Building Codes Training Program

- Goal: prepare the Missouri & Nebraska's workforce for upcoming changes in construction best practices
- Commercial & Residential Energy Code
- Focused on providing training to builders, code officials, design professionals, public officials and students
- For more information, visit:

VERDATEK SOLUTIONS

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Continuing Education

Participants of this training are eligible for continuing education credits through ICC and AIA. Certificates will be sent out following the training. Contact mthorsell@mwalliance.org for questions.

International Code Council

AIA

- Please email your AIA number to mthorsell@mwalliance.org

About Matt/Verdatek Solutions

-Builder, Consultant, Construction Arbitrator

- 40+ Years in the Building Industry
- Served as a Top Building Codes official in the St. Louis area.

-Director of University of Missouri Columbia High Performance Buildings Research Center. Created and Instructed Curriculum for Students and Industry Professionals.

- Currently Assisting University of Missouri Science & Technology in Building and Energy Code Curriculum and Policy.
- Board of Advisors for Missouri Technical School, Construction & Workforce Development.

-ICC Member serving on 2012, 2015, 2018, and 2024 Energy (& Green) Code Development Committees. 2021& 27 Building Code-General Committee, Vice Chair.

We Build too!!

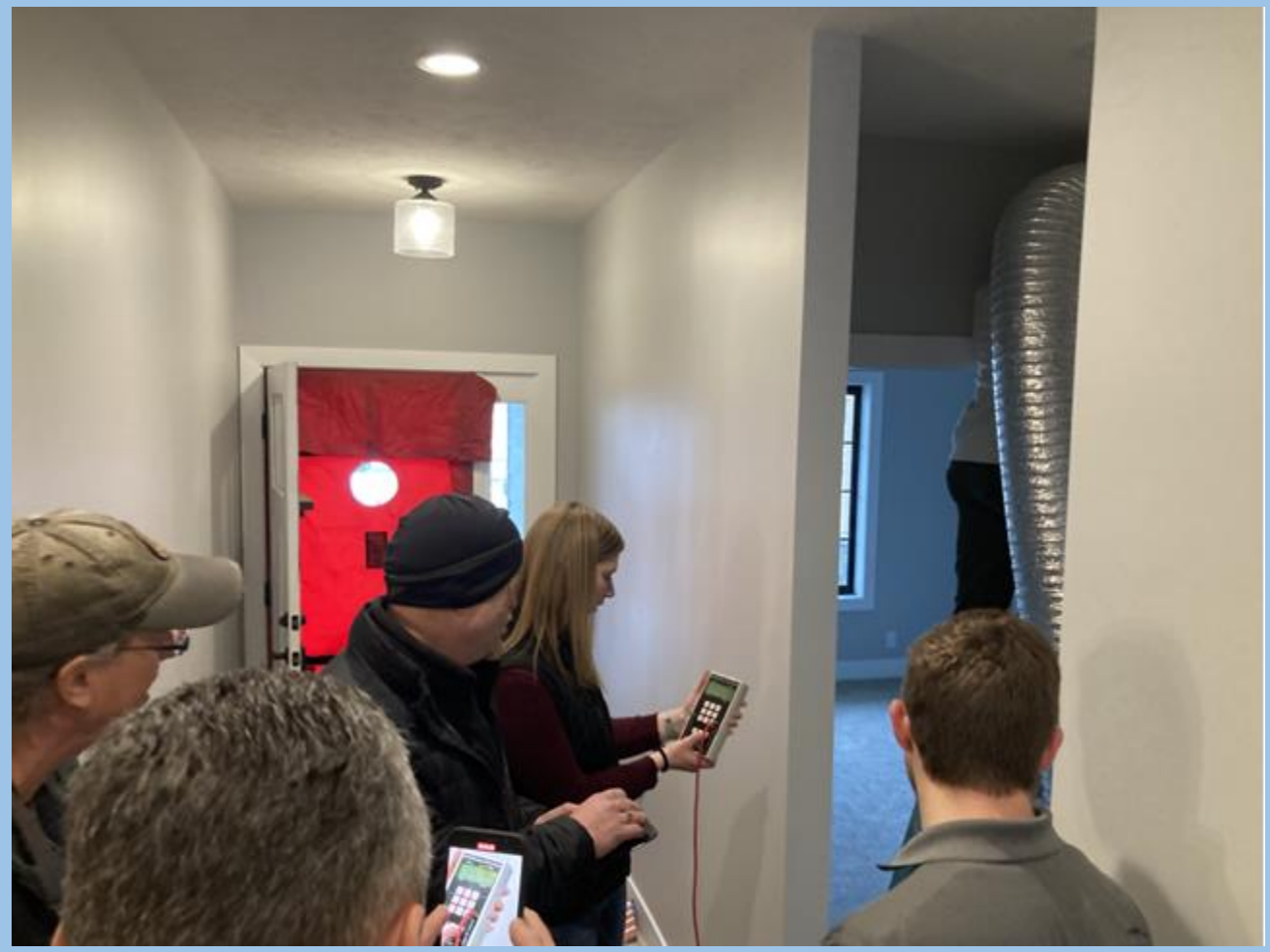
EBS

Enhanced Building Systems LLC

Builders/Project Managers/Technical Consultants

Duct & Envelope Testing (DET)Training

Class Instructions on Basic Envelope Requirements, Calculations and Hands on Experience with Blower Door and Duct Blaster Training.



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India Institute of Technology

Engineering Students Course on Commercial International Construction/Energy Codes and International Green Construction Codes

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Advanced Building Science and Business management Education to Trades

-Certification to Green/Energy Programs

-Stretch Codes and Above Code

-Business Basics

- **Margin vs. Mark up**
- **“Energy Equity”**
- **Valuations**
- **Marketing/selling the Monthly Pmt.**

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“Train the Trainer”

Professors from University of Baghdad touring New Construction Projects to teach students on Systems Building and Commissioning

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State Technical College of Missouri

Workforce Training & Continued Education

State Tech career development and workforce training offers short term, non-credit, and cost friendly courses for workers interested in continued learning for self-sufficiency, productivity, and quality of life. We offer a wide variety of daytime and evening classes in the classroom, online and via correspondence.

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2027 IBC-G Committee

IBC 2018

Chapter 16: Structural Design

ASCE 7 (as Referenced)
Structural Requirements

More emphasis on
Engineered Structures

Chapter 16

1604.4 Analysis

Every structure shall be designed to resist the effects caused by the forces specified in this chapter, including overturning, uplift and sliding. Where sliding is used to isolate the elements, the effects of friction between sliding elements shall be included as a force.

2018 IRC Walls (Significant Updates from 2015)

- An updated seismic map reflects the most conservative Seismic Design Category (SDC) based on any soil type and a new map reflects less conservative SDCs when Site Class A, B or D is applicable.
- The townhouse separation provisions now include options for using two separate fire-resistant-rated walls or a common wall.

New girder/header tables have been revised to incorporate the use of #2 Southern Pine in lieu of #1 Southern Pine.

New tables address alternative wood stud heights and the required number of full height studs in high wind areas.

2021 IBC
Significant Changes

- Puzzle rooms (escape rooms) are now defined and regulated as special amusement areas, requiring compliance with Section 411 and special means of egress requirements.
- *For the purposes of determining the allowable number of control areas in a building, each portion separated by one or more fire walls is now considered as a separate building.*
- In Group E occupancies, enhanced classroom acoustics in compliance with ICC A117.1 are to be provided in all classrooms having of volume of 20,000 cubic feet or less.
- The requirements for metal composite materials and systems (MCM) installed on the exterior walls of Types I, II, III and IV construction were simplified and sprinkler allowances were deleted

2021 IBC Significant Changes (Cont.)

- *The use of intermodal shipping containers as buildings is now specifically addressed through provisions intended to supplement existing applicable IBC requirements.*
- *Automatic sprinkler protection is now required in Group S-2 open parking garages where any fire area exceeds 48,000 square feet.*
- The 2017 edition of ICC A117.1 was adopted.
- Parapets of a minimum height are now required for aggregate-surfaced roofs to prevent blow-off.
- Mixed occupancy buildings with assembly spaces are placed in Risk Category III when the total public assembly occupant load is greater than 2500 people.

2021 IBC Significant Changes (Cont.)

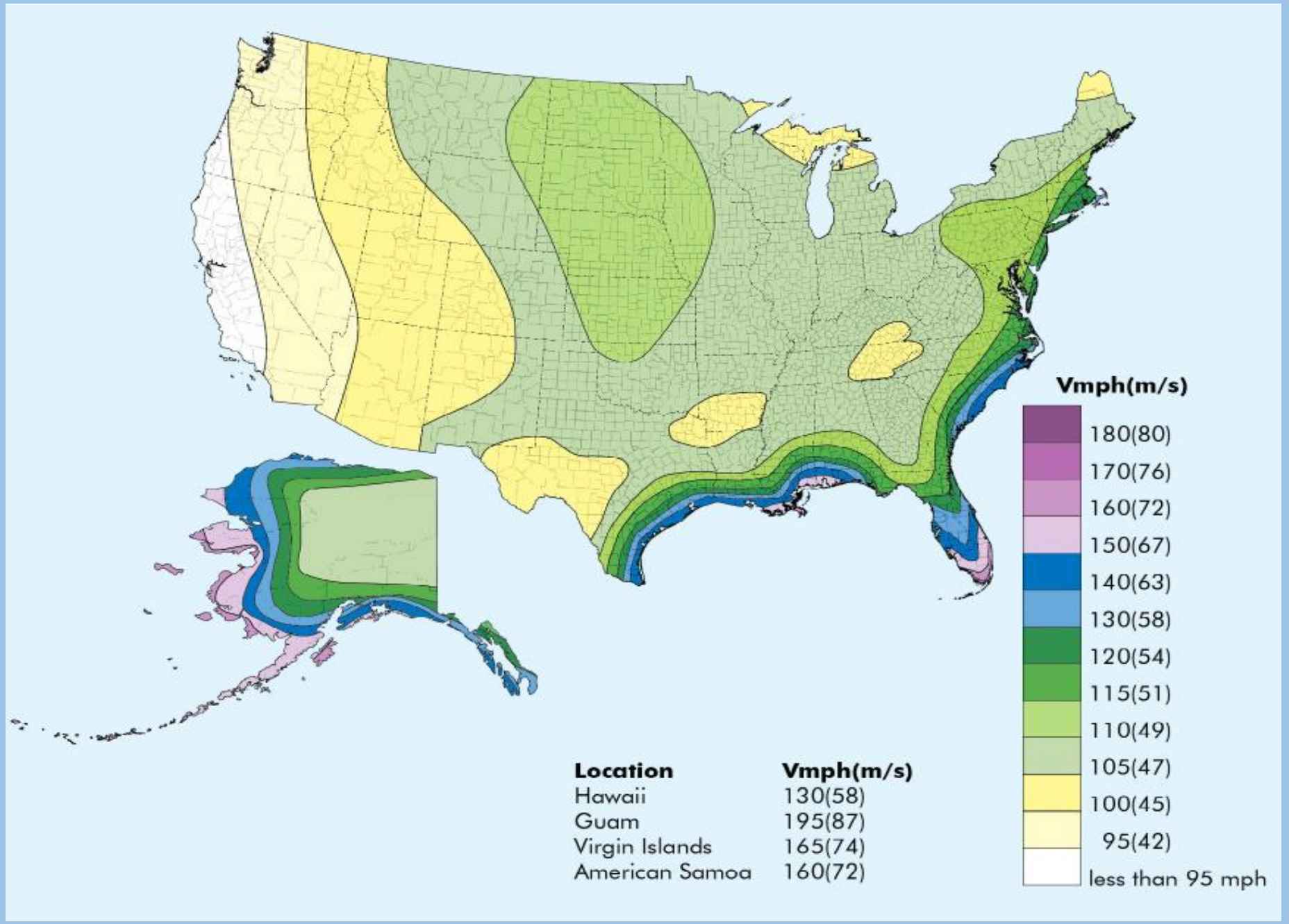
•*Special inspection requirements were added to address the anchorage and connection of mass timber structural elements.*

•*Installation of firestop, fire-resistant joint systems and perimeter fire barrier systems in residential-use buildings now requires special inspection in Group R fire areas having an occupant load exceeding 250 people.*

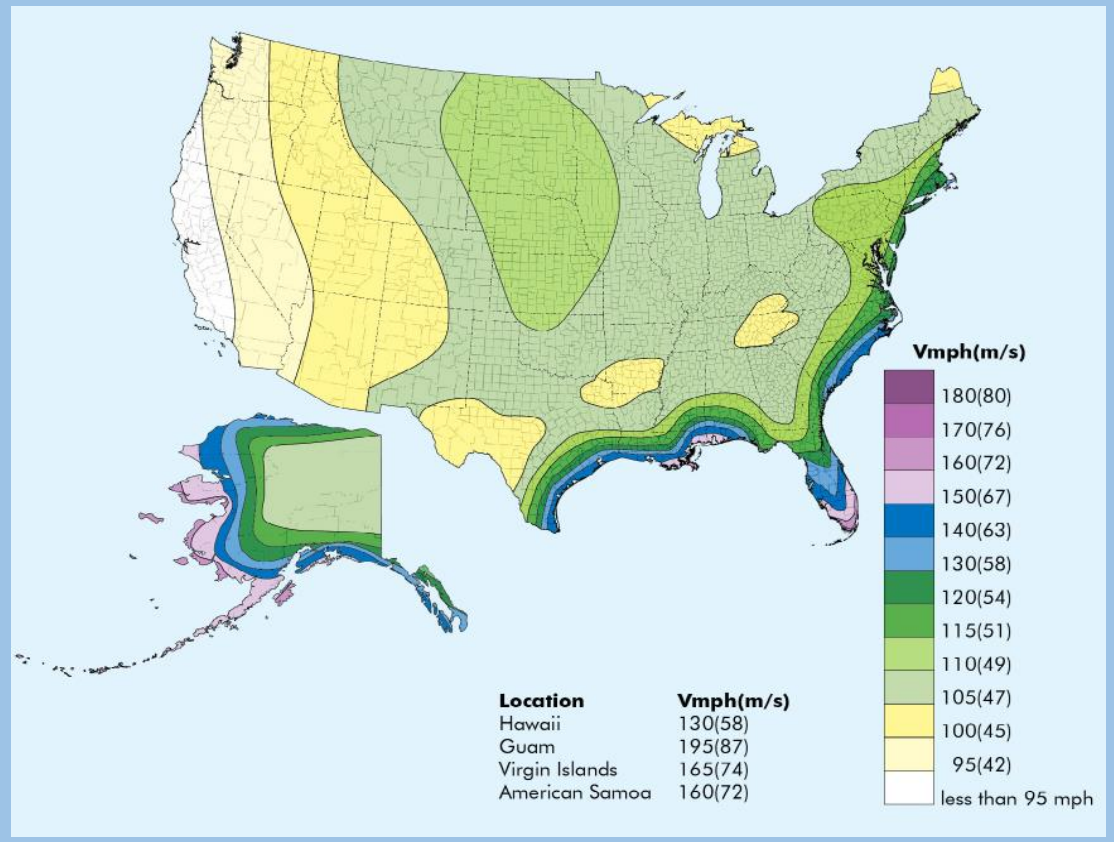
•Frost protection for egress doors was added to the foundation requirements.
•ACI standards ACI 117 and ITG 7 were added by reference to provide acceptable tolerances for concrete construction.

•*Three new types of construction (Types IV-A, IV-B, and IV-C) allow mass timber buildings of taller heights, more stories above grade, and greater allowable areas compared to existing provisions for heavy timber buildings.*

2018 IRC Walls



2018 --> 2021 IRC Walls



The 2021 IRC wall bracing provisions for wind apply only to residential structures located in areas where ultimate design wind speed is less than 140 miles per hour. Ultimate design wind speeds are obtained from the 2021 IRC Figure R301.2(2). Former 115 mph zones are broken into specific wind speeds with greater variation than previous editions of the IRC. Most regions will see a drop in the required wind speed.

Wall Bracing

Applies to all Buildings regardless of Size/Location.

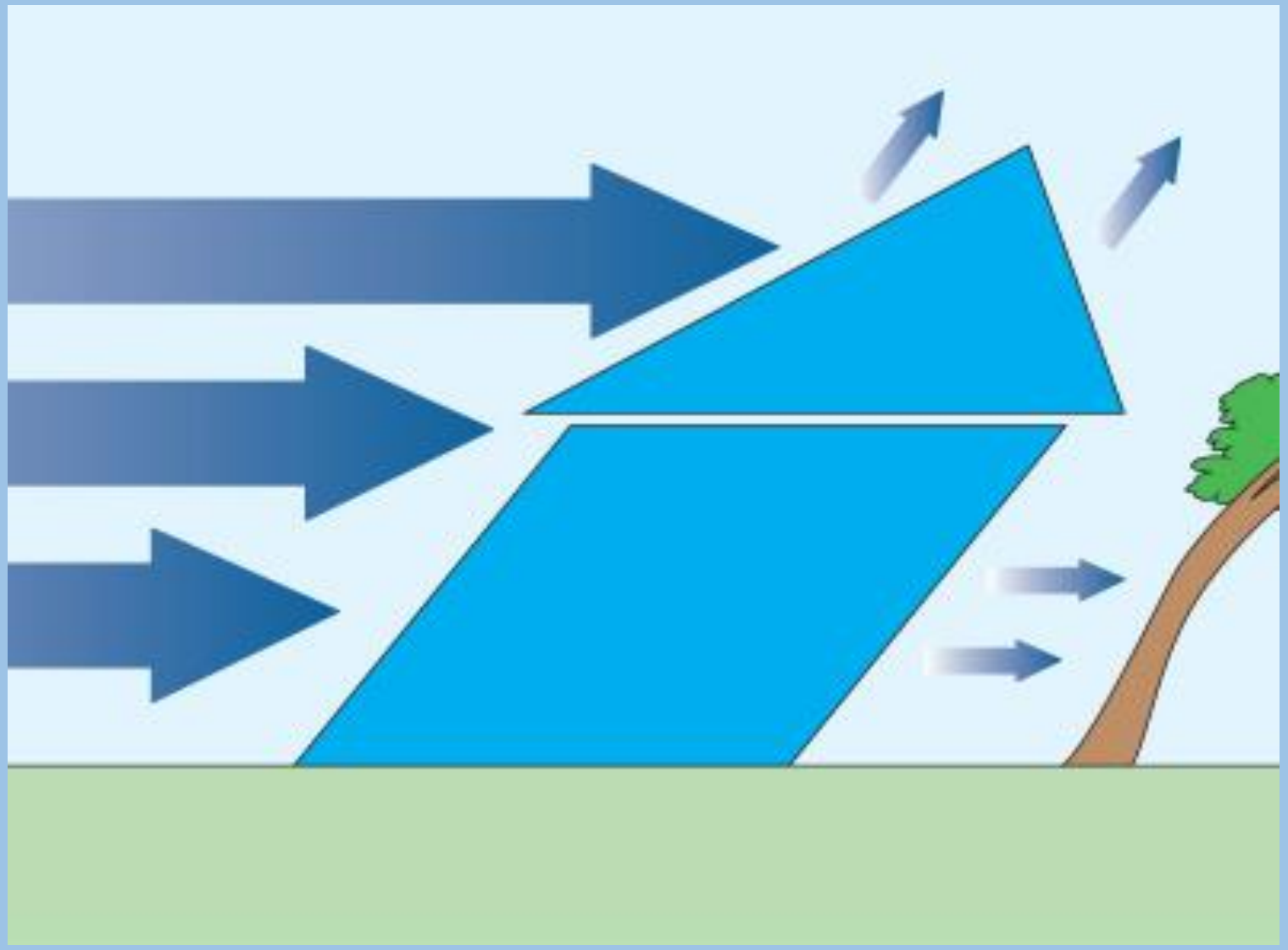
1. Two Categories:
   -Vertical Loads, (Up or Down Direction) (Gravity/Dead Loads)

2. -Lateral Loads, (Parallel to the Ground)(Seismic!)

Wall Bracing

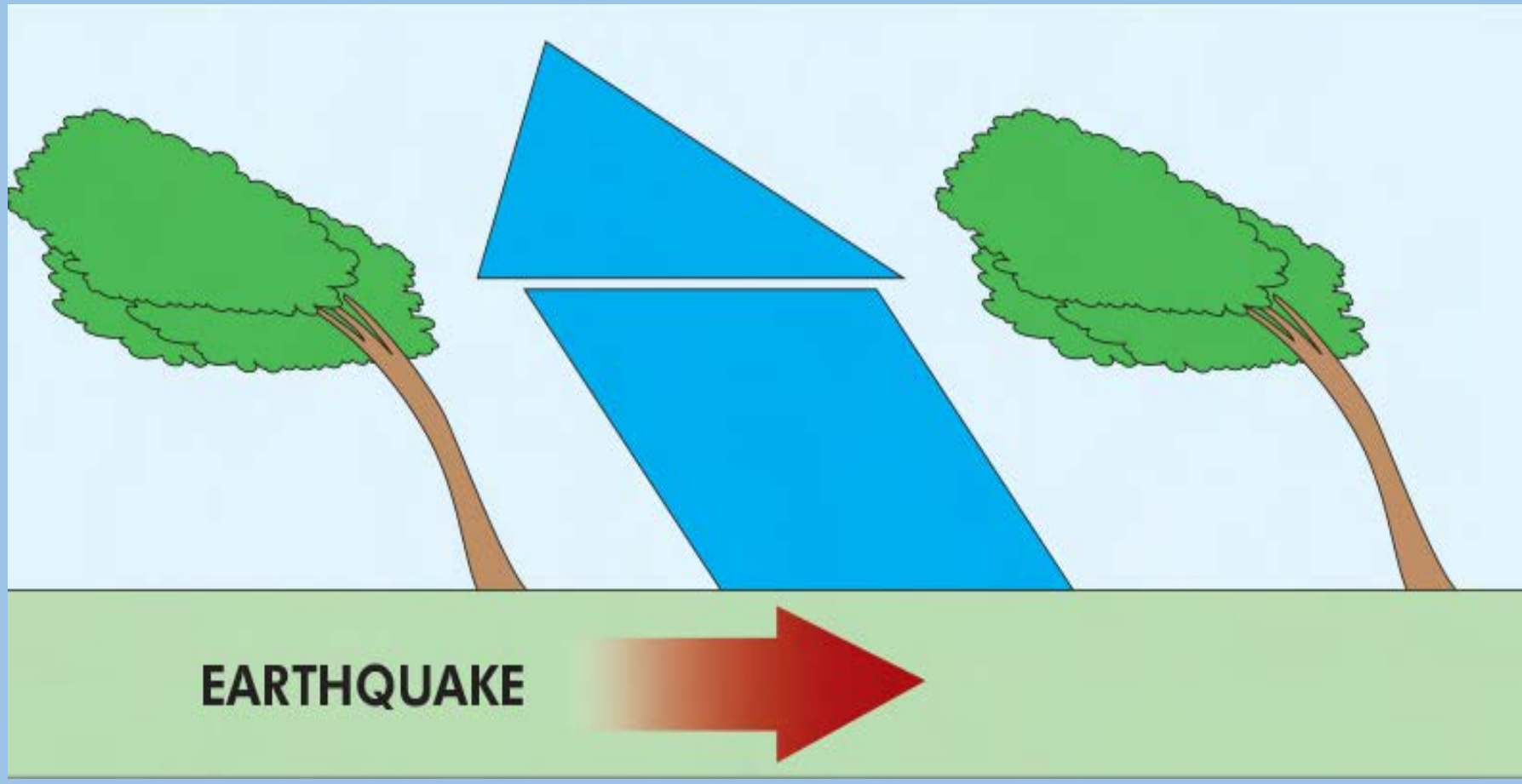
Wind!

