

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

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Interactive Resources

WESTCON ASTM E 2266 Seminar
June 23, 2005

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-resistive 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

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 *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)

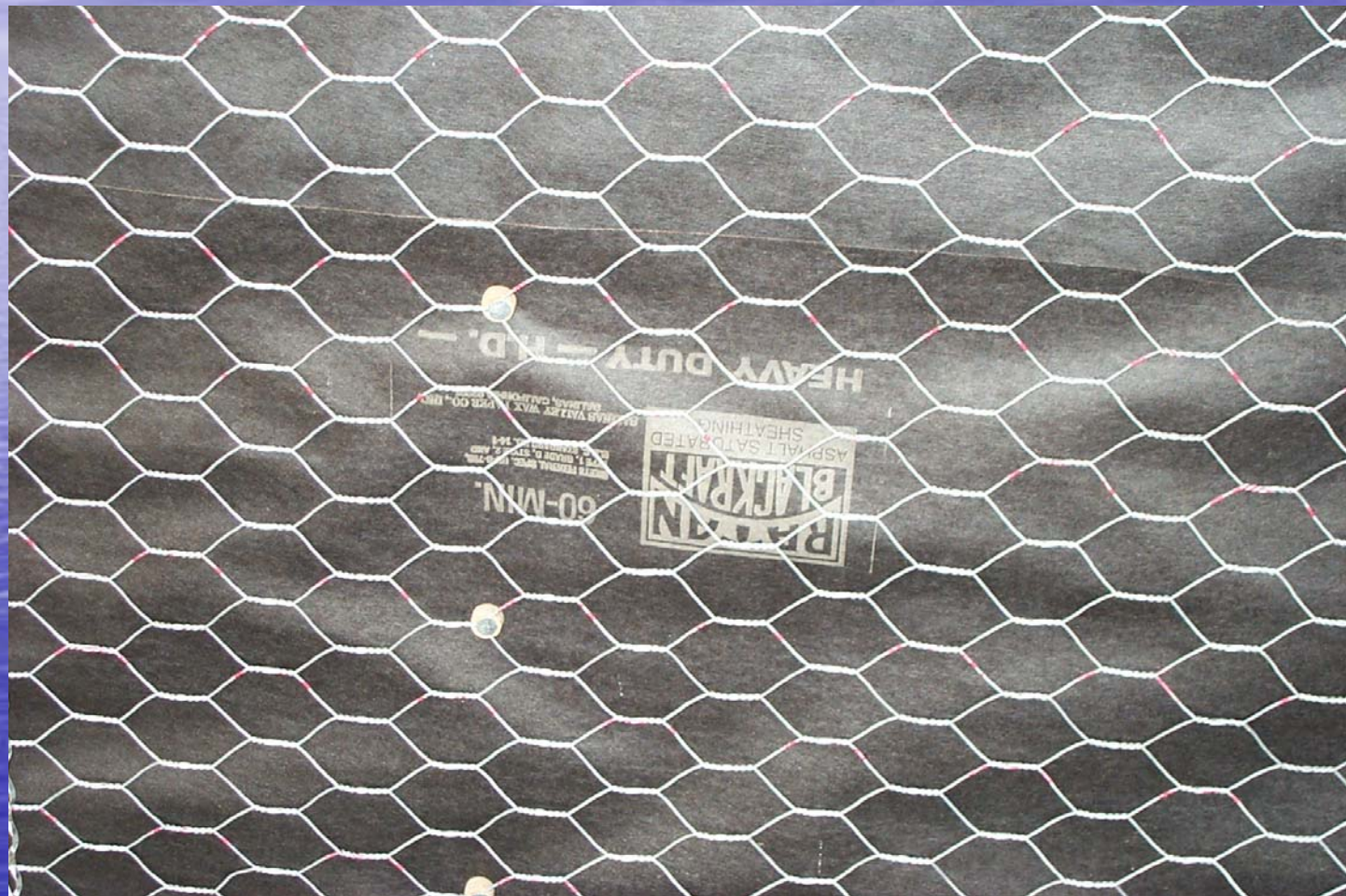
Other Types of WRBs

- Board products (i.e., foam core board)
- Liquid or trowel applied products

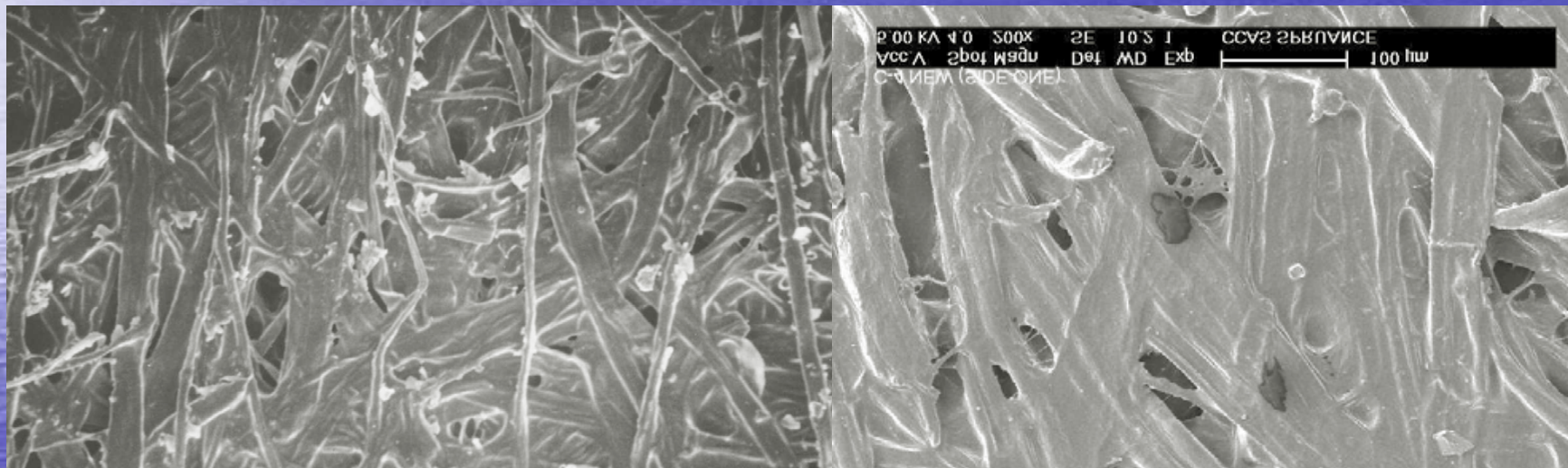
