The Enduring Mystery of Weather Resistive Barriers and the Need for Standards

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Interactive Resources

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What is a *Drainage Wall*?

- “A wall system in which the cladding provides a substantial barrier to water intrusion, but which also incorporates a means for dissipating water that may circumvent the cladding.”

ASTM E 2266
What is a drainage wall?

• “For the purpose of this standard, a drainage wall is assumed to incorporate a concealed weather-resistant barrier over which drainage, away from water-sensitive components of the wall, may occur. In addition to drainage behind the cladding, evaporation may play an important role in dissipating moisture in some types of cladding.”
What Is a *Weather Resistive Barrier* (WRB)?

- Component of a *drainage wall system*
- Secondary barrier to water penetration behind *cladding*
- Typically *neither exposed nor accessible*
- Usually *least durable* wall component but must perform for *life of building*
- May be *sheets, panels* or *liquid applied*
- Penetrating water escapes by *gravity* or *evaporation*
What is the Function of a WRB?
WRB Terms in Common Use and Misuse

- Building paper
- Tarpaper
- Felt
- House wrap
- Building wrap
- Sheathing membrane
- Underlay for wall
- Weather resistant barrier
- Sheathing paper
- Weather barrier
- Vapor barrier
- Water barrier
- Moisture barrier
- Underlayment
- Weather resistive barrier
- Water resistive barrier
Representative Code Terminology

- *Weather resistive barrier* (CBC, NFPA 5000)
- *Water resistive barrier* (IBC)
- *Weather resistant sheathing paper* (IRC)
- *Wall Sheathing Paper and Sheathing, membrane, Breather-Type* (NBCC)
- *Underlay for wall* (EU)
California Building Code - CBC
(based on 1997 UBC) Terminology

weather resistive barrier

- **1402.1:** Such [weather resistive barrier] shall be equal to that provided for in UBC Standard 14-1 for kraft waterproof building paper or asphalt saturated rag felt.
IBC Terminology

\textit{water-resistive barrier}

- **IBC 1404.2**: No. 15 asphalt felt, complying with ASTM D 226 for Type 1 felt, shall be attached to the sheathing, with flashing as described in Section 1405.3, in such a manner as to provide a continuous \textit{water-resistive barrier} behind the exterior wall veneer.
IRC Terminology

weather-resistant sheathing paper

- R703.2 Weather-resistant sheathing paper. Asphalt-saturated felt free from holes and breaks weighing not less than 14 pounds per 100 square feet (0.683 kg/m²) and complying with ASTM D 226 or other approved weather-resistant material …
NBCC Terminology

- Section 9.23.17 *Wall Sheathing paper*
- CGSB CAN/CGSB-51.32-M77: *Sheathing, Membrane, Breather Type* - ... intended for use on the outside of heated buildings under the external finish, as a secondary protective covering against the entry of wind and moisture ...
Types of Flexible Sheet Barriers

- Asphalt saturated organic felt
- Asphalt saturated kraft paper
- Polymer sheets (polyolefin fibers or extruded polyethylene films)
Other Types of WRBs

- Board products (i.e., foam core board)
- Liquid or trowel applied products
Asphalt Saturated Felt
Asphalt Saturated Kraft Paper
Felt and Paper Microscopy

Asphalt Saturated felt

Asphalt Saturated Building Paper

Courtesy Fortifiber
Polymeric Sheet
Performance Properties

- Water resistance (long and short term)
- Water vapor permeance
- Air resistance
- Durability (before and after cladding)
- Compatibility with other materials
- Cost of material and labor
- Installation issues
State of the Industry

- Inadequate and irrelevant code requirements
- Evolving product choices
- Inconsistent and conflicting product claims by manufacturers
- Increasing liability and insurance costs
- Decreasing insurance availability
- No optimum product
Selection Challenges