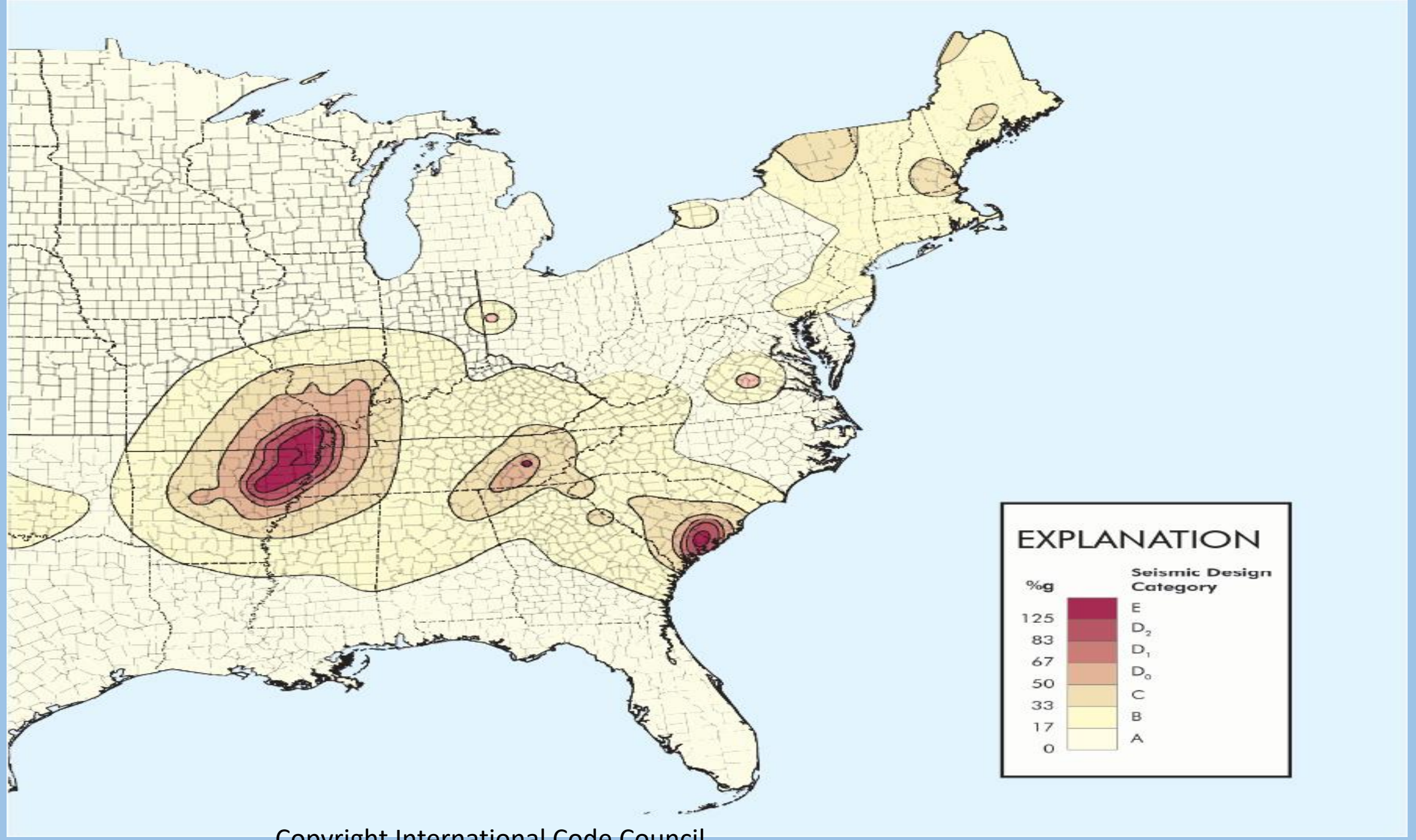
Wind pushes against one wall while pulling on the opposite wall.



Wall Bracing

Seismic forces are generated by ground motions during an earthquake event





Wall Bracing - Terminology

Braced wall line:

A straight line through the building plan that represents the location of the lateral resistance provided by the wall bracing

Braced wall panel:

A full-height section of wall constructed to resist in-plane shear loads through interaction of framing members, sheathing material, and anchors. The panel's length meets the requirements of its particular bracing method and contributes toward the total amount of bracing required along its braced wall line in accordance with Section R602.10.1

Wall Bracing - Terminology

Diaphragm:

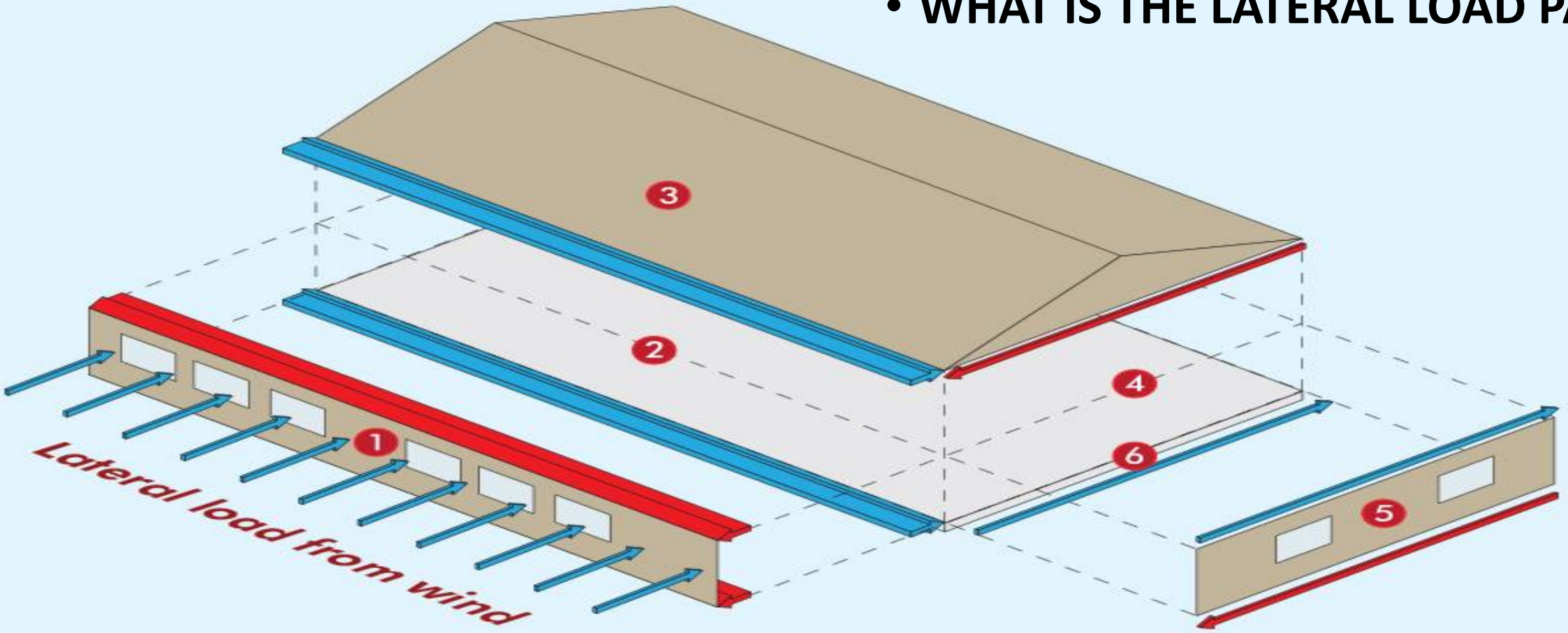
A horizontal or nearly horizontal system acting to transmit lateral forces to the vertical resisting elements. When the term “diaphragm” is used, it includes horizontal bracing systems

. **Shear wall*:**

A general term for walls that are designed and constructed to resist racking from seismic and wind by use of masonry, concrete, cold-formed steel or wood framing in accordance with Chapter 6 of this code and the associated limitations in Section R301.2 of this code.

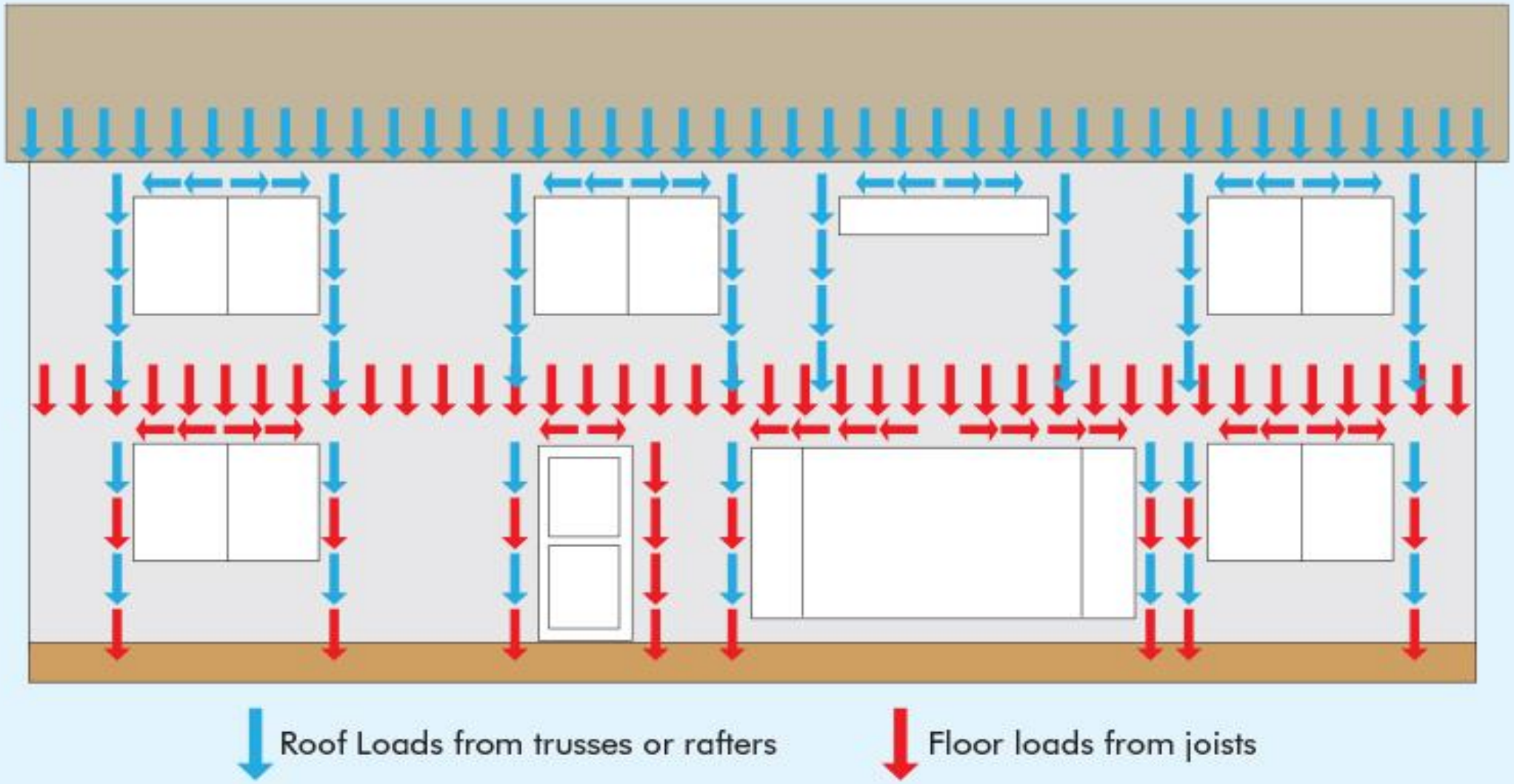
****this term is most often used in engineered design in accordance with the IBC or other appropriate referenced standards.***

• WHAT IS THE LATERAL LOAD PATH?



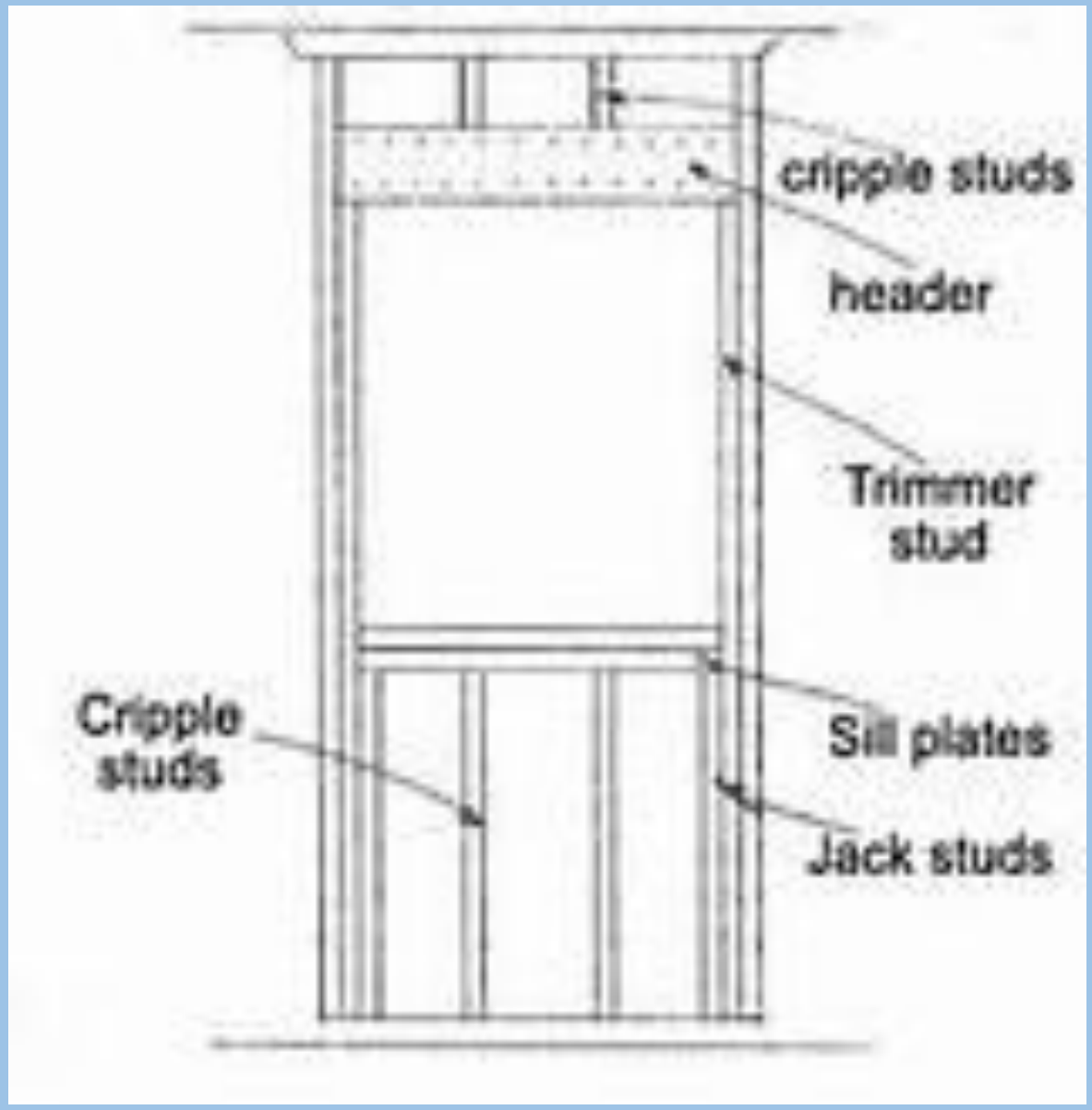
1. Windward receiving wall carries load to foundation at bottom of wall and roof diaphragm at top of wall
2. Connections at bottom and top of wall transfer these loads into the foundation and diaphragm
3. Roof or floor diaphragm carries load to bracing walls
4. Connections between roof/floor and wall transfers load from diaphragm to bracing walls
5. Bracing wall carries load from diaphragm to foundation
6. Transfer of loads from the bracing walls to the foundation

WHAT IS THE VERTICAL LOAD PATH?

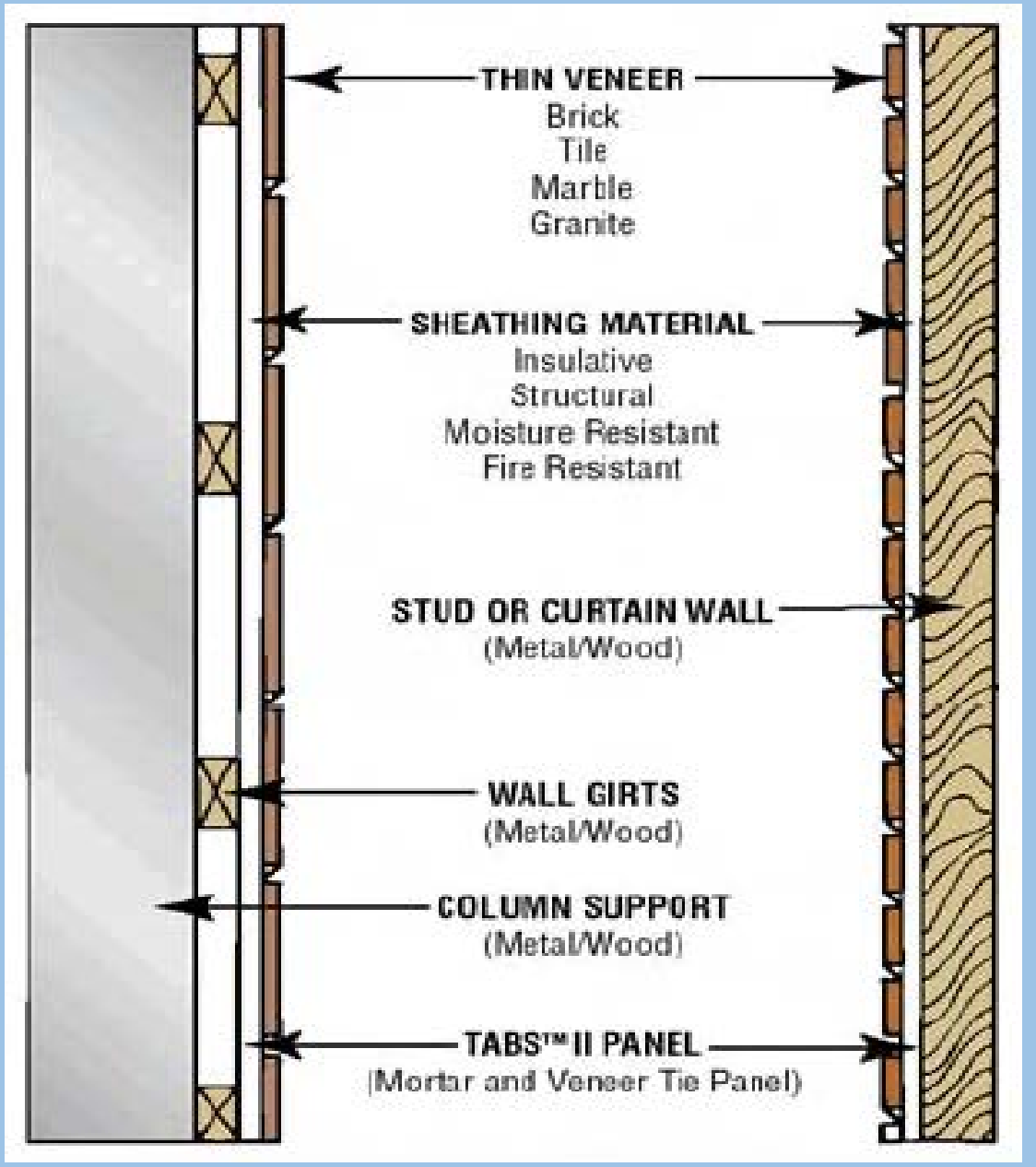


Frame Wall Systems

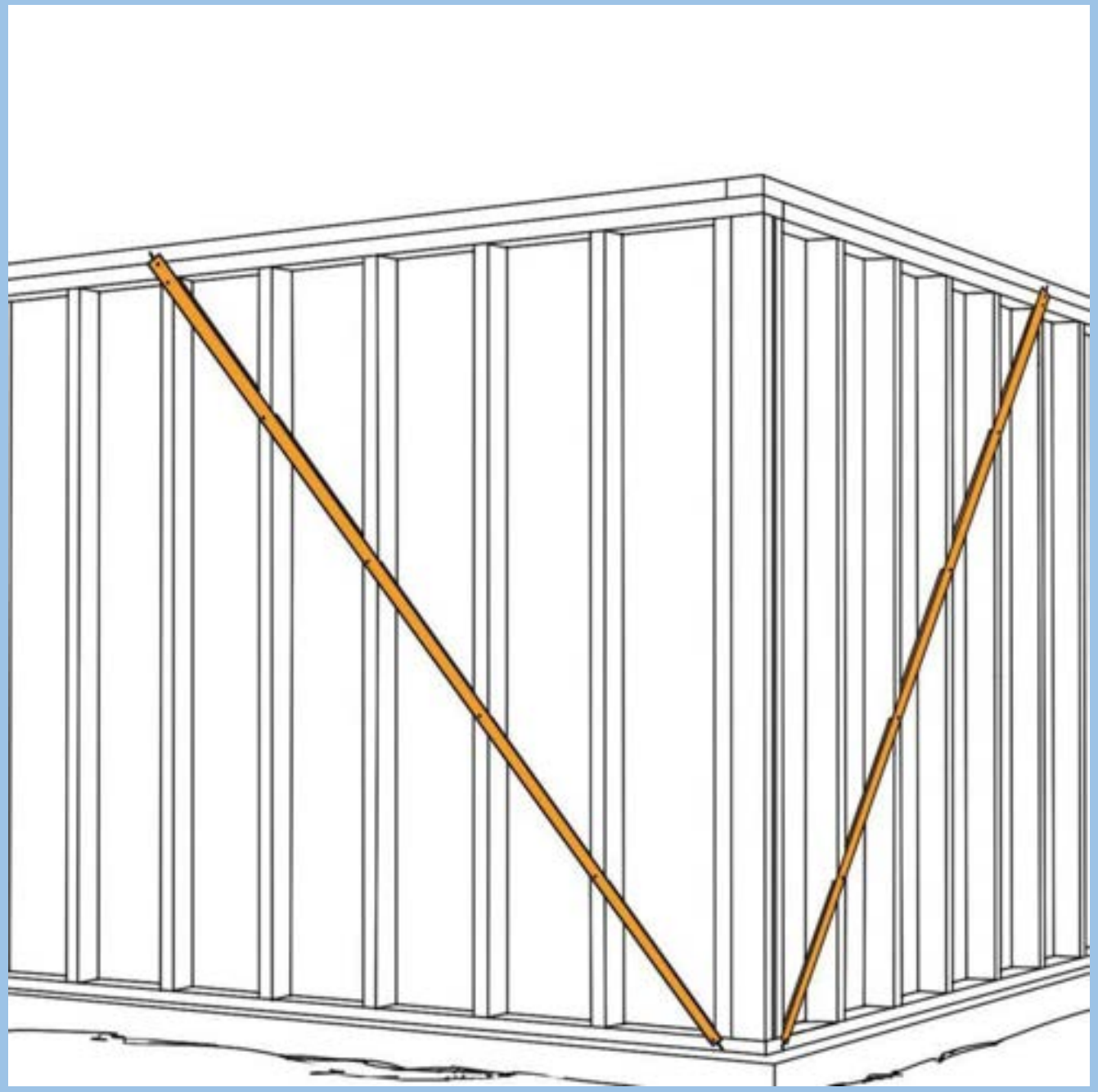
Vertical Load Path?