Asphalt Saturated Felt



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.

1997 *UBC Handbook*

- “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)
- ASTM D779 – Water Resistance of Paper, Paperboard and Other Sheet materials by the Dry Indicator Method (boat 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
- ASTM D779 Test Method for Water Resistance of Paper, paperboard and Other Sheet Materials by the Dry Indicator Method

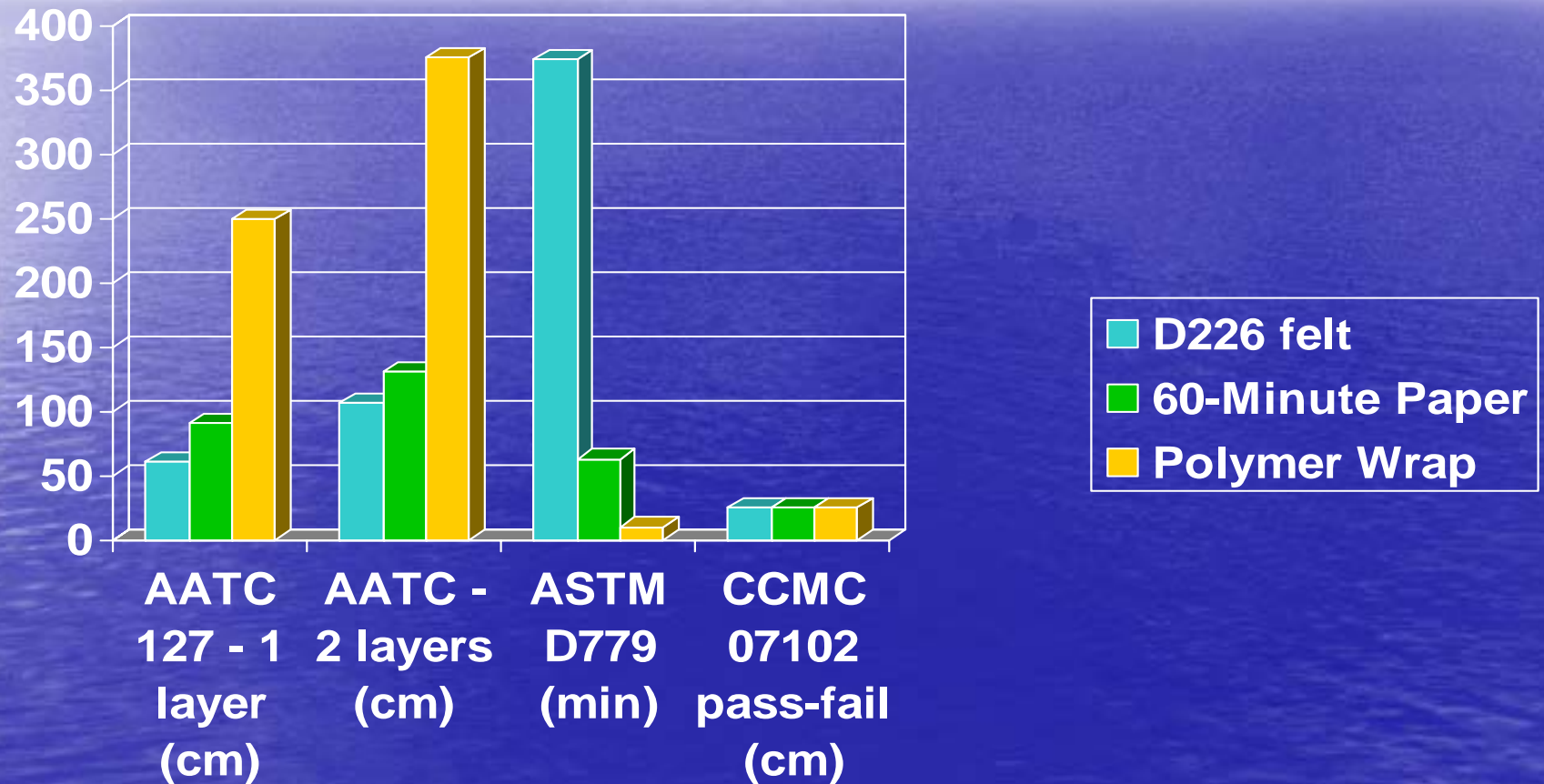
Hydrostatic Pressure Test (relevance to application performance?)

