ACHIEVING QUALITY IN ARCHITECTURAL COATINGS WORK:

Wind-Driven Rain Assessment

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Learning Objectives

- Explain the differences between waterproof, weatherproof, and water repellent.

- Identify a laboratory test method used for determining the wind-driven rain resistance of a coating.

- Explain the use of Rilem Tubes.

- Identify field methods that can be used to assess the wind-driven rain resistance of new or existing coatings or water repellents on walls.
Water Infiltration is the biggest culprit in building envelope failures.

Driving rain is significant source of bulk moisture for above-grade walls.

Repairing the building envelope becomes very costly if bulk moisture from rain is not controlled.
Wind-Driven rain is the process by which rainwater is driven or forced through an exterior wall system or assembly due to either existing voids in the wall system itself, or voids created by allowable, in-service deflection of the wall system under applied wind loads.

Uncontrolled wind-driven rain causes damage by rain that comes through an opening being propelled by wind.
Wind-Driven Rain Resistance
Wind-Driven Rain Resistance
Moisture Intrusion Problems

- Adverse Health Effects triggering respiratory problems
- Biological growth
- Damage to moisture sensitive materials
- Masonry spalling from excessive freeze/thaw cycles
- Corrosion of steel reinforcing and components
- Coating damage
- Efflorescence
- Reduction of the insulating Value (R-value) of thermal insulation
Moisture Intrusion Problems
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Moisture Intrusion Problems
When rain strikes a building, it will run off if unobstructed or infiltrate.

Water can infiltrate due to kinetic energy, gravity or other forces if there are defects.

Depending on the wall system type bulk water may be:
- Stored (Mass walls)
- Excluded or infiltrate (Barrier walls)
- Drained (Cavity or Screened walls)

The wall or enclosure should protect interior spaces from the environment.

Must understand differences in wall system types when it comes to wind-driven rain resistance.
Wall System Types – Mass Walls
Wall System Types – Mass Walls
Wall System Types – Barrier Walls
Wall System Types – Barrier Walls
Wall System Types - Drained/Screened Walls
Wall System Types – Drained/Screened Walls
Exterior coatings are a critical component for barrier type wall assemblies.

Wind-driven rain resistance of the coating is essential for protection of barrier type walls.

It is even more critical in coastal environments or areas with high amounts of rainfall.
Wind-Driven Rain Resistance of Coatings

- Test results for wind-driven rain resistance can be found on the product data sheet (PDS) in the “Performance data”, Technical data” or “Physical properties” section of the PDS.

- Test results are typically provided for high-build acrylic coatings such as elastomeric.

- It is not common to see wind-driven rain test results for thin-film acrylics.
Good wind-driven rain resistance does not mean a coating is “waterproof”

The term “waterproof” should not be used interchangeably with wind-driven rain resistance

Waterproofing is typically in the form of a sheet applied or liquid applied material defined as resistance to passage of water under hydrostatic pressure

Pigmented coatings used above grade on masonry or concrete structures are typically referred to as “Weatherproof” or “Weather Resistant”

Weatherproof typically refers to the resistance of the passage of water not subjected to hydrostatic pressure
Wind-driven rain resistance testing of coatings in the laboratory evaluates the ability to resist water penetration through a dried film, erosion of the coating or coating degradation on a concrete test panel when exposed to water spray under pressure

ASTM D6904 – “Standard Practice for Resistance to Wind-Driven Rain of Exterior Coatings Applied on Masonry” is the most common type of laboratory test

Wind-Driven Rain Testing Chamber
LABORATORY TESTING CONDITIONS

- ASTM D6904 and Fed Spec TT-C-555B are used to test above ground masonry and concrete coatings.

- Water is sprayed onto painted 8” x 16” x 2” concrete test panels using a fish-tail nozzle.

- 60 – 70 gallons per hour of water is sprayed under a 5 unit difference of atmospheric pressure inside the test chamber when compared to the outside pressure.

- This difference in atmospheric pressure is meant to produce an “equivalent dynamic pressure at 98 miles per hour wind velocity.”

