abaa2024 building enclosure conference

Future Ready Design Considerations for Building Enclosure Design

Paul Totten, PE, LEED AP

wsp

AIA Continuing Education Provider

abaa EDUCATION

Future Ready Design Considerations for Building Enclosure Design

In an ever-changing climate, with advances in materials and requirements for better long-term durability and resiliency, enclosures are being asked to sustain more over the long term. From storm risk, to flooding and increased heat and propensity to radiation, the detailing of systems requires additional thought process.

Using building science, whole building system knowledge, and in-depth experience in detailing of systems, the speaker will use project examples of how we can better prepare our building enclosures to be future ready. They will discuss changes needed within the building code and the importance of climate considerations in the code.

abaa building enclosure conference

Paul Totten

Paul Totten is a Vice President at WSP and leads the Building Enclosures Division. He has over 26 years of experience in the fields of structural engineering, building enclosure design and commissioning, and building science. He is a member of NIBS, ASHRAE, and USGBC.

abaa EDUCATION

Learning Objectives

1. Be able to better assess the climate considerations for your building enclosure design.
2. Comprehend where additional enclosure detailing and component considerations should be implemented.
3. Evaluate what additional building science models may be prudent.
4. Evaluate how climate change may impact construction schedules and risk for heightened built in moisture in some climate zones.

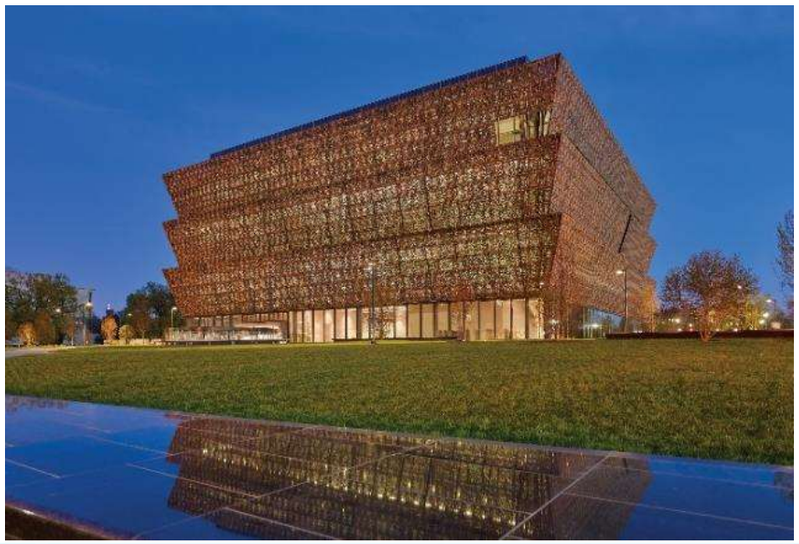
Presentation Outline

- **Basic purpose of buildings**
- **Building types and considerations**
  - Existing vs. New assets
- **Overview of design considerations**
  - Climate change
  - *Durability and redundancy*
- **HVAC and pressure interaction with enclosure**
- **Examples of enclosure considerations**
- **Questions**

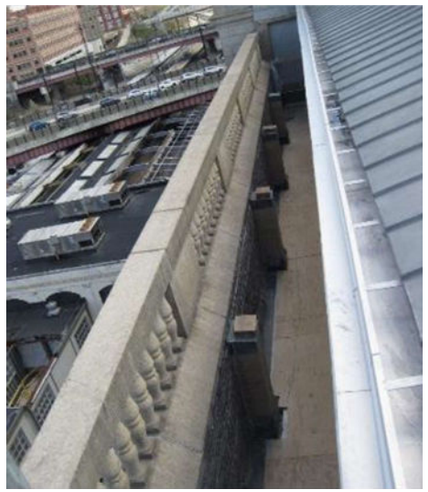
Purpose of Buildings

- Provide shelter
- Separate and protect us from outside environment
- Life safety
- Building science considerations
- User experience
- Use type
- Minimizing impact while maintaining

Building Examples and Types – New Assets



Building Examples and Types – Existing Assets



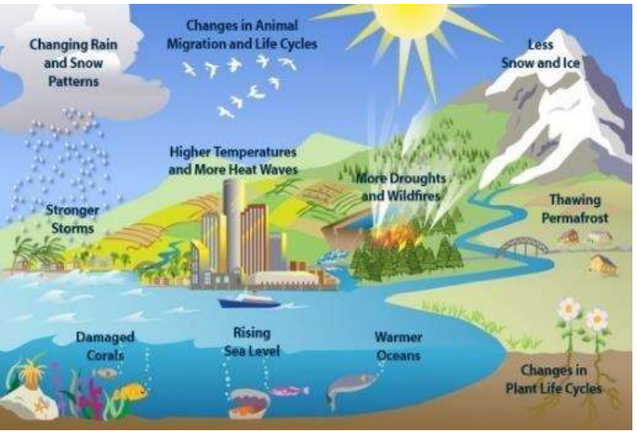
Asset Management Planning (AMP)

- **Existing building versus new construction**
- **If new construction, set asset management plan at completion of construction**
- **If existing, perform condition assessment and testing to develop asset management plan**
- **Set schedule and priority:**
  - Life safety
  - Maintenance cycles
  - Ease of doing multiple tasks simultaneously
  - Capital cost planning

Impact of People

- Materials made by people
- Designed by people
- Constructed by people
- Maintained by people

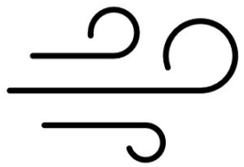




Impact of Climate Change

- **Change in type of precipitation events**
  - Increased volume/shorter duration
  - More severe storms/higher winds
  - Flooding
- **Solar considerations**
  - Increased radiation
  - Examine SHGC and window films
- **Need for improved durability, redundancy, and long-term planning of your asset(s)**

Code Considerations

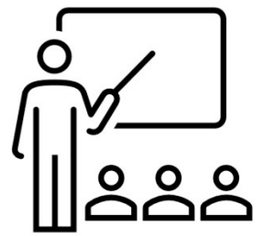


- **Wind Buffering**

- **Flood Proofing**

- **Latest Data & Future Mapping for Climate Ready Codes**

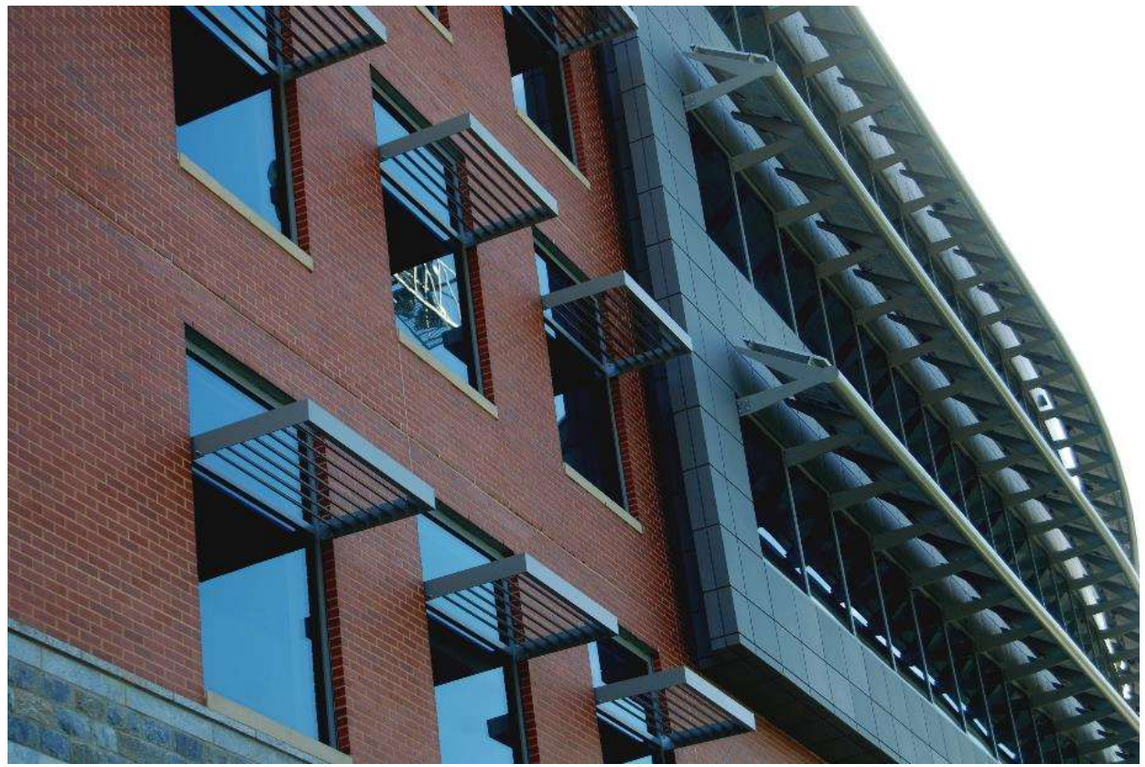
Three Storm Design



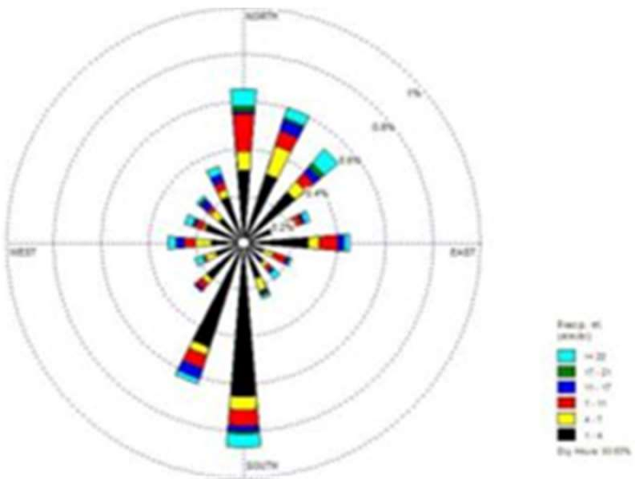
Apprenticeship Programs

Climate Forward Design

- Think of future climate considerations
- Volume of existing buildings
- Delivery efficiency of grid
- Not using outdated climate data
- Aged building materials (color)