Wall Systems



Corner Bracing



CASE STUDY:
Perry County Timber frame

CASE STUDY:
Perry County Timber frame

-ICF Foundation (12’ Pour)

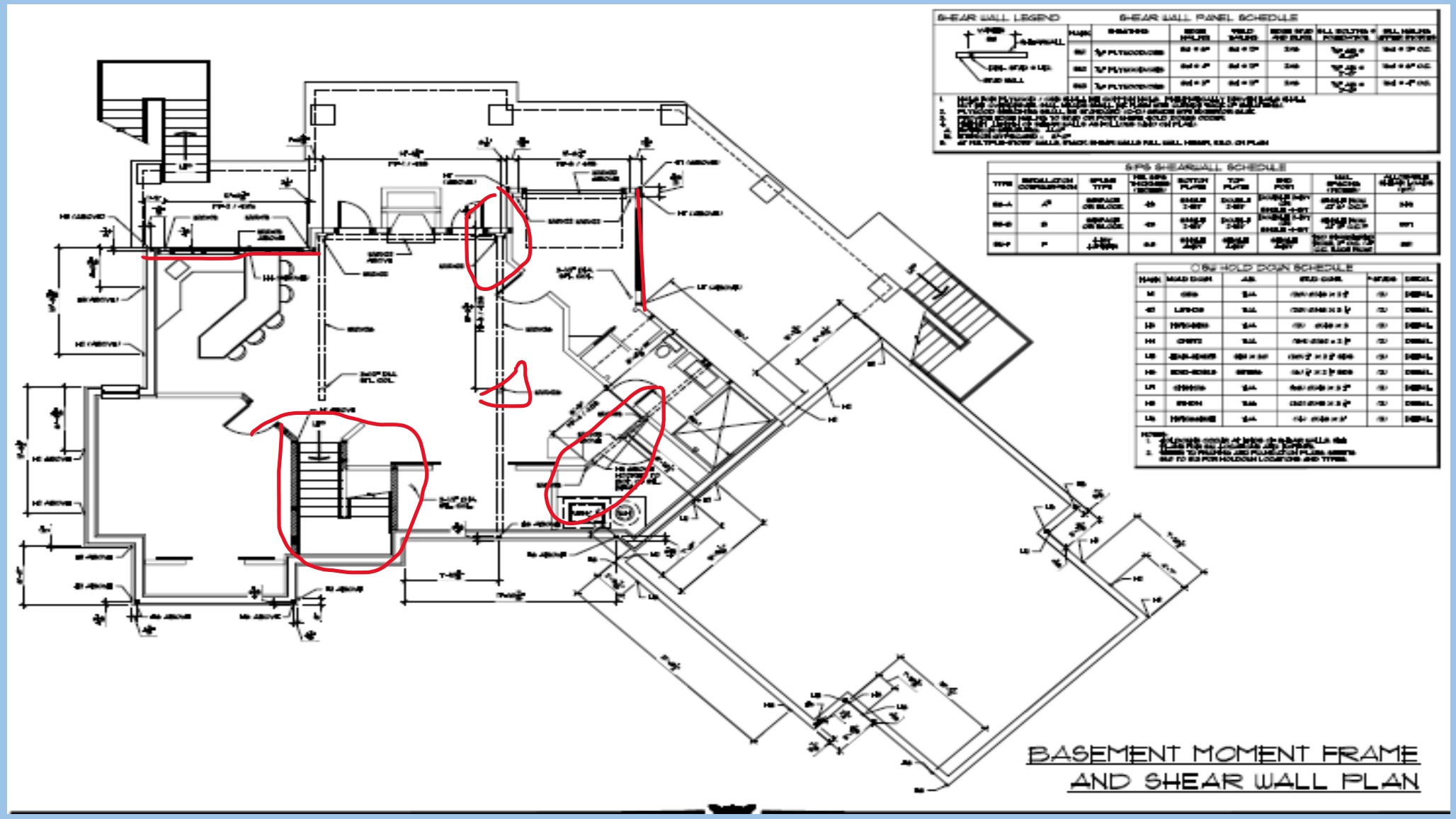
-Full Frame walkout wall

-Timber frame Structure (Main and 2nd level)

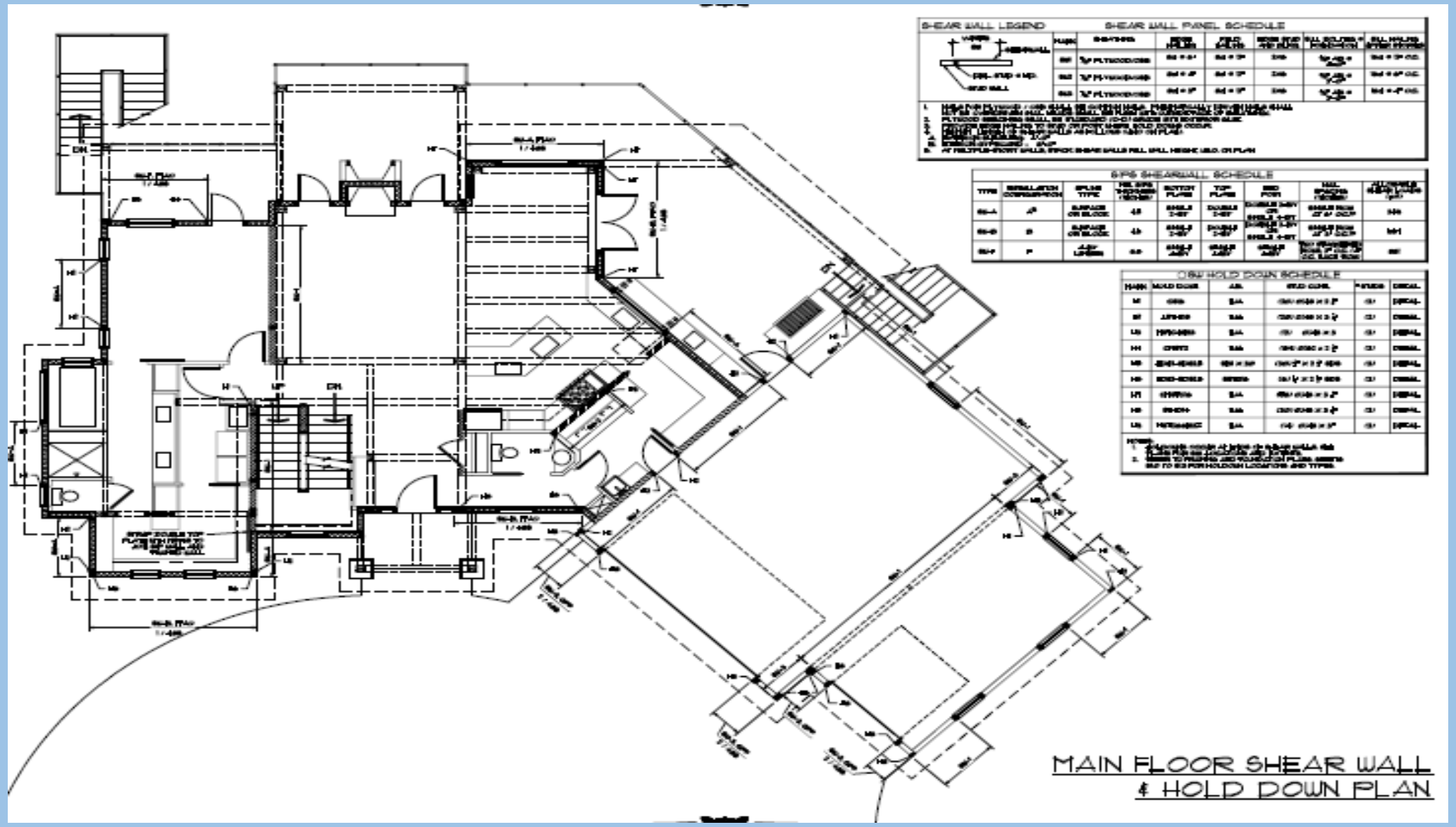
-Structural Insulated Panel Envelope

CASE STUDY: Perry County Timber frame

Basement



Main Level


SHEAR WALL LEGEND
SHEAR WALL PANEL SCHEDULE
SPS SHEARWALL SCHEDULE
HOLD DOWN SCHEDULE
MAIN FLOOR SHEAR WALL
& HOLD DOWN PLAN

Tall, Skinny Frame

Joinery

SIPS Enhance the Bracing

Braced Walls in place

-Timber Connections

-SIPS

-Tied Down through frame to Foundation

CRITICAL PARTS OF THE LATERAL LOAD PATH

1.The receiving wall

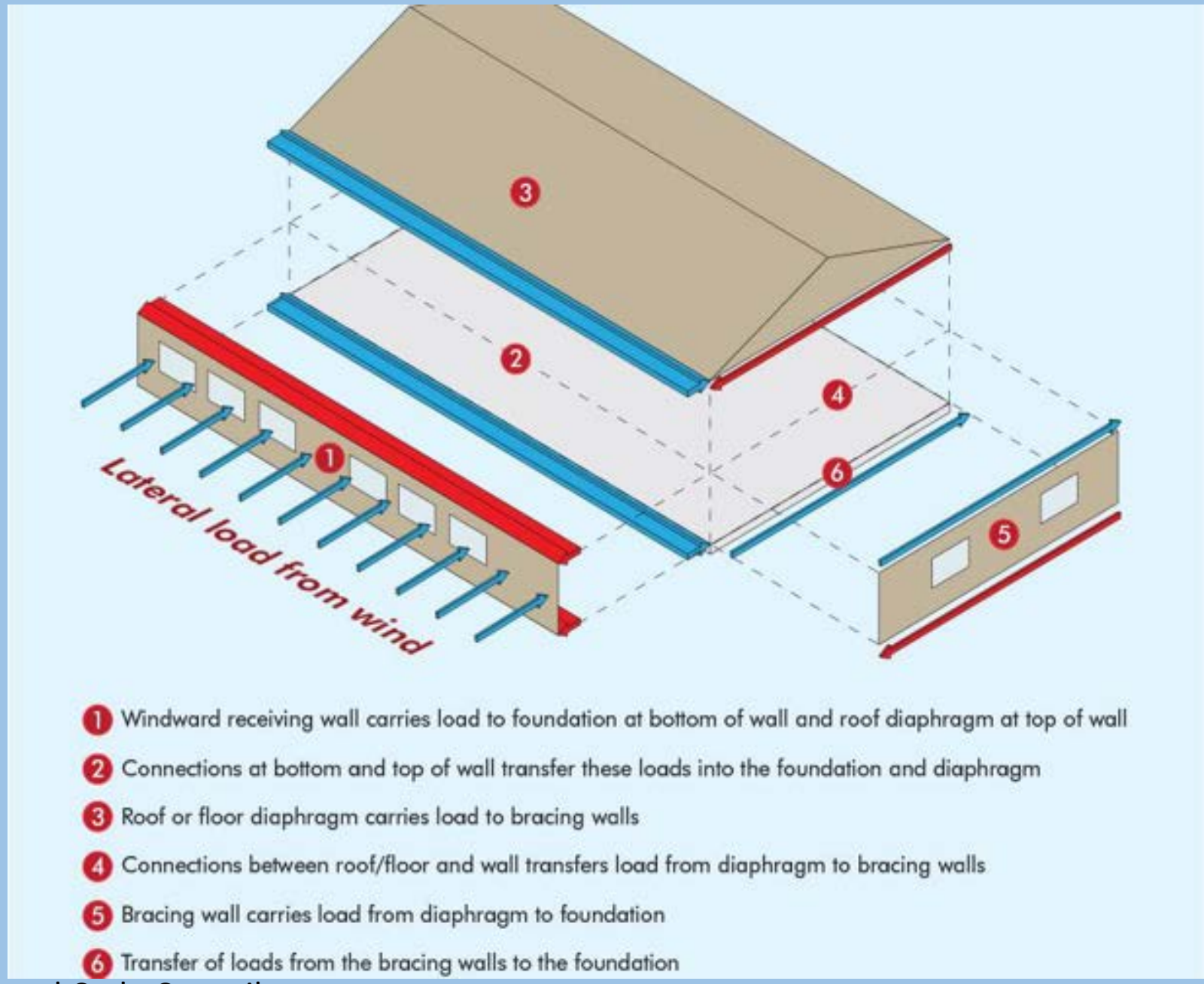
2.Connections at top and bottom of receiving wall

3.Floor and roof diaphragms

4.Roof-to-wall/wall-to-wall connections

5.Wall bracing

6.Wall bracing-to-foundation connections



CRITICAL PARTS OF THE LATERAL LOAD PATH

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5.Wall bracing

6.Wall bracing-to-foundation connections

Windstorm in Texas

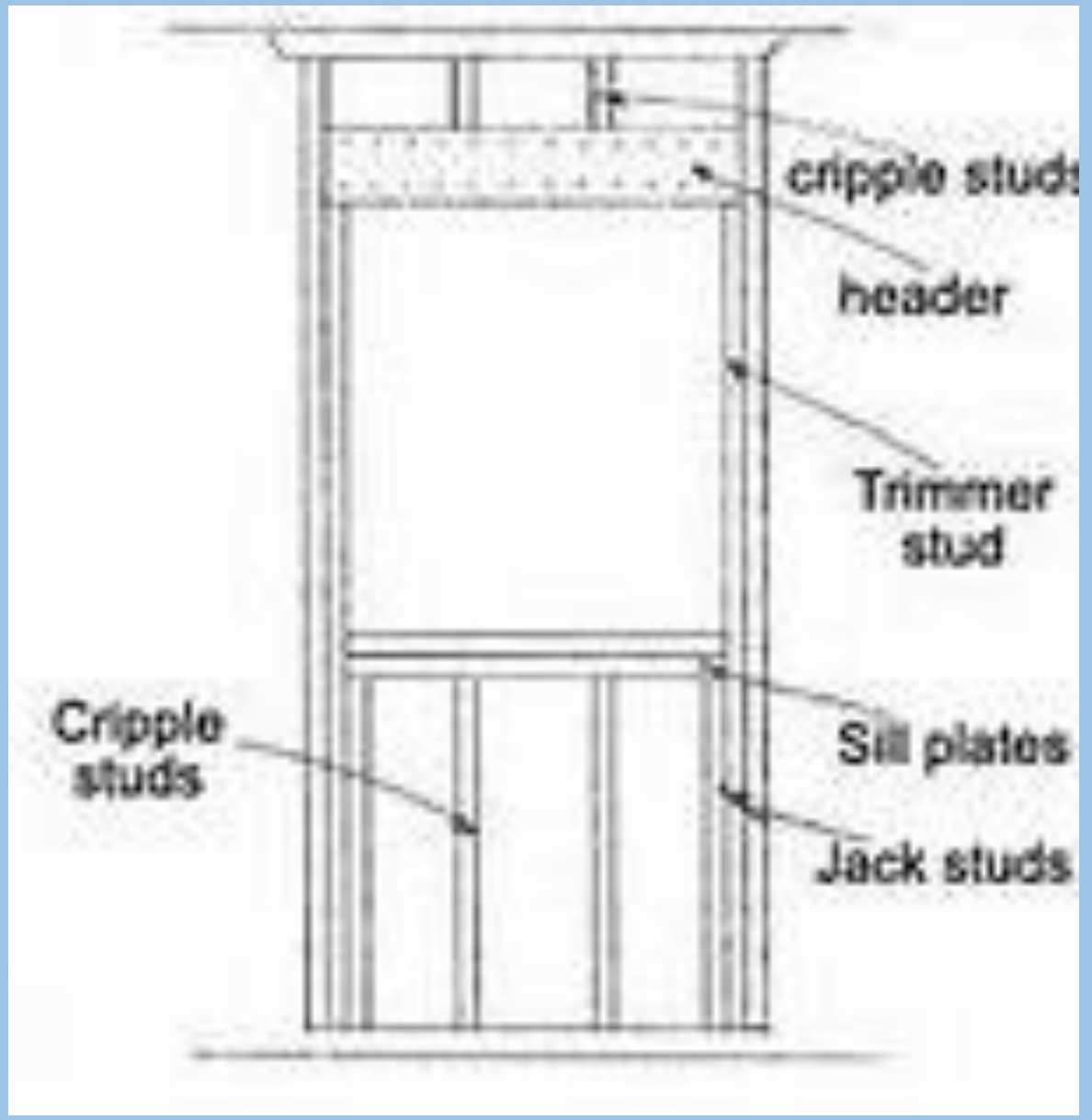
Wall covering is an essential part of the first step of the load path for wind. The wall studs can be seen behind the failed wall covering system.

Windstorm in Indiana

Partial failure of the wall covering system. In this case, it was brick veneer inadequately attached to framing/sheathing

Connections at top and bottom of receiving wall

The receiving walls must be properly attached at the base and at the top to adequately transfer the forces into the foundation



Floor and roof diaphragm

The floor and roof sheathing and framing form the diaphragms which transfer loads from the receiving wall to the bracing walls.

Floor and roof diaphragm

The floor and roof sheathing and framing form the diaphragms which transfer loads from the receiving wall to the bracing walls.

Roof-to-wall/wall-to-wall connections

A proper connection from the roof to the walls below and/or walls to the walls below (in the case of multi-story structures) is critical to the load path and is a common failure point.

Wall bracing

From a lateral load perspective, the walls support the roof and floor diaphragms through the use of bracing panels.

Wall-to-foundation connections

Just as the receiving walls must be attached to the foundation in order to resist the loads imposed, the bracing walls must be attached to the foundation.

These connections are critical.

Braced Walls vs. Shear Walls

Wall bracing comes from the prescriptive building code.

In the IRC, wall bracing is prescribed, and required bracing lengths are provided in tables; few, if any, calculations are necessary.

From the designer's and builder's perspective, there is no “engineering” required in conventional residential construction since construction requirements are prescribed in the code.

Braced Walls vs. Shear Walls (Cont.)