- Reliable comparable performance data of generic and proprietary products not available
- Performance objectives unclear to designers and builders
- Inconsistent, confusing and incomplete code requirements
- Improper reference to and use of standards by manufacturers in product literature
The Stucco Exception - *IBC*

- *IBC*2510.6: Weather-resistant barriers. Weather-resistant barriers shall be installed as required in Section 1404.2 and, where applied over wood-based sheathing, shall include a weather-resistant vapor-permeable barrier with a performance at least equivalent to two layers of Grade D paper. Some building officials interpret “equivalency” as comparable water resistance, while others interpret it as comparable permeance.
The Stucco Exception - *CBC*

- *CBC* 2506.04: “shall include two layers of Grade D paper” over wood based sheathing.
“This requirement is based on the observed problems where one layer of a typical Type 15 felt is applied over wood sheathing. The wood sheathing eventually exhibits dry rot because moisture penetrates to the sheathing. Cracking is created in the plaster due to movement of the sheathing caused by alternate expansion and contraction. Field experience has shown that where two layers of building paper are used, penetration of moisture to the sheathing is considerably decreased, as is the cracking of the plaster due to movement of the sheathing caused by wet and dry cycles. The Grade D paper is specified because it has the proper water vapor permeability to prevent entrapment of moisture between the paper and the sheathing.”
Penetration/Flashing Interface
WRB/Flashing Interface

- Felt and paper: Flashing prior to WRB installation (western U.S.)
- Polymer: Flashing after WRB installation (eastern U.S.)
Water Resistance Tests

- AATCC Test Method 127 (hydrostatic pressure test)
- CCMC Technical Guide for Sheathing, Membrane, Breather-Type, paragraph 6.4.5 (water ponding test)
Boat Test (water or vapor?)

- Water reacts with indicator dye on opposite side of sheet
- Based on Federal Specification UU-P-31b (March 3, 1949) incorporated into UU-B-790a (February 5, 1968)
- UBC Standard 14-1
Hydrostatic Pressure Test
(relevance to application performance?)

- Alternate test for polymeric materials (AC38)
- Measures pressure at which water is forced through a material by observation
- Resistance to liquid water usually varies inversely with water vapor permeance
Water Ponding Test

• Pass-fail test

• Cylindrical bowl of sample filled with 1 inch of water for two hours.

• Pass = no seepage observed below the sample
Comparable Water Resistance Using Code Required Tests

- AATC 127 - 1 layer (cm)
- AATC - 2 layers (cm)
- ASTM D779 (min)
- CCMC 07102 pass-fail (cm)

Bar chart showing water resistance comparison:
- D226 felt
- 60-Minute Paper
- Polymer Wrap
Water Resistance Under Pressure
(AATCC Method 127)

Water Resistance Under Pressure (Pa)

- Felt (1 layer)
- Felt (2 layer)
- Paper (1 layer)
- Paper 2 layers
- Polymer (1 layer)
- Polymer (2 layer)
- C20 Window
- C40 Window

C20 Window and C40 Window - too low to register
Vapor Permeance - ASTM E96 – Test Methods for Water Vapor Transmission of Materials

- Two basic methods (desiccant and water) and six variations (procedures A, B, BW, C, D and E)
- “Agreement should not be expected between results obtained by different methods” (E96)
Permeance is the accepted measure of vapor transmission of a building component acting as a vapor retarder.

Both AC38 and UBC Standard 14-1 use water vapor transmission (WVT)

NBCC uses permeance

Without additional information, permeance cannot be converted to WVT, or vice-versa
Asphalt Saturated Felt

- Treschel:
  - 5.6 perms using E96 Desiccant Method
  - 1.0 perms using E96 Water Method
Asphalt Saturated Kraft Paper
“Breather-Type Sheathing Paper”

- CMHC Wood Frame Envelopes in Coastal Climate of British Columbia: 2.96 to 24.39 perms
“Permeance” of Polymer WRBs

Courtesy Fortifiber
Permeance varies with humidity, temperature, vapor pressure and moisture content.

