SIMPSON GUMPERTZ & HEGER
Engineering of Structures and Building Enclosures

Top Ten Roofing Problems and How to Avoid Them

David S. Slick, PE, CFM
Associate Principal

National Facilities Management & Technology Conference
Session R3.39
Thursday, 18 March 2010
2:10pm-3:00pm
Room 339

Presentation Outline

- Section 1 – Functions of the Roofing System and Some Basic Roofing Design Concepts
- Section 2 - Top 10 Roofing Problems and How to Avoid Them
- Section 3 - Strategies for Ensuring Construction Quality

Section 1

Functions of the Roofing System and Some Basic Roofing Design Concepts

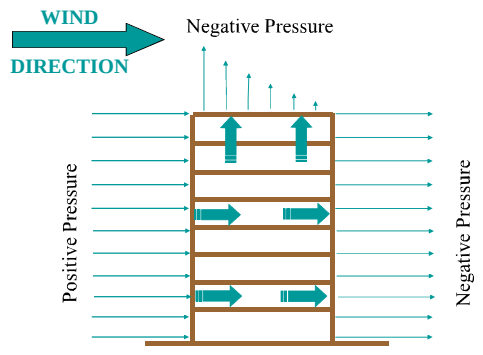
Typical Roofing System Problems

- Water leakage
- Air leakage
- Material failure
- Loss of attachment
- Condensation
- Poor noise control
- Poor thermal performance

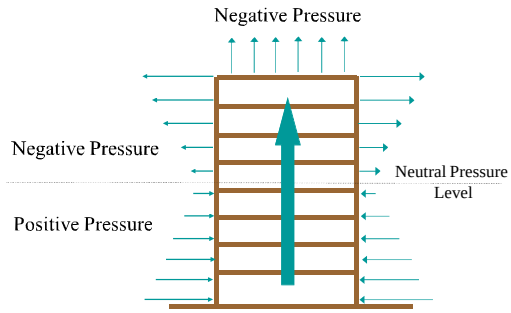
Functions of the Roofing System

- Resist wind and building pressurization loads
- Resist weather events
- Water penetration resistance
- Air infiltration resistance
- Ventilation control
- Condensation control