Importance of Climate Variation



Review of Macro Climate

- Understand the climate zone
- Consider rain fall volume

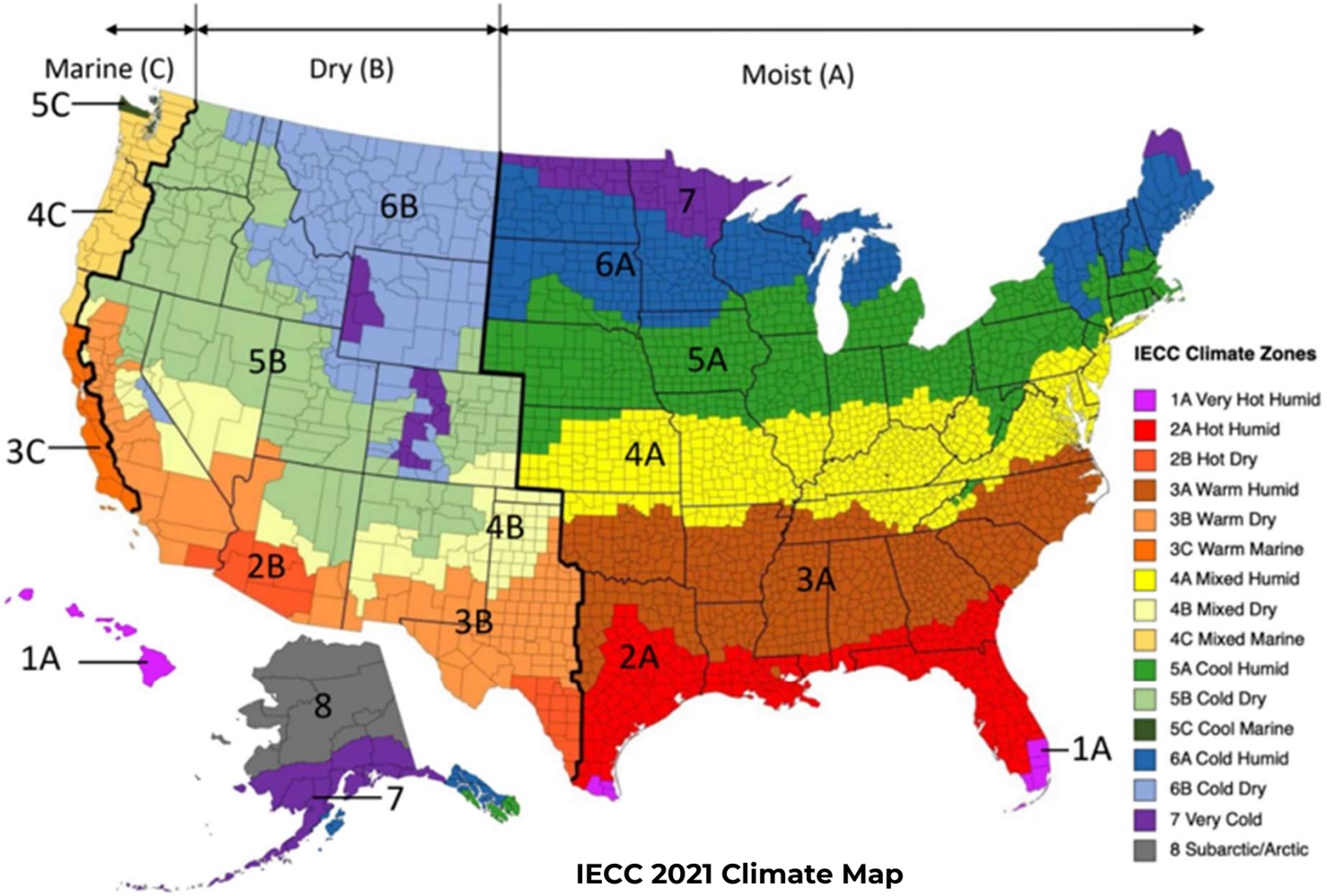
Review of Micro Climate

- Asses the site topography
- Evaluate development density
- Examine neighboring existing buildings and planned future development

Existing building versus new construction

Orientation of building and considerations by elevation

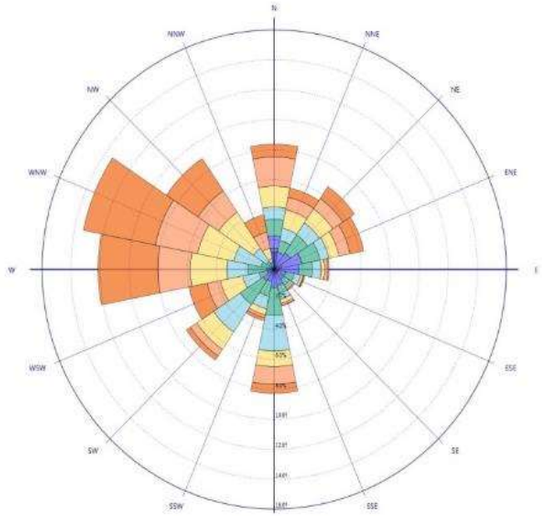
Climate Zones



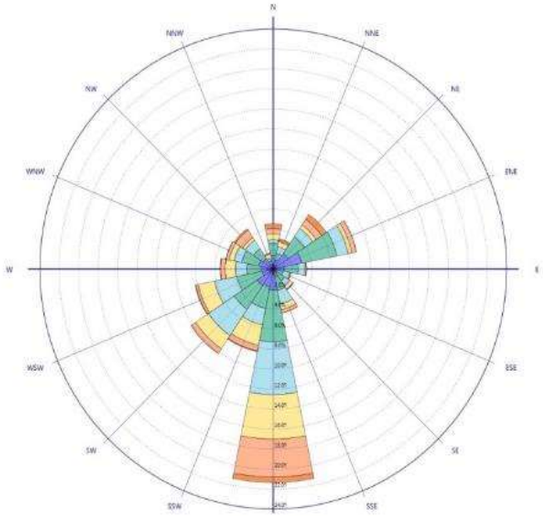
IECC 2021 Climate Map

Seasonal Evaluation

Winter



Summer

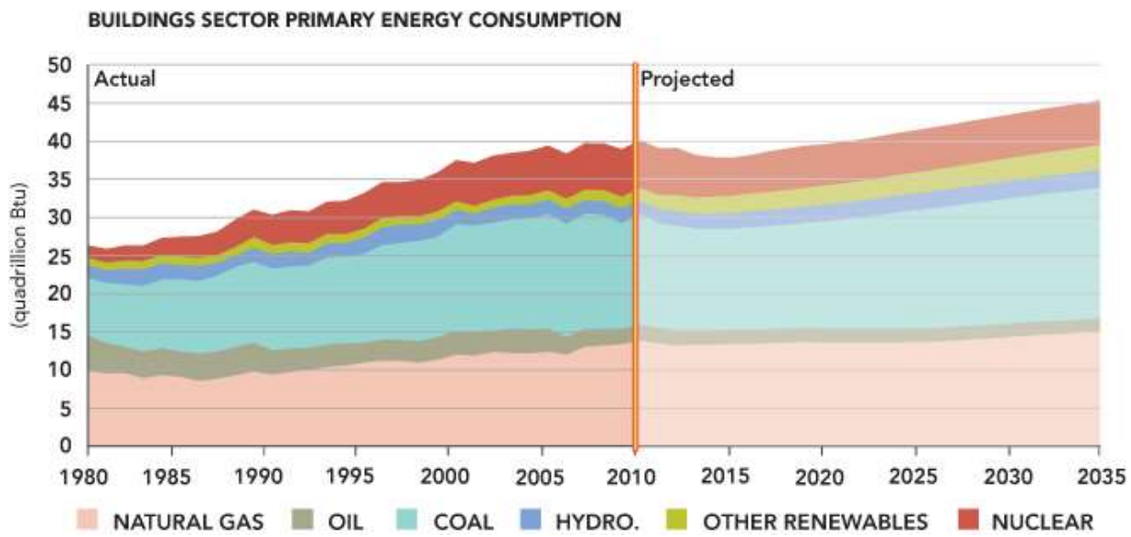


Need to understand seasonal variations:

- Short winter
- Mold count and pollen count
- Heavy rain in spring and summer
- Similar heights of buildings in certain cities (Metro DC) and affect on wind flow
- Wind flow variations
- Heat gains
- Exterior humidity levels

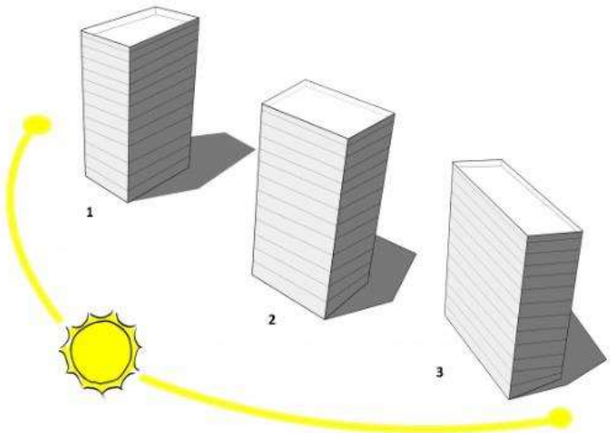
High-Performance Buildings

- Safety and security
- Energy Use
- Durability and resiliency
- Maintainability
- Water use efficiency and conservation
- Occupant expectations

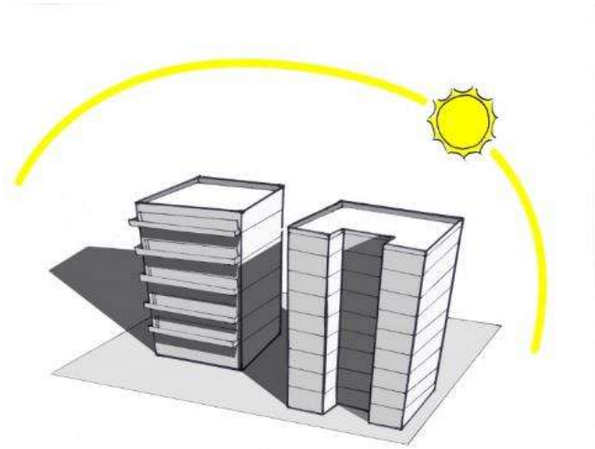


SOURCE: http://buildingsdatabook.eren.doe.gov/images/chap_1_chart3.jpg

Building Design Considerations



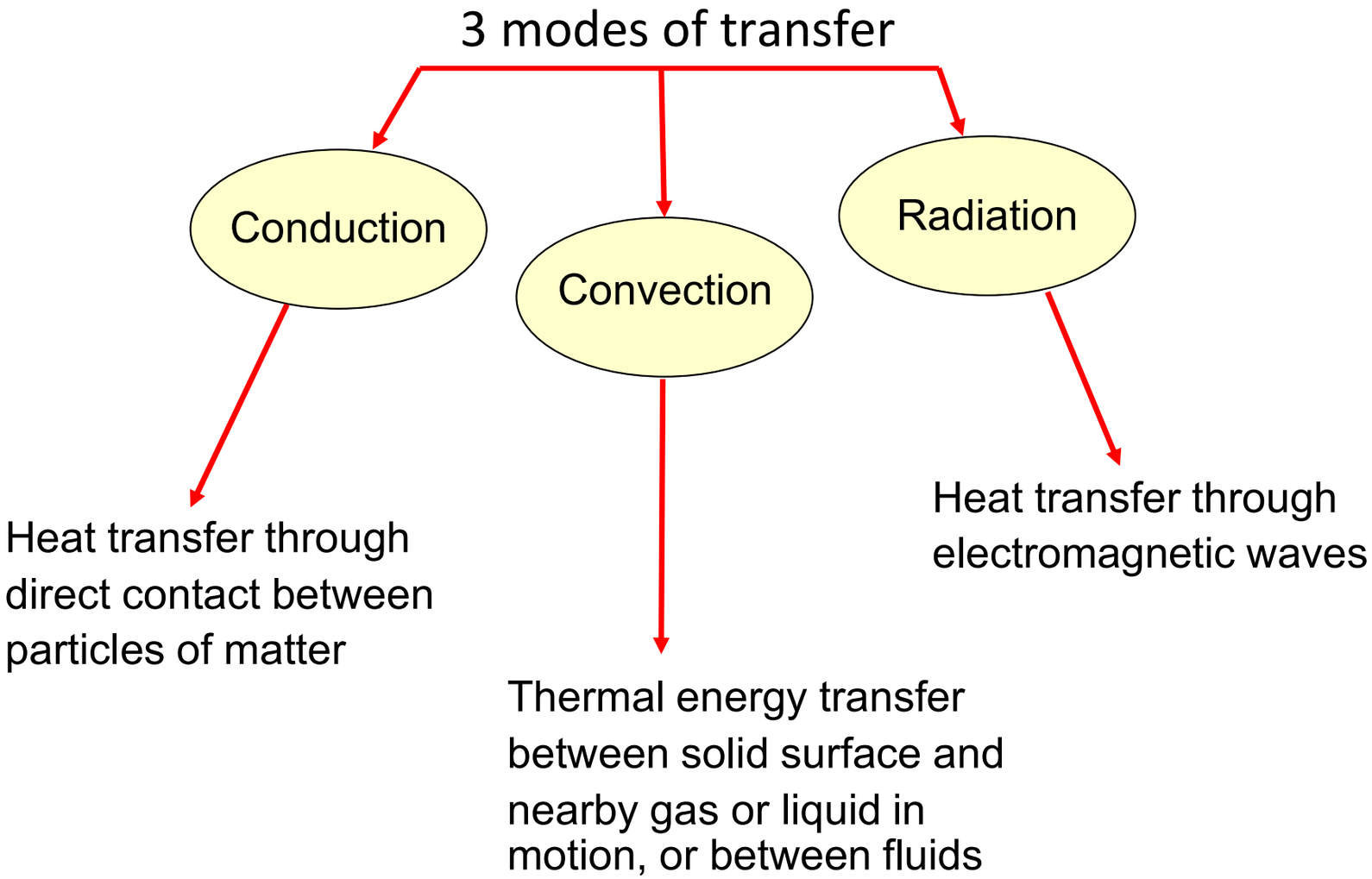
SOURCE: http://sustainabilityworkshop.autodesk.com/buildings/building-massing-orientation