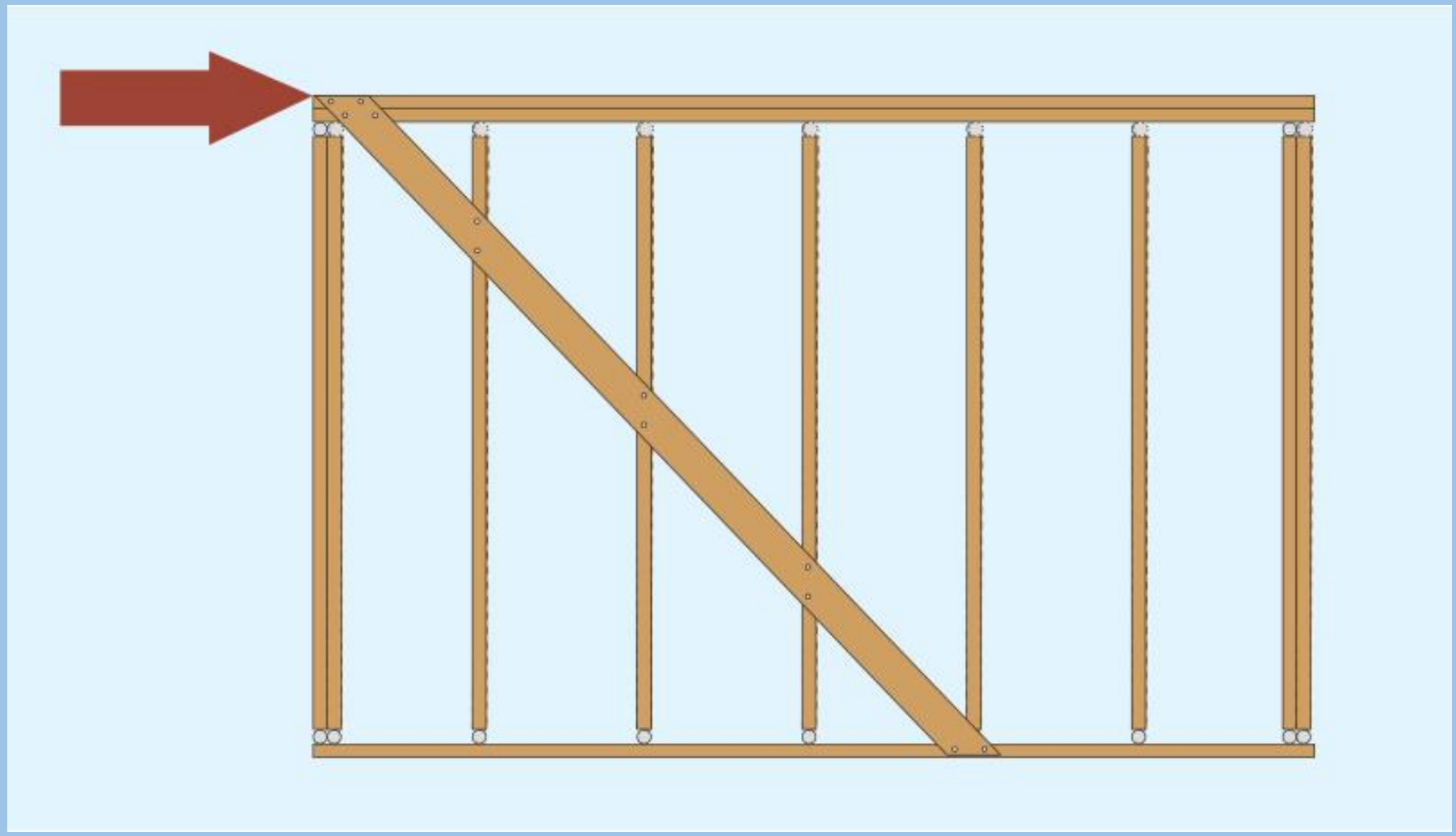
Shear walls, on the other hand, are used in portions of structures that do not meet the prescriptive limits and conventional construction parameters of the IRC.

Shear walls are designed or “engineered” by a design professional and have specific design values depending on fastener spacing, fastener size, sheathing type and thickness, and framing species. Shear walls usually require manufactured hold downs to resist overturning.

Shear walls must resist the loads that are calculated through engineering analysis and are generally associated with the design provisions of the IBC.

Stud wall with let-in brace

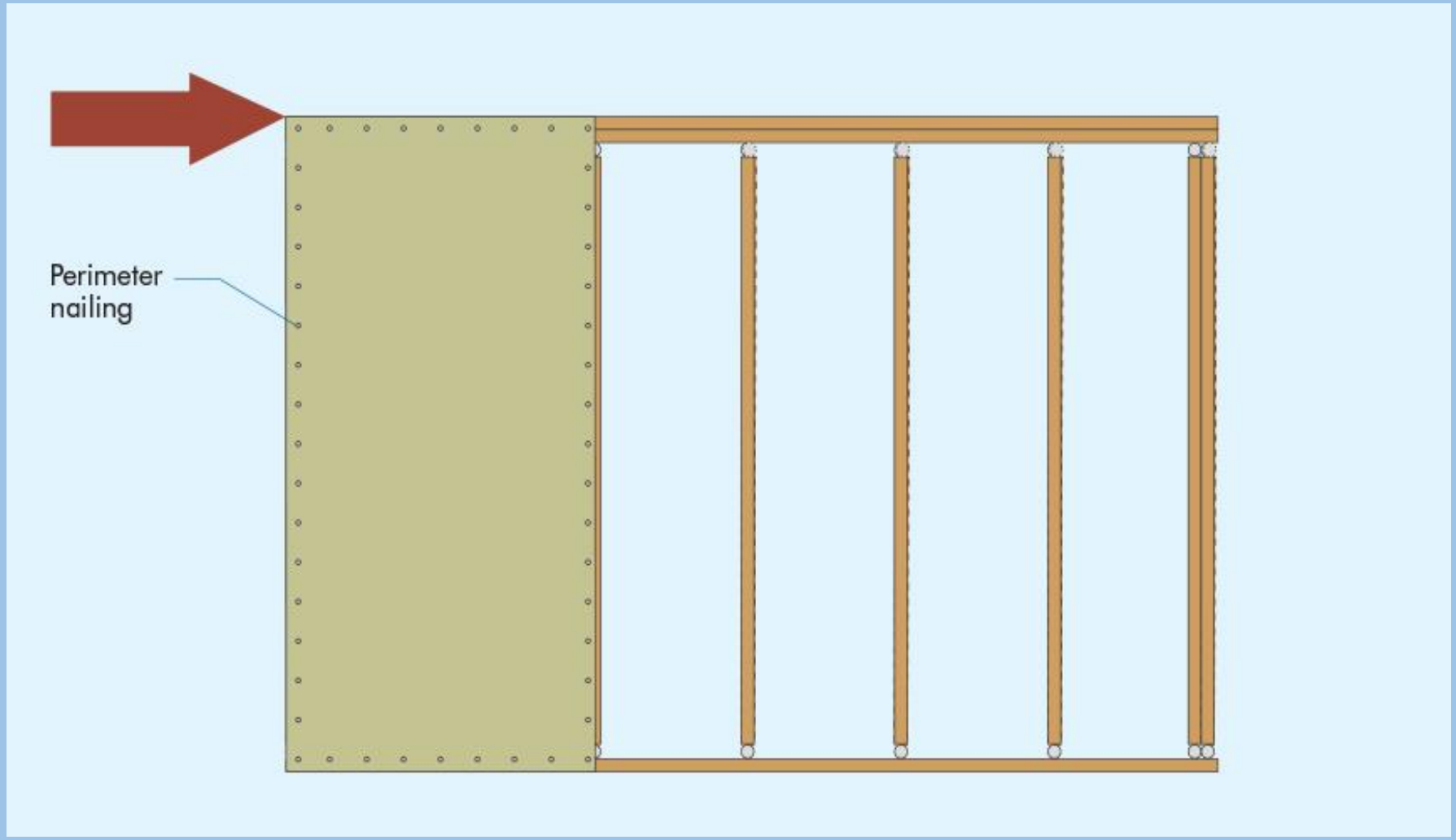
The diagonal brace and two nails into the top and bottom plates and each stud it crosses prevent the wall from racking



Stud wall with panel bracing

Perimeter nailing prevents the wall from racking.

(Intermediate nailing not shown for clarity.)



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Commercial Energy Code Short Course Updates and Applications; Building Envelope Requirements

And Your Business….

Instructor; Matt Belcher

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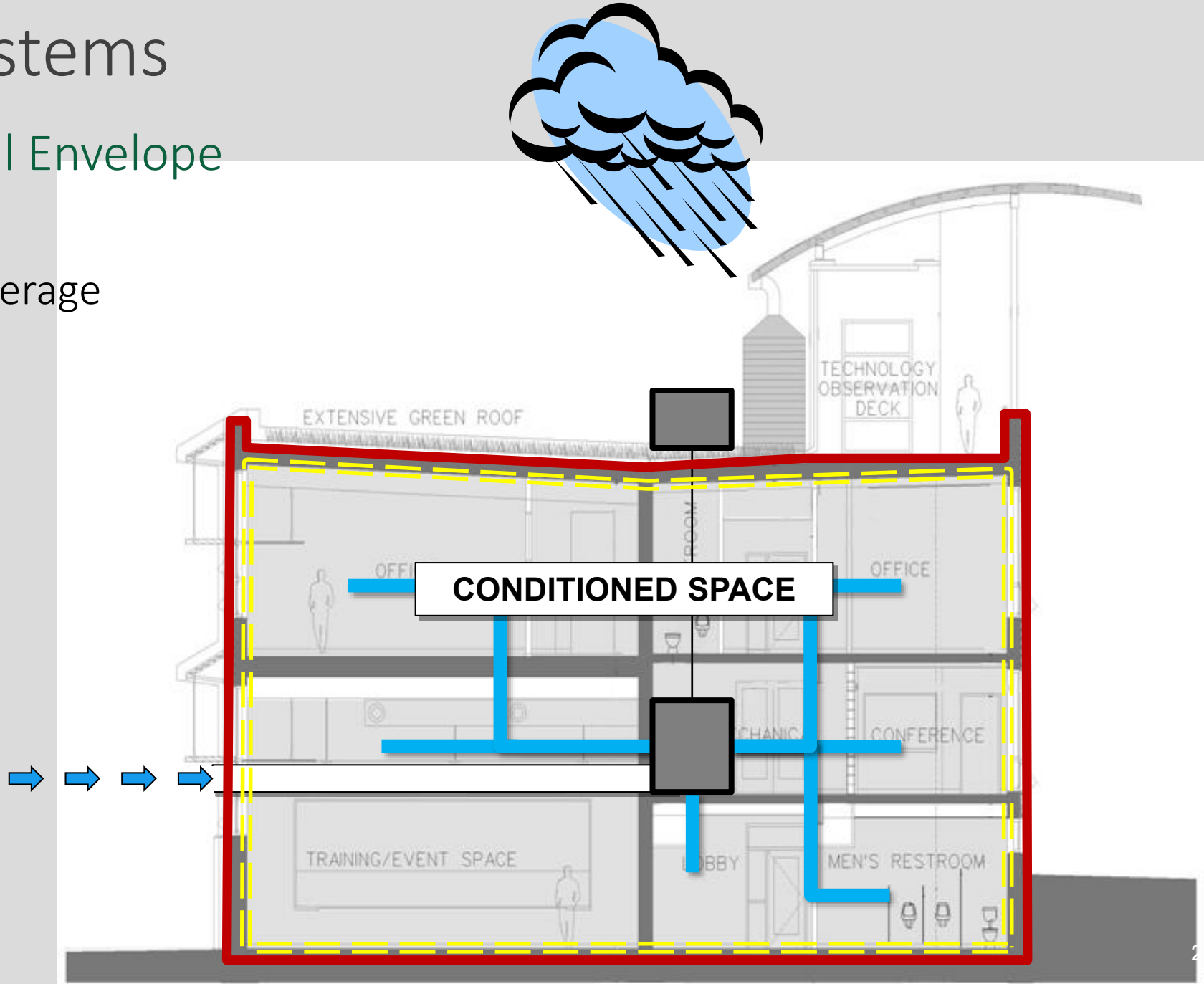
Buildings are Systems

Complete Building Thermal Envelope

- Continuous Air Barrier
- Complete Insulation Coverage

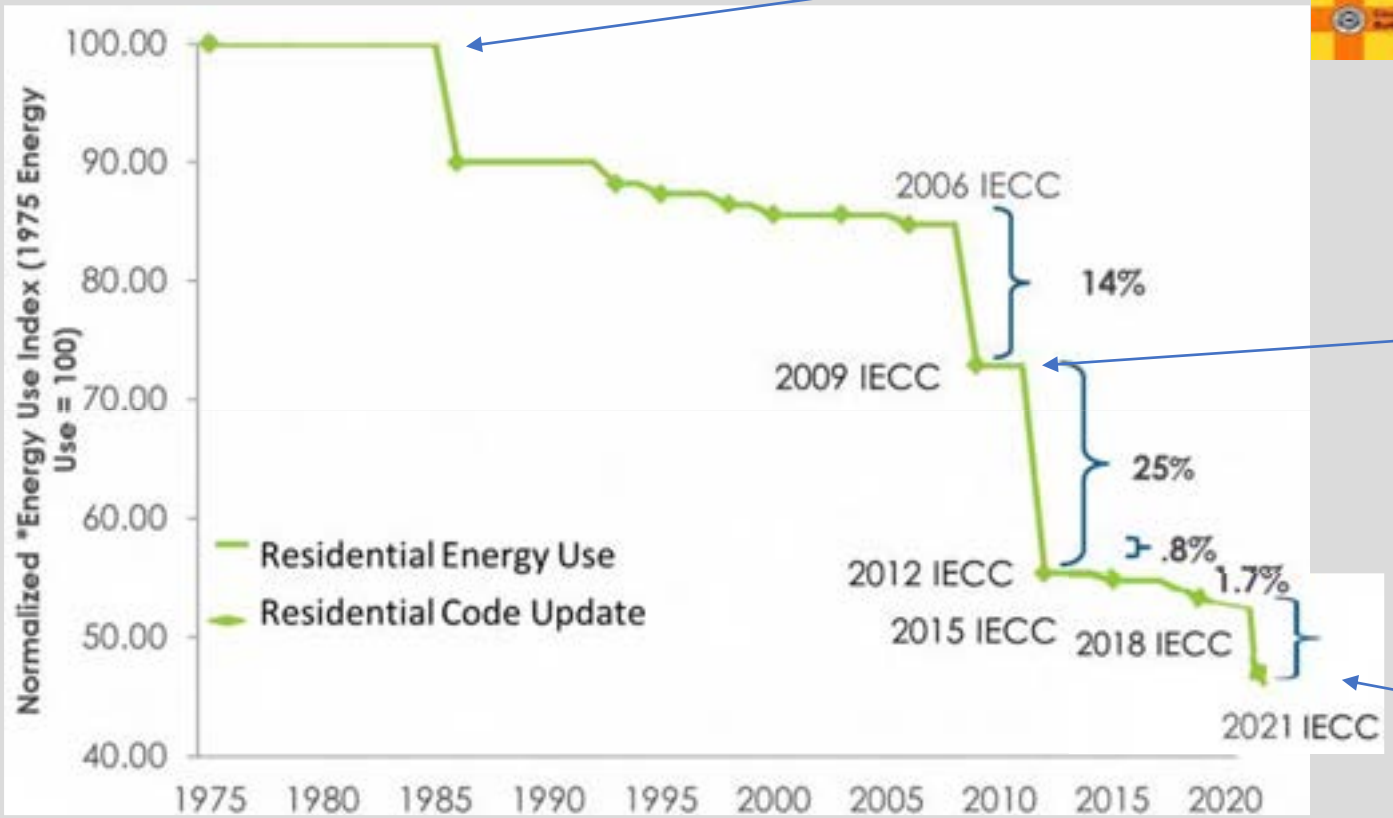
- Proper Heating & Cooling Systems
- Controlled Ventilation
- Deal with Moisture!

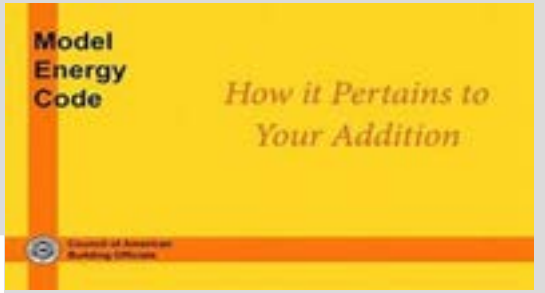


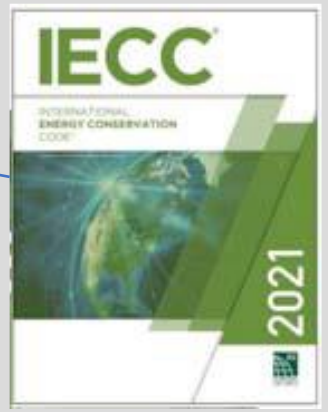
Commercial Energy Codes

Photo: Jonathan Hillyer, 2009

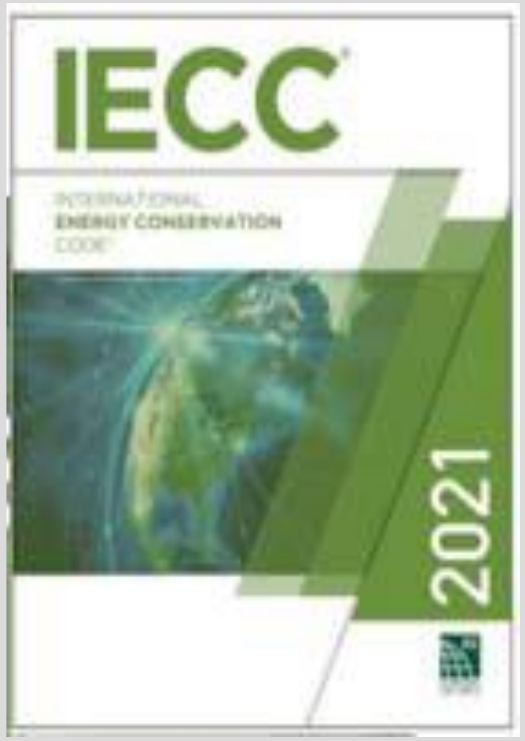
Energy Code History



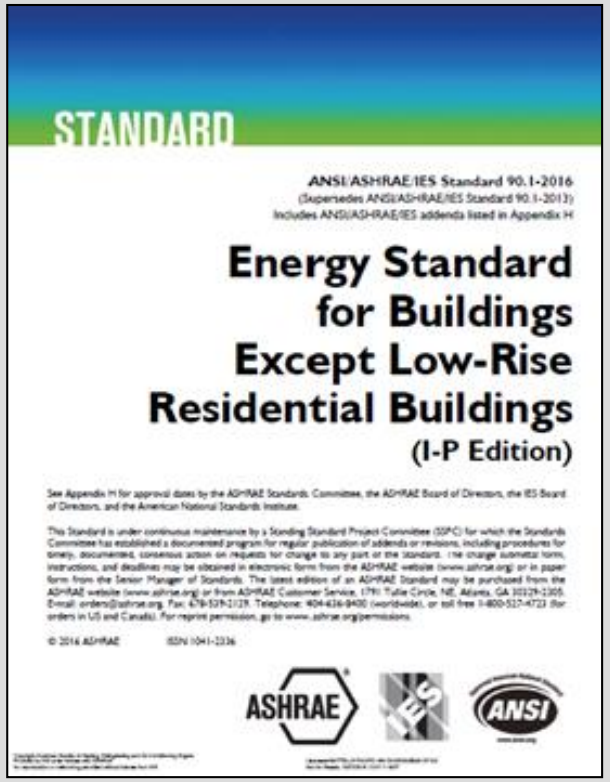




Two Commercial Compliance Options



We are going to discuss ASHRAE 90.1-2019 and its application with 2021 IECC**!**



Existing Buildings - Scope

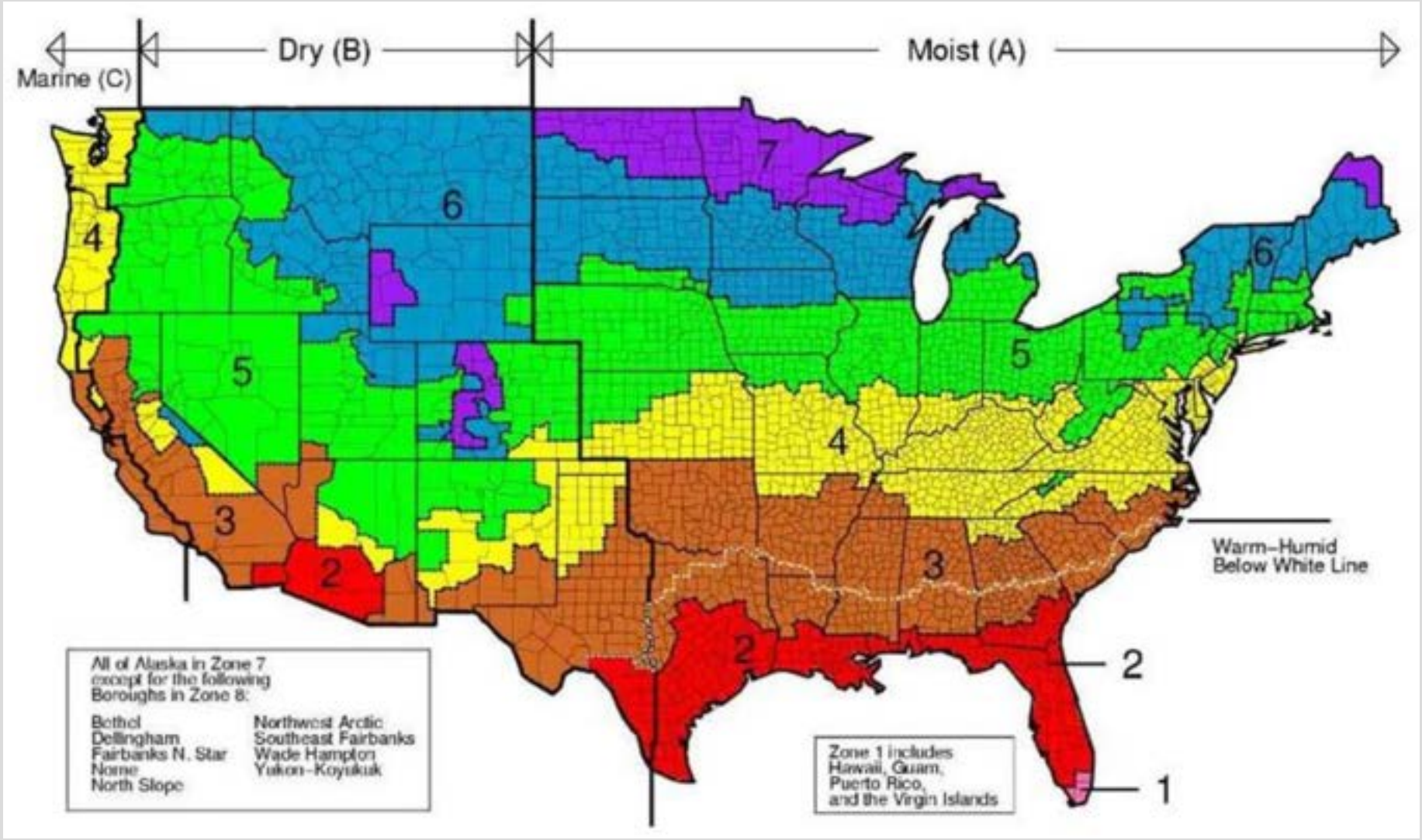
Chapter 5

- Applies to alterations, repairs, additions, and change of occupancy (C501.1)
- Additions must comply with code without requiring unaltered portions to comply (C502.1)
  - Specific requirements for new vertical fenestration and skylights (C502.2.1 and C502.2.2)
- Alterations shall not make building less conforming (C503.1)