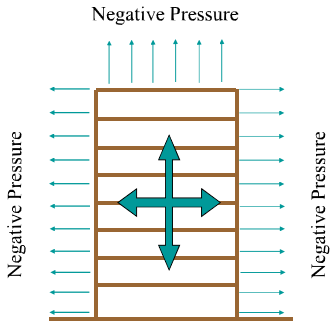
Design Concepts: Wind Effect



Design Concepts: Stack Effect

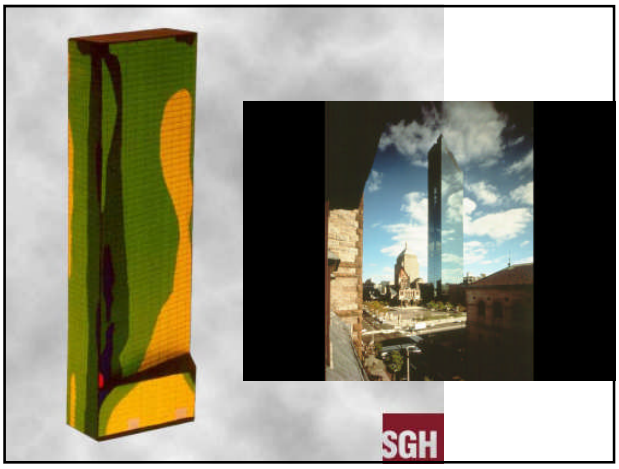


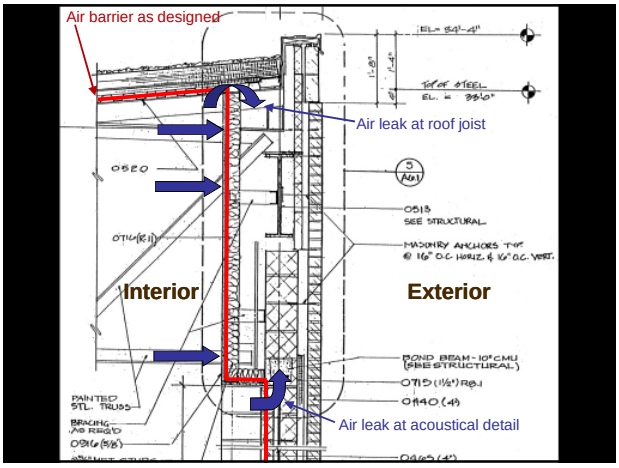
Design Concepts: Mechanical Systems

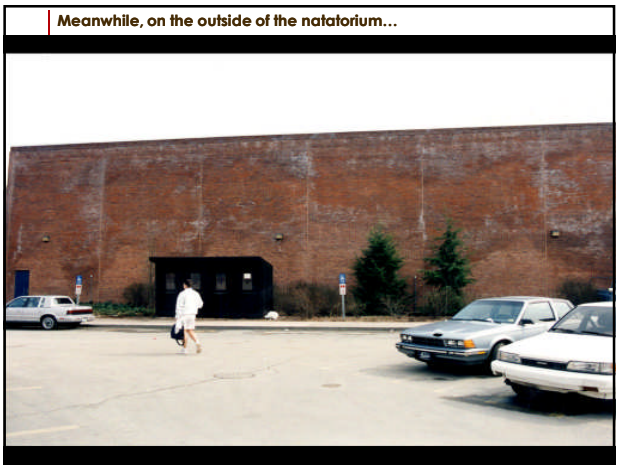


Design Concepts: Roofing Wind Loads

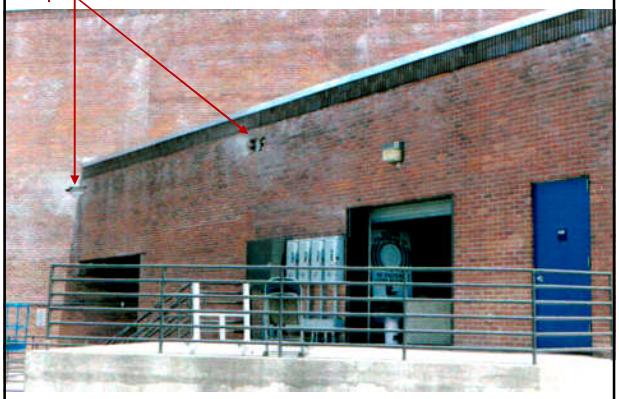
- Wind forces are building and location-specific:
  - Basic wind velocity at the site
  - Building height
  - Exposure and terrain roughness
  - Pressure coefficients based on building geometry
- Wind tunnel studies can give more precise design wind loads, and are sometimes used for:
  - Unusual geometries
  - Very large or prominent buildings
  - Possibility for design economy


SGH

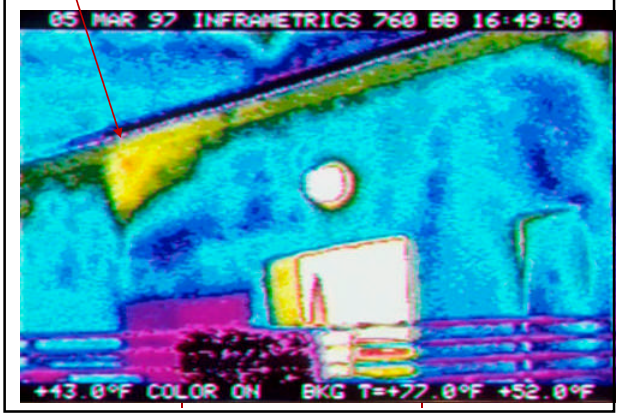

Air barrier as designed
Air leak at roof joist
Interior
Exterior
Air leak at acoustical detail


Meanwhile, on the outside of the natatorium…

Highest rate of air flow at corner transition and exterior column



High rate of air flow at exterior column.....on a cold day, shows up as a "hot spot"



Design Concepts: Vapor Retarder vs Air Barrier

Vapor Retarder

- Continuity does not need to be perfect
- Location set by particulars of climate and material properties
- Strength is not an issue
- May be detrimental for some wall assemblies

Air Barrier

- Must be continuous; perfect barrier seals
- Location set for ease of detailing
- Vapor permeance not important
- Must resist positive and negative pressure
- Always a good idea

Design Concepts: Vapor Retarder vs Air Barrier

- Need both a vapor retarder and an air barrier system in the building envelope to control vapor diffusion and air leakage
- These two systems can sometimes be combined into one
- Be careful during design and construction