SOURCE: http://sustainabilityworkshop.autodesk.com/buildings/building-massing-orientation

- Orientation
- Floor plate – shape, depth
- Layout and type of mechanical systems
- Occupant comfort expectations – stretching the comfort zone

Heat Transfer Mechanisms



Initial Analysis

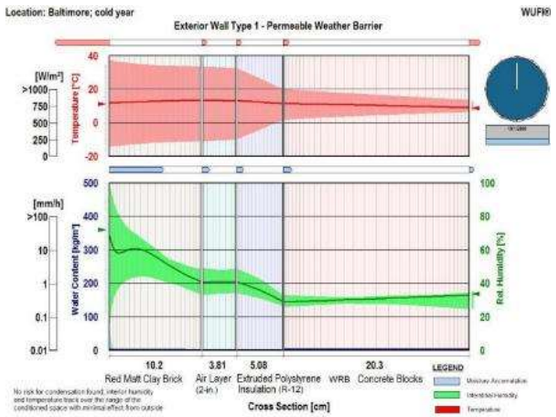
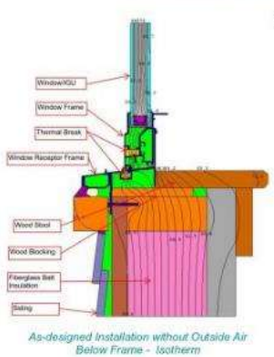
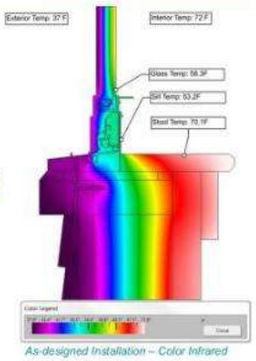


Table 2: Data gathered for March 20th 9:15am as one of several spot checks for model validation – Exterior Temperature 37°F

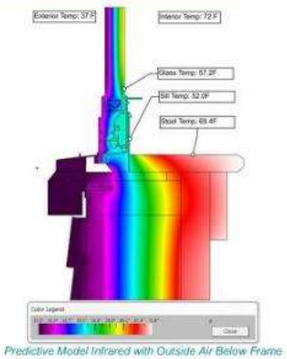
Sensor Location	Sensor and Data Logger Identifier	HOBO Temp, RH	As Designed Model without Exterior Air Below Frame	Predictive Model with Exterior Air Influence Below Frame
Exterior (outdoor)	EX	36.795°F, 85.485RH	37°F	37°F
Interior (indoor)	INT	71.274°F, 28.691RH	72°F	72°F
Window Glass	K1	57.15°F	58.3°F	57.2°F
Window Sill	K2	52.0°F	53.2°F	52°F
Window Stool	K3	65.41°F	70.1°F	69.4°



As-designed Installation without Outside Air Below Frame - Isotherm



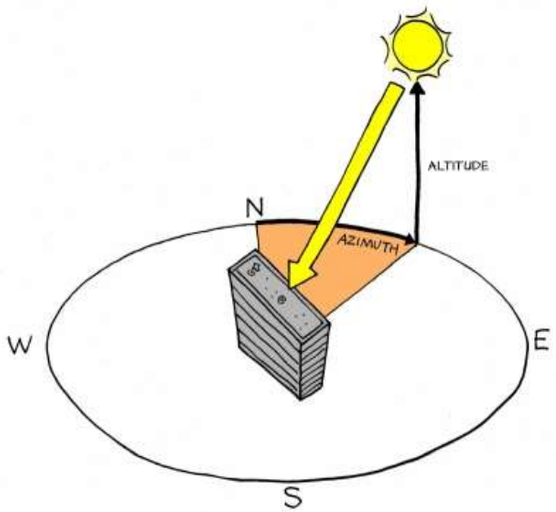
As-designed Installation – Color Infrared



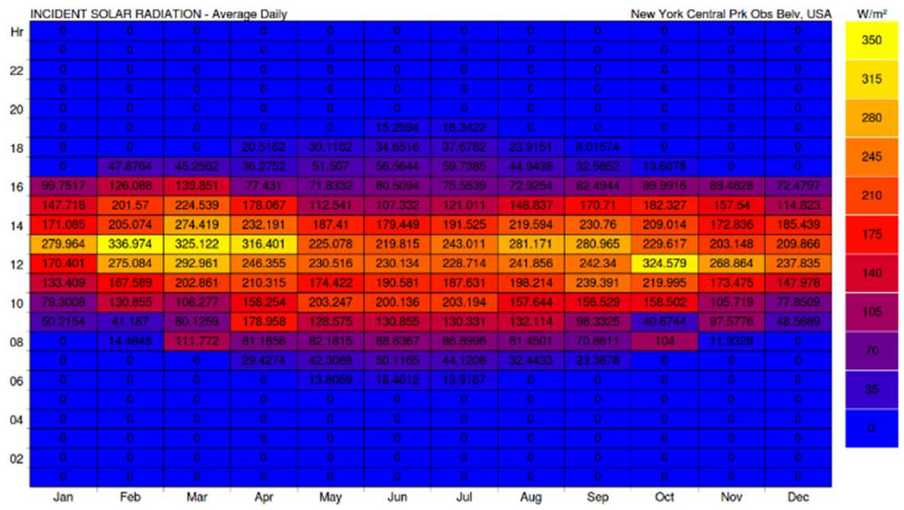
Predictive Model Infrared with Outside Air Below Frame

- Perform initial hygrothermal and thermal analysis during schematic design based on options for systems, orientation, etc.
- Conceptual energy analysis
- Not just present and historic climate data, but examine future prediction
- Design for adaptability
- System interaction
  - Mechanical with enclosure
  - Daylighting/lighting
  - Mechanical can drive the loads - ventilation

Temperature Considerations



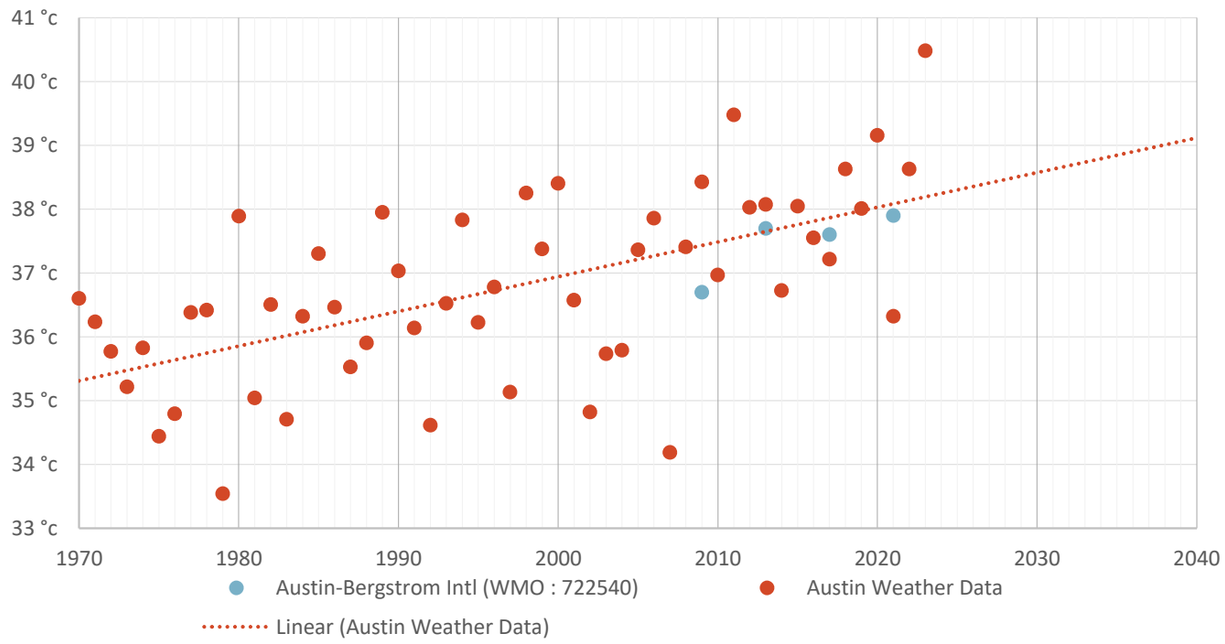
SOURCE: http://sustainabilityworkshop.autodesk.com/buildings/solar-position



- Solar angle
- Solar radiation and absorption
- Insulation levels
- Interior conditions
- Aged material – color and when stained
- Use updated climate data
- Much of current available data - outdated

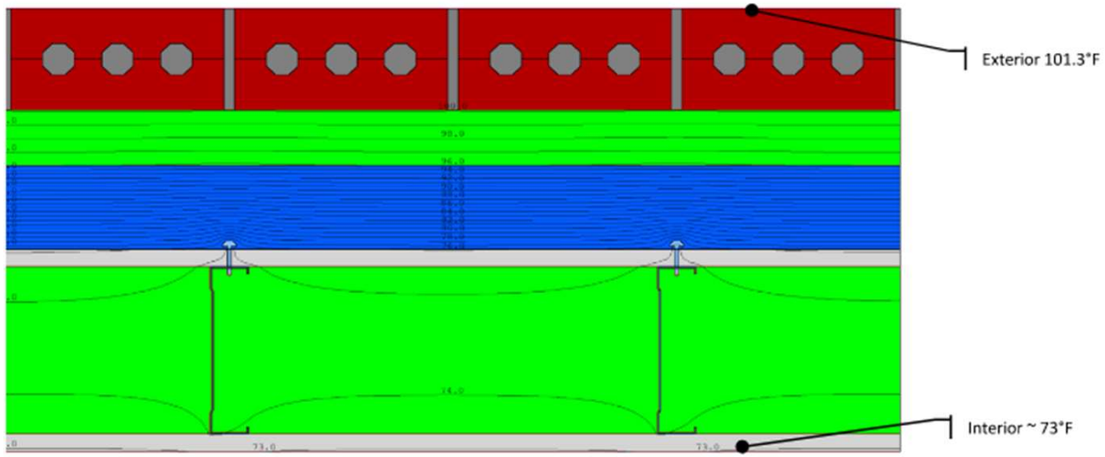
Temperature Considerations – Hot Climates