- The ASTM method recommends a water exposure time of 24 hours, while the Federal Specification recommends a 48-hour exposure time, unless water penetration occurs sooner.

- Assessment of test panels is either visual (wet block) or by weight loss/gain.
ASTM references testing a specified coating system, consisting of block filler and a second layer of masonry paint.

May include a water repellent if specified.

Coating system requirements are recommended by manufacturer or the specifications requiring the wind-driven rain results.

Parameters for testing including the number of layers, type of material applied, thickness of each layer, the curing time and conditions, and length of exposure (24 hrs or 48 hrs) are documented.

Testing is performed in either duplicate or triplicate.

The test panels are clamped into the test chamber and subjected to water exposure.

Coating system should prevent water from penetrating into the masonry concrete panels under specific testing conditions. Results evaluated visually or by weight of block.
Laboratory Testing Pass/Fail Criteria

- There is no pass/fail criteria listed in the test methods
- Pass/fail criteria is left up to the discretion of the manufacturer and user
- Acceptance criteria may include:
  - Total weight loss/gain
  - Blistering
  - Softening
  - Other visual changes, i.e. water penetration to the back of the concrete panels, erosion of coating from concrete surface
- Most coating manufacturers require a maximum limit of weight loss (due to erosion) or gain (due to absorption) of 0.2 pounds
Initial purpose of ASTM D6904 was to evaluate a clear sealer (non-pigmented) or penetrating sealer for water penetration and degradation.

Test methods have been used frequently to test a wide variety of coatings than originally intended, including pigmented coatings.

Coating manufacturers commonly use pigmented primers as sealers or other pigmented coatings to resist water penetration.
Wind-Driven Rain Resistance Field Testing

- Purposes of field testing the wind-driven rain resistance of exterior coating systems:
  - Evaluate mock ups
  - Analyze moisture intrusion problems
  - Determine if and why leakage has occurred into a building
- Tests are meant to simulate a blowing rain
- Common types of field test methods:
  - Sealed test chamber
  - Calibrated nozzle
  - Spray rack
  - Garden hose
  - Rilem® tube
ASTM C1601, “Standard Test Method for Field Determination of Water Penetration of Masonry Wall Surfaces”, measures the amount of water penetration into a wall and designed to test in-situ walls.

ASTM E514, “Standard Test Method for Water Penetration and Leakage Through Masonry”, is a similar test but is a laboratory test method.

ASTM E514 measures through-wall penetration whereas ASTM C1601 measures surface water penetration.
Field Testing – Water Chamber
ASTM C1601

- Uses a pressure/test chamber with a 12 square-foot test area (typically 3’ x 4’)
- Mechanically anchored and sealed to the wall
- Water is pumped into the test chamber and through the spray bar at the top of the chamber (3.4 gal/hr. per s.f. of wall)
- Air pressure is applied to simulate wind-driven rain (typically 10 psf)
- Water is collected and recirculated
Field Testing – Water Chamber
ASTM C1601

- Pre-conditioning period
- Four hour test
- Water intrusion can occur within a few minutes
- Volume of water loss, air pressure and water flow recorded in 5 minute intervals
- Air pressure along with capillary action results in water transport
- Rate water is absorbed or penetrates indicates wall’s resistance to wind-driven rain
Field Testing – Calibrated Spray Nozzle

- Apparatus primary intended as a field test on window and fenestration products
- AAMA 501.2 “Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtainwalls and Sloped Glazing Systems”
- Same test and principle can be used to test exterior coatings and water repellents
- Uses a special nozzle (Type B-25 #6.030)
Field Testing – Calibrated Spray Nozzle

- Attached to ¾” garden hose
- Directs a cone of water spray at 30-35 PSI
- Typical rate of 2.2 gal/hr. per s.f. of wall
- Does not include forced air pressure
- Water is directed at the test area
- Move slowly back and forth at a distance of 1’ 0”
- Observer on inside will check for leakage
Field Testing - Spray Rack

