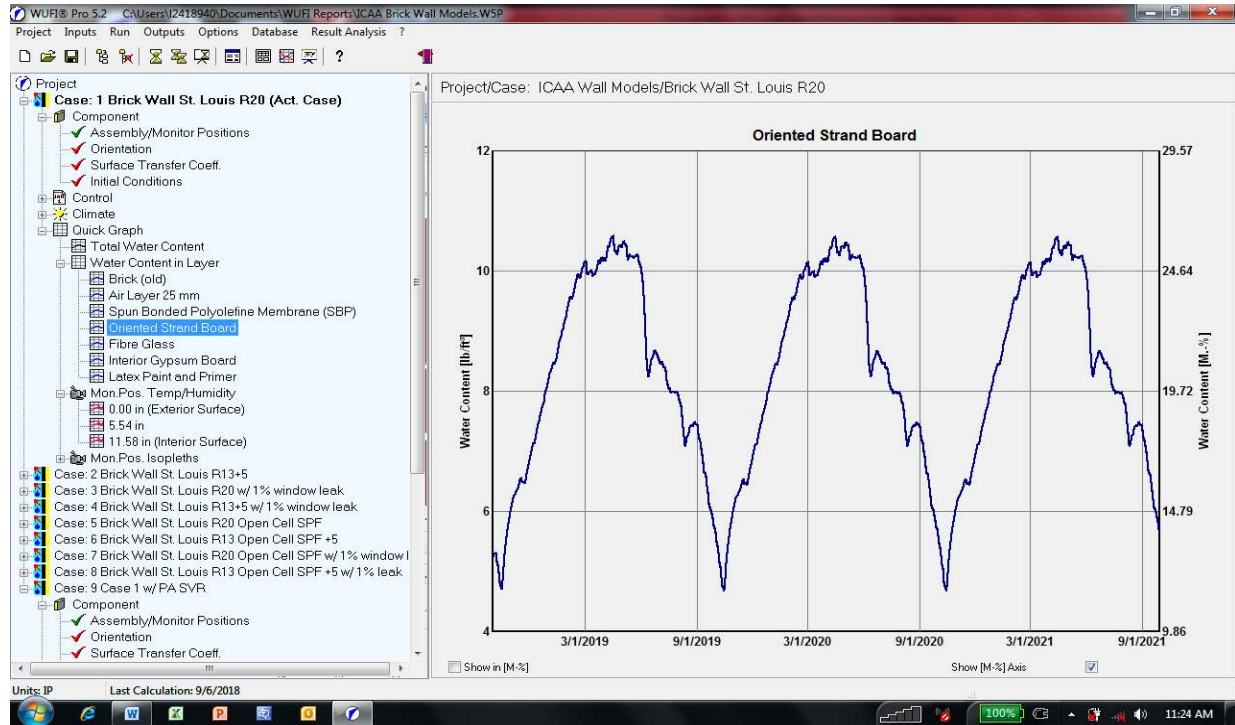
The screenshot displays the WUFI Pro 5.2 software interface. The main window shows a project titled "ICAA Wall Models/Brick Wall St. Louis R20". The left sidebar lists the project components, including "Assembly/Monitor Positions", "Orientation", "Surface Transfer Coeff.", and "Initial Conditions". The main area shows a cross-section of the brick wall assembly with various layers and materials. The right sidebar displays the "Assembly/Monitor Positions" tab, showing the layer name "Brick (old)" with a thickness of 4.09449. Below this, a table shows the exterior and interior surface transfer coefficients and the grid definition. The bottom of the window displays the total thickness and thermal performance results.

Exterior (Left Side)	Orientation/Inclination/Height	Surface Transfer Coeff.	Initial Conditions
4.09449	0.96/0.0/4.9213	5.5	0.450,0.095

Total Thickness	Total Thermal Performance
Thickness: 11.58 in	R-Value: 26.3 h ² ft ² F/Btu
	U-Value: 0.037 Btu/h ft ² F