- 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

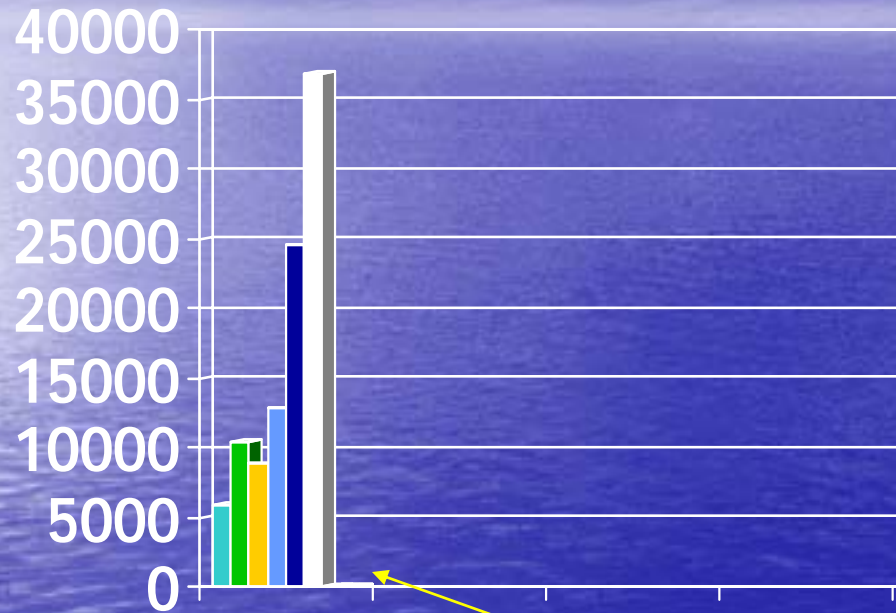
Water Ponding Test

- 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



Water Resistance Under Pressure (AATCC Method 127)



Water
Resistance
Under
Pressure
(Pa)

**C20 Window
and C40
Window – too
low to register**

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

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)

E96 Vapor Transmission Terms

- Permeance is the accepted measure of vapor transmission of a building component acting as a vapor retarder.
- Both AC308 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

