

PHRC Webinar Series | Tuesday, December 9, 2014 @ 1pm

Fundamentals of Exterior Plaster and Manufactured Stone Veneer

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.





Description

- Exterior plaster systems such as stucco and manufactured stone veneer have been a part of the residential and commercial construction industries for decades. While their popularity may vary regionally, building codes that address these systems do not vary significantly between regions. This webinar will take a look at the impact that exterior plaster and adhered masonry veneer systems have on the current residential construction market as well as the changes that took place in order to get to that point. This analysis will take into consideration material properties of each system, the building physics that determines the performance of each system, as well as building code provisions that dictate the installation of each system.




Learning Objectives

- Identify changes that have occurred in the International Residential Code over the last decade and whether or not these changes have had an effect on building performance and health.
- Analyze material properties associated with exterior plaster and manufactured stone veneer systems and how their evolution has affected affordability and durability of these systems.
- Understand how accepted installation practices have changes with new code cycles and how above-code installation practices alter the durability and risk associated with each system.
- Examine past building envelope failures in order to understand how builders can mitigate risk, increase occupant safety, and reduce the need for repairs and / or tear offs.




Agenda

1. What is exterior plaster?
2. Why are we talking about exterior plaster?
3. What are current code requirements?
4. How have our assemblies changed?
5. What is a rainscreen?



What is *Exterior Plaster*?

- 2009 IRC
 - CEMENT PLASTER. A mixture of portland or blended cement, portland cement or blended cement and hydrated lime, masonry cement or plastic cement and aggregate and other *approved* materials as specified in this code.
- Traditional assembly:
 - Scratch coat
 - Brown coat
 - Finish coat



What is *Exterior Plaster*?



And *Manufactured Stone Veneer*?

- **2009 IRC**
 - **ADHERED STONE OR MASONRY VENEER.** Stone or masonry veneer secured and supported through the adhesion of an approved bonding material applied to an approved backing.
- **Traditional assembly:**
 - Scratch coat
 - Mortar & pointing mortar
 - Finish coat (adhered veneer)



And *Manufactured Stone Veneer*?



Why are we talking about *Exterior Plaster*?

- Moisture infiltration into exterior plaster and manufactured stone veneer wall assemblies and subsequent material and structural degradation has become a significant issue facing the construction industry, and has led to Joe Lstiburek of Building Science Corporation to label *Eastern Pennsylvania* the

“Stucco failure capital of the United States.”

“Stucco Woes: The Perfect Storm” - Joseph W. Lstiburek



What does *failure* mean?



Observed Patterns of EPMSV Failure

1. Penetrations
2. Water-resistive barriers (WRB's)
3. Flashing
4. Grading

Courtesy of William Dare (Spotlight Home Inspection, LLC)



1. Penetrations



Courtesy of William Dare (Spotlight Home Inspection, LLC)



1. Penetrations



Courtesy of William Dare (Spotlight Home Inspection, LLC)



1. Penetrations



Courtesy of William Dare (Spotlight Home Inspection, LLC)



2. Water-Resistive Barriers



Courtesy of William Dare (Spotlight Home Inspection, LLC)



3. Flashing



Courtesy of William Dare (Spotlight Home Inspection, LLC)



3. Flashing



Courtesy of William Dare (Spotlight Home Inspection, LLC)



3. Flashing



Courtesy of William Dare (Spotlight Home Inspection, LLC)



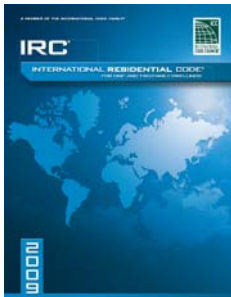
4. Grading



Courtesy of William Dare (Spotlight Home Inspection, LLC)




What are Current *Code Requirements*?



Water-Resistive Barriers


- **R703.2 Water-resistive barrier.**
 - One layer of No. 15 asphalt felt, free from holes and breaks, complying with ASTM D 226 for Type 1 felt or *other approved water-resistive barrier* shall be applied over studs or sheathing of all exterior walls.

D 226-06 Specification for Asphalt-saturated (Organic Felt) Used in Roofing and Waterproofing R703.2, R905.2.3, R905.3.3, R905.4.3, R905.5.3, R905.6.3, R905.7.3, R905.8.3, R905.8.4, Table R905.9.2



ASTM D226-06

- **Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing**
- **Type I – No. 15 asphalt felt**
- **Type II – No. 30 asphalt felt**




Exterior Plaster

- **R703.6 Exterior plaster.**
 - Installation of these materials shall be in compliance with ASTM C926 and ASTM C1063 and the provisions of this code.


C 926-04a (2000) Specification for Application of Portland Cement-based Plaster R702.2.2, R703.6, R703.6.2, R703.6.4

C 1063-06 Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-based Plaster R702.2.2, R703.6




Lath Fastening Schedule

- **2009 IRC R703.6.1**
 - Expanded metal or woven wire lath shall be attached with 1 1/2-inch-long (38 mm), 11 gage nails having a 7/16-inch (11.1 mm) head, or 7/8-inch-long (22.2 mm), 16 gage staples, spaced at *no more than 6 inches* (152 mm), or as otherwise *approved*.
- **ASTM C1063-06**
 - **7.10.2.1** - Lath shall be attached to framing members with attachments *spaced not more than 7 in.* (178 mm) on centers *along supports*.