Image: MontgomeryCountyMD.gov

Old 2018 IECC climate zones

MO is CZ4-5

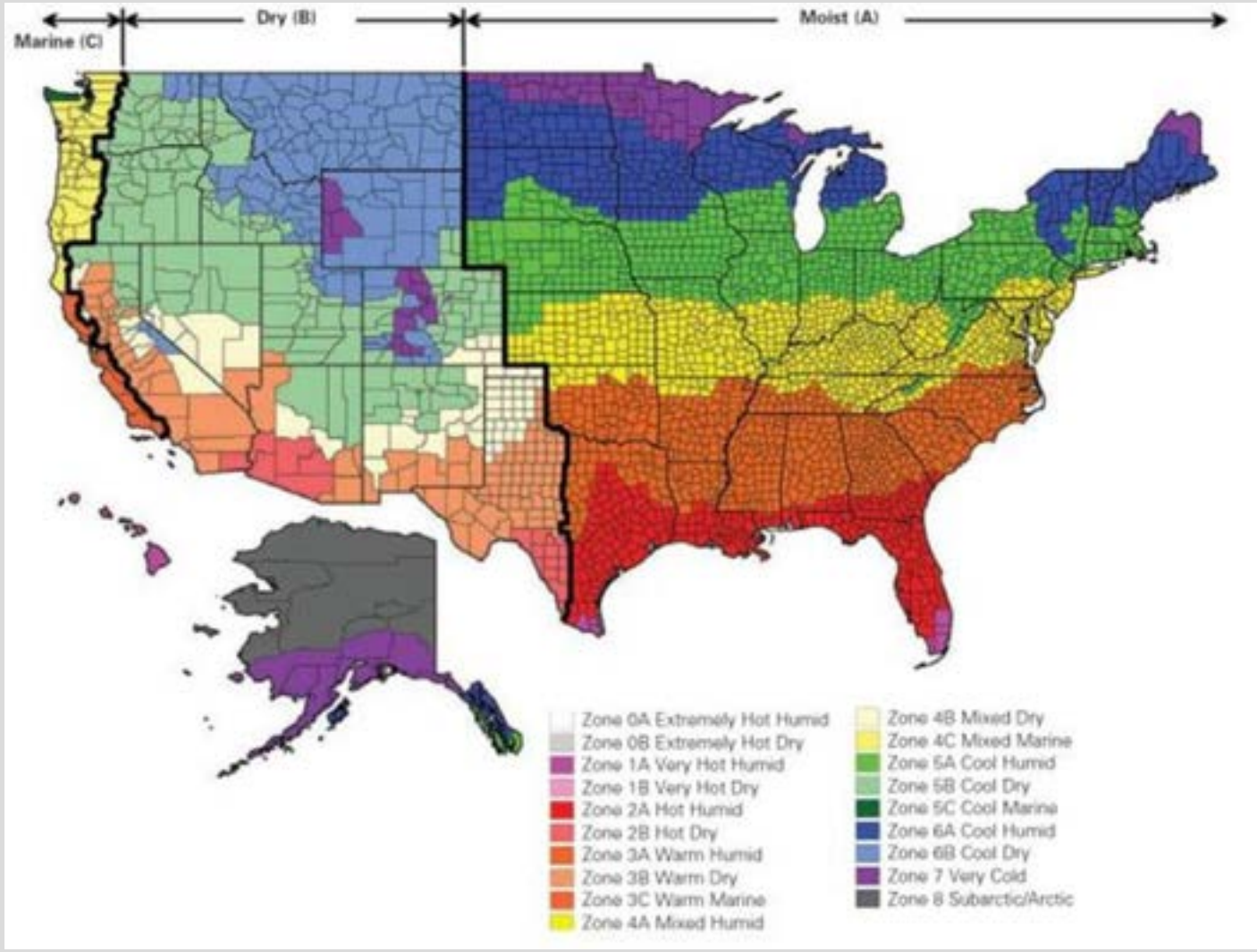


How are envelope requirements determined?

Requirements for building energy codes are linked to the dominate climate within a given jurisdiction, determined by a 30-year average of local surface observations.

Note: Climate zones change! Climate zones change! ASHRAE 90.1-2019 & IECC 2021 have important changes, including a new climate zone (CZ0) and shifts in county designations.

Question: Why should you (or a building owner/operator) care?



Biggest Changes in IECC 2021

- Redrawn Climate Zones (6 CZ's in MO) Nebraska unaffected
- ASHRAE 90.1 2019 = Alternate Path
- Improved Window U-factors & Wall and Ceiling R-values
- Updated Mechanical/Lighting requirements
- Controls!
- Must choose your Additional Efficiency Package
- Increased Alternative Methods
- ComCheck
- More Focus on Commissioning

Changes in IECC 2021

- **Administrative**
- C102: More Authority for Code Official to approve alternative material(s). (or not!)
- More definition for Code Officials Approval of Above Code Programs. (or not!)
- Information on Construction Documents must include: Energy Compliance Path and Air Sealing Details and Location of Air Barrier.

C401

Thermal Envelope Certificate Required

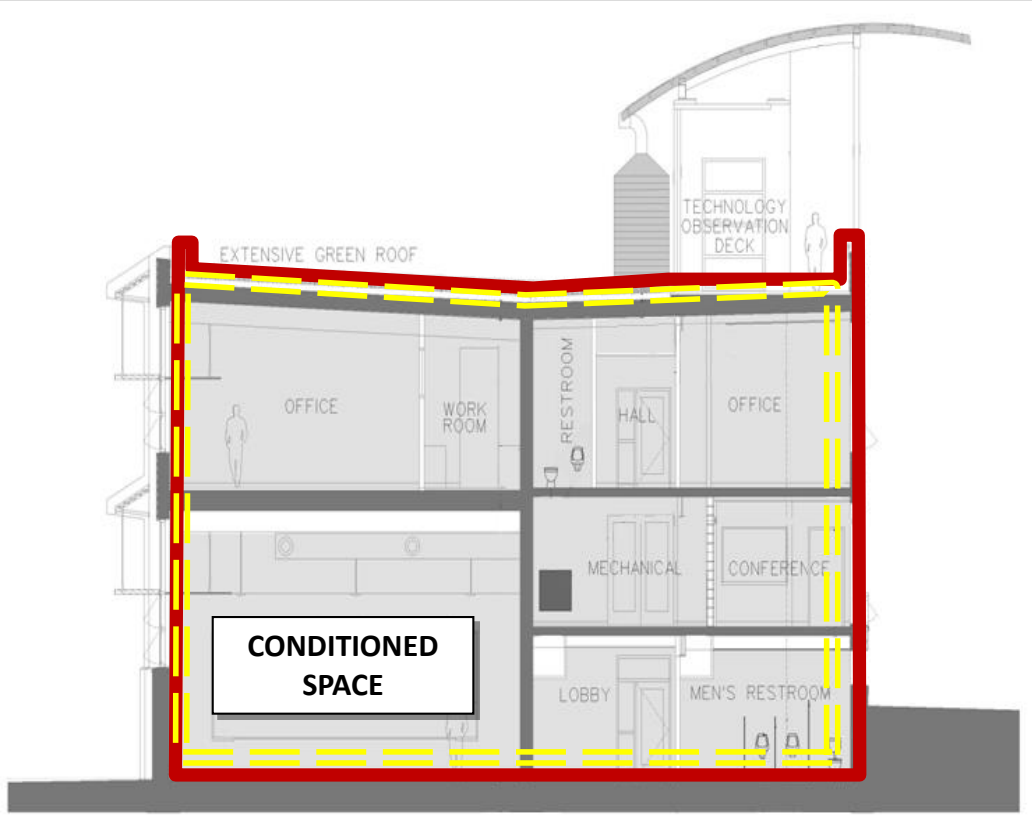
- Completed by an *Approved Party*
- Posted on a wall in the space where space conditioning equipment is located
- Shows R-Values, U-Values, Envelope Leakage Test Results, Etc.

In Addition:

- Updates to Greenhouse Requirements.
- More Insulation Installation requirements.

What is the Building Thermal Envelope?

- These assemblies can comprise the building thermal envelope if they **separate conditioned from unconditioned space or outside air**
  - Roof/Ceiling Assembly
  - Wall Assembly
  - Vertical Fenestration and Skylights
  - Floor Assembly
  - Slab Edge
  - Below-Grade Wall Assembly



Compliance Options - Prescriptive

- Building must comply with
- C402 Envelope
- C403 Mech
- C404 SWH
- C405 Lighting
- Plus pick one additional efficiency package

Additional Efficiency Package Options

- One additional efficiency feature must be selected to comply with the IECC
- C406.2 More efficient **HVAC** performance, OR
- C406.3 Reduced **lighting** power density system, OR
- C406.4 Enhanced lighting **controls**, OR
- C406.5 On-site supply of **renewable** energy
- C406.6 Dedicated outdoor air system (**DOAS**), OR
- C406.7 More efficient SWH (**hot water**) OR
- C406.8 Enhanced **envelope** performance OR
- C406.9 Reduced air **infiltration**

Compliance Options - Performance

- C407 Total Building Performance
- Building energy cost to be less than 85% of standard reference design building
- C402.5 Air Leakage
- C403.2 Provisions applicable to all mechanical
- C404 SWH
- Mandatory Lighting C405.2, C405.3, C405.4, C405.6

Changes in IECC 2021

- **Definitions Added/Modified:**

- BioGas
- *Biomass*
- *Data Center/Computer Room*
- Direct Digital Control (DDC)
- Enthalpy Recovery Ratio
- Fans: Many Additions and Changes (Energy/Power, Number, etc.)
  - Large Diameter Fans
- Fault Detection and Diagnostics (FDD) System

Changes in IECC 2021

- **Definitions Added/Modified:**

- *Lighting Definition Modification*
- Information Technology Equipment (ITE)
- Internal Curtain System
- *On-Site Renewable Energy*
- *Renewable Energy Resources*
- *Testing Unit Enclosure Area*
- *Thermal Distribution Efficiency (TDE)*
- *Vegetative Roof*
- *Visible Transmittance*

Insulation – prescriptive requirements

Mandatory Provisions - Insulation

- Insulation must be in substantial contact with inside surface in a permanent manner
- No loose-fill insulation in attic when ceiling is steeper than 3:12 slope
- Dams & baffles at eave vents to deflect incoming air
- Recessed equipment – effect on insulation
- Insulation protected from sunlight, moisture, landscaping operations, equipment maintenance, and wind
- Stagger joints of multilayered rigid insulation

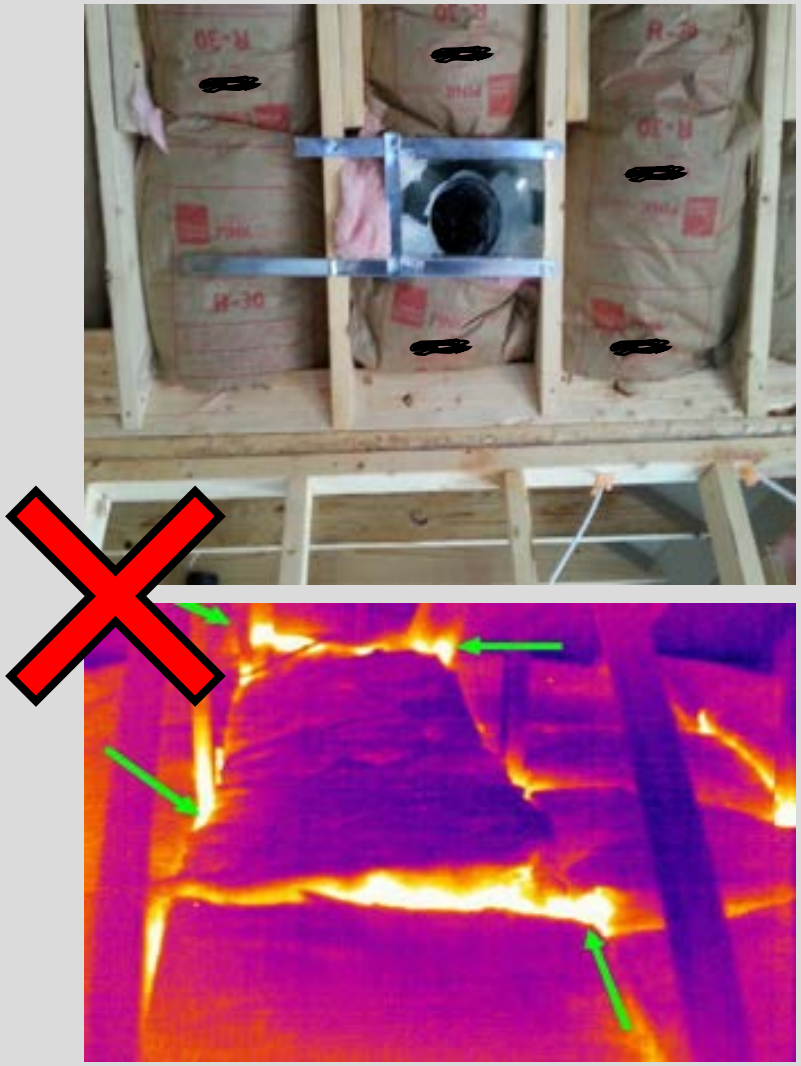


TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, *R*-VALUE METHOD[a]

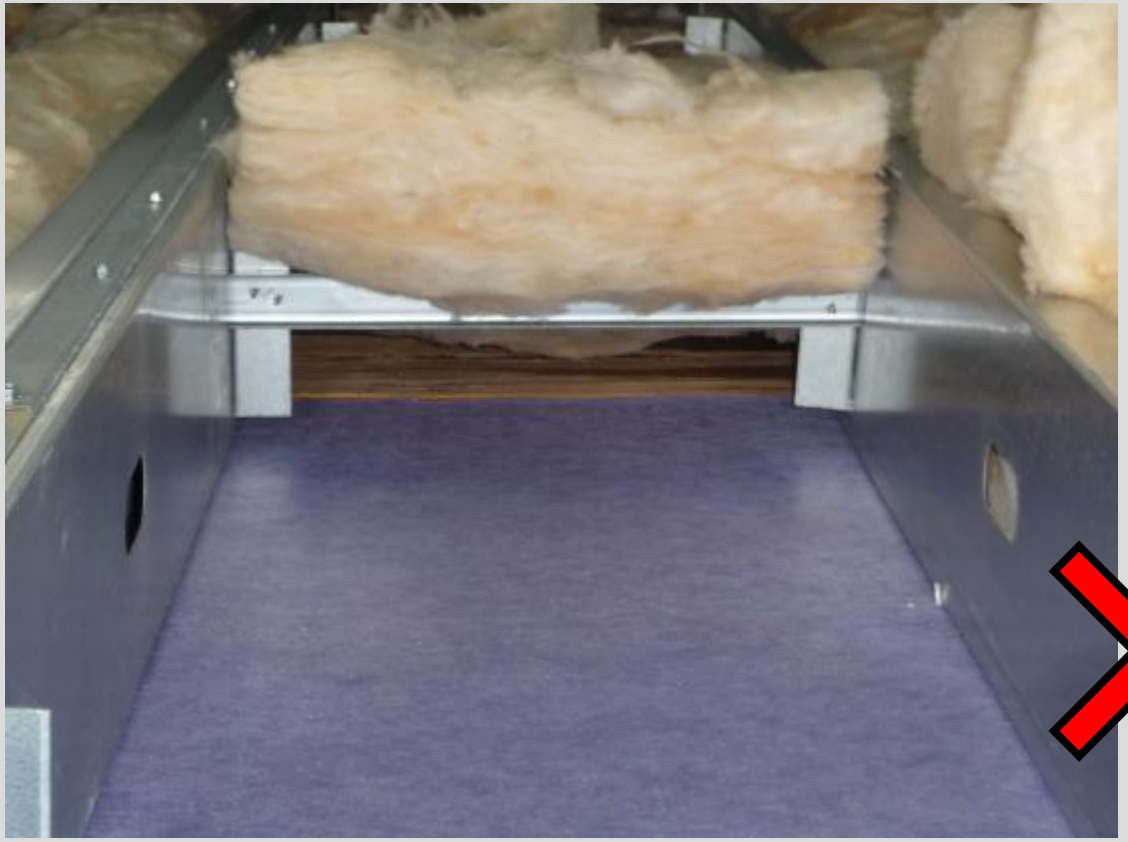
CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group
Roofs														
Insulation entirely above roof deck	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci	R-25ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-35ci	R-35ci
Metal buildings[b]	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-25 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS
Attic and other	R-38	R-38	R-38	R-38	R-38	R-38	R-49	R-49	R-49	R-49	R-49	R-49	R-60	R-60
Walls, above grade														
Mass[f]	R-5.7ci[c]	R-5.7ci[c]	R-5.7ci[c]	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci	R-11.4ci	R-11.4ci	R-13.3ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci
Metal building	R-13 + R-6.5ci	R-13 + R-6.5ci	R13 + R-6.5ci	R-13 + R-13ci	R-13 + R-6.5ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-17ci	R-13 + R-19.5ci
Metal framed	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-10ci	R-13 + R-10ci	R-13 + R-12.5ci	R-13 + R-12.5ci	R-13 + R-12.5ci	R-13 + R-15.6ci
Wood framed and other	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-7.5ci or R20 + R3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci o R-20 + R-3.8ci
Walls, below grade														
Below-grade wall[d]	NR	NR	NR	NR	NR	NR	R-7.5ci	R-10ci	R-7.5ci	R-10ci	R-10ci	R-15ci	R-15ci	R-15ci
Floors														
Mass[e]	NR	NR	R-6.3ci	R-8.3ci	R-10ci	R-10ci	R-14.6ci	R-16.7ci	R-14.6ci	R-16.7ci	R-16.7ci	R-16.7ci	R-20.9ci	R-20.9ci
Joist/framing	R-13	R-13	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-38	R-38	R-38	R-38
Slab-on-grade floors														
Unheated slabs	NR	NR	NR	NR	NR	R-10 for 24" below	R-15 for 24" below	R-15 for 24" below	R-15 for 24" below	R-20 for 24" below	R-20 for 24" below	R-20 for 48" below	R-20 for 24" below	R-20 for 48" bel
Heated slabs[g]	R-7.5 for 12" below + R-5 full slab	R-7.5 for 12" below + R-5 full slab	R-7.5 for 12" below + R-5 full slab	R-7.5 for 12" below+ R-5 full slab	R-10 for 24" below + R-5 full slab	R-10 for 24" below + R-5 full slab	R-15 for 24" below + R-5 full slab	R-15 for 24" below + R-5 full slab	R-15 for 36" below + R-5 full slab	R-15 for 36" below + R-5 full slab	R-15 for 36" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab

TABLE C402.1.4 OPAQUE THERMAL ENVELOPE ASSEMBLY MAXIMUM REQUIREMENTS, *U*-FACTOR METHOD[a, b]

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above roof deck	U-0.048	U-0.039	U-0.039	U-0.039	U-0.039	U-0.039	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.028	U-0.028	U-0.028	U-0.028
Metal buildings	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.031	U-0.029	U-0.029	U-0.029	U-0.026	U-0.026
Attic and other	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.017	U-0.017	U-0.017	U-0.017
Walls, above grade																
Mass[f]	U-0.151	U-0.151	U-0.151	U-0.123	U-0.123	U-0.104	U-0.104	U-0.090	U-0.090	U-0.080	U-0.080	U-0.071	U-0.071	U-0.071	U-0.037	U-0.037
Metal building	U-0.079	U-0.079	U-0.079	U-0.079	U-0.079	U-0.052	U-0.052	U-0.050	U-0.050	U-0.050	U-0.050	U-0.050	U-0.044	U-0.039	U-0.039	U-0.039
Metal framed	U-0.077	U-0.077	U-0.077	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.055	U-0.055	U-0.049	U-0.049	U-0.049	U-0.042	U-0.037	U-0.037
Wood framed and other[c]	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.032	U-0.032
Walls, below grade																
Below-grade wall[c]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-0.119	C-0.092	C-0.119	C-0.092	C-0.092	C-0.063	C-0.063	C-0.063	C-0.063	C-0.063
Floors																
Mass[d]	U-0.322[e]	U-0.322[e]	U-0.107	U-0.087	U-0.074	U-0.074	U-0.057	U-0.051	U-0.057	U-0.051	U-0.051	U-0.051	U-0.042	U-0.042	U-0.038	U-0.038
Joist/framing	U-0.066[e]	U-0.066[e]	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027
Slab-on-grade floors																
Unheated slabs	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.54	F-0.52	F-0.52	F-0.52	F-0.51	F-0.51	F-0.434	F-0.51	F-0.434	F-0.434	F-0.424
Heated slabs	F-0.69	F-0.69	F-0.69	F-0.69	F-0.66	F-0.66	F-0.62	F-0.62	F-0.62	F-0.62	F-0.62	F-0.602	F-0.602	F-0.602	F-0.602	F-0.602
Opaque doors																
Nonswinging door	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31
Swinging door[g]	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37
Garage door < 14% glazing[h]	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31

Insulation

Insulation



Substantial contact?