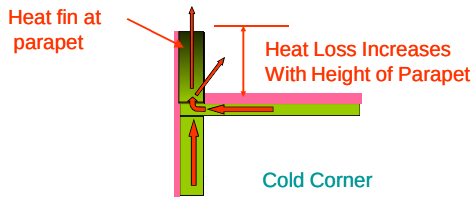
Design Concepts: Thermal Barrier Basics

- Thermal resistance expressed as R-value
- Energy codes stipulate minimum R-values for roofing assemblies
- High density products (XPS, Isocyanurate)
- Consider insulation, air and vapor barriers as interdependent systems during design

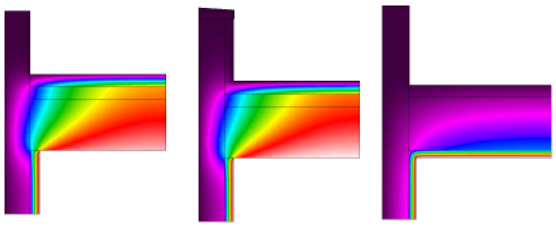
Design Concepts: Common Thermal Barrier Pitfalls

- Inadequate location/sequencing of materials, e.g., insulation on wrong side of vapor barrier
- Heat fins
- Discontinuity of thermal barrier
- Insulation effectiveness reduced if wet

Design Concepts: Parapet Heat Loss



Design Concepts: Parapet Heat Loss



Design Concepts: Thermal Resistance

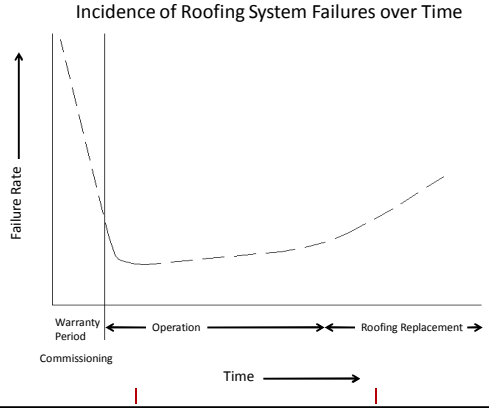
- Continuous thermal barrier, like continuous waterproofing barrier, is most efficient
- Must be designed as part of integrated roofing system (i.e., coordinated with location of vapor retarder and air barrier)

So why does all this matter?

- Most construction claims arise from roof and facade problems (40% of construction claims related to roofs alone).
- Estimate of premature building envelope failure rate 3 to 5%.
- Remedial work to concealed envelope components is extremely costly.

"I never had a problem that didn't cost me money."

Plan for Roofing Replacements and Be Aware of Potential Problems



Section 2

Top 10 Roofing Problems and How to Avoid Them

TOP 10 THINGS TO REMEMBER WHEN DESIGNING A ROOF

1. Avoid ballasted or IRMA roofing systems
2. Use a roofing system with a history of success
3. Provide reliable flashing in rising walls above roof
4. Provide minimum 8 in. base flashing height
5. Extend roof membrane over parapet
6. Use a coverboard to prevent crushing and facer delamination
7. Provide slope to drain at 1/4 in./ft. minimum
8. Provide tapered sumps at all drains and scuppers
9. Check adhesion and open seams in base flashing
10. Avoid pitch pockets – cover them if they are unavoidable

#1 Avoid Ballasted/IRMA Roofs

Same goes for gravel ballast !!!