Vapor Permeance and Humidity

Vapor Transmission vs %Rh
Isothermal at 70 deg F

Uncorrected Experimental Data
Actual Permeance + 50%

Fortifiber Corporation
Confidential Information

Fred Baker - April 12, 2004
Code Requirements for Permeance

- **CBC:** Average WVT for asphalt saturated kraft paper = minimum 35 g/m²·24h
- **CBC/IBC/IRC – AC38:** Average WVT (E96 Desiccant Method) for polymer (AC38) = g/m²·24h maximum 4 for Grade A, maximum 6 for Grade B and minimum 35 for Grade D.
- **NBCC:** New: perms ≥ 170 ng/(Pa·s m²) and ≤ 1400 ng/(Pa·s m²) and Aged: ≥ 2900 ng/(Pa·s m²)
Potential Advantages of Asphalt Saturated Felt

- Long history of successful use under normal exposure conditions
- Conforms prescriptively to most codes
- Low material cost
- Long-term durability may be superior to paper-based WRBs (more asphalt)
- Best “boat test” performance
Potential Disadvantages of Asphalt Saturated Felt

- Minimal performance data available for use as WRB
- Comparatively low permeance
- Low resistance to breaking and tearing
- Vulnerable to deterioration after long-term exposure to water, especially when combined with UV
- Surfactant exposure may degrade water resistance
- May not be code-compliant for stucco over wood-based sheathing
Potential Advantages of Asphalt Saturated Kraft Paper

- Long history of successful use under normal exposure conditions
- Prescriptively conforms to most codes – including for stucco over wood-based sheathing
- Low material cost
- More performance data available than for felt
- Better resistance to bending damage than felt, but tears easily
- Comparatively higher permeance than felt
- Small pore size, dense matrix
Potential Disadvantages of Asphalt Saturated Kraft Paper

- Low resistance to tearing
- Decomposes after long-term exposure to water, especially when combined with UV
- Surfactant exposure may degrade water resistance
- Less asphalt compared to felt-based WRBs
Potential Advantages of Polymeric Sheets

- High resistance to tearing and breaking
- Large sheets with fewer lap joints
- Remains durable after long-term water exposure
- Air barrier functionality
- High water vapor permeance
- High resistance to water under pressure
Potential Disadvantages of Polymeric Sheets

- Relatively expensive material cost
- UV sensitivity
- Sensitivity to surfactants
- Adhesion to cement plaster (stucco) may affect water resistance
- May retain liquid water in wall cavities
Continuing Debate

• Should air barriers always be water vapor permeable?
• Should WRBs be vapor permeable?
• Can any WRB also be an air barrier?
• What penetration flashing techniques and materials provide the best interface and compatibility with specific WRBs?
Conclusions

• All three common sheet WRBs used in North America have a history of satisfactory performance under normal conditions and proper use.

• Codes and standards pertaining to WRBs are inconsistent and possibly irrelevant.

• Little reliable information available to compare performance properties of WRBs.
Hot Tips

• Two layers of WRB provide better drainage than one layer behind all claddings, not just stucco.
• Natural drainage channels are created behind stucco when paper/felt WRB is wetted then dries.
• Proper installation and integration with flashings are critically important performance factors.
Critical Needs

• Building models that test and monitor WRB properties in conditions that replicate actual service

• Test methods that provide performance data pertinent to service requirements

• Consistent code requirements and standards

• WRB’s designed around performance requirements
Who is Working on It?

- ASTM Task Group E06.55.04 Weather Resistance of Frame Buildings
- ASTM Task Group E06.55.07 Weather Resistive Barriers
- ASTM Task Group E06.22.09 Durability of Weather Resistive Barriers
- ASTM Subcommittee E.06.41 Air Leakage and Ventilation Performance
- ASTM E 06.51.11 Fenestration Installation Task Group
- AAMA Self-Adhering Flashing Group
- BETEC/NIBS