Envelope Minimum Requirements

- Poor wall insulation details

Envelope Minimum Requirements

- Poor wall insulation detail

Envelope Minimum Requirements

- Good wall insulation details

Envelope Minimum Requirements

- Good wall / floor insulation details

High Performance Walls - ICF's

Continuous Air, Thermal & Moisture Barriers

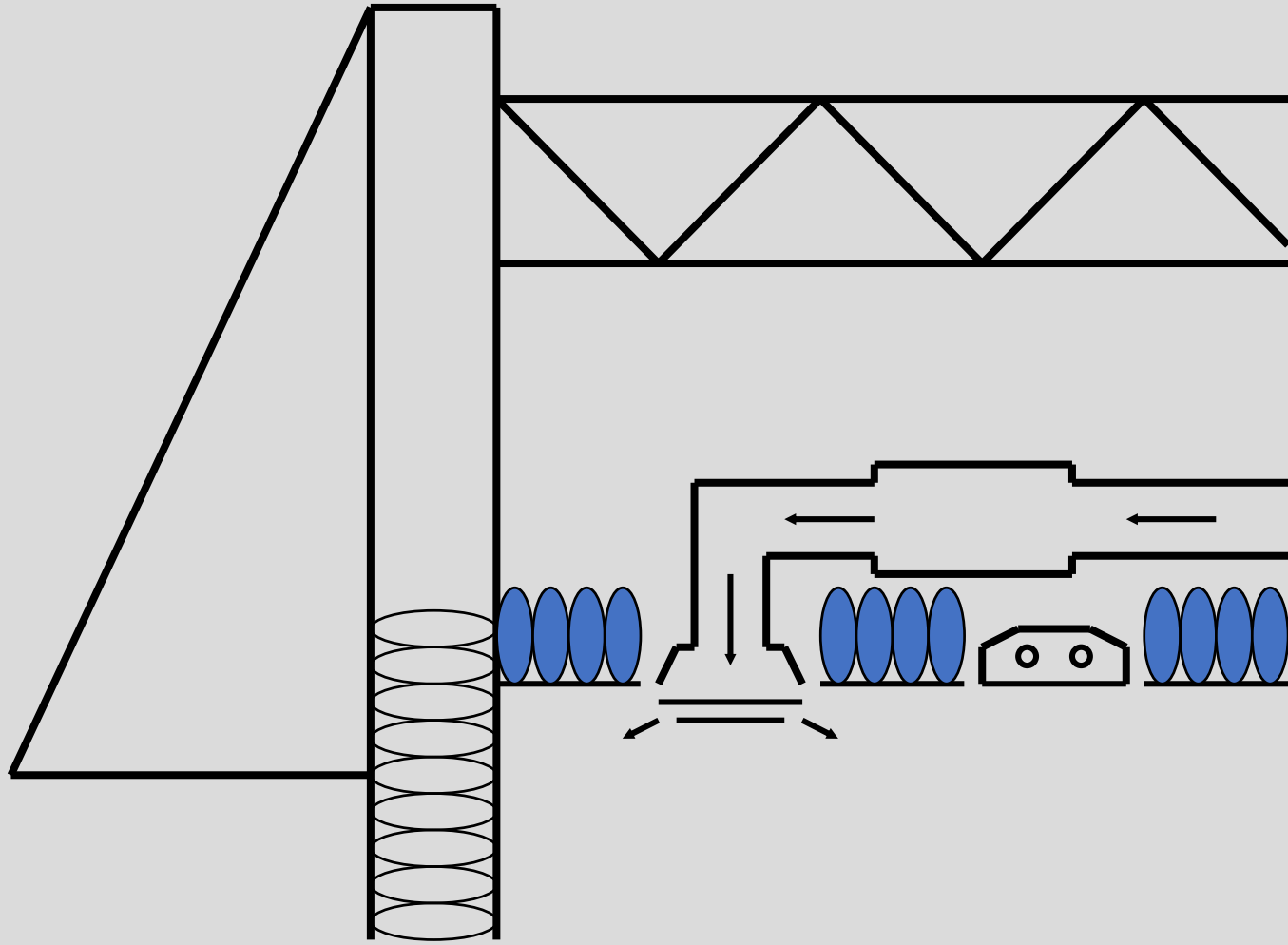
- ICF's are resource efficient & reduce waste
- Cost effective alternative to light gauge steel
- 40% recycled fly ash and slag to "green" the concrete

Roofs

Unacceptable Roof Design

Batts over suspended ceiling tiles

- Poor pressure boundary caused by tile grid, porous tiles, lighting vent holes
- Poor durability – maintenance disrupts batts, exposure to fiberglass dust
- Many thermal breaks due to ductwork, light fixtures, grid and support wires



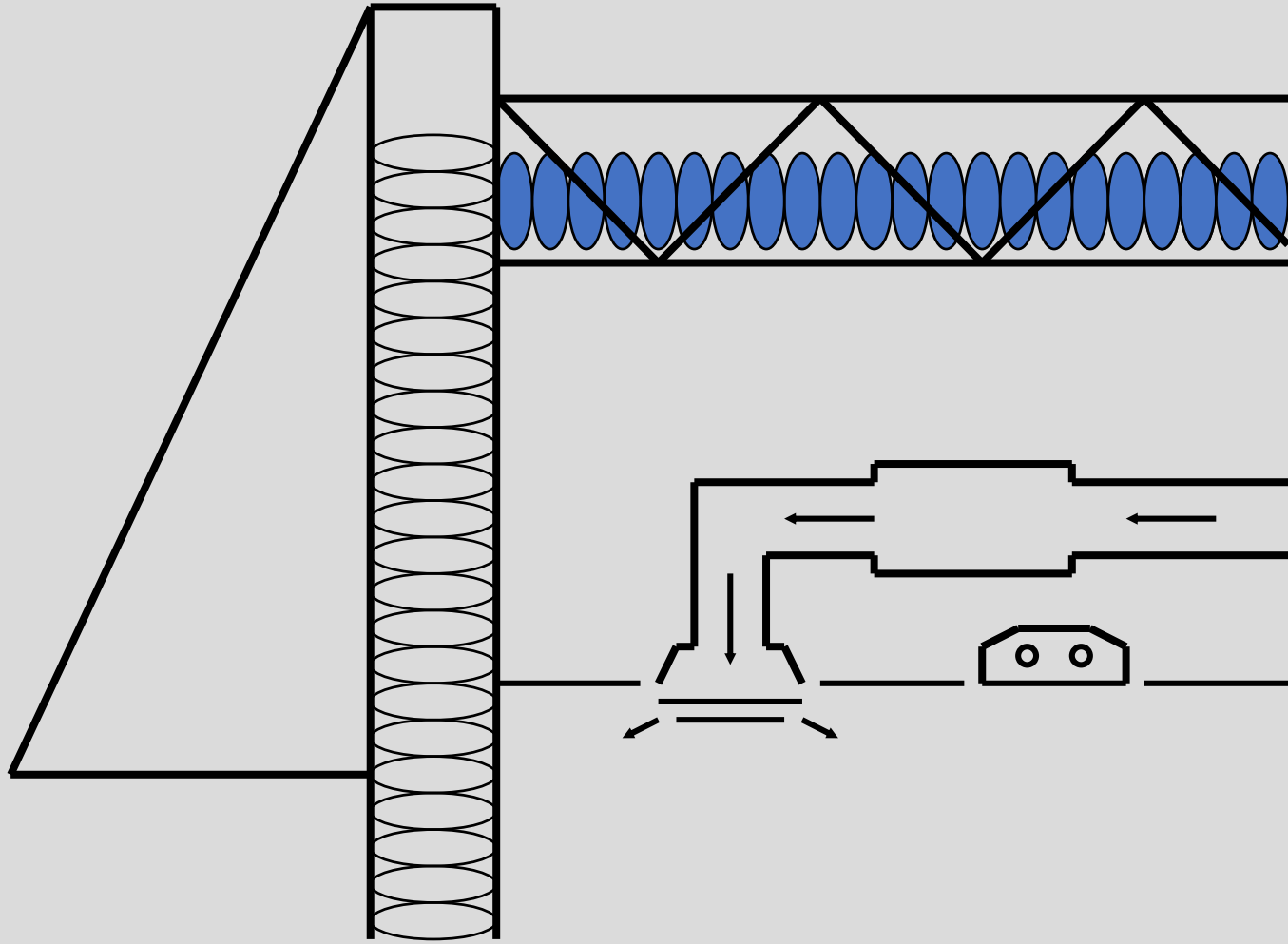
Suspended Ceilings

- The roof insulation shall not be installed on a suspended ceiling with removable ceiling panels.

Good Roof Design

Insulation above hard ceiling

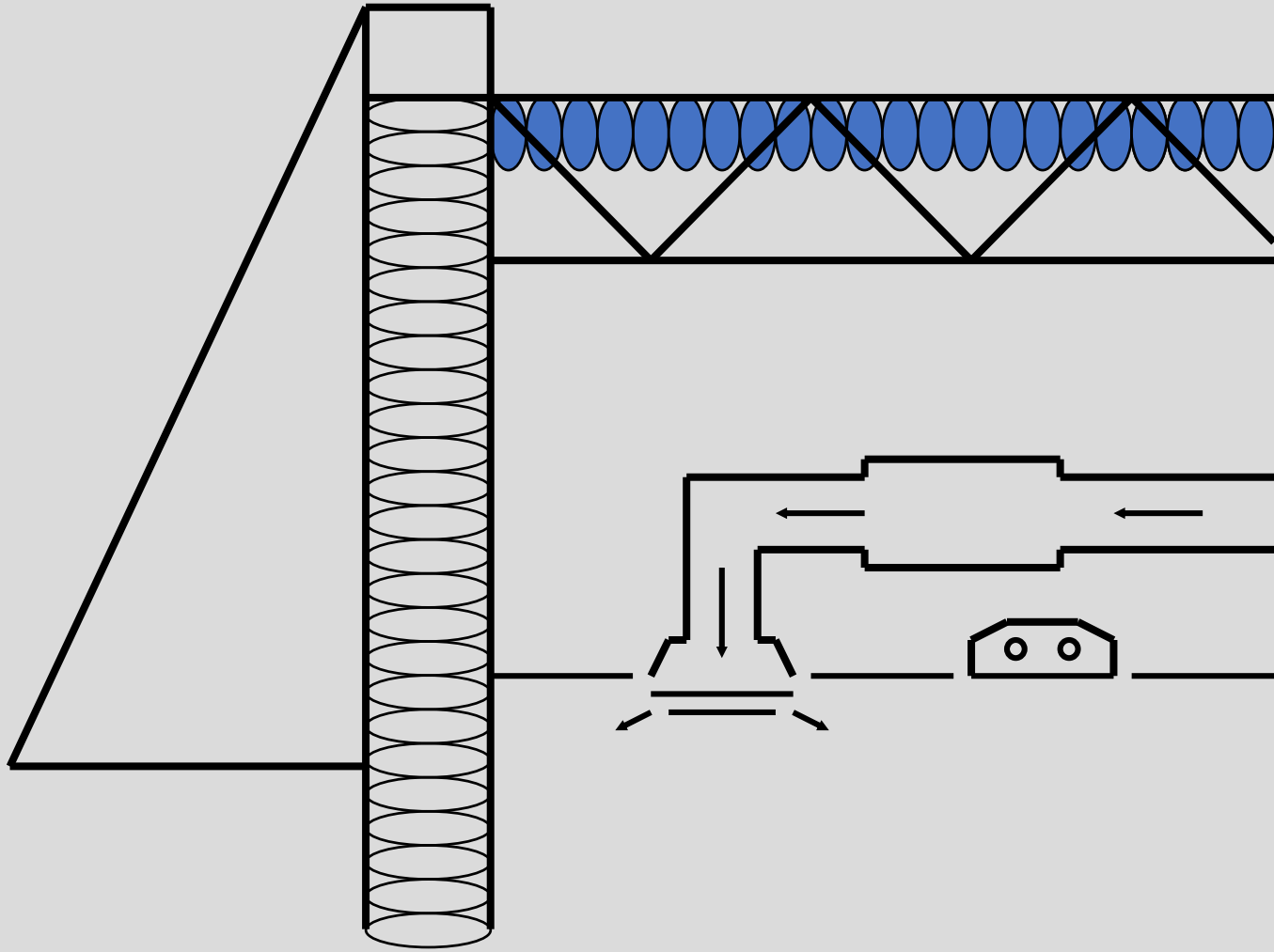
- Example: taped gypsum; similar to residential construction
- Ductwork is inside but must limit and seal HVAC, plumbing, and electrical penetrations through pressure boundary
- Thermal bridging from metal roof trusses



Better Roof Design

Spray foam insulation against underside of roof deck

- Minimal thermal breaks and continuous pressure boundary
- HVAC equipment and ductwork located within
- Good durability
- Preferred for retrofits



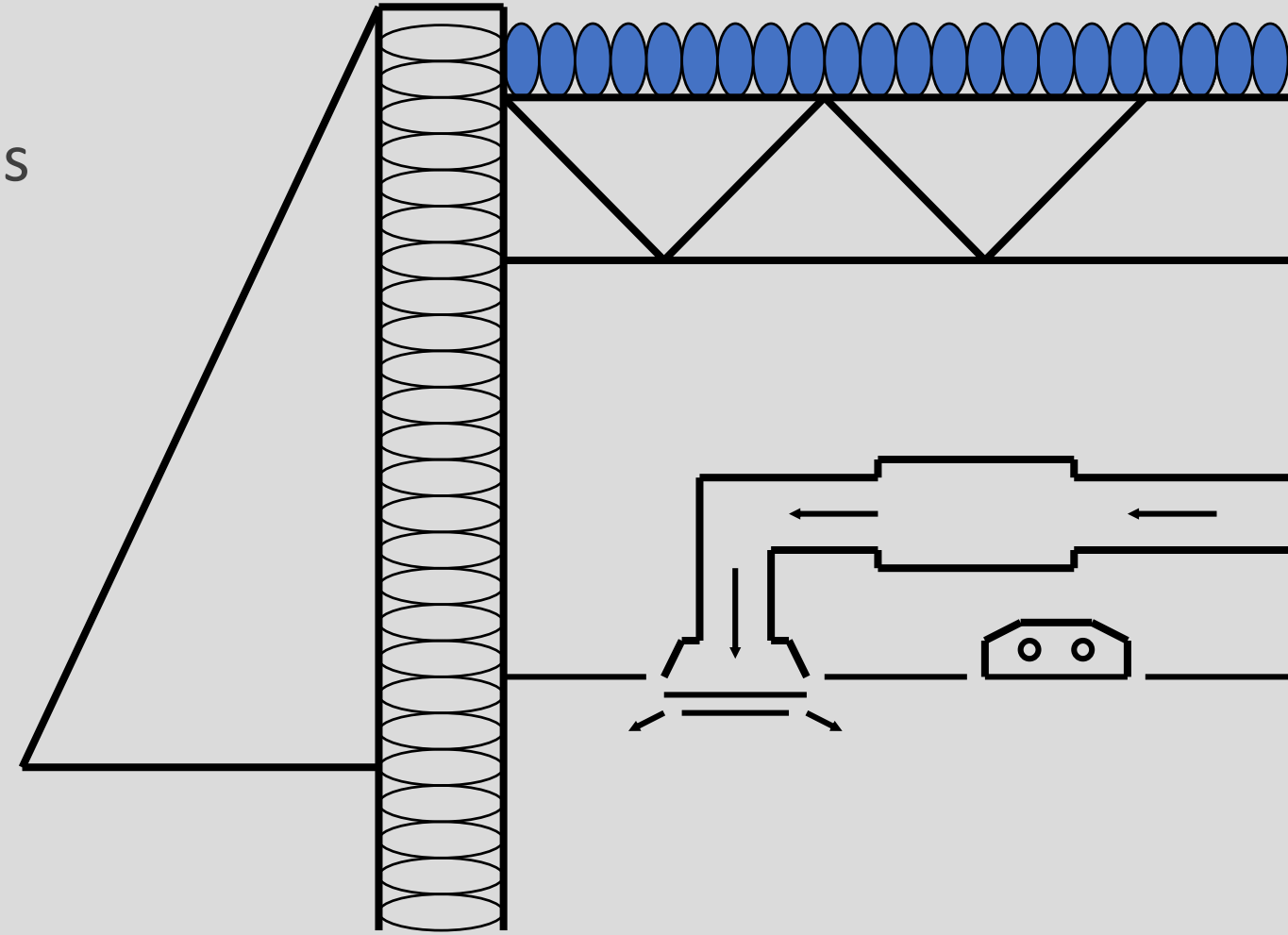
Case Study - Preschool

- Sprayed foam to R20 against underside of roof deck
  (+ new lighting fixtures)
- <u>HVAC load reduced 33%</u>

Best Roof Design

Rigid insulation above roof deck

- No thermal breaks and continuous pressure boundary
- HVAC equipment and ductwork located within conditioned space
- Good durability

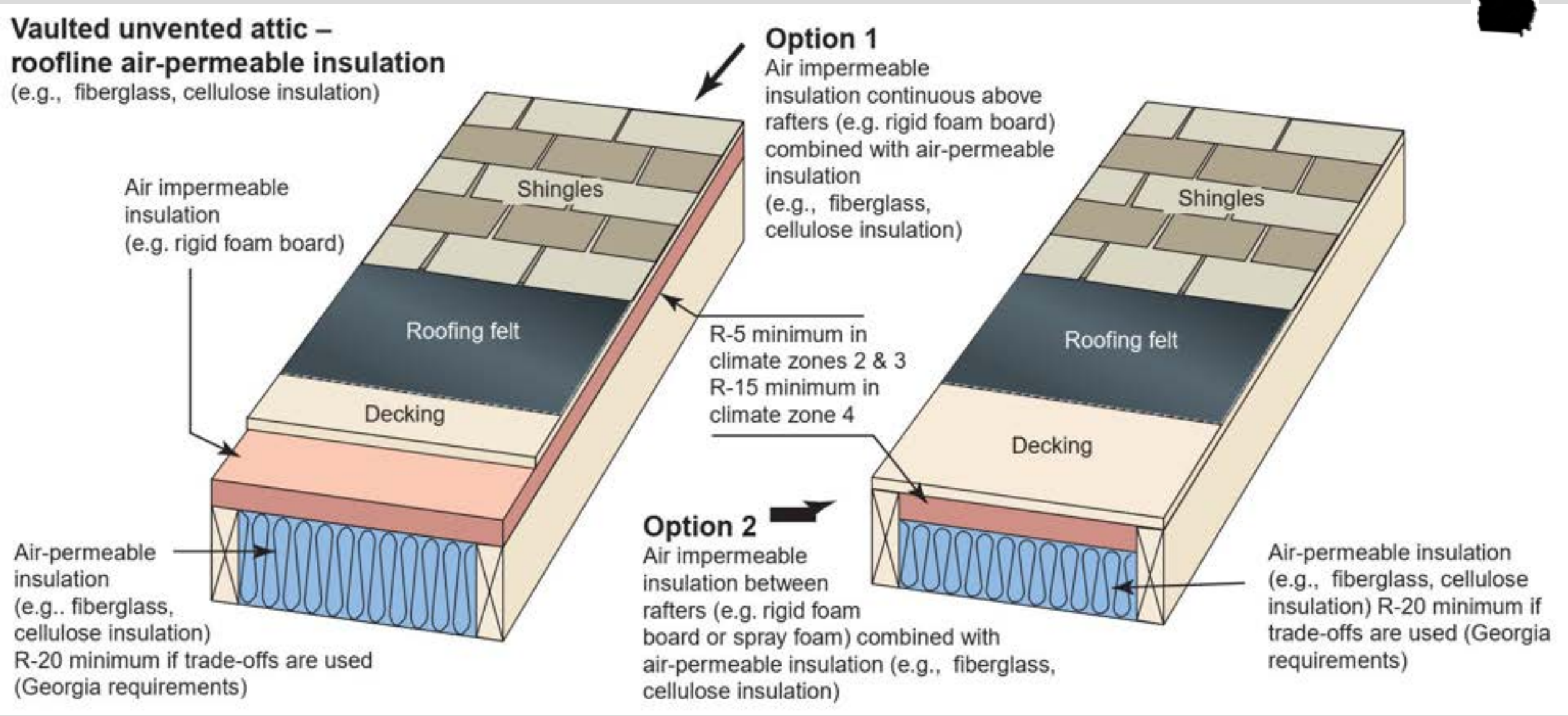


Insulation Above roof Deck

- Insulation considered continuous
- Continuous insulation board to have > 2 layers and the edge joints between each layer shall be staggered.

Peachcrest community center

Hybrid insulation approaches



5.3. Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.

IBC 806.5 unvented roof assemblies

- To reduce risk of condensation, install a certain amount of "air-impermeable" insulation before using an "air-permeable" product in an unvented roof assembly

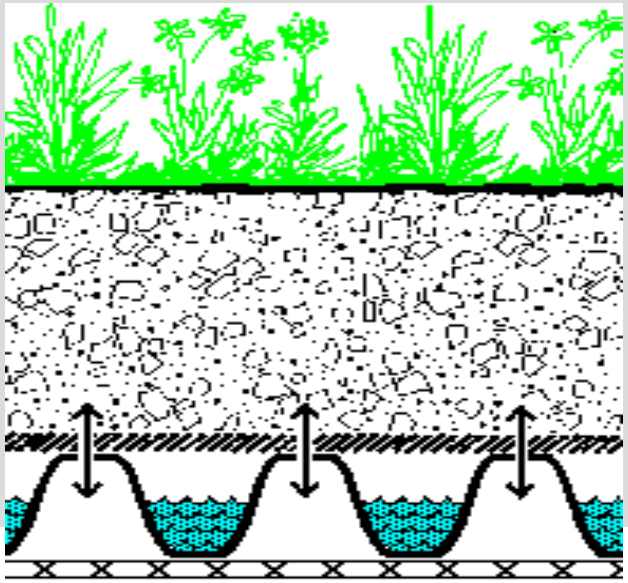
TABLE R806.5
INSULATION FOR CONDENSATION CONTROL

CLIMATE ZONE	MINIMUM RIGID BOARD ON AIR-IMPERMEABLE INSULATION *R*-VALUE[a, b]
2B and 3B tile roof only	0 (none required)
1, 2A, 2B, 3A, 3B, 3C	R-5
4C	R-10
4A, 4B	R-15
5	R-20
6	R-25
7	R-30
8	R-35

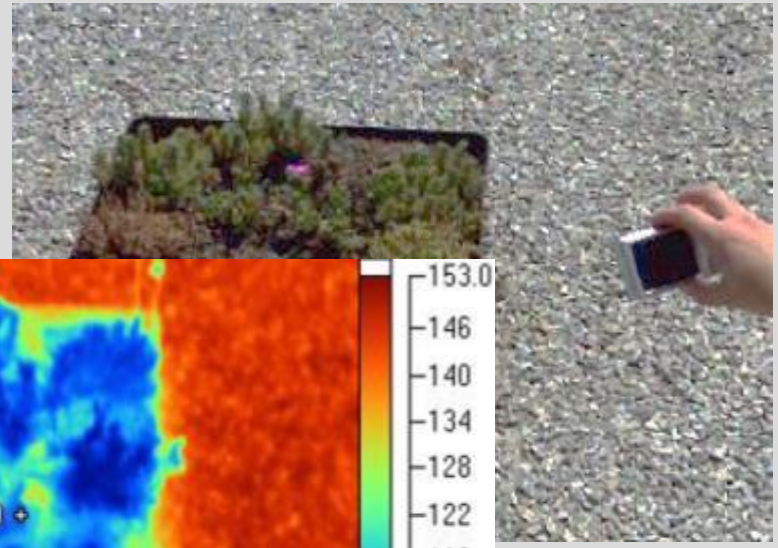
a. Contributes to but does not supersede the requirements in Section N1102.