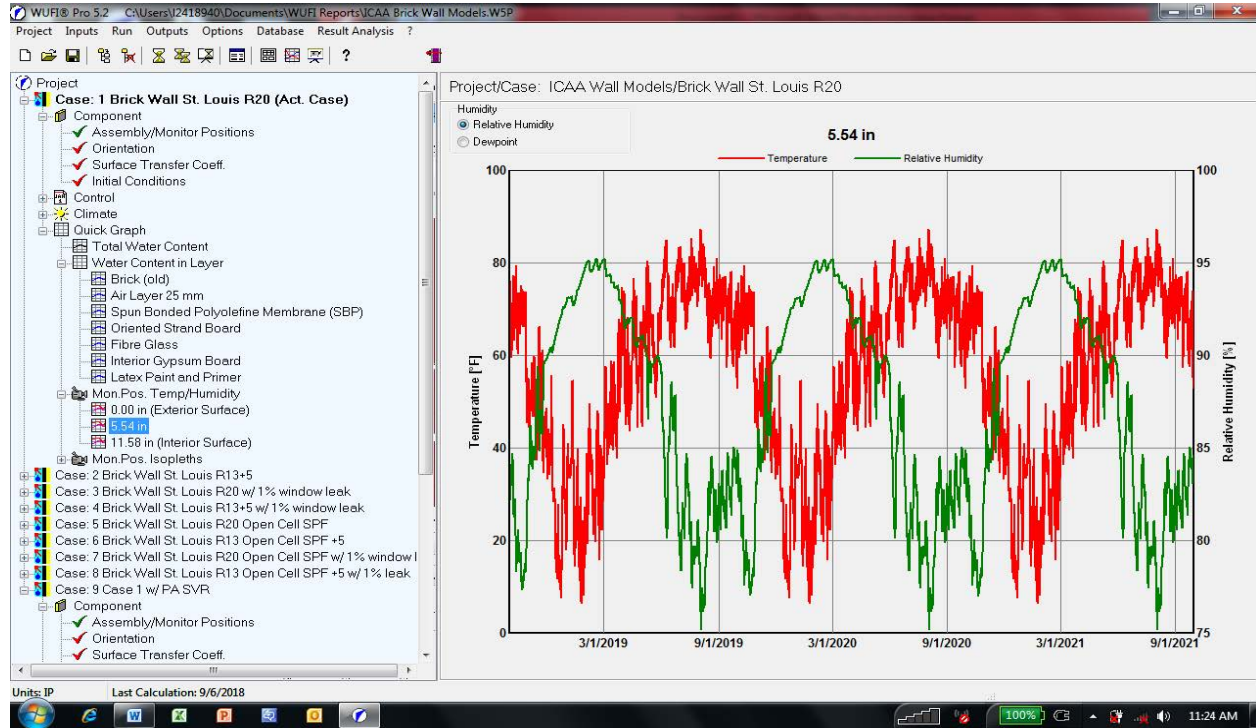
The building code challenge:

Predicting performance using modeling programs such as WUFI



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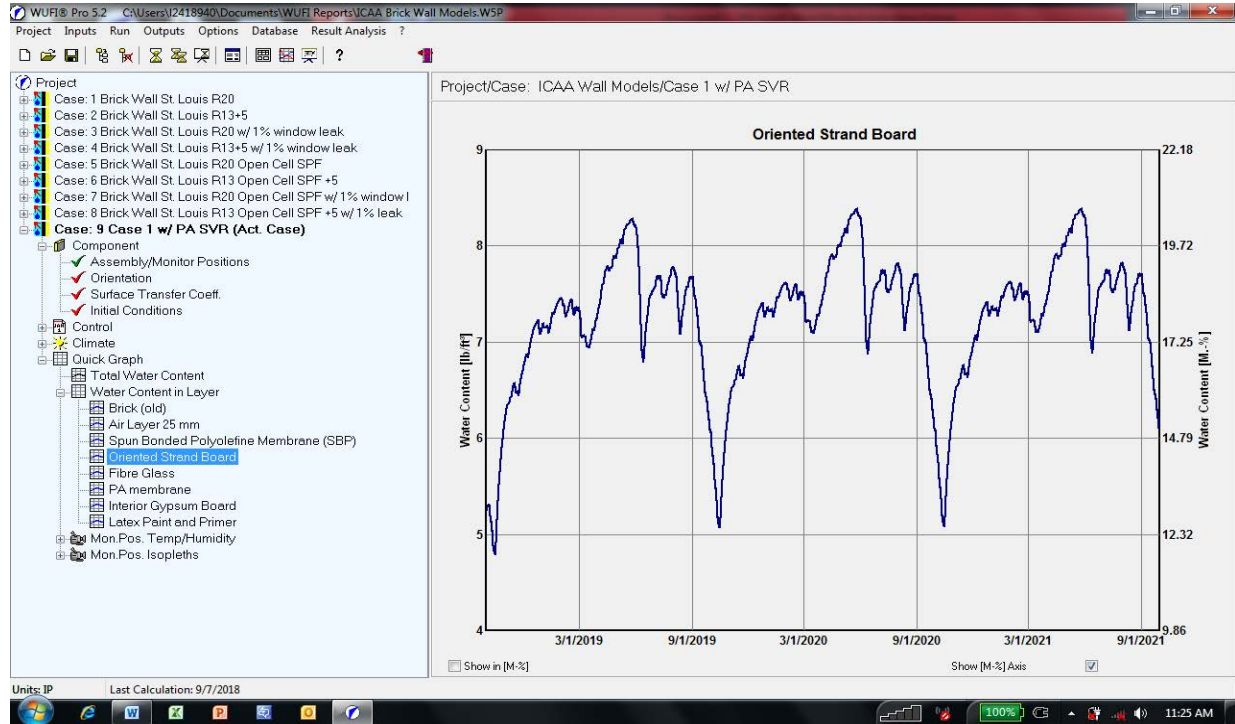
Predicting performance using modeling programs such as WUFI