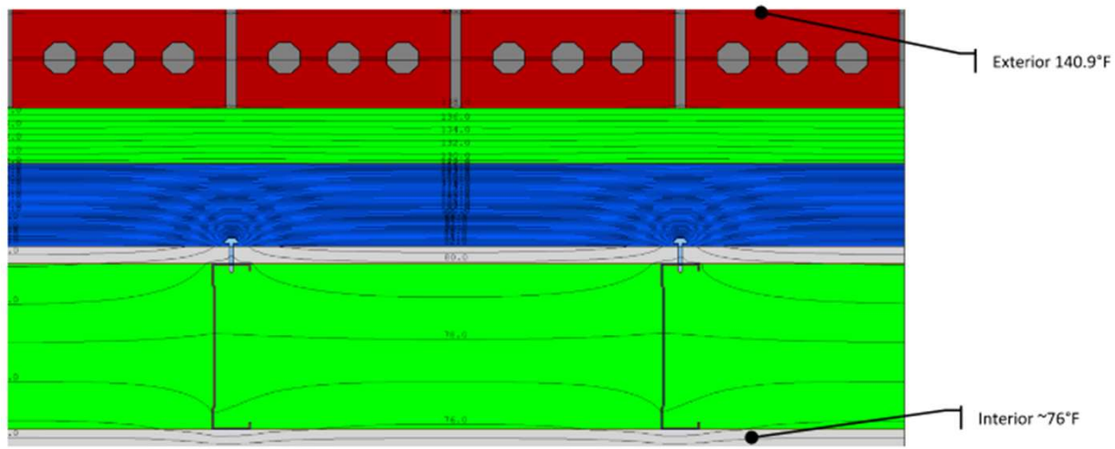
- Current outdated data
- Updated data sets
- 0.4% and 1% CDD Temps as written are now 4 to 8%
- Factor of 10 – a data set used today may miss by 10 to 15 ^{o}F
- With aged materials – darker – more absorption – 30 to 40 ^{o}F

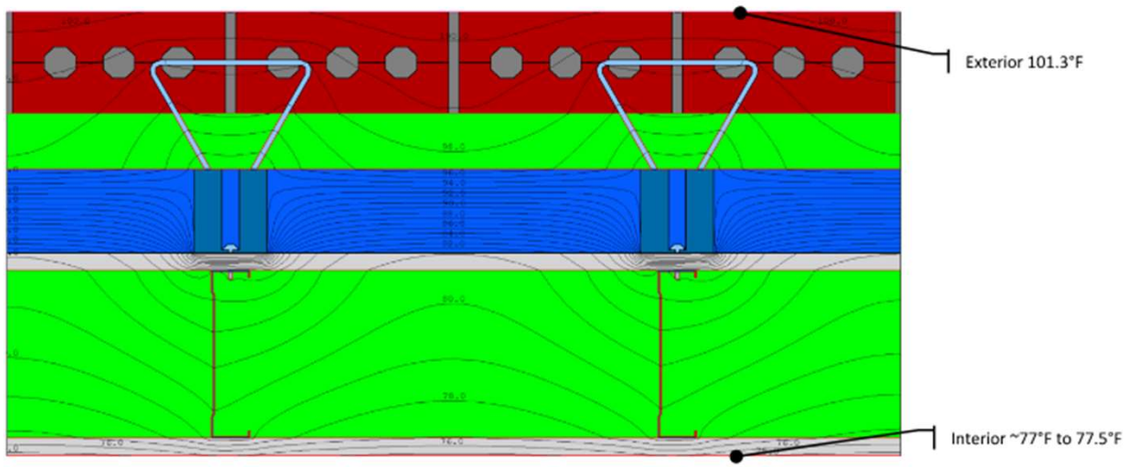


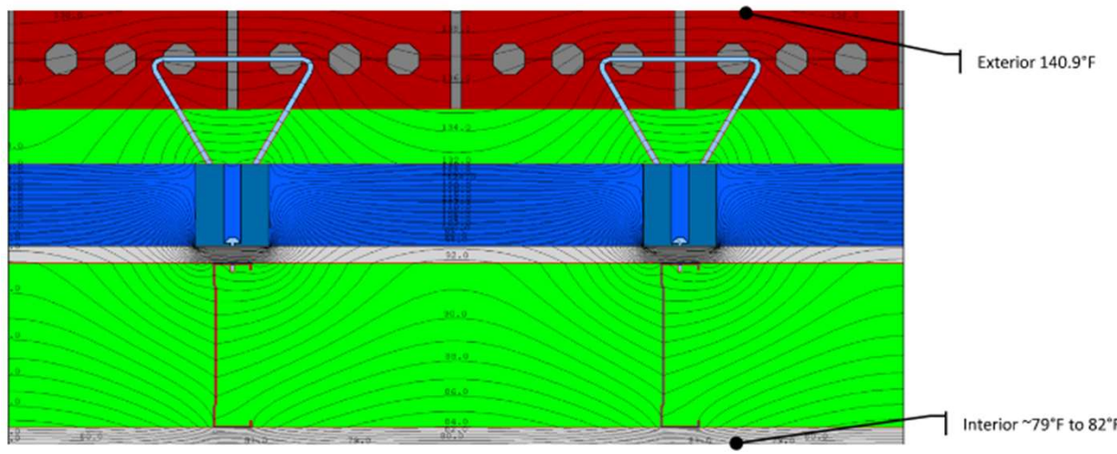
Austin 0.4% Cooling Design Temperature - Weather Data vs. ASHRAE Climatic Design Conditions (2009/2013/2017/2021)