#1 Avoid Ballasted/IRMA Roofs

#2 Choose a Roof System with a History of Reliable Performance

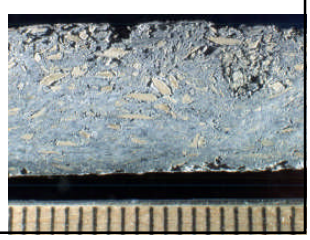
Roof Membrane Comparison

System	Advantages	Disadvantages
EPDM (Single Ply Rubber) Such as by Firestone or Carlisle	☒ Less expensive than PVC or MB. ☒ Flashing conforms well to uneven substrates. ☒ Can be installed in large sheets to minimize seams. ☒ Repairs made with "peel and stick" seam tapes.	☒ Single ply is not redundant, more susceptible to damage. ☒ Tape seams improve performance over traditional glue, but still workmanship sensitive. ☒ Seams cannot be inspected without destroying the seam.
PVC (Polyvinylchloride) such as by Sarnafil	☒ Heat welded seams do not rely on adhesives (generally more reliable). ☒ Seams can be inspected without destroying good seams. ☒ Good resistance to standing water.	☒ Susceptible to damage or defects because no redundant layers. ☒ More expensive than EPDM. ☒ Repairs require special equipment (heat gun and training). ☒ Flashing materials not as easy to work with as EPDM.
2 Ply Modified Bitumen Such as by Siplast or Tamko	☒ Better resistance to roof top traffic than single ply systems. ☒ Provides redundancy of 2 layers. ☒ Excellent flashing details. ☒ Repairs made with traditional materials and can be initially performed by maintenance staff.	☒ More expensive than EPDM. ☒ Application in hot asphalt poses odor issues. Less odor with cold adhesive. ☒ Flashing details generally require more work (more $) than EPDM or PVC. ☒ Transverse seams in base flashing can be problematic.

#2 Choose a Roof System with a History of Reliable Performance – Example: Synthetic Shingles

- Problems have arisen with fiber-cement shingles as manufacturers have replaced asbestos with organic fibers (wood, cellulose)
- Many fiber-cement products are not fit for use as roofing
- Compliance with standards does not assure that the products will work when used for roofing

#2 Choose a Roof System with a History of Reliable Performance – Example: Synthetic Shingles

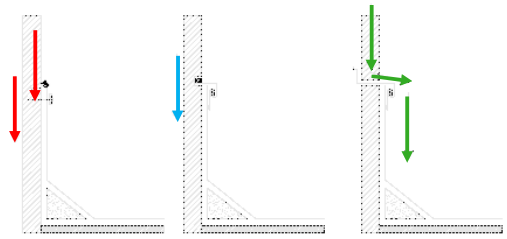


#3 Provide reliable flashing in rising walls above roof

Always assume water will penetrate the wall's exterior face, then:

- Provide continuous waterproofing membranes
- Ensure continuity of waterproofing at penetrations and changes in direction
- Provide continuous metal (copper or stainless steel) through wall flashing at bottom-of-wall terminations
- Provide continuous metal through wall flashing at window and door head, sill, and jambs

#3 Provide reliable flashing in rising walls above roof

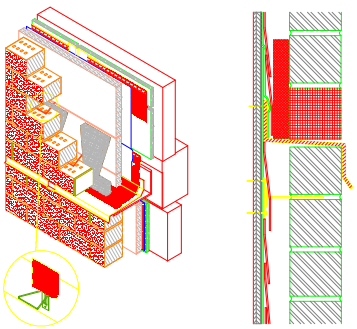


Surface-Sealed Reglet
Large potential for leakage

Reglet-Set Flashing
Reduced potential for leakage

In-Wall Flashing
Very limited potential for leakage

#3 Provide reliable flashing in rising walls above roof



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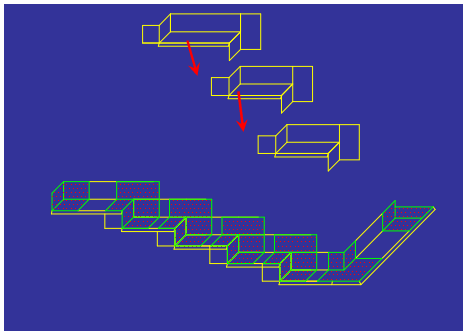
Unique Flashing Configurations



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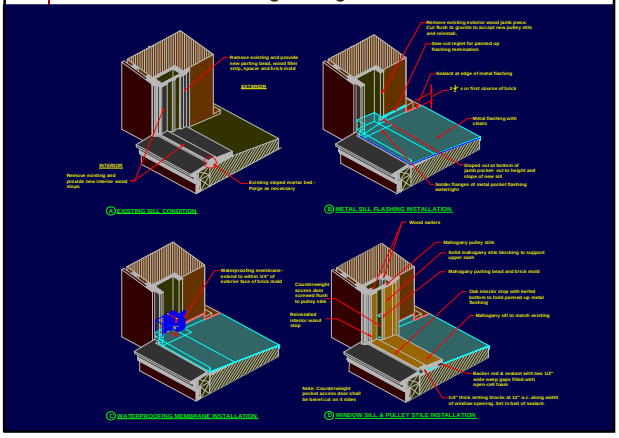