The screenshot displays the WUFI Pro 5.2 software interface. The left sidebar shows a project tree with 'Case 9 Case 1 w/ PA SVR (Act. Case)' selected. The main window shows the 'Assembly/Monitor Positions' tab for a wall assembly. The assembly consists of several layers: Brick (old), Air Layer 25 mm, Spun Bonded Polyolefine Membrane (SBP), Oriented Strand Board, Fibre Glass, PA membrane, Interior Gypsum Board, and Latex Paint and Primer. The thermal performance results are shown at the bottom of the main window:

Parameter	Value
Total Thickness	Thickness: 11.62 in
Total Thermal Performance	R-Value: 26.3 h ² °F/Btu
U-Value	0.037 Btu/h ft ² °F

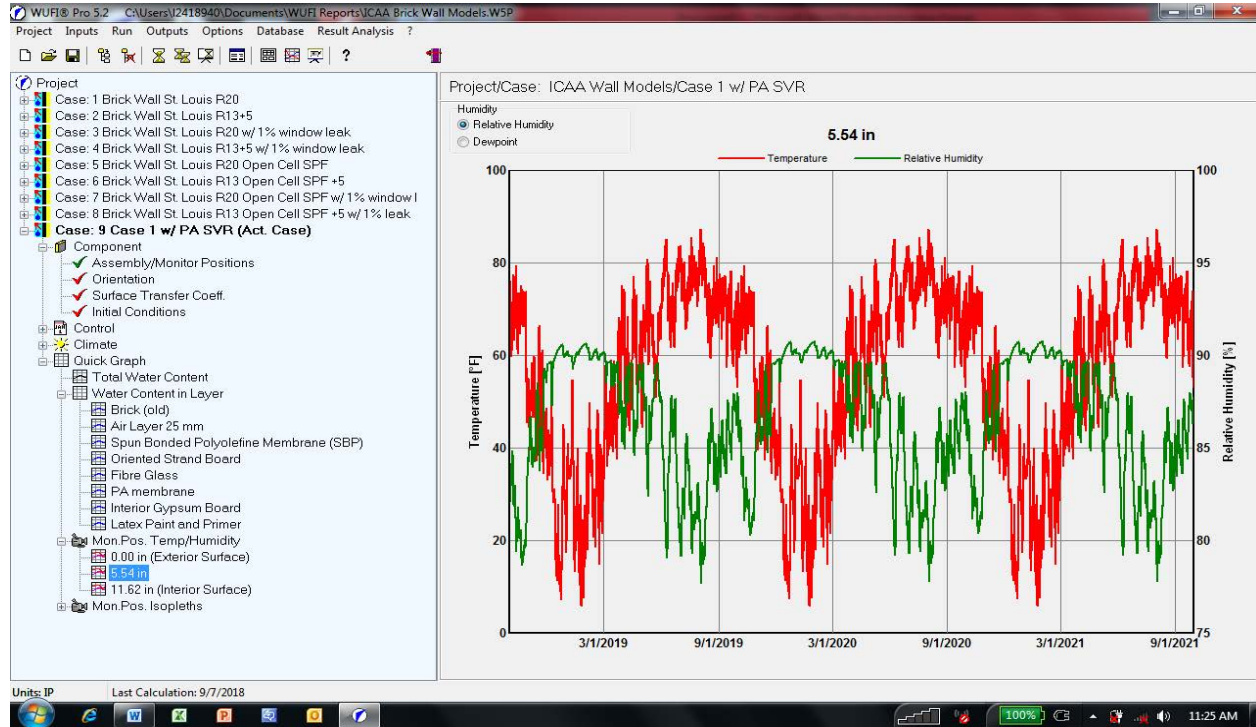
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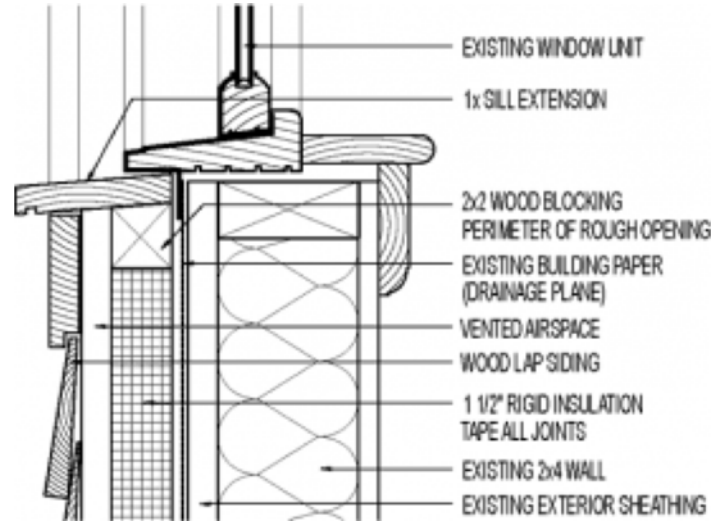
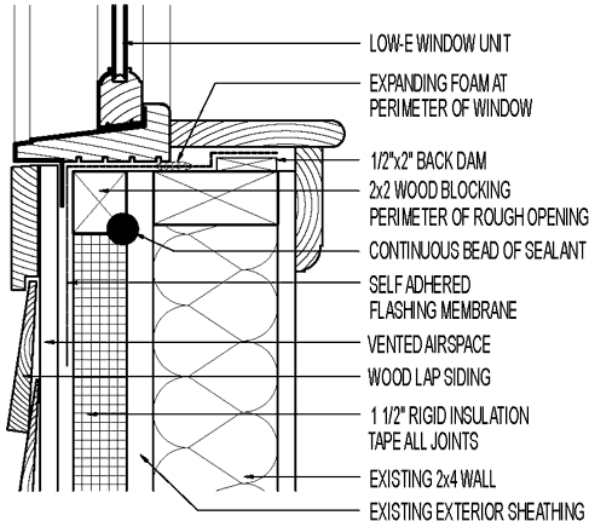
The building code challenge:

Predicting performance using modeling programs such as WUFI



The building code challenge:

So you want to breathe? Why? Do you suspect your going to get wet?

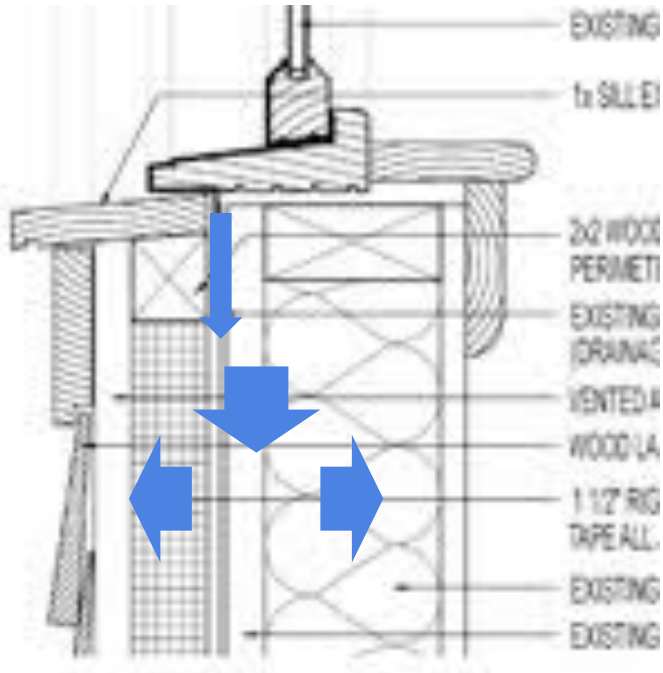


The building code challenge:

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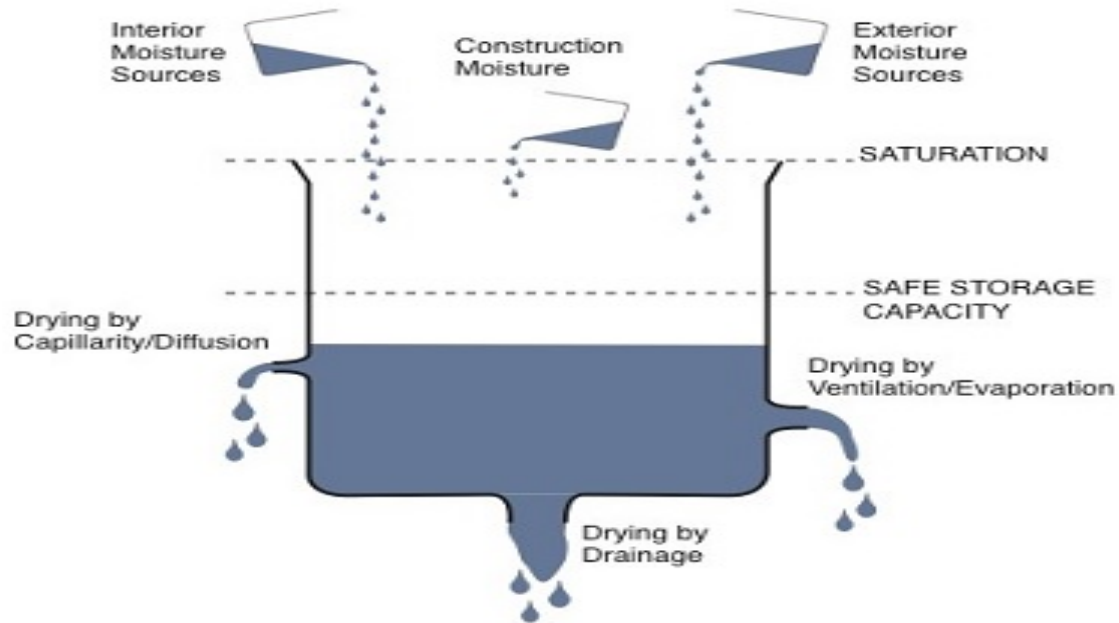


The building challenge:



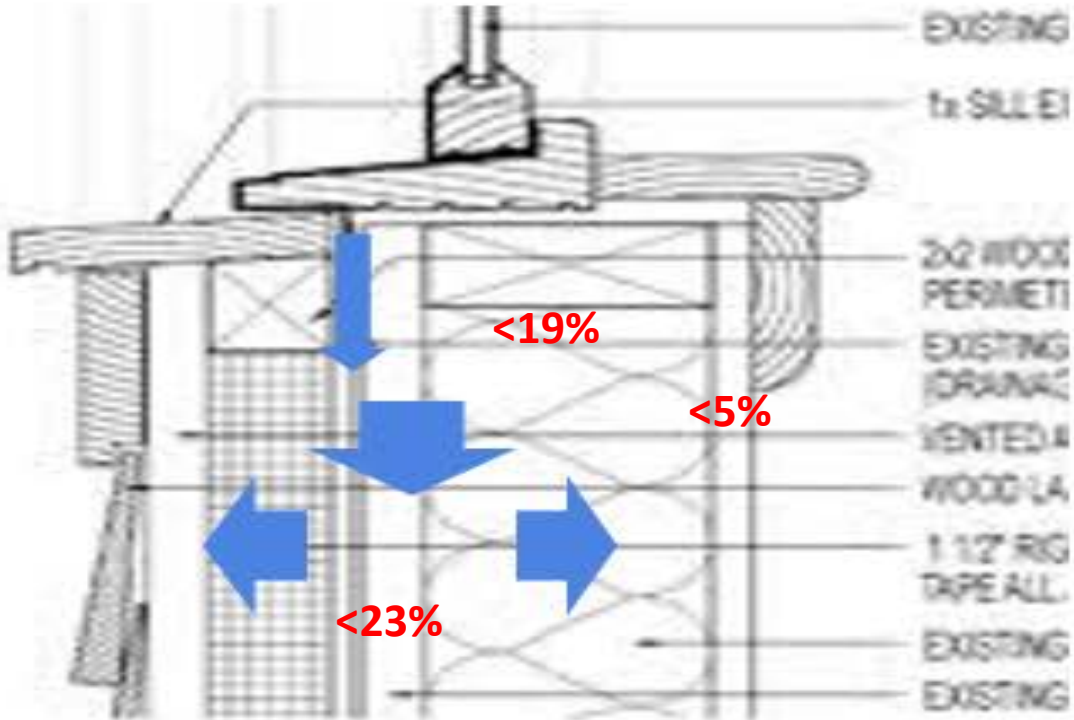
Materiality: why we choose materials for a specific job. Always consider a building materials resistance to heat flow, air flow, and moisture flow simultaneously.

Safe moisture storage:



The concept of moisture balance is more easily understood than achieved. By maintaining a balance between wetting and drying, moisture will not accumulate and exceed the safe storage capacity of the material. The extent and duration of wetting, storage and drying must always be considered when assessing the risk of moisture damage. It is also important to reconcile strategies for reducing the amount of wetting potential versus providing greater drying potential and storage.

Safe moisture storage:



Applied knowledge:

Predicting performance using modeling programs such as WUFI

The screenshot displays the WUFI Pro 5.2 software interface. The main window shows a project titled "ICAA Wall Models/Brick Wall St. Louis R20". The left sidebar lists the project components, including "Case: 1 Brick Wall St. Louis R20 (Act. Case)", "Control", "Climate", "Quick Graph", "Total Water Content", "Water Content in Layer", "Brick (old)", "Air Layer 25 mm", "Spun Bonded Polyolefine Membrane (SBP)", "Oriented Strand Board", "Fibre Glass", "Interior Gypsum Board", "Latex Paint and Primer", "Mon.Pos. Temp./Humidity", "Mon.Pos. Isopleths", and "Case: 2 Brick Wall St. Louis R13+5" through "Case: 9 Case 1 w/ PA SVR".

The main panel shows the "Assembly/Monitor Positions" tab. It displays a cross-section of the brick wall assembly with various layers and materials. The "Layer Name" is "Brick (old)" with a thickness of 4.09449. The "Exterior (Left Side)" has a surface transfer coefficient of 4.09449, and the "Interior (Right Side)" has a surface transfer coefficient of 0.450095. The "Total Thickness" is 11.58 in, and the "Total Thermal Performance" is R-Value: 26.3 h ft² F/Btu and U-Value: 0.037 Btu/h ft² F.

Layer Name	Thickn. [in]
Brick (old)	4.09449

Exterior (Left Side)	Orientation/Inclination/Height	Surface Transfer Coeff.	Interior (Right Side)
4.09449	0.96/0.0/4.9213	5.5	0.450095