Thermal Analysis – Current Code Compliant Wall

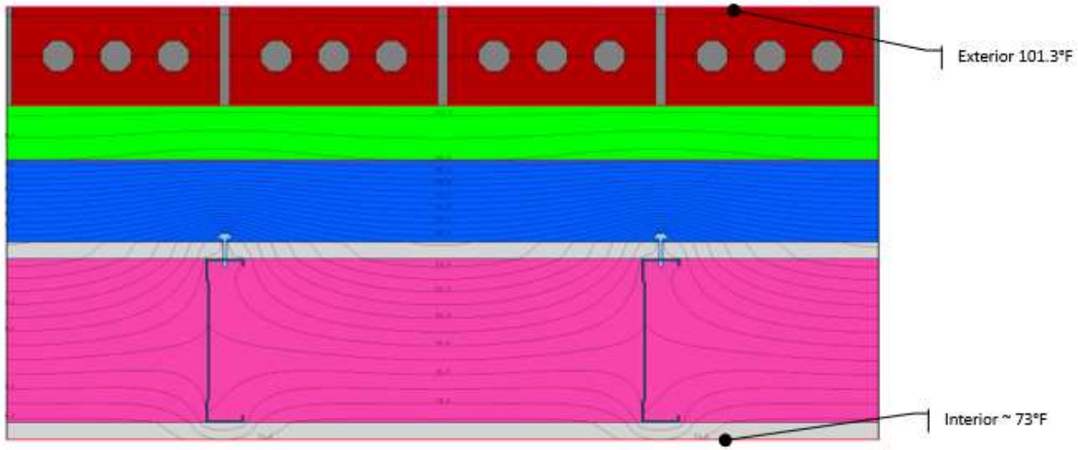


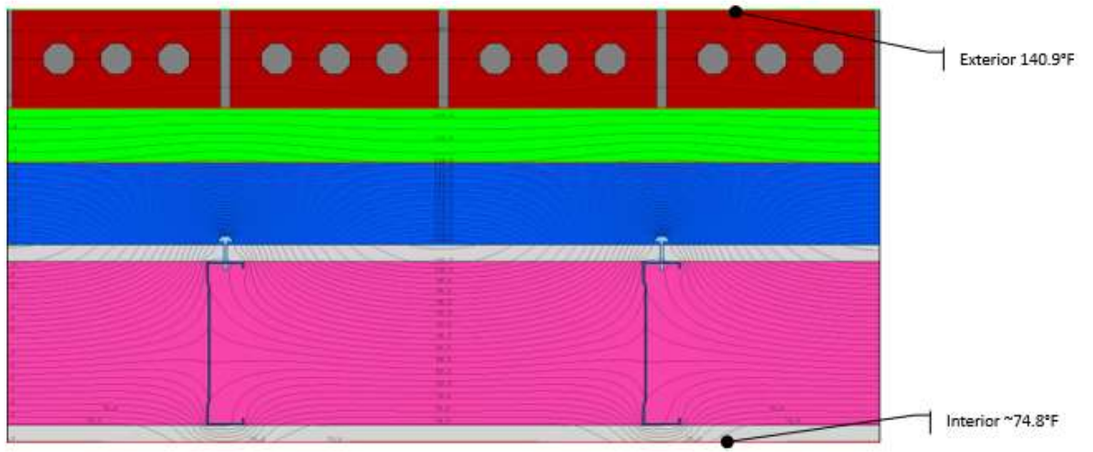


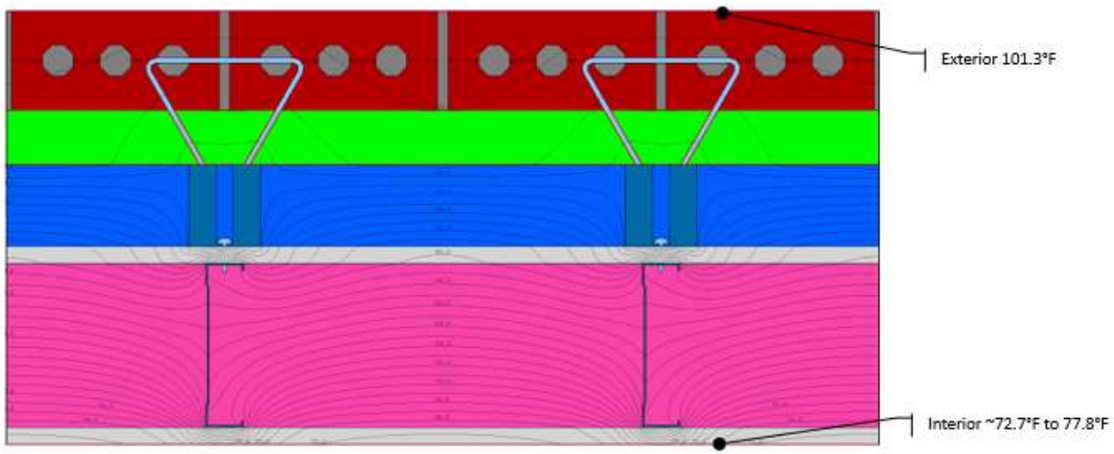


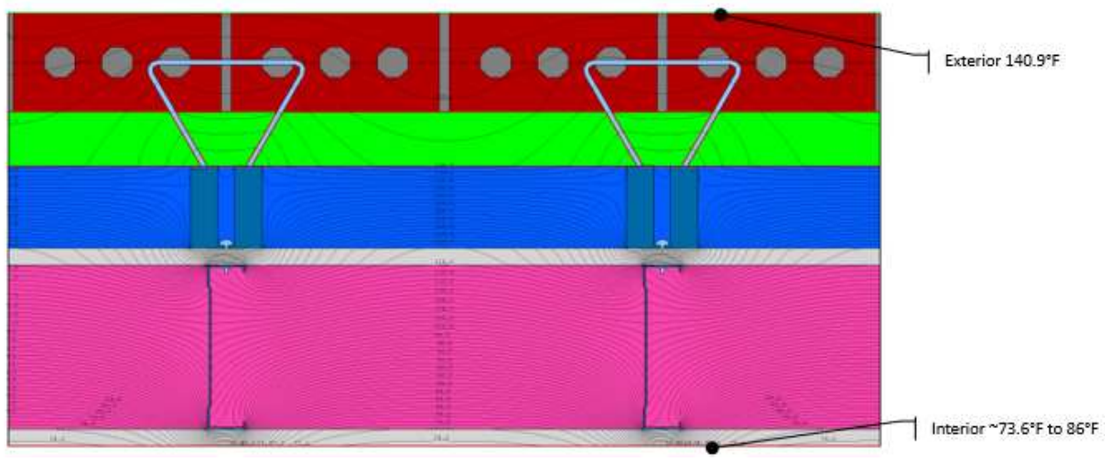


Thermal Analysis – Climate Forward Design

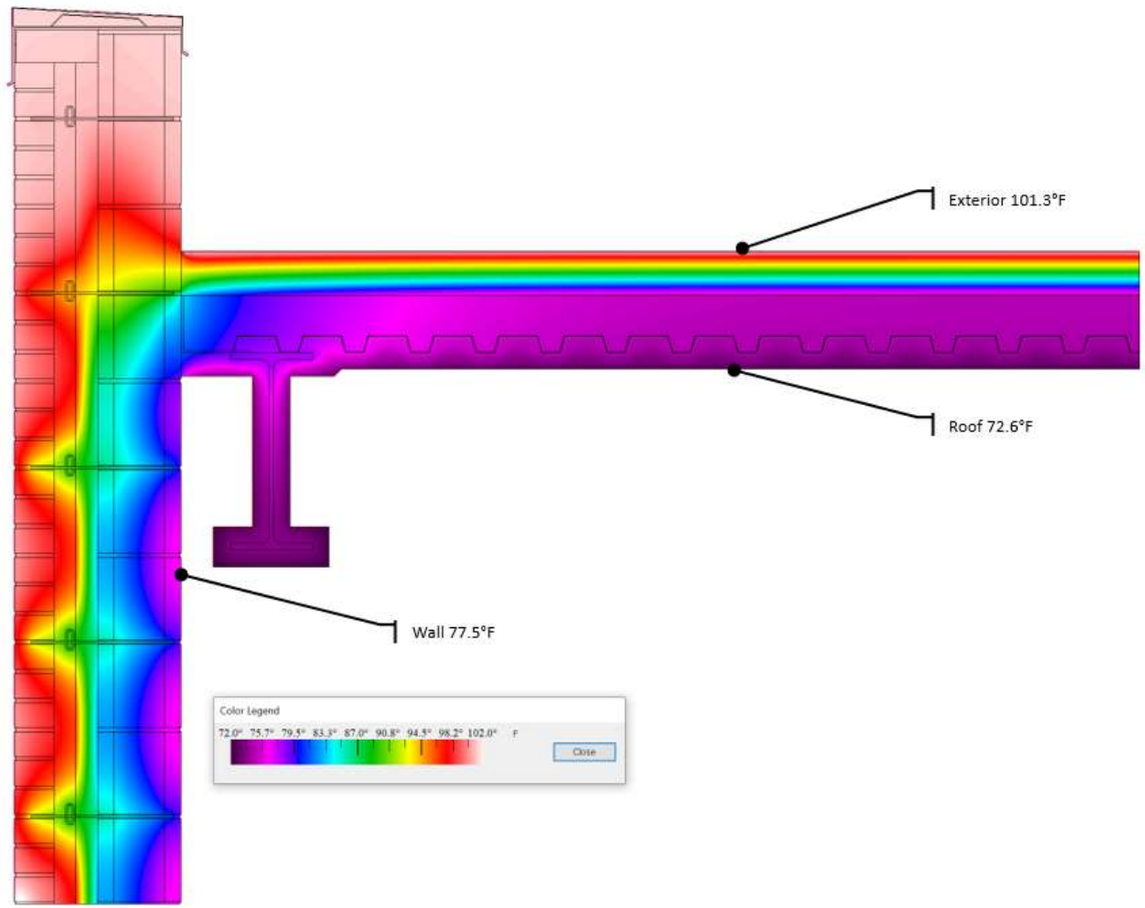


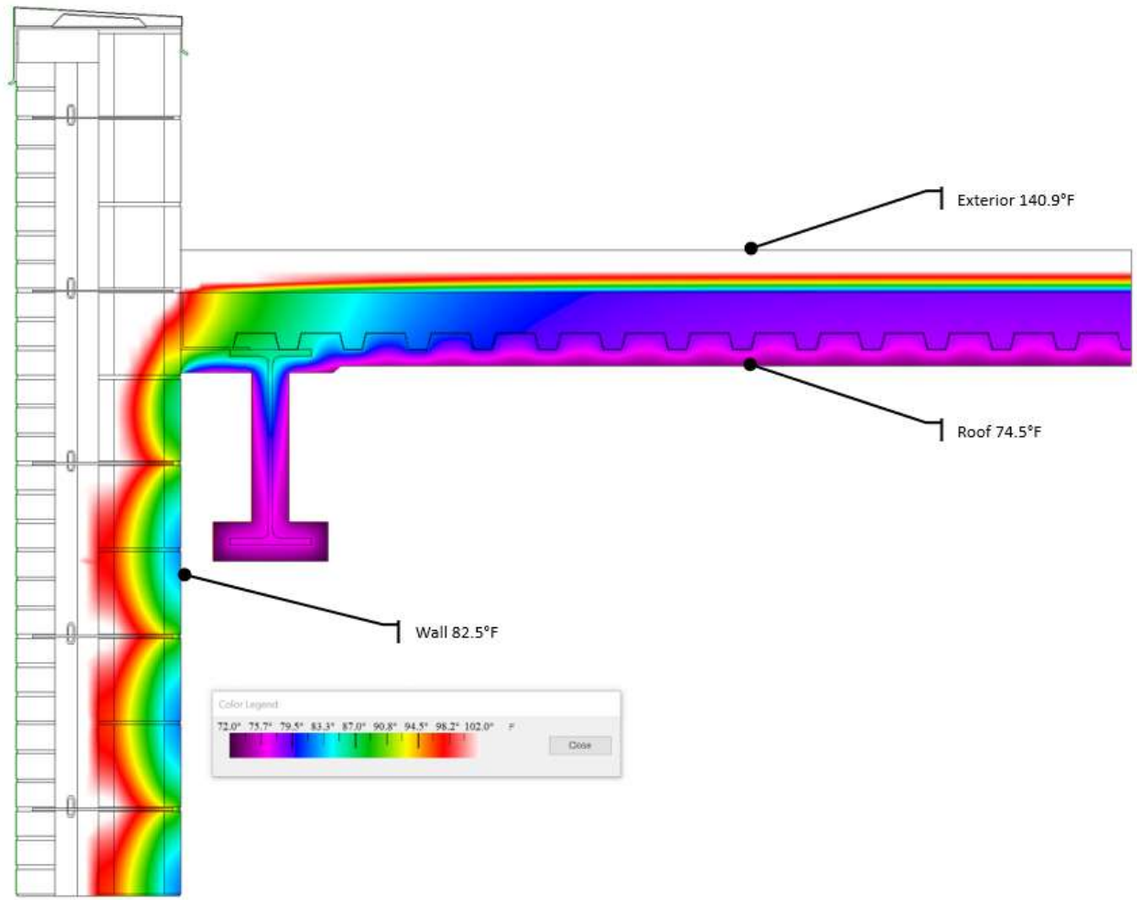




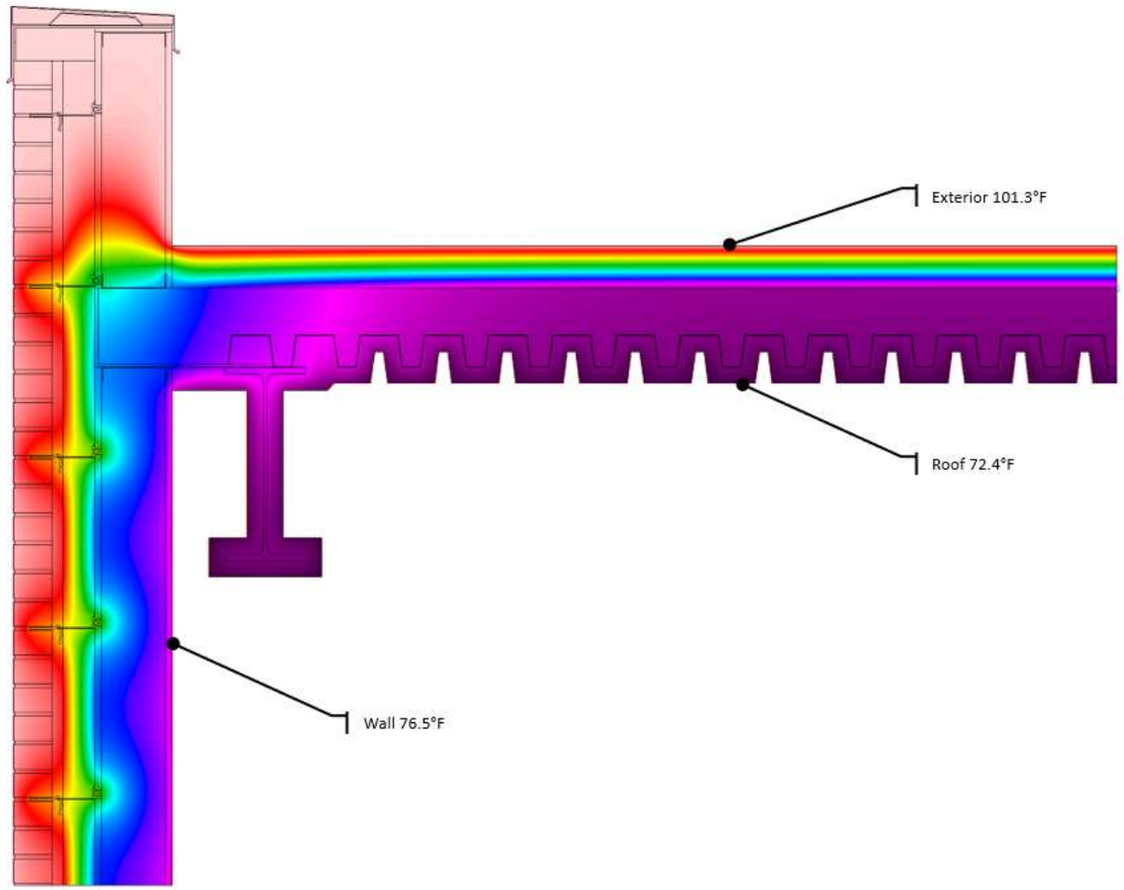


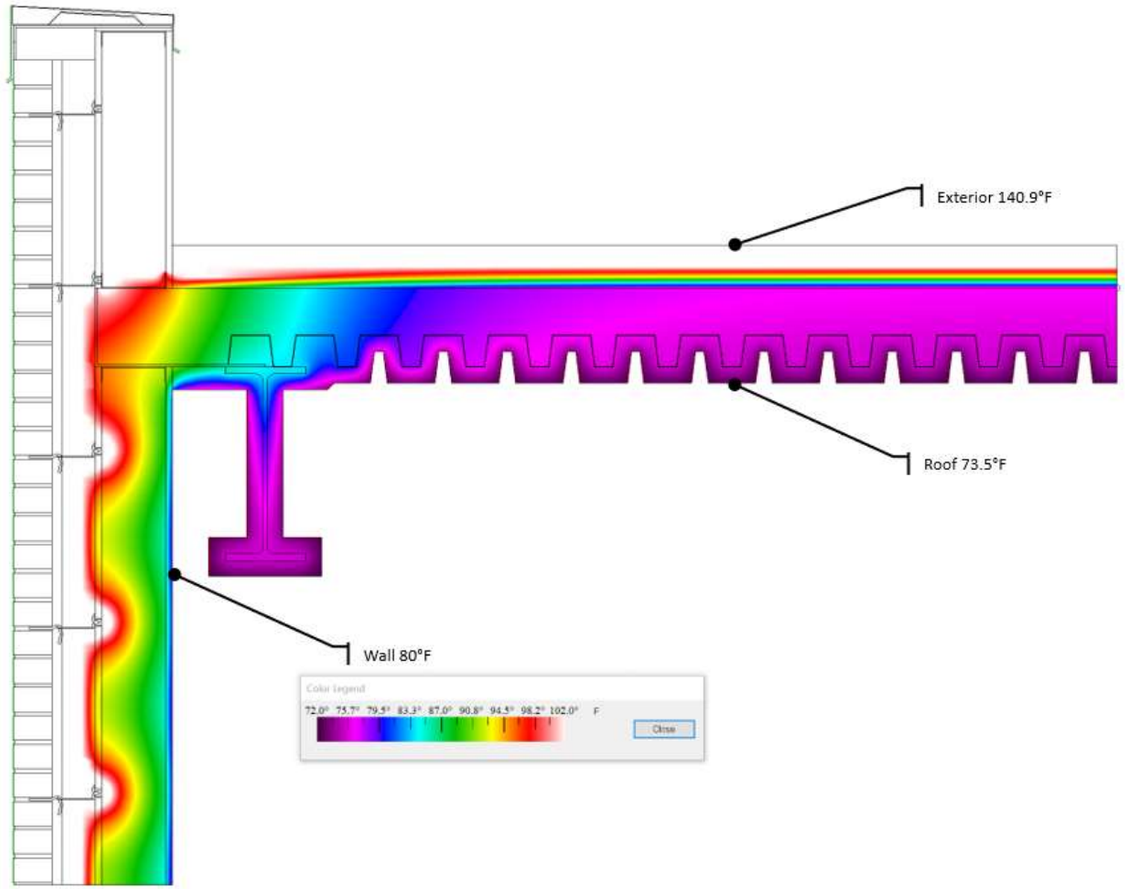
Thermal Analysis – Current Code Compliant Roof and Wall