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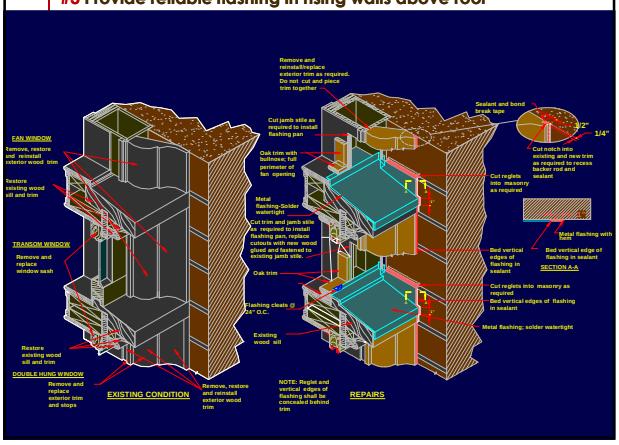

#3 Provide reliable flashing in rising walls above roof

Do not economize on concealed waterproofing elements, use materials that match expected service life of wall system; for example:

- Don't use thin un-reinforced PVC flashings
- Don't use unprotected "cardboard" sheathing even though code and manufacturers allow its use as a weather barrier
- Don't use code-allowed non-durable building papers in wet zone of walls, e.g., Grade D paper as weather barrier behind traditional stucco

#3 Provide reliable flashing in rising walls above roof

- Details at interfaces and terminations need close examination
- Key elements that require periodic maintenance require identification
- Information on means, methods, and rate (how often) maintenance required provided to client, owner, etc.

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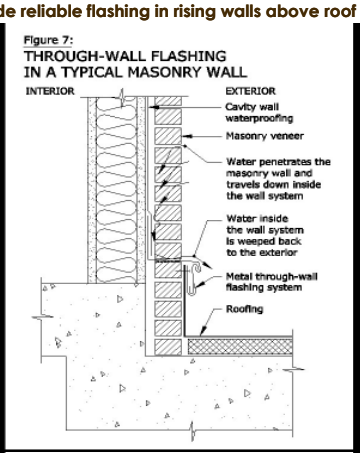

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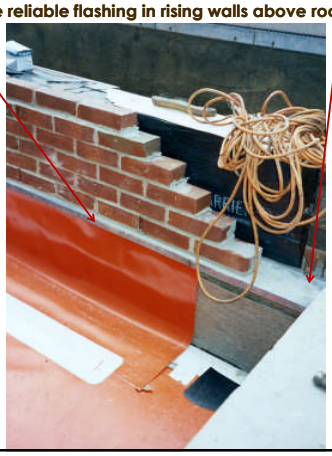

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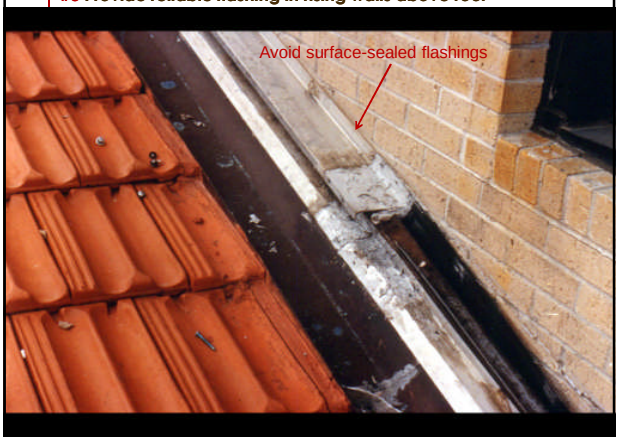

