How Long Should It Last?

Water-Resistive Barrier Durability as a Factor in Construction Litigation

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Durability
Durability

• Everyone understands *duration*
  – We want things to last
• Durability is “Green”
• Essence of sustainability
• Reduce waste and keep building materials out of landfill longer:
  – Select products with optimal *Design Life*
  – Prevent premature failures to achieve long *Service Life*
Water-Resistive Barriers
Liquid-Applied WRB

Or is it an air barrier?
Or a weather barrier?
Biggest Problem: (it’s not air)

Water
Previous WRB Tests

• Many new liquid-applied WRBs
• They join crowded market:
  – Wraps
  – Self-adhered membranes
  – Felt and paper
• Researching 121 (!) products
• They cite 89 (!) different ASTM standards
• Some cite bogus standards
Durability Phase 1: Initial Factors

- How easy is it to use?
- Are the instructions okay?
- How long can it be exposed?
- How does it work on typ. details?
- What is the coverage rate?
- How well does it seal fasteners?
Test Design

- Sloped at 25-degree angle would have max. solar exposure (faster)
- But gravity has major effect on WRBs, so test vertical
- Testing 31 primary products (plus their accessories)
- Also built code minimum “control” to compare
Accessories & Details

- We used products and details per each manufacturer’s literature
- Contractor independently determined products and details
- We called manufacturer’s reps to reconcile differences
- Other reps visited Lab:
  - Recommended different products!
Outside Corner
Small Diameter Penetration
Large Diameter Penetration
Octagonal Junction Box
Brick Tie
Coverage Rate Testing
Coverage Rate

• Relates to durability:
  – Affects crack-bridging ability
  – “Delamination more likely…”
• Difficult to measure precisely
• Depends on product formulation
• Depends on substrate
• Other variables
  – Ambient conditions
  – Sheathing batch variability
Tech Bulletin Warnings

Actual coverage under ambient condition and application condition and application coverage under actual barrier product, to verify such as ambient conditions, substrate suggest a field coverage test to verify, by the contractor who is applying the air on-hand.
Sealing Fastener Holes

• **Self-sealing:**
  – Seals around fastener shaft without additional treatment
  – Crucial property for WRBs

• **Self-healing:**
  – Repairs damage over time
  – Rare for WRBs
  – Erroneously used as a synonym for self-sealing
• Self-gasketing:
  – Seals under fastener head by compression
  – Emerging term
  – Downplays intrinsic self-sealing in favor of extrinsic gasketing
  – But no wall design has fastener heads against WRB
Sealing Fastener Holes

• No WRB seals abandoned fastener holes
  – Huge problem for construction industry (1 case: $42M)
  – Worse with blind fastening through continuous insulation

• Least-bad best practice:
  – Disable reverse on screw gun
ASTM D1970 and D7349

- D1970: “Borrowed” roofing spec, includes nail sealability test
- Changed in 2014 to D7349
- No similar standard for WRBs yet
- Severe test: apply product to CDX plywood; pound in nails; submerge in cold water
- Products that pass cite D1970
- Products that don’t pass cite... Nothing
39°F, 3 days

5” Water

Specimen

Leak?
Nail Sealability Testing
## Nail Sealability Testing

<table>
<thead>
<tr>
<th>ASTM Standard</th>
<th>Products Tested</th>
<th>Pass</th>
<th>Fail</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1970 Until 2014</td>
<td>9</td>
<td>0</td>
<td>9</td>
<td>0%</td>
</tr>
<tr>
<td>D7349 From 2015</td>
<td>18</td>
<td>5</td>
<td>13</td>
<td>28% 72%</td>
</tr>
</tbody>
</table>
Durability Phase 2: Factors Before Cladding

- Crack-Bridging Ability
- UV Resistance
Crack-Bridging Ability

The graph illustrates the relationship between dry film thickness (mils) and crack width at rupture (inches). Different symbols represent different products, with each symbol color indicating a specific product type.
One inescapable conclusion:
Thicker is better
Cladding (siding)
Cladding Tests

• Cladding installed at max. recommended exposure time
• Only 1 published time for all seasons and locations
• Clad only upper half, to see how exposure degrades unclad WRB
• Removable cladding, to observe concealed WRB portion
• How durable is this WRB?
• This is a concealed, permanent component
Durability Phase 3: Factors After Cladding

- Continued UV degradation
- Heat resistance
- Water resistance
- Abrasion
- Cutting
- Organic growth (mold)
Cladding Removal

- Cladding removed after 1 year
- Could not remove from 3 panels
- Mechanical damage at 3 others
- WRB washed away at 1 other
- Weathering damage observed
Cutting

Abrasion

Cutting
Real materials are thicker than CAD lines
Metal Coping: not water tight
Do not remove cladding from 3 parts (fused)
No. 15 Non-Spec.
Peel-and-Stick Go-Wrongs

- Wrinkles and “fishmouths”
- Long-term edge adhesion
- Sag
- Facer curls, especially in heat
- Memory / rebound from rolling
- Shrinkage
- Low tack when cold
Key Point: Seal every edge and seam of self-adhered flashing.
Tapes and Flashings: Testing
Tape Adhesion Testing

- Industry standard: tension
- 16 psi desired adhesive strength
  - Based on cohesive strength of expanding urethane foam air seal
- Tension gives highest test values
  - Doesn’t represent service condition
  - Misleading value
  - Everything passes
Tape Adhesion Testing

• Could use torsion

• 2nd highest test numbers
  – Doesn’t represent service condition
Tape Adhesion Testing

- We use shear
- Lowest test values
- Realistic
- Discriminates (not all pass, fail)
Tape Shear Tests

• Fairly quick test (30 days max.)
• Large number of specimen slots
• So can test many combinations
  – Tapes
  – Substrates
  – Temperature
  – Rollers
  – Primers
• Test minimum 3 replicates each
Acrylic Tape Testing

- Plywood
- OSB Smooth
- OSB Rough
- DensGlass
- Zip Sheathing

Time of Failure (days)

Acrylic Tapes

1 2 3 4 5 6 7 8 9 10 11 12 13
Butyl Tape Testing

- Plywood
- OSB Smooth
- OSB Rough
- DensGlass
Asphalt Tape Testing

- Plywood
- OSB Smooth
- OSB Rough
- DensGlass

Time of Failure (days)

Modified Asphalt Tapes
Long Specimen Tests

• Shear tests too short for some failure modes
  – Short time
  – Short length

• Also need to test long pieces for long time
WRB Summary

- **Installation Issues**
  - Instructions missing, wrong, or unrealistic
  - Coverage problems
- **Nail Sealability**
  - Most products fail test
- **Crack Bridging**
  - Problem for thin products
- **UV Resistance**
  - Some premature failure (before cladding)
  - Some continued degradation after cladding
- **Water Resistance**
  - Some fused
  - Some washed away
Durability vs. Economy

- Robust waterproofing
  - Premium products
  - Meticulous workmanship
- But at a cost
  - More $ per SF
  - Longer construction schedule
- How much do failures cost?
Thank You
Questions?

Building Diagnostics

“The Durability Experts”