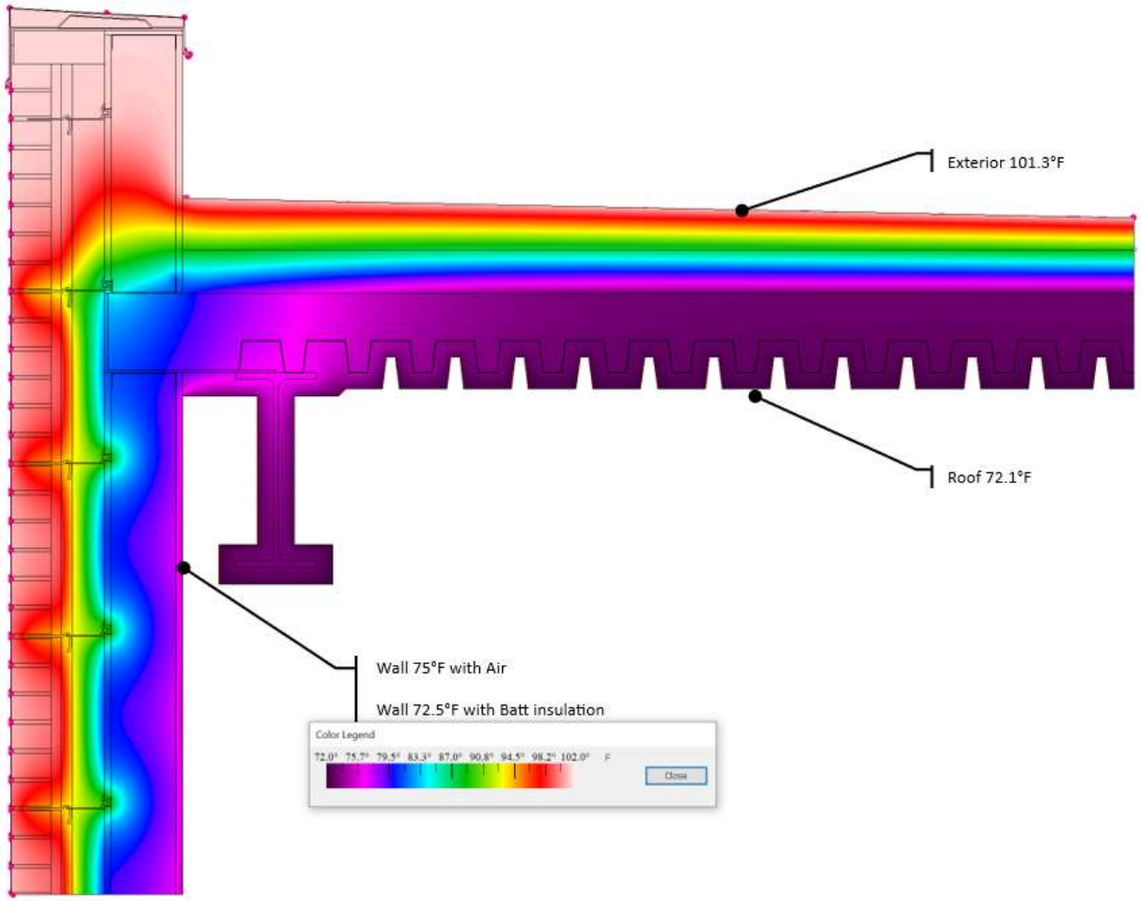


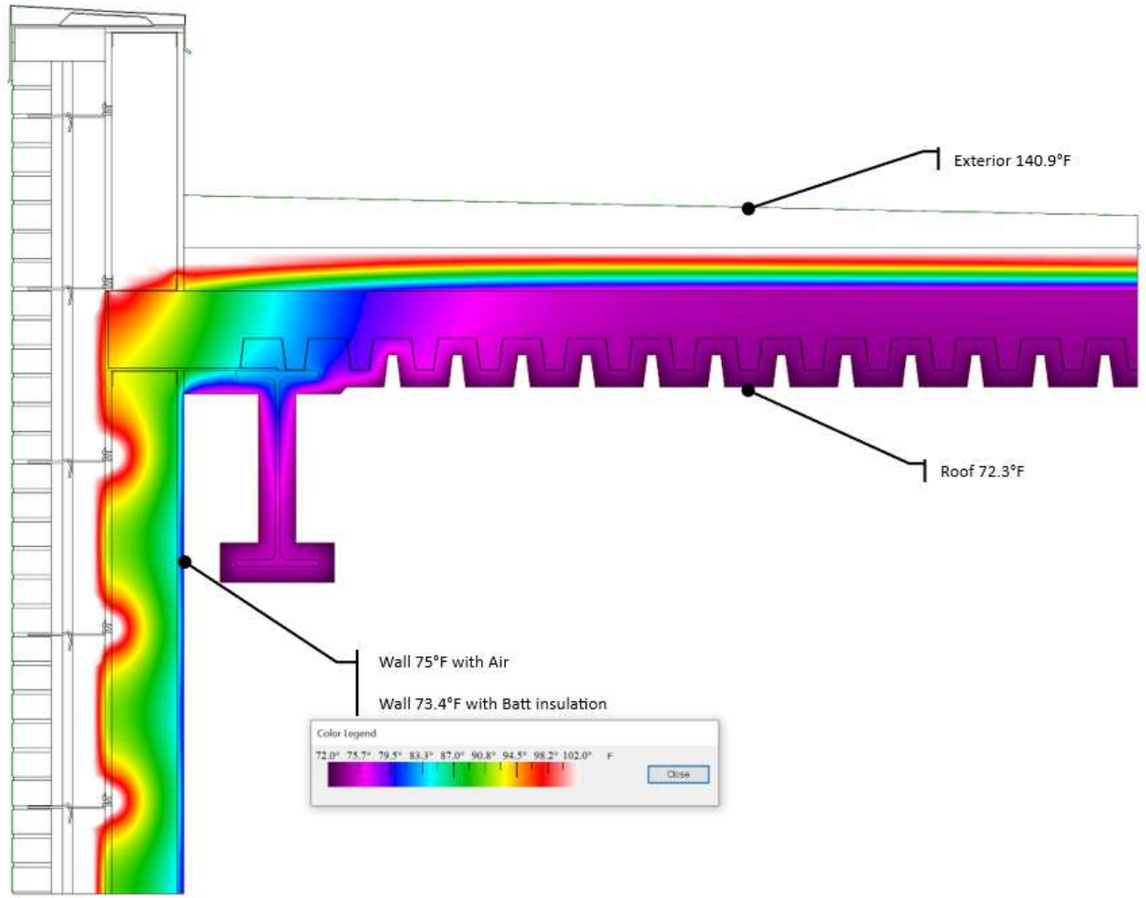
Thermal Analysis – Current Code Compliant Roof and Wall





Thermal Analysis – Climate Forward Design

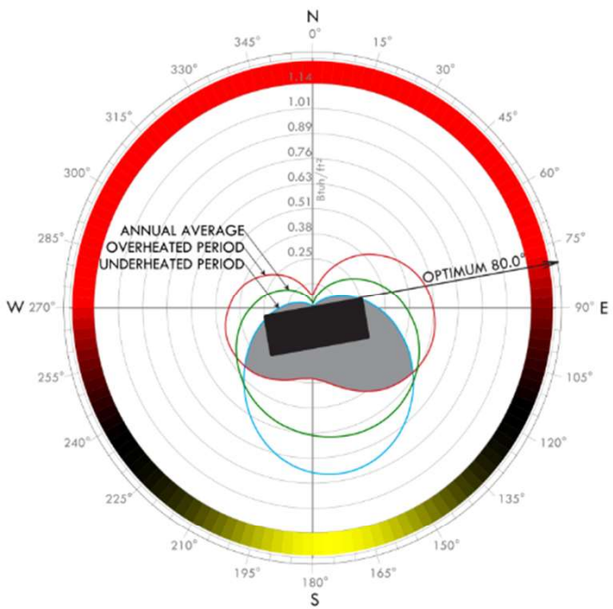




Hot Climates – Climate Forward Design

- Update CDD temperatures to realign - 8 to 15 ^{o}F jump in hot climates
- Update to latest climate files and build future predictive files and make code to follow both
- Used aged and stained values for material absorption
- Increased insulation to reduce heat gains – cooling dominant design
- Improve the massive existing building stock to be 30% better
- More localized energy generation including improved alternative energy
- Educate the industry and change how we design

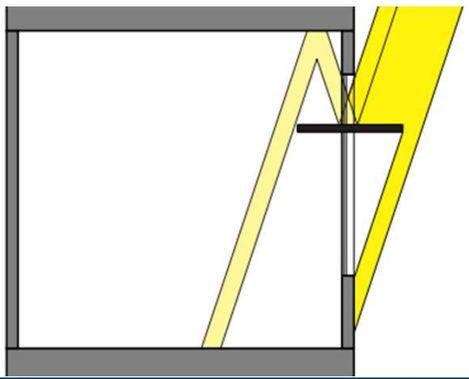
Passive Solar

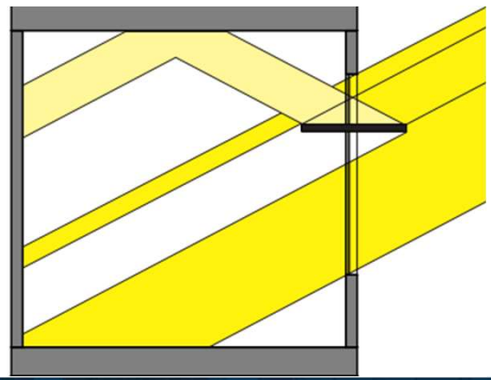


- Darkened materials
- Avoid overheating
- Building orientation
  - Shading due to adjacent development
  - Shading of neighboring spaces
- Glazing considerations
- Double skinned facades and the importance of distance between portions of skin and proper climate zone

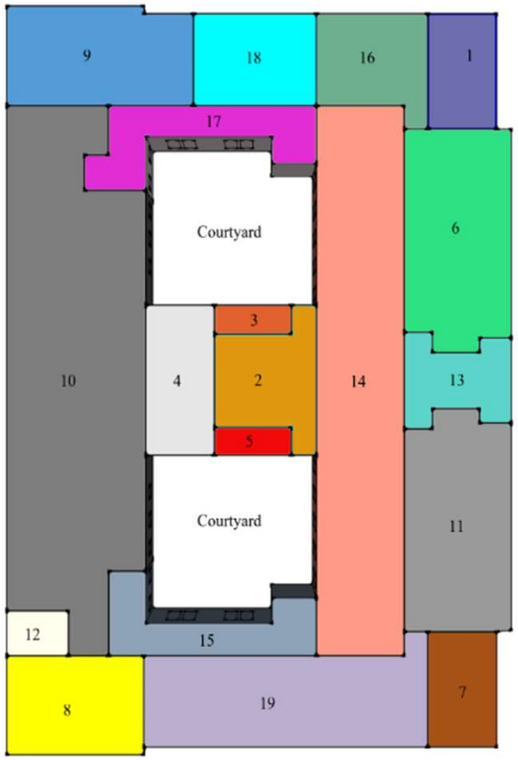
Shading and Light Shelves

- Effect on passive solar gains
- Thermal bridging issues
- Angle, not just look
- Optimize by orientation
- Analyze site for other shading – trees, adjacent buildings