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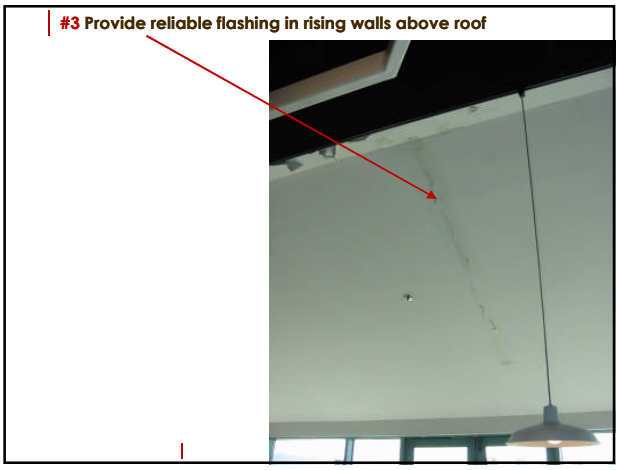
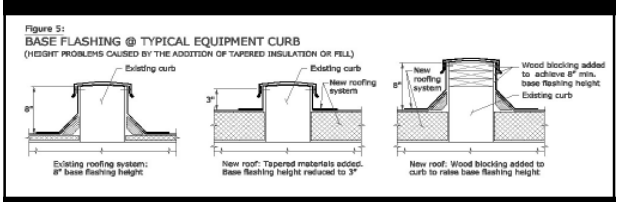


#4 Provide Minimum 8 in. Base Flashing Height

- Overtopping can occur on slow draining roofs with inadequate height
- Difficult to construct flashing in small space – follow NRCA guidelines
- Frequently is a problem on roof reconstruction with added insulation

#4 Provide Minimum 8 in. Base Flashing Height

#5 Extend roof membrane over parapet



#5 Extend roof membrane over parapet

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#6 Use a Coverboard to Prevent Crushing and Facer Delamination

- Rooftop traffic (during construction or in service) can crush isocyanurate insulation and delaminate the facer, leaving adhered roofing systems unattached
- Provide a cover board (typ. 1/2 in. fiberboard, perlite, or siliconized gypsum board)
- Avoid traffic over new roof areas

#5 Extend roof membrane over parapet

#6 Use a Coverboard to Prevent Crushing and Facer Delamination

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#7 Design Roof to Slope to Drain

- Slope entire roof system to drain at 1/4 in./ft minimum (coal tar BUR at 1/8 in./ft)
- Provide slope to internal drains – avoid gutters and scuppers in northern climate
- Maximize slope on re-roofs by adding drains and using tapered insulation
- Provide saddles between drains in long runs
- Send roof plan to tapered insulation manufacturer

#7 Design Roof to Slope to Drain

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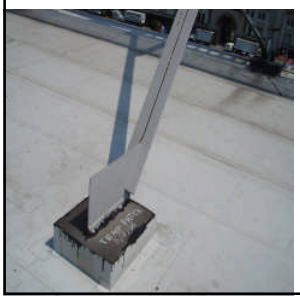
#8 Provide tapered sumps at all drains and scuppers

#9 Check adhesion and open seams in base flashing

#10 Avoid Pitch Pockets – Cover them if they are unavoidable



Section 3

Strategies for Ensuring Construction Quality

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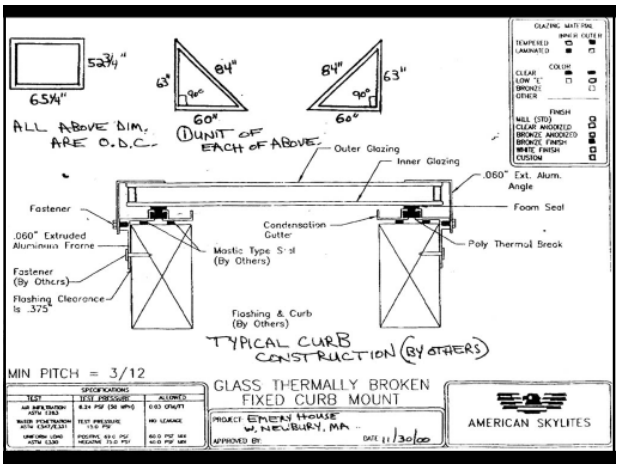
- Shop drawing and submittal process
  - Roofing systems require high degree of coordination among trades
  - Coordinated shop drawings are critical
  - Mock-ups can fulfill some shop drawing requirements

