The Designer’s View

AE-544 – Week-8

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Hypothetical Building

Location: Atlantic City
Use: Apartment Building
Exterior: Brick Veneer
Structure: Steel Frame

Dimensions:
- Height: 113.3 m
- Width: 69.4 m
- Basement: 18.0 m
- Ground Floor: 12.5 m
What are the elements of the building envelope?

- **Roof** – will cover next week
- **Basement** – Walls, Floor
- **Wall** – windows, doors, materials
What are the forces that Impinge on it?

- **Load** – e.g. live loads applied to envelope
  - Wind
  - Seismic
- **Climate**
  - Thermal – daily & seasonal
  - Moisture – All phases
- **Internal**
  - Thermal
  - Moisture
- **Time** – in the sense of changes in building, particularly materials
What are the problems we must anticipate?

- Structural Failure
- Environment Penetration
  - Air
  - Objects
  - Moisture
- Operating costs – primarily HVAC, but also maintenance
- Envelope deterioration
- Chemical – Corrosion, efflorescence, calcification
How Do We Address the Potential Problems?

- Design to Control
  - Stress
  - Movement
  - Thermal flow
  - Moisture flow
  - Materials mismatch
- Supervise Construction
- Observe and Maintain
Know the Potential Weak Points

- Flat roofs
- Exterior wall “barriers”
- Parapets
- Corners
- Dissimilar materials
- Membrane penetrations
- Material connectors
- Membrane support
- Below Grade
Designing to Control Stress

- Calculate applied loads
  - Wind
  - Blast
  - Seismic
- Design section to resist
  - Calculate stresses in material
Design to Control Movement

- Locate Joints to accord with architectural goals and physical requirements
  - Control
  - Expansion
- Select Joint Materials
- Size Joints
  - Calculate max requirement
Design to Control thermal Flow

- Establish goal – often from HVAC
- Design section
- Calculate Thermal Transfer
  - Include thermal bridging
  - Max periods – winter + summer
- Calculate Thermal Profile
  - Check that works with materials movement
Design to Control Moisture Flow

- Consider Phases: Solid, Liquid, Gas
- Design to address how moisture moves
  - Gravity
  - Kinetic Energy
  - Surface tension
  - Capillary Suction
  - Air Transport
  - Diffusion
Controlling Gravity Moisture

- **Liquid**
  - Cover entrances
  - Slope elements
  - Use Flashing
  - Use Weep holes

- **For Snow, Ice, prevent falling off**
  - Design thermally to prevent accumulation
Controlling Kinetic Energy Moisture

- For Liquid
  - Cover entrances
  - Use offsets in holes
- For Solid
  - Ice – prevent dropping on people
  - Snow – provide screens
Controlling Surface Tension

- For Liquid
  - Use Drips
  - Use Sealants
Controlling Capillary Suction

- For Liquid
  - Prevent absorption – water repellent coating
  - Block movement – membrane
  - Capillary break – in flashing and overlaps
Controlling Air Transport

- **Solid & Liquid**
  - cover entrances
  - Prevent air Flow

- **Gas – Water Vapor**
  - Barrier on Exterior
  - Thermal analysis to identify condensation points
  - Air Barrier(s)
Controlling Diffusion

- Identify Vapor Pressure Conditions
  - Inside and Outside
  - Different seasons
- Calculate Saturated Vapor Pressure Gradient
- Calculate Actual Vapor Pressure Gradient
- Look for Conflicts
- Calculate seasonal accumulation
Observe Construction

- Check Shop Drawings for design intent
- Review sample Assemblies
- Review performance tests
- Check actual installation
- Perform commissioning tests
Observe and Maintain Building

- Actual performance should be monitored
  - Note that this is often not designer’s responsibility
  - Thermal performance against predicted
  - Moisture Appearance
  - Visible or sensor signs of deterioration
  - There is **much** opportunity for improvement

- Maintain the Building
  - There should be a Preventive maintenance schedule
    - There seldom is for building envelopes