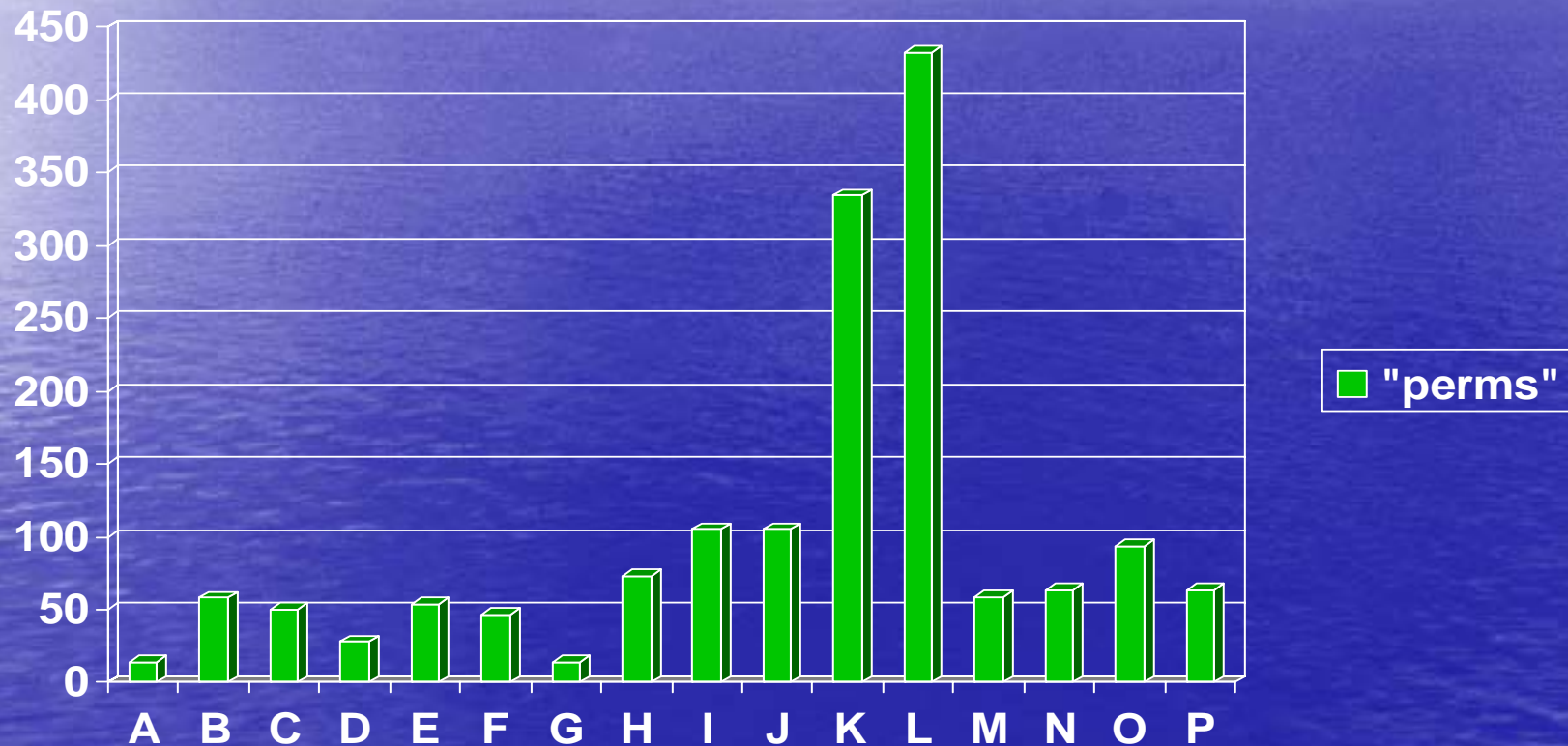
Asphalt Saturated Felt

- 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

Challenge of a Hypothetical Service Condition

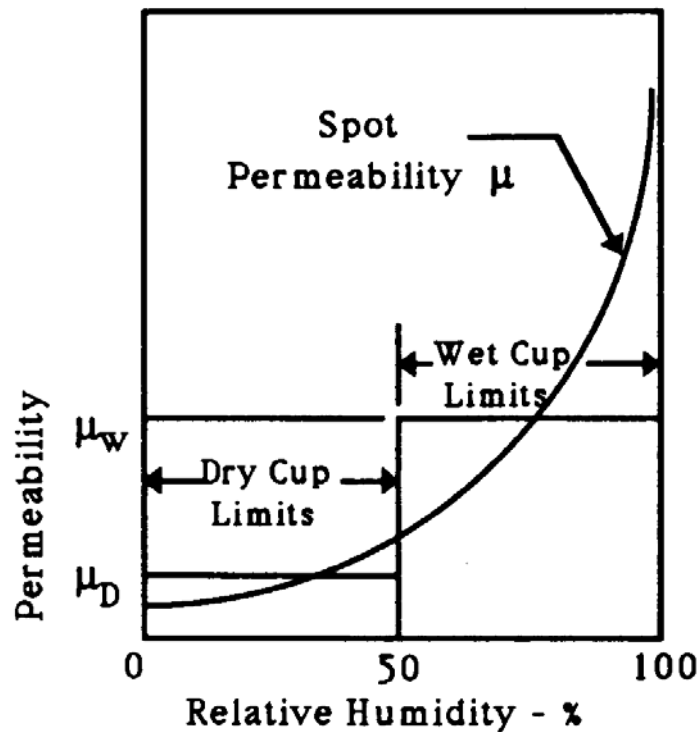


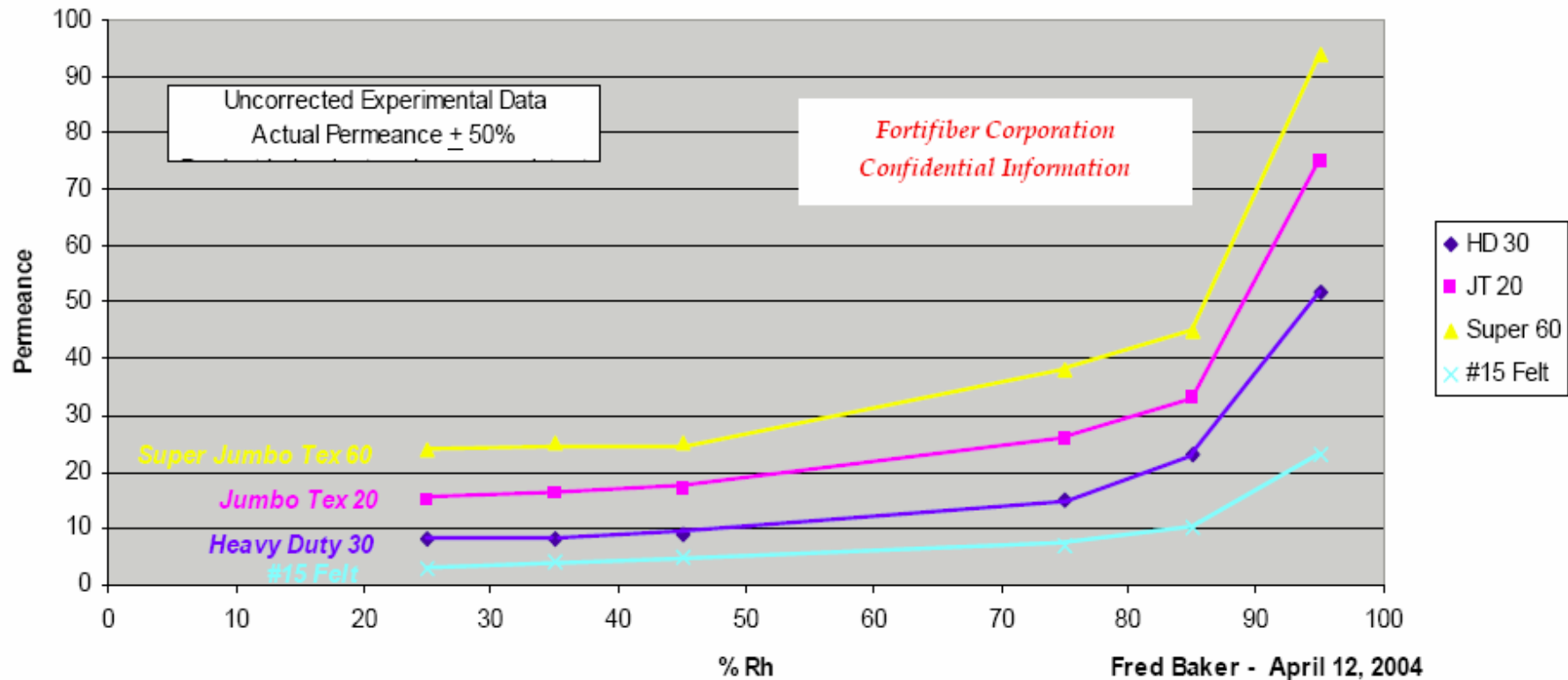
FIG. 1—Typical relationship between dry- and wet-cup methods and spot permeability for many building materials (schematic representation).

Permeance varies
With humidity,
temperature, vapor
pressure and
moisture content

Ronald P. Tye, "Relevant Moisture Properties of Building Construction Materials," *Moisture Control in Buildings*, ed., Heinz R. Trechsel (Philadelphia: American Society for Testing and Materials, 1994) 41-46

Vapor Permeance and Humidity

Vapor Transmission vs %Rh
Isothermal at 70 deg F



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