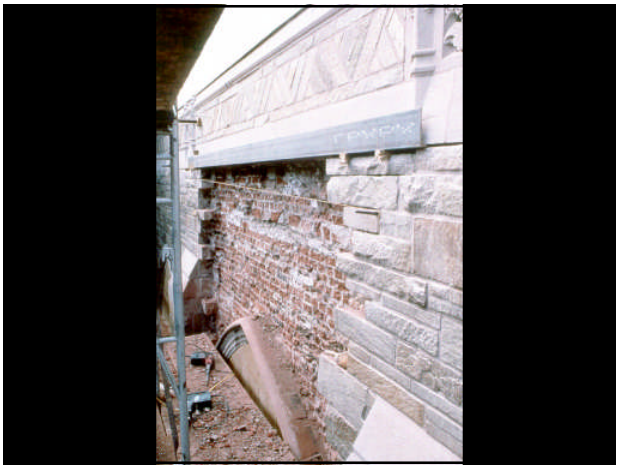


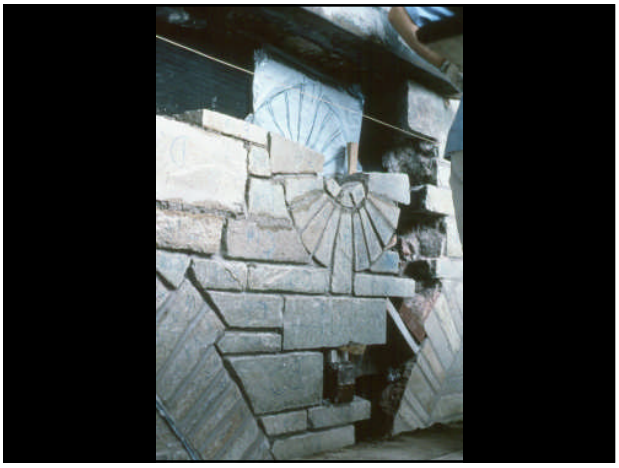
Strategies for Ensuring Construction Quality

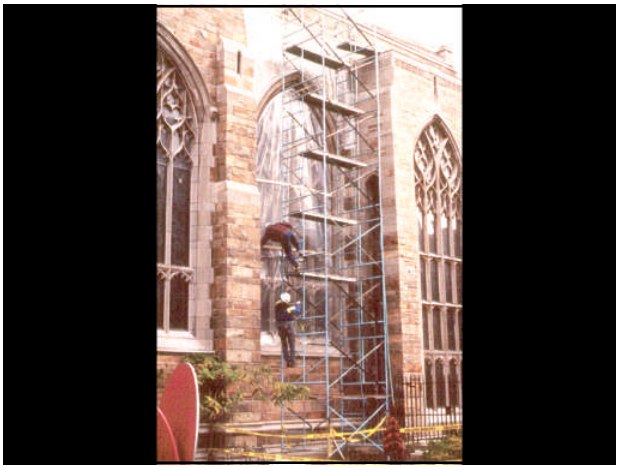
- Shop drawing and submittal process
- Project specific craftsperson certification: mechanics must pass certification test before they can work on the project

Strategies for Ensuring Construction Quality

- Craftsperson certification
- Shop drawing and submittal process
- Mock-ups and sample installations
  - Aesthetic review (by architect and owner)
  - Functional review
    - Does it meet performance requirements?
    - Is it buildable?
    - What about coordination of materials, building components, and trades?
    - Any better ideas?
  - Cost

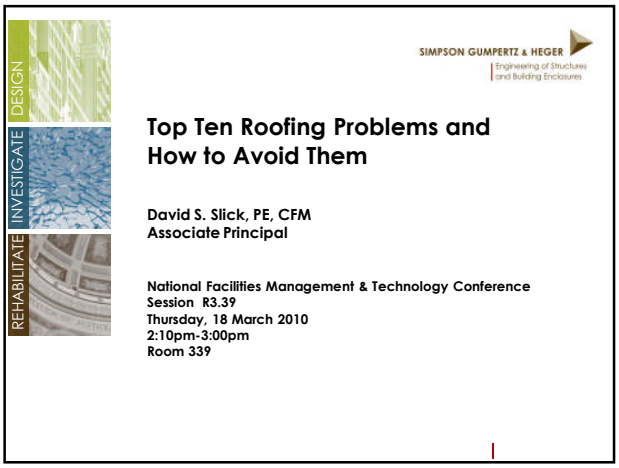






Strategies for Ensuring Construction Quality

- Craftsperson certification
- Shop drawing and submittal process
- Mock-ups and sample installations
- Test representative work samples during installation in “production mode”
  - Continued check on construction quality under actual conditions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