Building Type, Use, Massing and Zoning



Building type and use

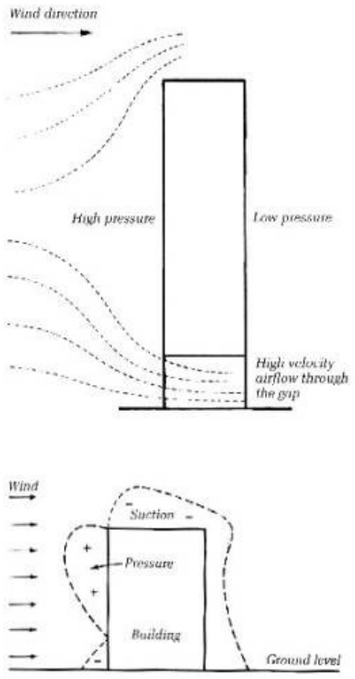
- Office space
- Residential
- Mixed-use
- Hospital/Medical
- Specialty Building
- Education
- Hospitality
- Science and technology

Full-time versus partial day occupancy

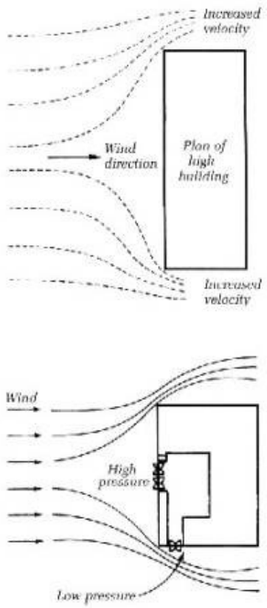
Use of mass

Zones based on use and orientation

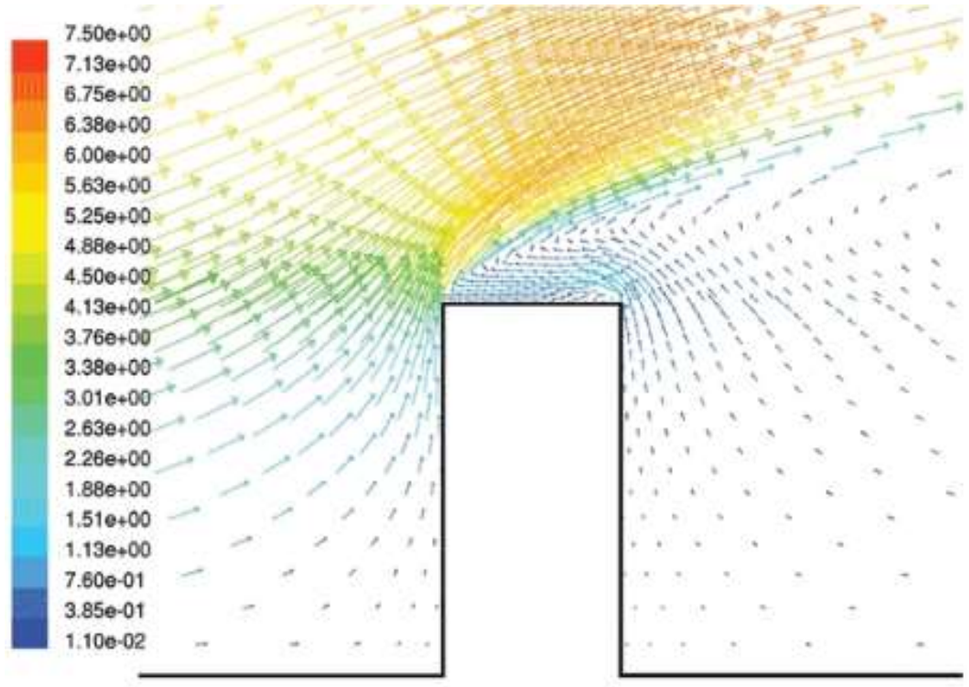
Wind Pressure



ELEVATION

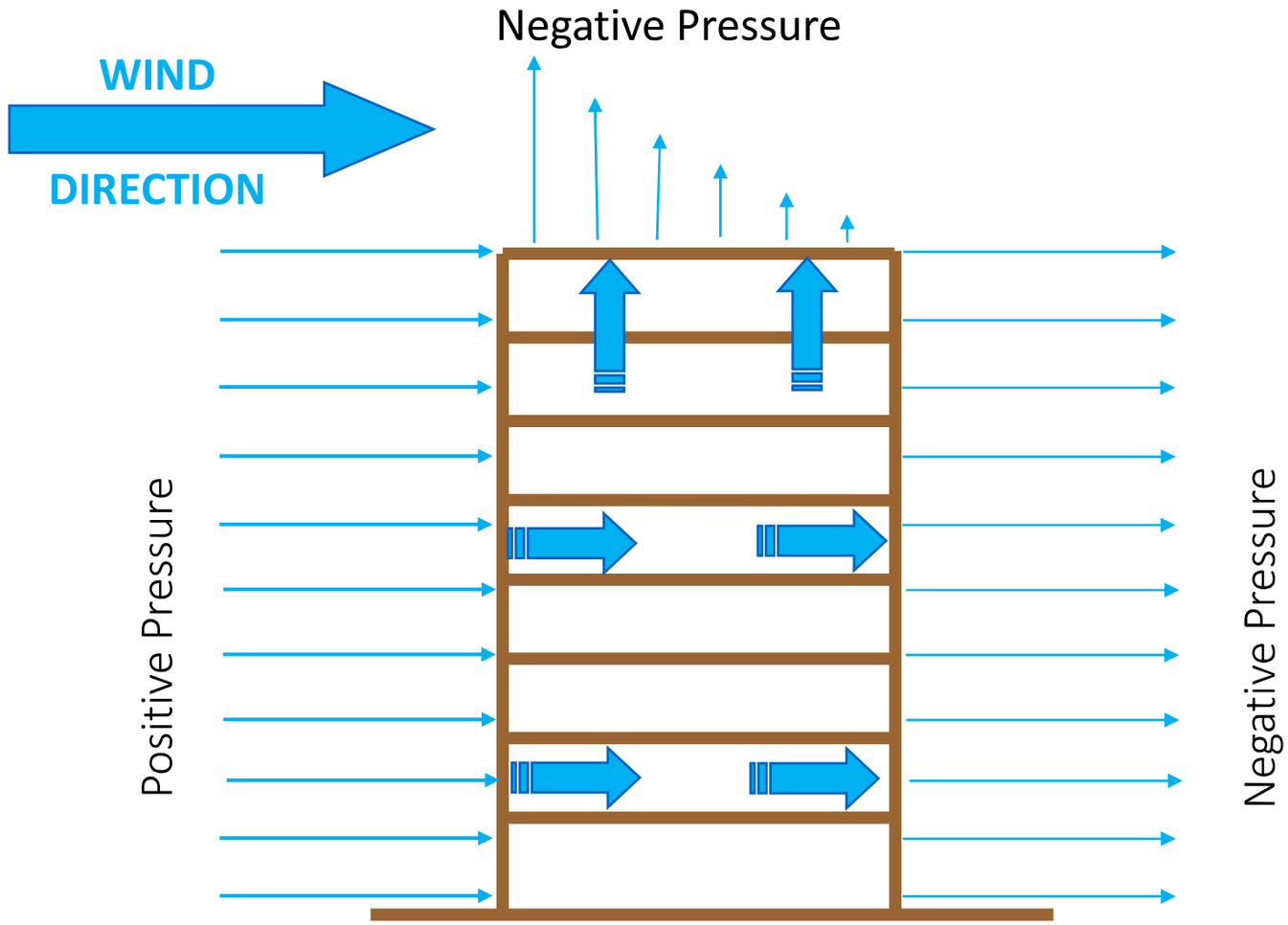


PLAN

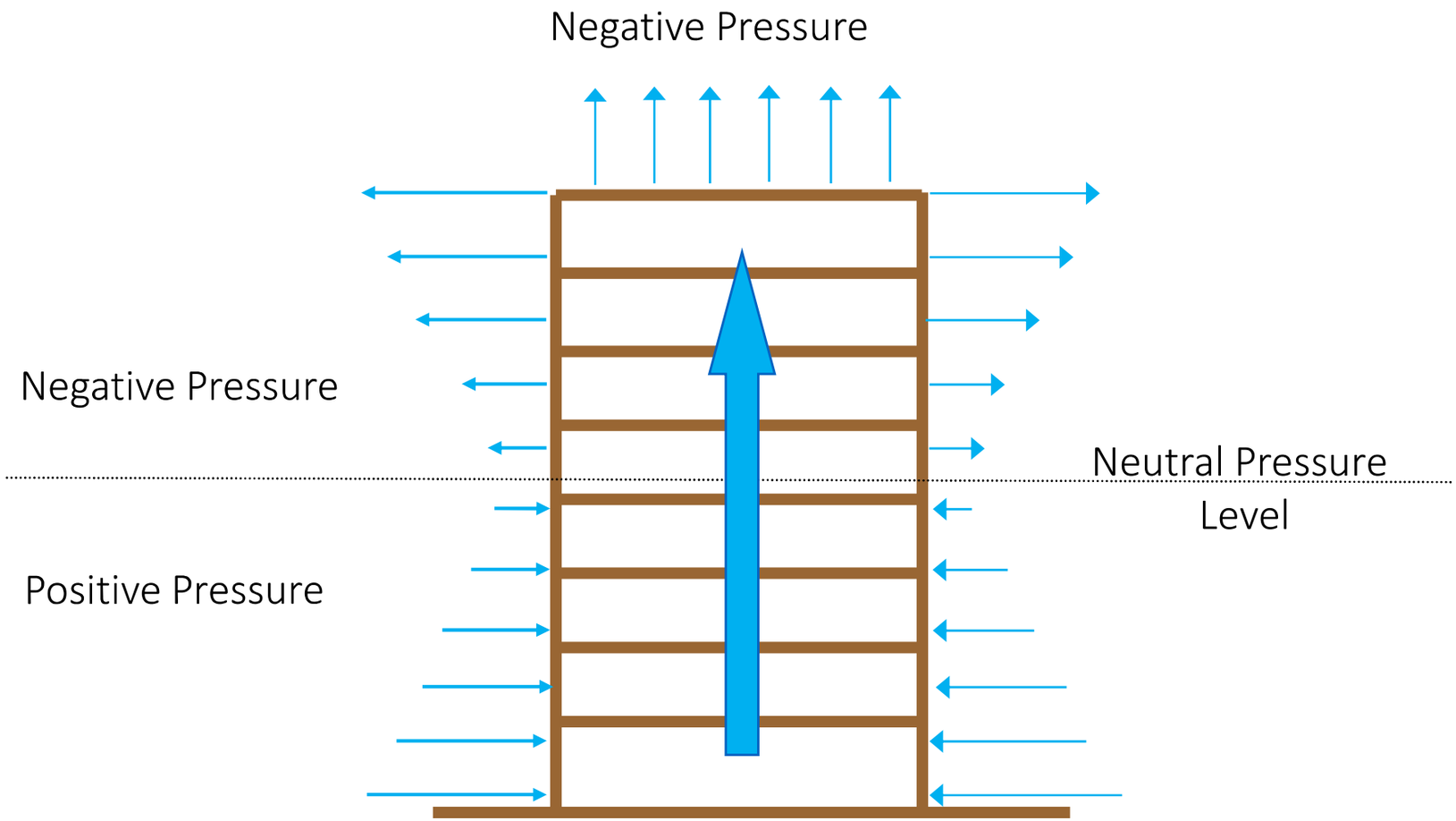


Velocity Vectors Colored By Velocity Magnitude (m/s)