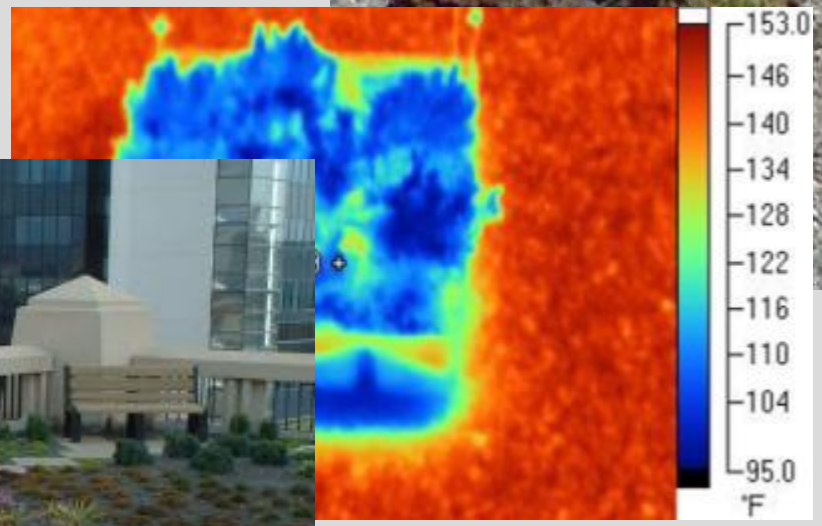
b. Alternatively, sufficient continuous insulation shall be installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside of the structural roof sheathing above 45°F (7°C). For calculation purposes, an interior air temperature of 68°F (20°C) is assumed and the exterior air temperature is assumed to be the monthly average outside air temperature of the three coldest months.

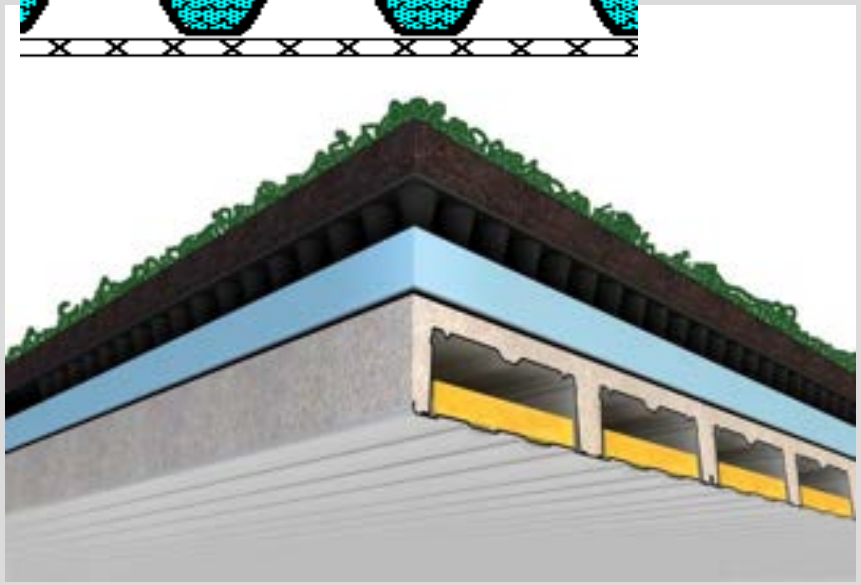
Vegetative Roofs



- Reduces heat island
- Insulates
- Extends life of roof membrane
- Absorbs storm water







Unintentional Green Roofs

Air Barrier

Recessed Lighting

All recessed luminaires installed in the building thermal envelope must be IC rated and have the following:

- Sealed with gasket or caulk between housing and interior wall or ceiling covering
- Labeled in accordance with ASTM E 283 to allow ≤2.0 cfm of air movement between conditioned and unconditioned spaces

Major Air Leakage Locations

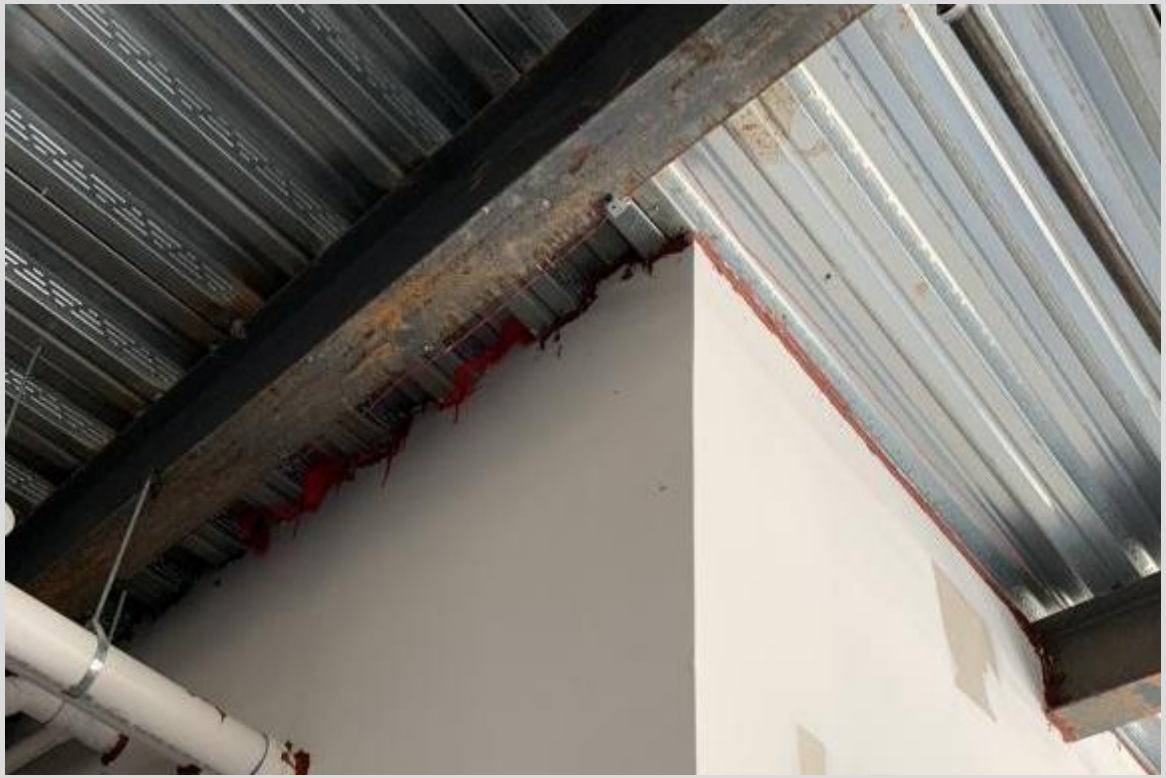
- Cavities above suspended ceilings
- Plenum return spaces (Highly depressurized)
- Ventilated walls
- Equipment tunnels and chases
- Mechanical rooms and mezzanines
- Unconditioned adjacent space (storage, plant, warehouse, etc.)

Air sealing is mandatory

- Roof leak or something else?

No or poor quality Air sealing

Getting Better



How to assess Air sealing

Look up!
Sometimes behind
a drop ceiling.

Verifying an Energy Efficient Building Envelope

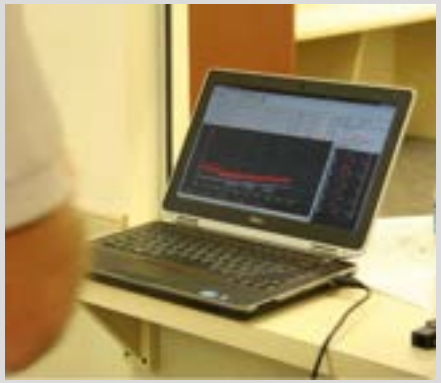
Blower Door Testing – Recognized by IECC

- Prove Air Sealing
- Envelope Integrity

C402.5 Air leakage—thermal envelope (Mandatory). The *thermal envelope* of buildings shall comply with Sections C402.5.1 through C402.5.8, or the building *thermal envelope* shall be tested in accordance with ASTM E 779 at a pressure differential of 0.3 inch water gauge (75 Pa) or an equivalent method approved by the code official and deemed to comply with the provisions of this section when the tested air leakage rate of the building thermal envelope is not greater than 0.40 cfm/ft^2 (0.2 L/s · m^2). Where compliance is based on such testing, the building shall also comply with Sections C402.5.5, C402.5.6 and C402.5.7.

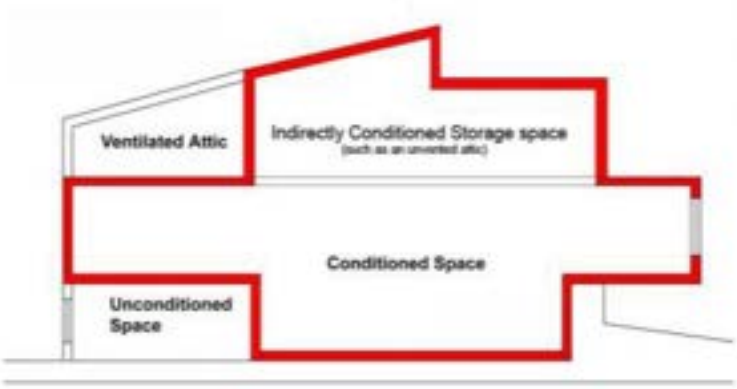
$$ELR_{75} = \frac{CFM_{75}}{\text{shell area}}$$

$$ELR_{75} \leq 0.40$$



Envelope leakage ratio @ 75 Pa "ELR75" – A better metric

- Leakage occurs through shell of building (not through volume)
- Normalizing leakage at 75Pa (0.3 in w.c.) based on shell area is most common for commercial buildings



Building Thermal Envelope

The building thermal envelope is the portion of the building envelope that is comprised of the continuous air barrier and insulation and separates conditioned space from unconditioned space.

Example Calculation

A 7,600 square foot building (First floor: 3,600 square feet and second floor: 4,000 square feet) has a shell area of 13,920 square feet. The blower door test measures a flow of 3,340 CFM_{75}.

What is the Envelope Leakage Ratio at 75 Pa?

ELR75 is calculated by dividing the measured CFM75 by the total shell area of the envelope.

$$\textbf{Shell Area} = 4000ft^2 + 4000ft^2 + 5920ft^2 = \mathbf{13,920}ft^2$$

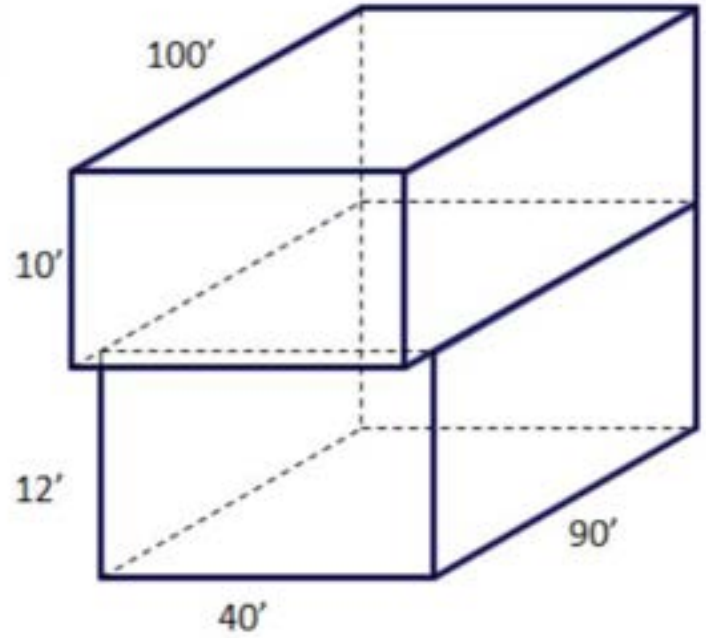
$$\textbf{BD Fan Flow Measurement} = \mathbf{3,340}\ CFM_{75}$$

$$ELR_{75} = \frac{CFM_{75}}{\textbf{Shell Area}}$$

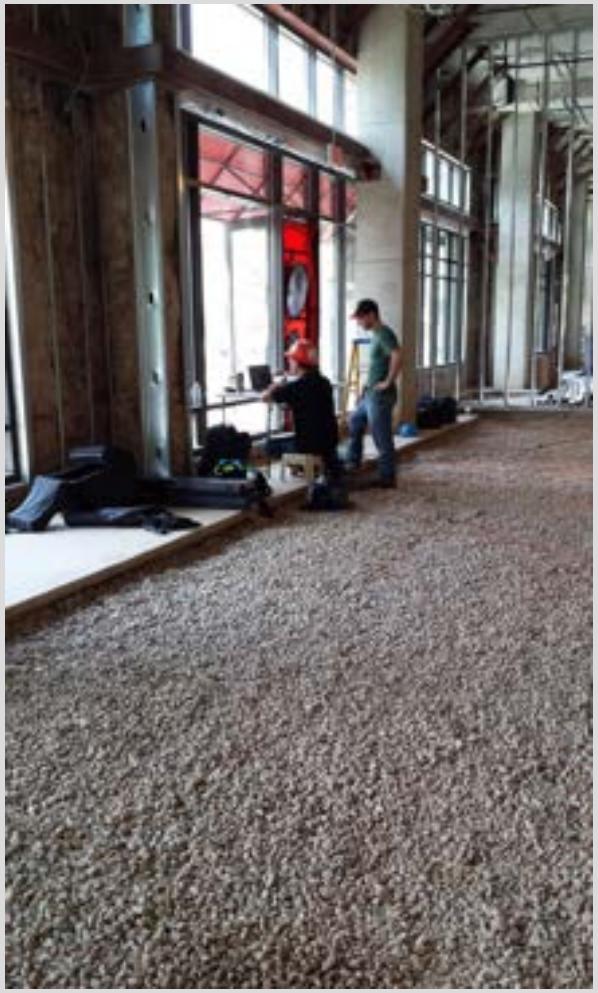
$$ELR_{75} = \frac{3{,}340\ CFM_{75}}{13{,}920\ sf}$$

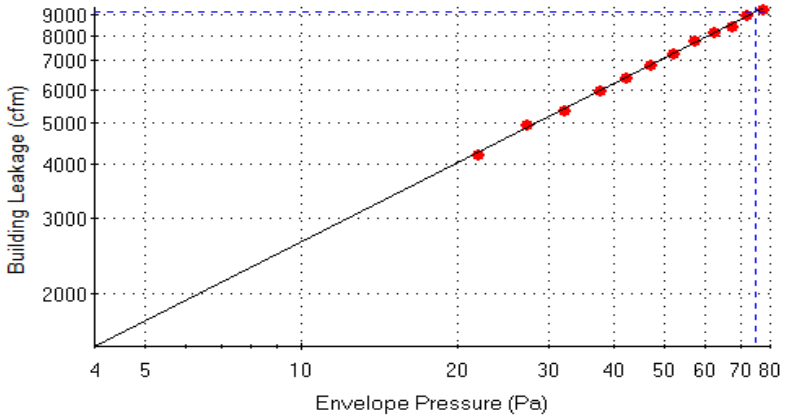
$$ELR_{75} = \mathbf{0.24}$$

Envelope passes program requirement and earns additional points



Multi-blower door – envelope leakage test





Label	Base?	start	end	nobs	Avg Pressu	Total Flow
pre depress	True	5571	5686	116	1.92	0
-75Pa	False	7414	7443	30	-75.06	9233.5
-70Pa	False	7469	7498	30	-69.94	8950.7
-60Pa	False	9106	9135	30	-59.98	8128.6
-65Pa2	False	9146	9175	30	-65.08	8381.5
-55Pa	False	9196	9225	30	-55.06	7795.6
-50Pa	False	9244	9271	28	-49.76	7255
-45Pa	False	9286	9313	28	-44.85	6837.3
-40Pa	False	9333	9362	30	-39.97	6360.2
-35Pa	False	9390	9419	30	-35.31	5945.9
-30Pa	False	9476	9503	28	-29.9	5341.5

Copy Data Table to Clipboard

Reporting Pressure (Pa) 75

Test to View test 1

Test 1: Depressurization

Airflow at 75 Pascals

9150 cfm +/- 1.0 %
Range: 9057 to 9243
0.160 CFM @75/sq ft (0.159 to 0.162)

Leakage Areas

EqLA (10 Pa) = 776.6 in2 +/- 2.6 %
ELA (4 Pa) = 426.5 in2 +/- 4.1 %

Building Leakage Curve

Coef. (C) = 639.5 cfm/Pa^n +/- 6.3 %
Exponent (n) = .616 +/- 0.016
Correlation Coef. (r) = .99929
Corr Coef Squared (r^2) = .99857

View / Edit Test Details

Export to Tectite Express...

USACE Report

OK

Bonus - Reduced Air Infiltration

- Air infiltration verified by whole-building pressurization test
  - Per ASTM E779 or ASTM E1827
  - By an independent third party
- Measured air-leakage rate not to exceed 0.25 cfm/ft^2 under pressure differential of 0.3 inches w.c. (75 Pa), with calculated surface area the sum of above- and below-grade building envelope
- Submit report to code official and building owner, including: tested surface area, floor area, air by volume, stories above grade, and leakage rates

Exception: Buildings over 250,000 ft^2 of conditioned floor area don't need testing on whole building, can test representative above-grade sections. Tested areas to total not less than 25% of conditioned floor area and tested per C406.9

Building Envelope

- Case Study Overview
  - Dining Hall
    - One Story; 4,615 sf; climate zone 3A
    - SFBE 14,668 sf; CMU with brick veneer
  - House of Worship
    - One Story; 12,864 sf; climate zone 3A
    - SFBE 36,845 sf; metal stud with EIFS

Building Envelope

- Findings of Case Study
  - Dining Hall
    - VE effort to save on materials led to increased cost and time on new envelope solution
    - Following manufacturer material installation recommendations did not always happen

Building envelope

Building Envelope

Findings of Case Study

- House of Worship
  - Designate materials that will act as air barrier
  - Create material transition location details to link one air barrier material to the next