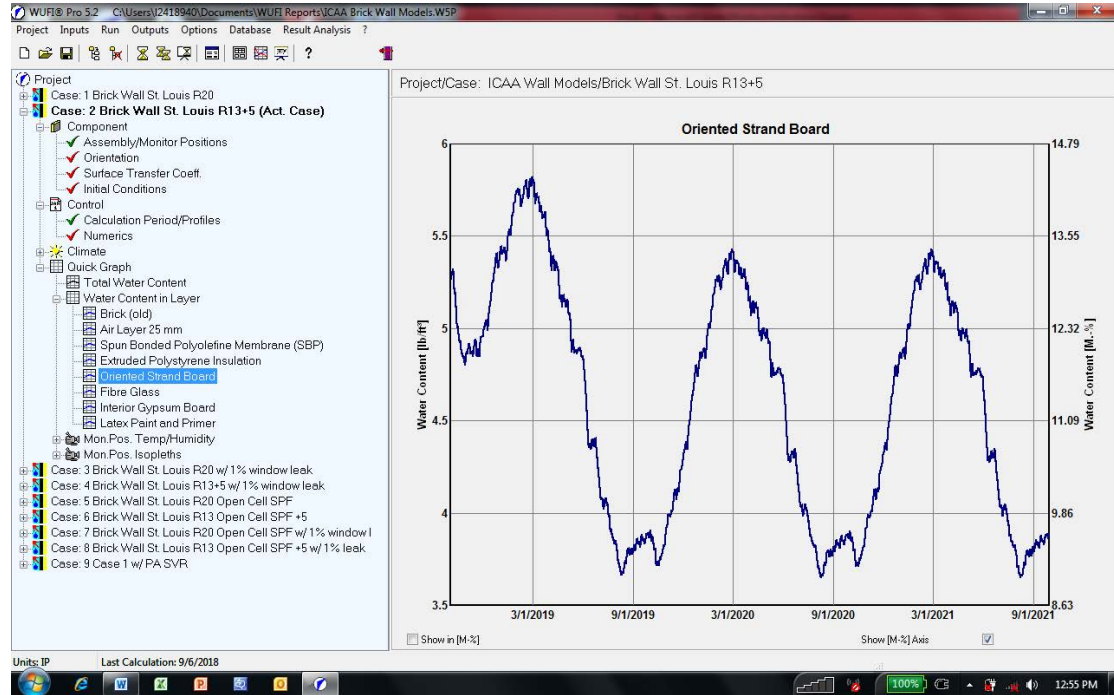
Assign from: Material Database, Example Cases
Grid: Automatic (I), 70, Medium
Copy Auto. Grid Def. for Manual Editing

Total Thickness: Thickness: 11.58 in
Total Thermal Performance: R-Value: 26.3 h ft² F/Btu, U-Value: 0.037 Btu/h ft² F

Units: IP, Last Calculation: 9/6/2018

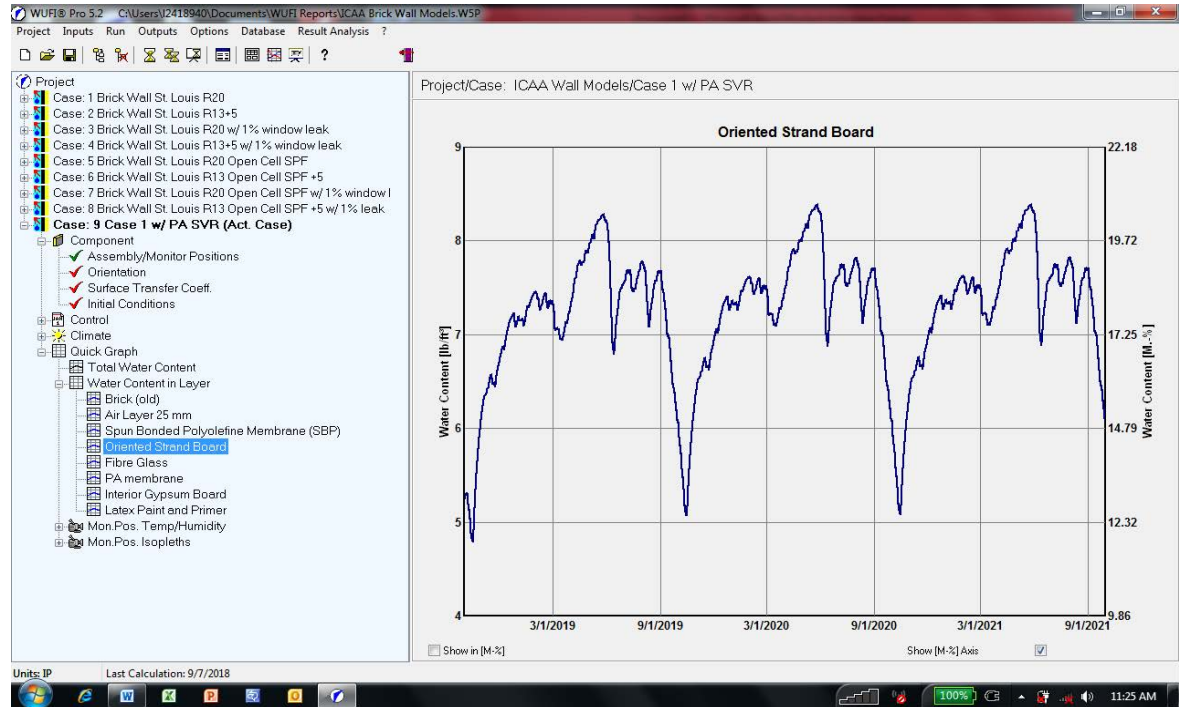
Applied knowledge:

R13 +5 in Zone 4A
doesn't need a
vapor retarder and
is better off
without one



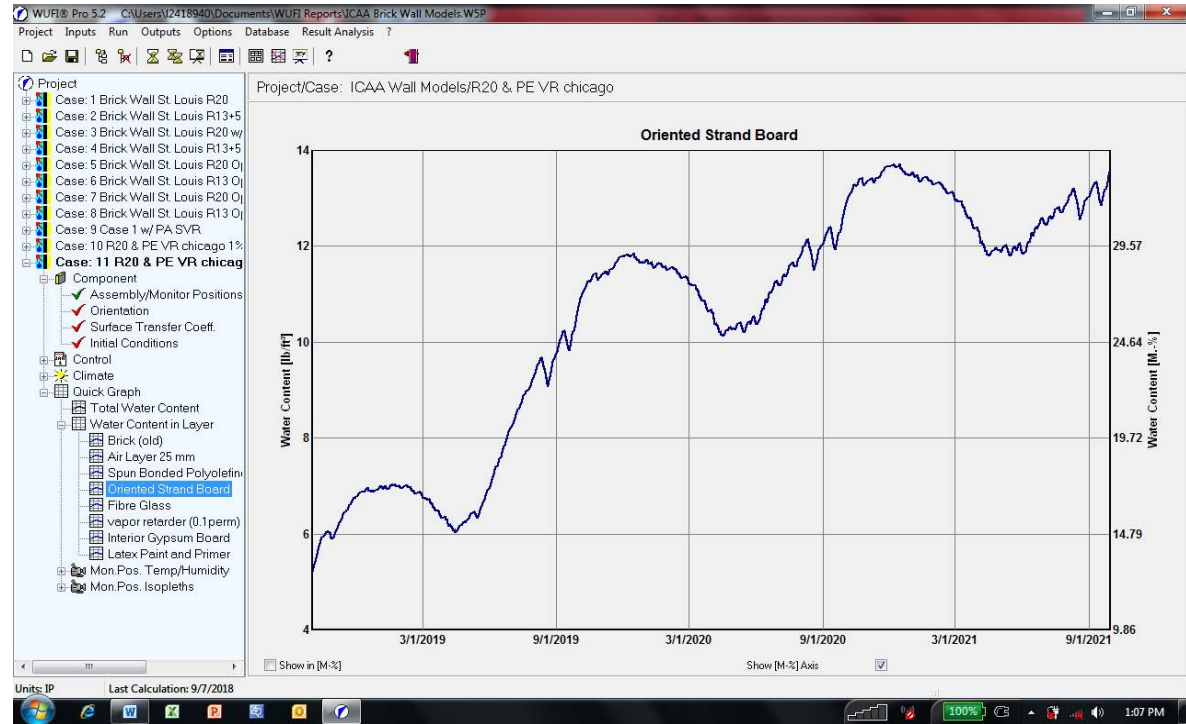
Applied knowledge:

Use smart vapor retarders in zone 4 on R20 walls



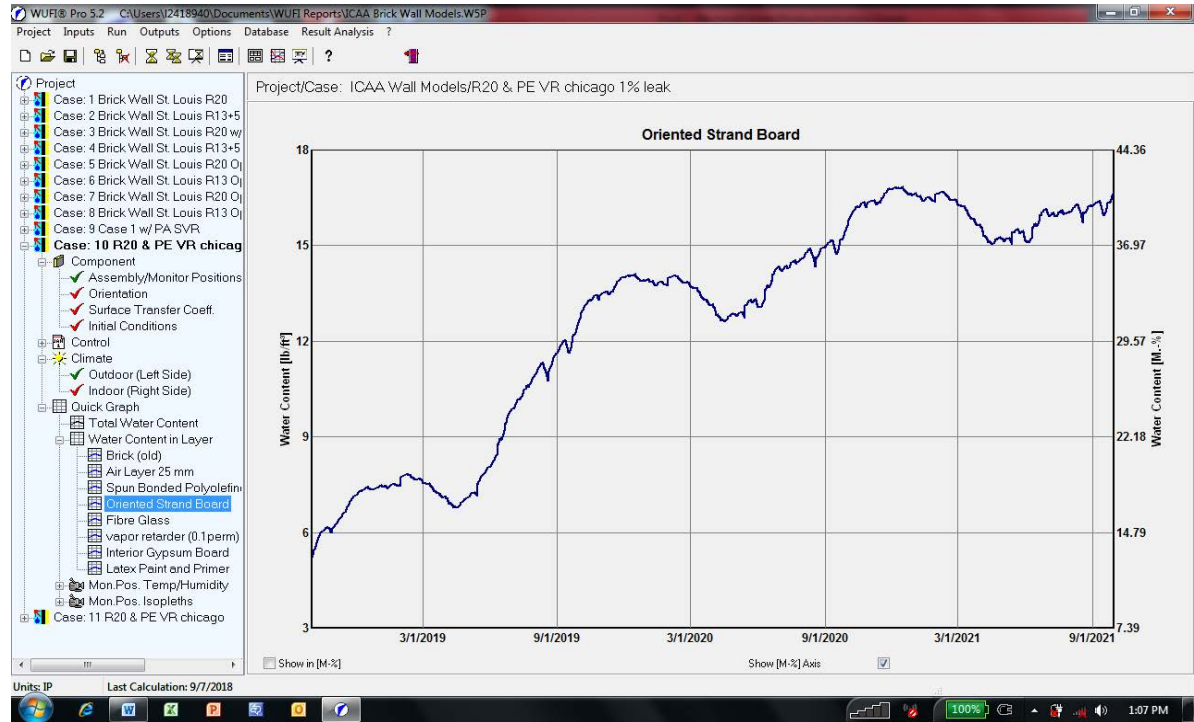
Applied knowledge:

Don't use PE (polyethylene vapor retarders) on R20 in Chicago



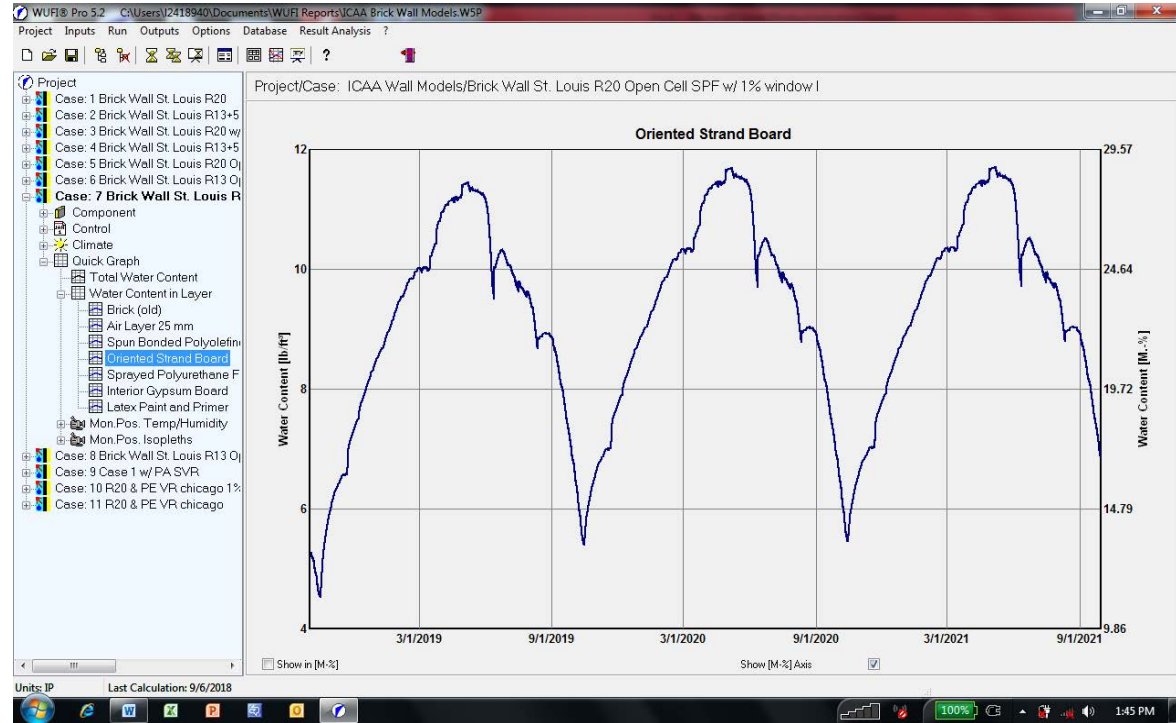
Applied knowledge:

Don't use PE on R20 in Chicago. A window leak is gonna kill the wall.



Applied knowledge:

Be aware that SPF, even open cell doesn't forgive like fiber glass




Applied knowledge:

- ✓ When folks say they want a wall or building to breathe, logically they could only be talking about moisture
- ✓ We've been adding layer upon layer to these assemblies for the past 4 decades and none of them were meant to improve "breathing"
- ✓ We need to look at each layer and consider its resistance to heat flow, air flow, and moisture flow because they are each going to influence the performance of the whole
- ✓ Continuous insulation materials that don't "breathe" can pose additional challenges to whole wall durability
- ✓ Fiber glass' "breathability" and hydrophobicity makes it the ideal insulation to put in framing cavities
- ✓ On thicker framing cavities, use smart vapor retarders (even when the code doesn't tell you to) in order to prevent wetting and promote drying!



Conclusions

- Examine the relationship between heat flow, air flow and moisture flow
 - Discuss how the building code addresses each of the above and how recent changes to the code could potentially reduce building durability
 - Review the four key mechanisms of moisture flow in buildings in order to explain how things get wet and how things dry
 - Describe some of the properties of building materials that play an important role in moisture management
 - Explain the concept of safe moisture storage
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Questions





Thank You

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