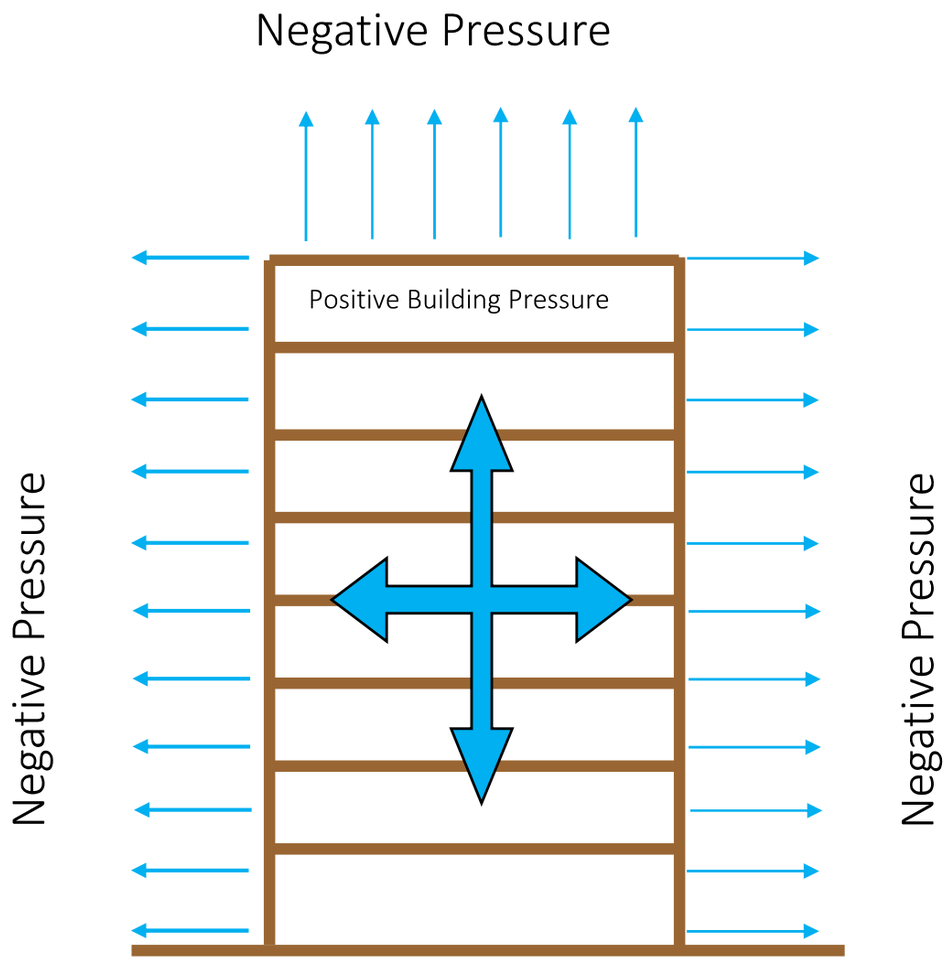
Wind Pressure



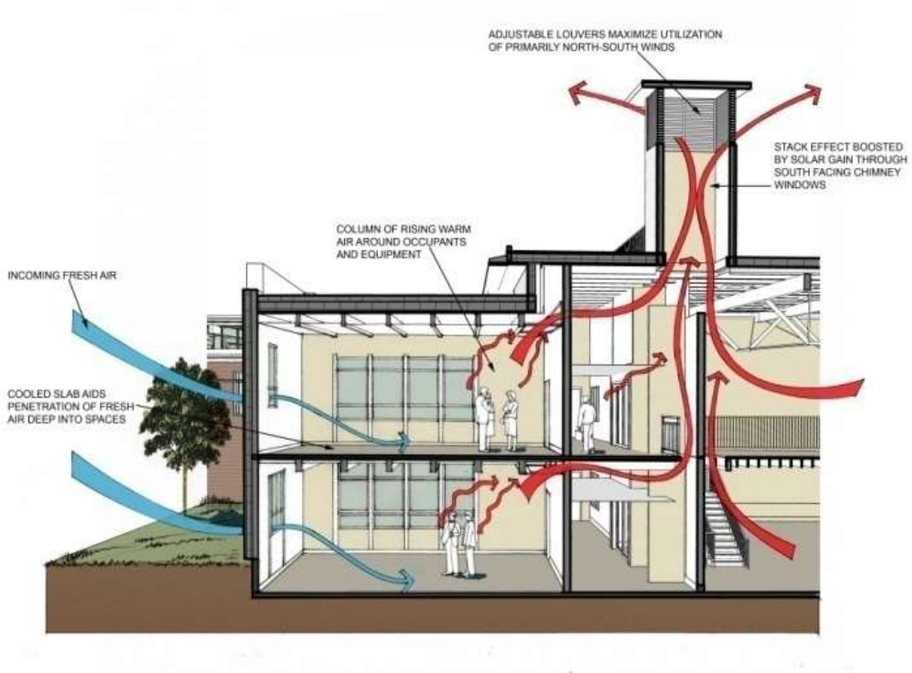
Stack Effect



Mechanical Systems



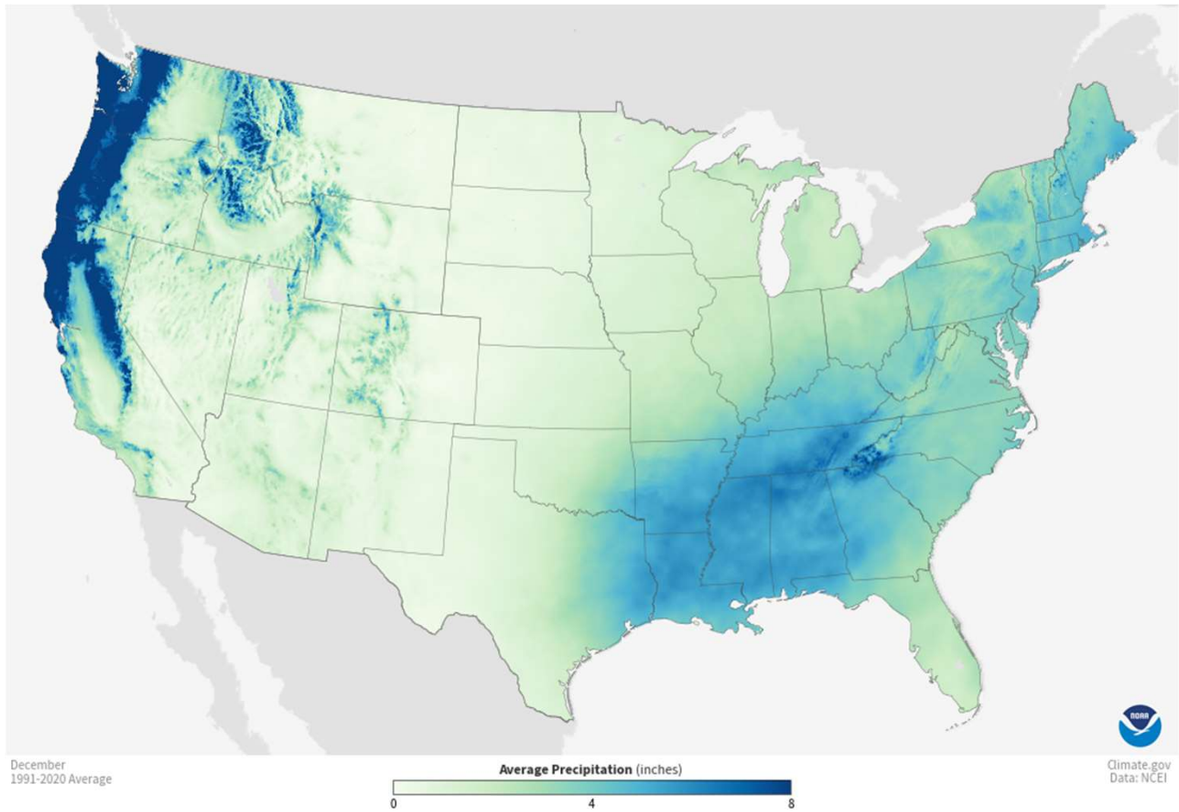
Natural Ventilation

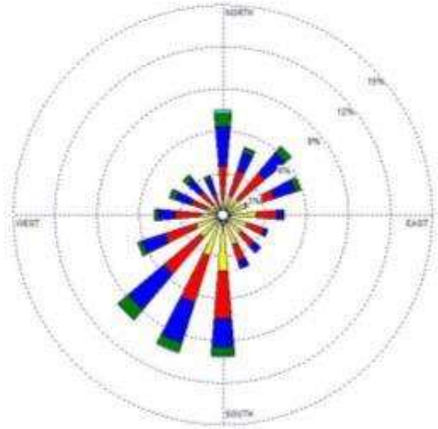


- Natural ventilation
  - Considerations for natural ventilation
  - Stagnation of air and fresh air considerations
  - Ventilation offset
  - Solar chimneys

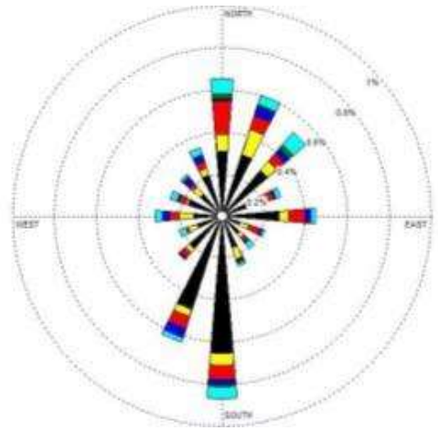
Rainfall Zones

Designing and building in a moderate to high rainfall zone





Wind Rose Diagram

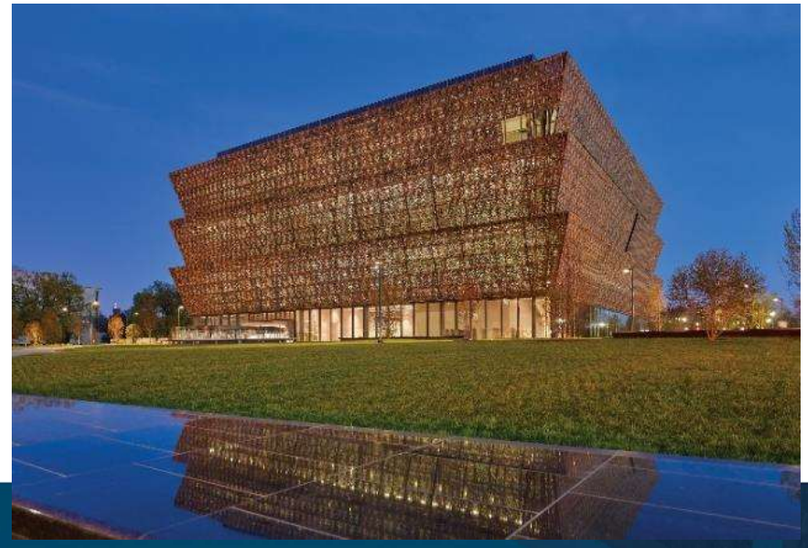


Rain Rose Diagram

https://www.climate.gov/maps-data/data-snapshots/data-source/precipitation-1991-2020-monthly-average

Climate Responsive Building Design

- Responsiveness of systems
- Controls
- How it reacts to the environment
- How it adapts to the future



Connect with Paul

Paul Totten, PE, LEED AP
Vice President
Building Enclosures | National Practice Leader

Direct +1 703-945-1469
Email paul.totten@wsp.com

wsp.com

Paul Totten


abaa2024
building
enclosure
conference