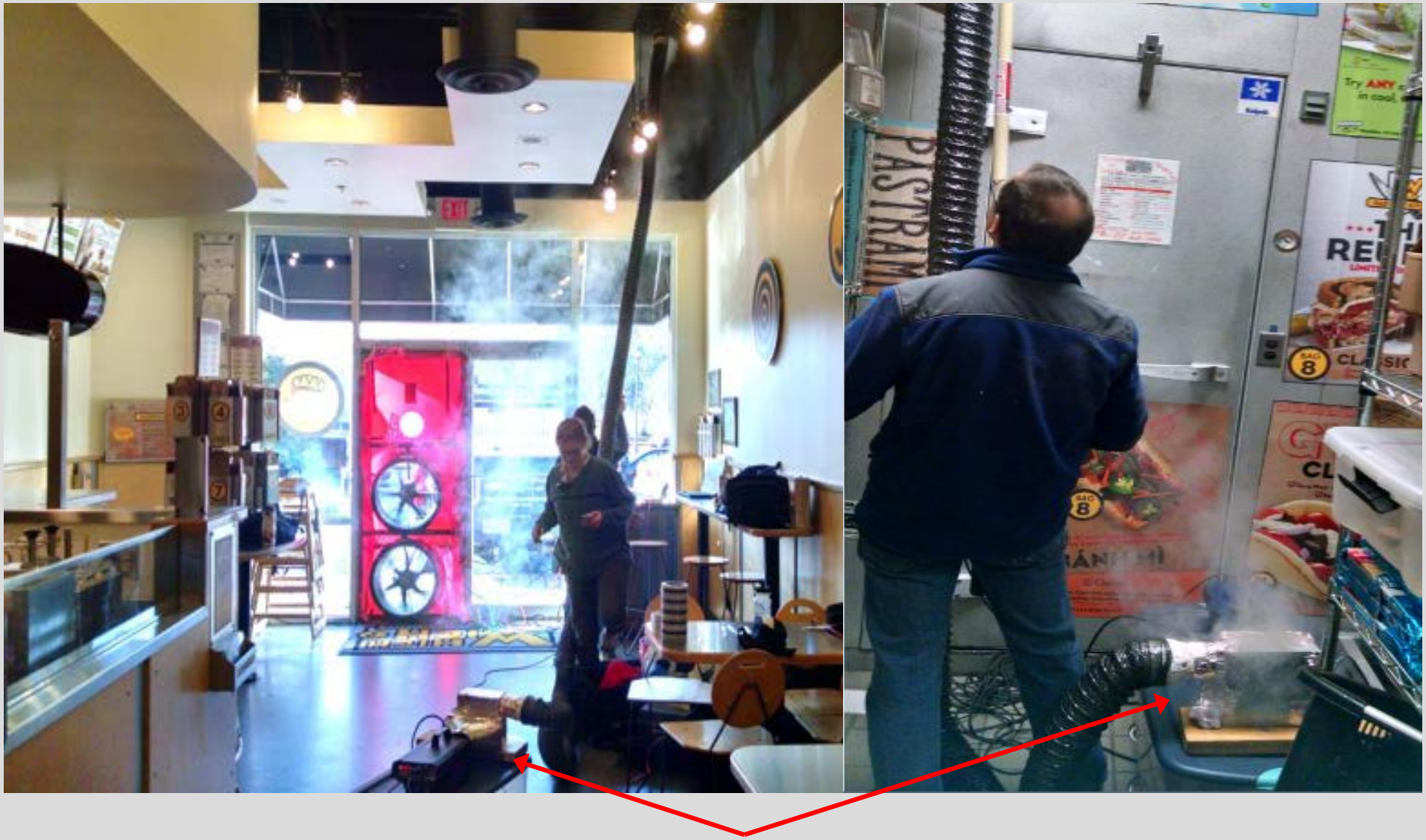
Building envelope

Case Study Findings

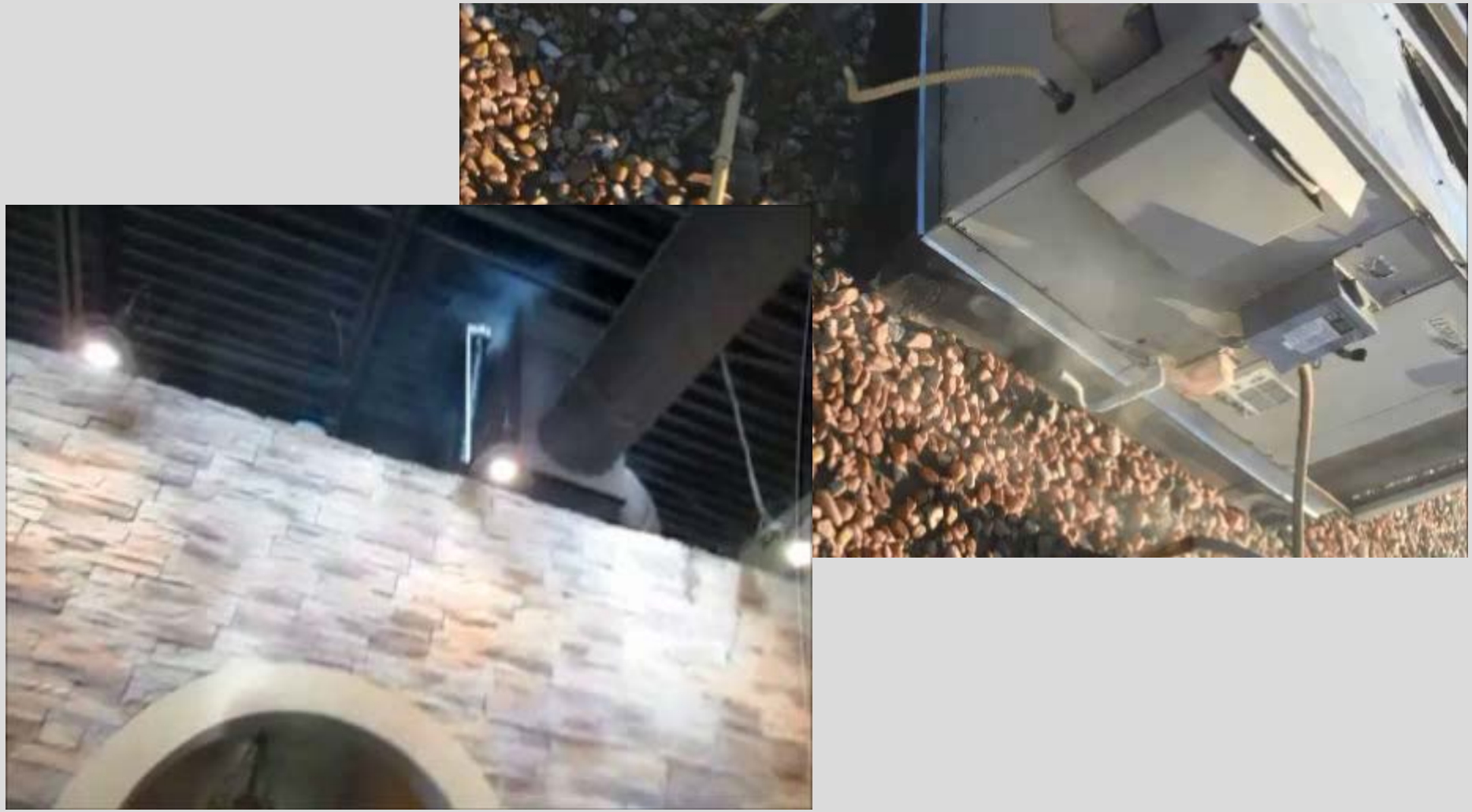
- Inline Retail
  - Envelope Transitions

Utility chase

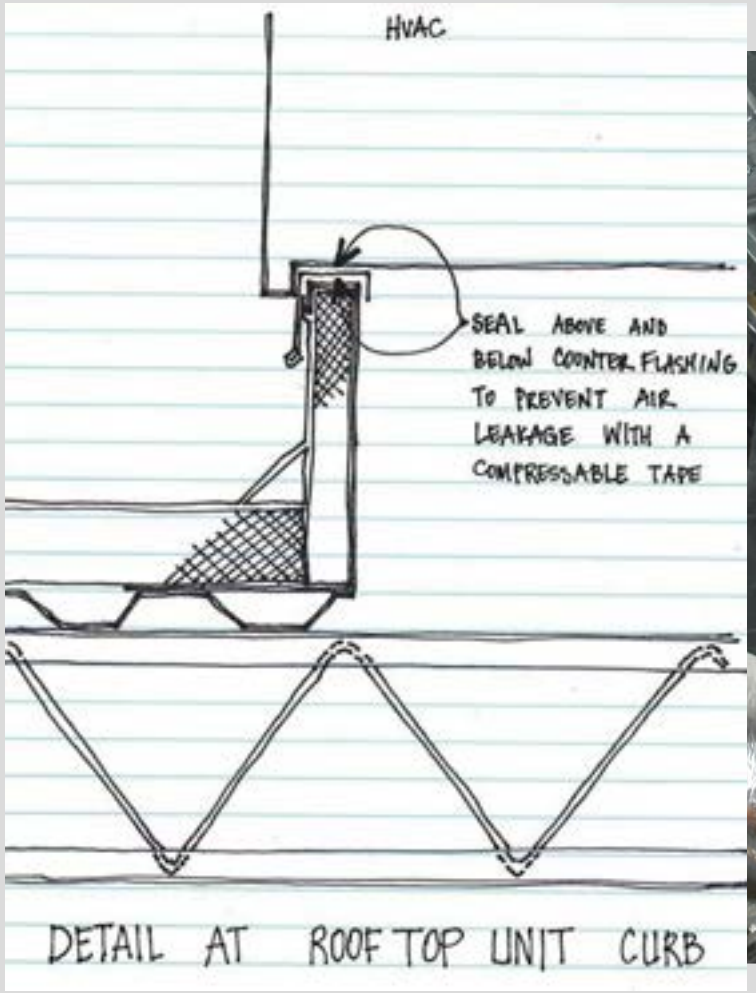
How to get fog in the right place



RTU envelope Penetrations



RTU Envelope Penetrations



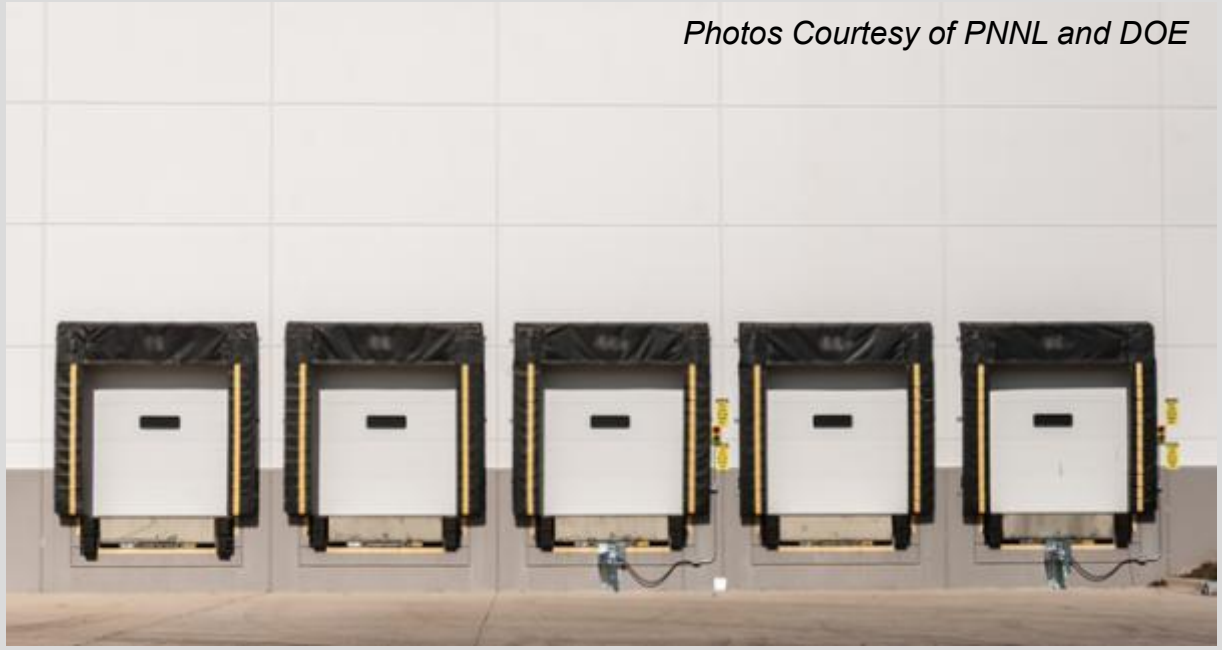
Wall and roof penetration require sealing at curb and equipment

Roof membrane connections

Parapet leak

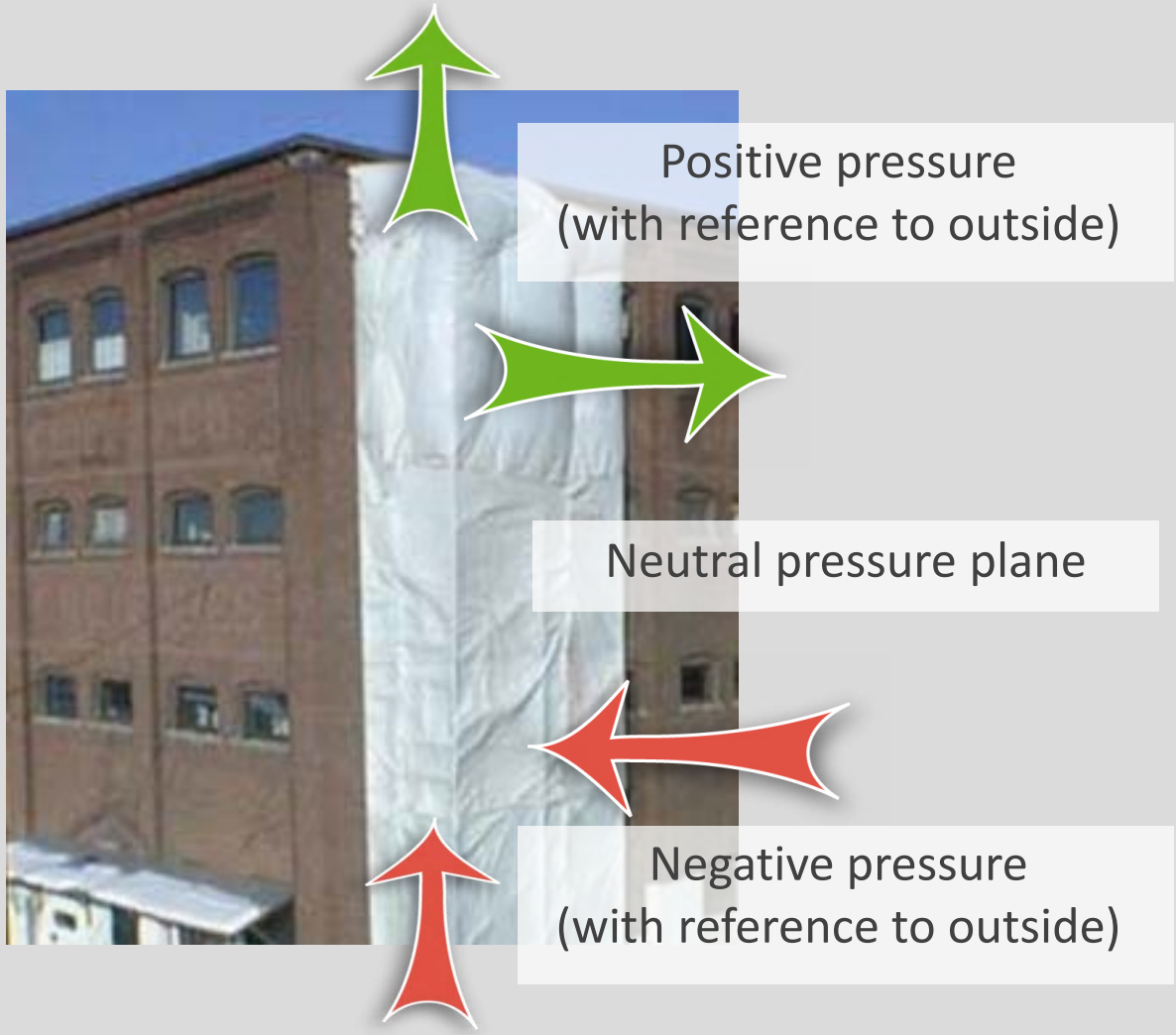
Loading Dock Weatherseals

- Cargo and loading door openings must be equipped with weatherseals to restrict infiltration and provide direct contact with vehicles along top and sides



Vestibules

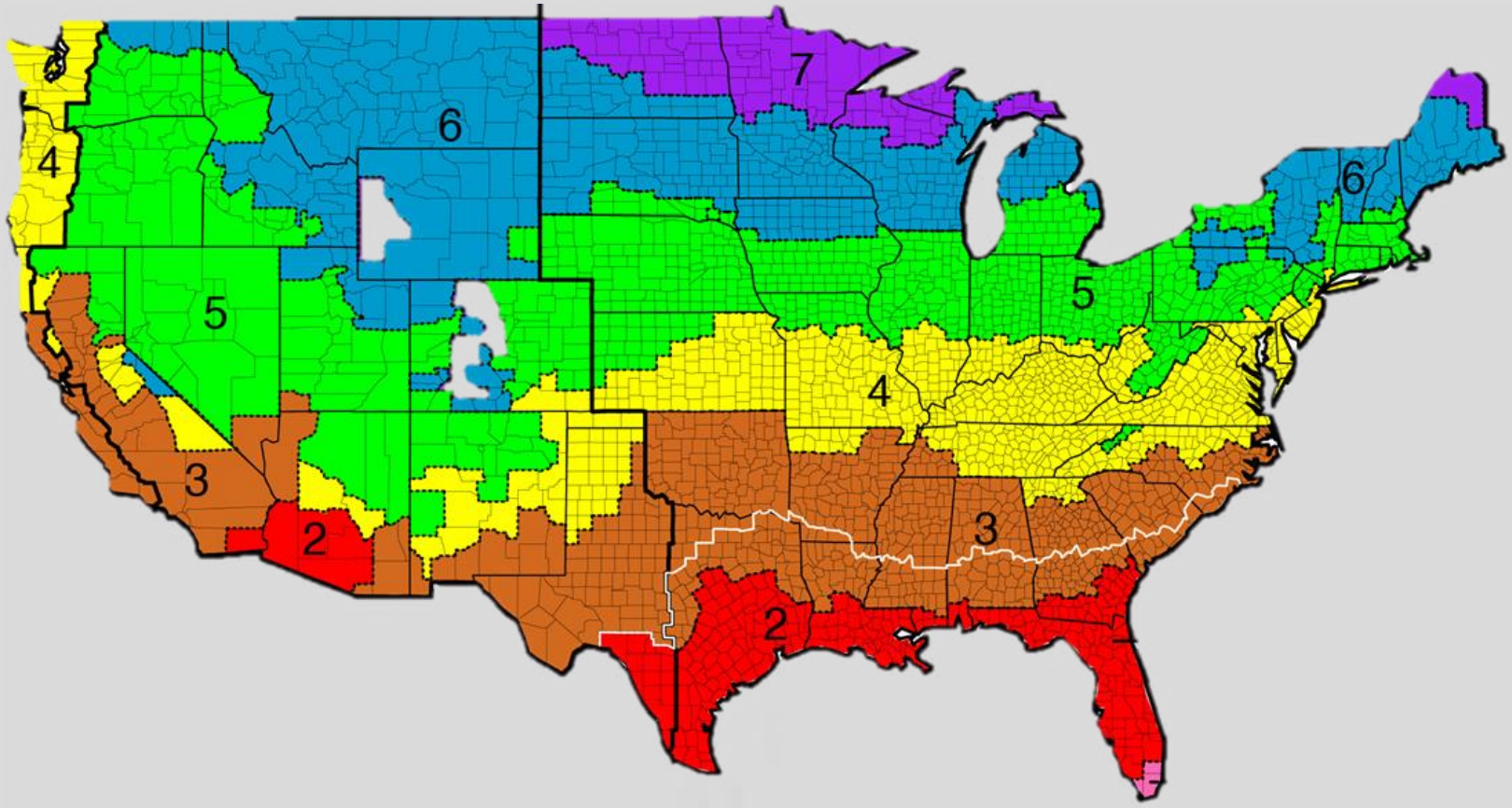
- Required for both codes with many exceptions
- The taller the building, the greater the need for vestibules
- Both codes vary greatly on requirements based on zones and other inputs



Biggest Changes in IECC 2021

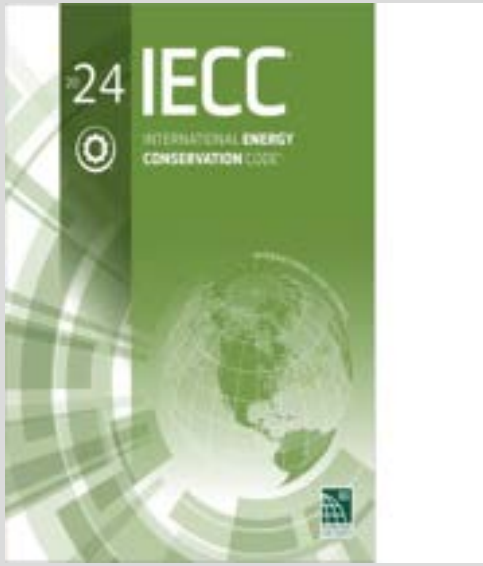
- Redrawn Climate Zones (6 CZ's in MO)
- ASHRAE 90.1 2019 = Alternate Path
- Improved Window U-factors & Wall and Ceiling R-values
- Updated Mechanical/Lighting requirements
- Controls!
- Must choose your Additional Efficiency Package
- Increased Alternative Methods
- ComCheck
- More Focus on Commissioning

Climate Zones



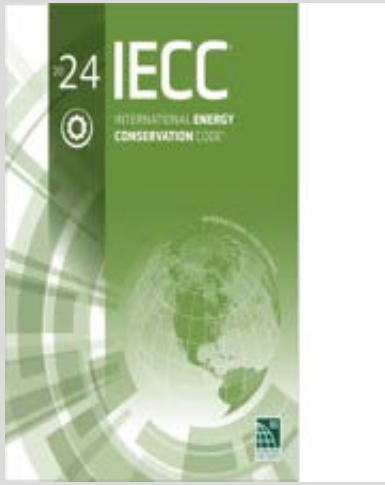
2024 National Energy Standard

- **In Process since November ’21 *Final Approval 3/24!***
- **Use ‘21 Energy Code as Basis and Improvements from there.**
- **Many more stakeholders than IECC Development**
- **Glide slope to Net Zero by 2030**
- **Expanded Appendices**
- **Carbon Impact/Credits**



2024 National Energy Standard (Cont.)

- ***More*** **focus on Electrification**
- **Tables for Envelope and Fenestrations (402/403)updated**
- **More reliance of high performance**
- **More focus on testing/verification**
- **More intent to move appendices items forward in 2027 & 2030 versions**



2024 IECC The final result is a code that:

- **Wall insulation and ceiling insulation issues from 2021 IECC – this was the biggest issue with the 2021 IECC**
- **Expanded the performance path to include equipment trade-offs, duct location trade-offs, and very reasonable envelope backstops**
- **Includes a much-slimmed down version of the electrification readiness measures in an appendix that would have been if it wasn't for the omnibus**

2024 IECC The final result is a code that:

- **Added a wide range of reasonable options for compliance with R408**
- **Fixed the ERI path**
- **Recognizes federal preemption challenges with both electrification and higher levels of stringency**

Key Takeaways

- **2024 Energy Standard has new requirements for:**
  - **Electrification**
  - **EV Charging**
  - **Solar**
  - **Grid Interaction**
  - **Carbon**
- **Using & Understanding Guides and formulas is *critical***
  - **Good Design!!!**
  - **Proper envelope construction is key**
  - **Right-sizing HVAC is required**
  - **Documenting construction and certification**

2024 Energy Standard

- **Many of these “advanced” technologies and practices have actually been in use for a number of years.**
- **As newer technologies and components come along, they are easier to incorporate**
- **They all require the “basics” to be done properly!**
- **They are all systems part of a larger system!**

Questions?

Energy & Building Codes Updates and Applications; Building Science & Moisture Management *And Your Business….*

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Looking Ahead to 2024 IBC/IRC

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Looking Ahead to 2024 IBC/IRC

- IBC
  - Duties and powers of the building official: an overall reformat of Section 104 regulating duties of the building official, the approach for reviewing for code compliance has been significantly updated to reflect the current manner that alternate materials, designs and methods are evaluated.
  - For the first time ever, the 2024 IBC includes provisions for tornado loadings.
  - Updated wind, earthquake, and snow loads.

Looking Ahead to 2024 IBC/IRC

- **IBC (Cont.)**

•Updates to Risk Categories including Photovoltaic (PV) panel systems and facilities providing power generation.
•Updated and expanded provisions for Temporary Structures.
•New provisions regarding the wind resistance of aggregate-surfaced roofs.
•Roof Coverings: Updated provisions for underlayment.
•New special inspection provisions for metal building systems.
•New provisions for structural concrete reinforced with glass-fiber reinforcement.
•Concrete: To improve ease of use, Chapter 19 on Concrete has been Updated and reformatted.

Looking Ahead to 2024 IBC/IRC

- **IBC (cont.)**
- An increase in the allowable height of a Group R-2 occupancy building with a NFPA 13R sprinkler system.
- Occupiable space requirements now apply if a roof is usable for anything more than maintenance or repair and occupants must have access to multiple egress options from a story based on the occupant load and the story requirements.
- Openings in Shaft Enclosures: Additional exceptions are provided for shaft enclosures, including new allowances for openings and penetrations.
- Carbon Monoxide Detection: Carbon monoxide (CO) detection is now required in all occupancies where a CO-producing device is present. Detection and notification can be addressed in several ways.
- Vapor retarders: Several updates have been made to the vapor retarder provisions for consistency with the IRC and IECC. The changes also provide additional options and better guidance for allowable types and locations of permitted vapor retarders.

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Looking Ahead to 2027 IBC/IRC

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Looking Ahead to 2024 IBC/IRC

- IBC

- Focus on Current Events and Circumstances
- Data Centers!
- Multi-Gen Housing
- Daycare/Childcare
- More focus on Wind/Seismic and Fire/Wildfire