- Water spray test using a water rack
- Similar in principle to ASTM E1105, “Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference”
- Test uses small nozzles attached to a water rack delivering water uniformly
- ASTM E1105 primarily intended for field testing of installed fenestrations and uses a sealed test chamber on the inside
- Spray rack apparatus can be used to evaluate the wind driven rain resistance of the coating or water repellent
EXAMINE WALL SURFACE PRIOR TO WATER SPRAY

OBTAIN MOISTURE READINGS PRIOR TO WATER SPRAY
## Field Testing – Spray Rack

### Exterior – Pre Water Rack Test Moisture Readings

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### Exterior – Post Water Rack Test Moisture Readings

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Field Testing – Spray Rack

Interior Visually Inspected During Water Spray

Infrared is useful in identifying leaks
Field Testing – Spray Rack
Although not complying with a standard, a garden hose or sprinkler can be used to evaluate resistance to leakage through a coating or water repellent.

- Not Quantitative
- “Garden hose” tests can identify if the wind-driven rain resistance created by the coating is poor, but they do not confirm that it is good because the test variables are not adequately controlled.
Field Testing – Rilem® Tube

- Measures the rate of water absorption through a porous material
- Developed by a European association headquartered in Paris, France
- Measures the quantity of water absorbed over a definite period of time
- Test method 11.4 was developed by a technical committee within Rilem®
Test apparatus consists of a clear plastic tube that is graduated from 0 to 5 mL.

- Tube is connected to a small reservoir with a circular brim.
- Brim is attached with putty.
- Area where it joins wall is approximately 1 square inch.
- Water is filled to the 0 graduation mark.
Field Testing – Rilem® Tube

- When filled, test exerts approximately 0.17 psi of pressure on the wall, which is equivalent to 96.4 mph
- Check test at least every 5 minutes, up to 20 minutes
- Record mL absorbed
- Conduct tests in block and mortar joints
- Testing can be done on pigmented or clear water repellents
- Avoid testing during rain or after rain
Water loss of 20% or less during the 20-minute test period is adequate (SWRI)

The start time, end time, mL loss and material type is recorded.

Testing of an entire wall can take several hours

Typically multiple tests are conducted at the same time
## Comparison of Field Test

<table>
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<tr>
<th>Type of Test</th>
<th>Wind Pressure Factored into Test</th>
<th>Standard</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>Test Chamber</td>
<td>Yes</td>
<td>ASTM C1601</td>
<td>Complies with standard. Most quantitative. Most controllable. Long history of use</td>
<td>Expensive. Tests fairly small area. Requires specialized equipment and expertise</td>
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<td>Calibrated Spray Nozzle</td>
<td>No</td>
<td>AAMA 501.2 (Applies to Fenestrations)</td>
<td>Inexpensive, easy to use</td>
<td>Qualitative only</td>
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<td>Spray Rack</td>
<td>No</td>
<td>None (ASTM E1105 if used with sealed chamber)</td>
<td>Large Test area</td>
<td>Expensive. Qualitative only (except for moisture readings). Requires specialized equipment and expertise</td>
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<td>Garden Hose</td>
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<td>Inexpensive, easy to use</td>
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<td>Rilem® Tube</td>
<td>Yes</td>
<td>Rilem® Test Method 11.4</td>
<td>Inexpensive, easy to use, quantitative</td>
<td>Small test area</td>
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High build elastomeric are common pigmented coating systems used to control wind-driven rain.

Some water-repellent systems may have 15% solids or more used to control wind-driven rain.

Better wind-driven rain resistance can link to lower permeance.

Designer must consider the trade off.

Delicate balance between breathability and controlling wind-driven rain.
Coatings and water repellents play a key role in controlling moisture intrusion in a barrier wall type assembly.

Both laboratory and field tests can be performed to verify a coating system’s resistance to wind-driven rain.

ASTM D6904 is the most common type of laboratory test.

Field tests include; test chamber, calibrated spray nozzle, spray rack, garden hose and Rilem® Tube.

Some tests are used for wind-driven rain resistance testing of fenestrations but the same principles apply when testing coatings.
Questions?

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