Weep Screens

- **R703.6.2.1 Weep screeds.**
 - A minimum 0.019-inch (0.5 mm) (No. 26 galvanized sheet gage), corrosion-resistant weep screed or plastic weep screed, with a minimum vertical attachment flange of 3 1/2 inches (89 mm) shall be provided *at or below the foundation plate line* on exterior stud walls in accordance with ASTM C 926. The weep screed shall be placed a minimum of *4 inches (102 mm) above the earth* or 2 inches (51 mm) above paved areas and shall be of a type that will allow trapped water to drain to the exterior of the building. *The weather-resistant barrier shall lap the attachment flange.* The exterior lath shall cover and terminate on the attachment flange of the weep screed.



WRB in Exterior Plaster Assembly

- **R703.6.3 Water-resistant barriers.**
 - Water-resistant barriers shall be installed as required in Section R703.2 and, where applied over wood-based sheathing, shall include a water-resistant *vapor-permeable* barrier with a performance at least equivalent to *two layers of Grade D paper*.
 - **Exception:** Where the water-resistant barrier that is applied over wood-based sheathing has a water resistance equal to or greater than that of 60 minute Grade D paper and is separated from the stucco by an *intervening, substantially non water-absorbing layer or designed drainage space*.



How have our Assemblies *Changed*?

- **Water resistive barriers**
 - Material properties
 - One layer vs. two
- **Plywood vs. OSB**
- **More insulation**



Water Resistive Barriers




WRB Material Properties

- **Older building papers contained more cellulose and were more resistant to bond with scratch coat**
 - Building paper acted as drainage plane
- **Newer building papers, including plastic house wraps, weigh less and are more prone to bond development**



WRB Material Properties


- **No. 15 / No. 30 felt**
 - ASTM D226
- **Grade D building paper**
 - UU-B-790
- **Plastic house wraps**
 - ES Reports (“other approved water resistive barrier”)



WRB Material Properties - Felt

- **Asphalt Felt**
 - Used to be identified by weight (15-pound felt = 15 pounds / 100 SF)
 - Modern felts weigh between 7-14 pounds / 100 SF
- **ASTM D226 weight requirements:**
 - No. 15 felt = 11.5 pounds / 100 SF
 - No. 30 felt = 23 pounds / 100 SF


All About Water-Resistive Barriers. GreenBuildingAdvisor.com



WRB Material Properties – Grade D

- **Asphalt-Impregnated Kraft Paper**
 - Uses lighter weight paper than asphalt felt
- **Grade D comes from 1968 Federal Standard UU-B-790**
 - “Federal Specification; Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellant and Fire Resistant)”
 - Grade D = Water-vapor permeable
- **Specified according to ASTM D779 Water Holdout test**
 - 20 / 30 / 60 minute...

All About Water-Resistive Barriers. GreenBuildingAdvisor.com



WRB Material Properties – Plastic


- **Polyolefin Fabric**
 - Polyethylene
 - Polypropylene
- **Two Categories:**
 - Perforated
 - Punched holes allow water vapor passage
 - Non-perforated
 - Allow water vapor to pass between fibers of plastic fabric

All About Water-Resistive Barriers. GreenBuildingAdvisor.com




WRB - Example

- **Tyvek ESR-2375**
 - HomeWrap, StuccoWrap, DrainWrap, etc.
 - “nonwoven, flash spunbonded, nonperforated, olefin sheets”
 - “...are used as *water-resistive barriers* on the exterior side of exterior walls of building of any construction type under the IBC and *construction permitted under the IRC*”
 - “They are equivalent to Grade D paper with a 60-minute water-resistance rating as described in IBC Section 2510.6 and *IRC Section R703.6.3*.”



WRB Material Properties

- **What can happen with a single layer of house wrap or building paper behind exterior plaster?**
 - Scratch coat can *bond to WRB*, reducing or eliminating its ability to function as a drainage plane
 - Drainage plane becomes next interior layer, typically exterior sheathing (OSB or plywood)



WRB Material Properties



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WRB Material Properties



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One Layer vs. Two

- **2003 International Residential Code**
 - **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 shall be applied over studs or sheathing of all exterior walls as required by Table R703.4. Such felt or material shall be applied horizontally, with the upper layer lapped over the lower layer not less than 2 inches (51 mm). Where joints occur, felt shall be lapped not less than 6 inches (152 mm).
 - *No requirement of two layers*

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One Layer vs. Two

- **2006 International Residential Code**
 - **R703.6.3 Water-resistive barriers.**
 - Water-resistive barriers shall be installed as required in Section R703.2 and, where applied over wood-based sheathing, shall include a water-resistive vapor-permeable barrier with a performance at least equivalent to *two layers of Grade D paper.*
 - WRB in contact with scratch coat becomes *sacrificial layer*




Plywood vs. OSB



Exterior Sheathing Materials

- **Plywood** (Source: APA)
 - First patent for plywood issued in 1865
 - Manufacturing began in Portland, OR in 1907
 - Promoted as commodity product in 1930's and 40's by Douglas Fir Plywood Association
- **Oriented Strand Board** (Source: OSBGuide)
 - Introduced in 1978
 - Became competitive in 1990's
 - Gained 60% of market share by 2006



Exterior Sheathing Materials

- **Structural sheathing can provide safe storage capacity for seasonal moisture**
 - Seasonal moisture refers to interior water vapor condensing within wall cavities during winter, drying out in the summer
 - Moisture infiltration from rain events is **NOT** seasonal moisture



Plywood

- **Plywood is manufactured from thin sheets of cross-laminated veneer and bonded under heat and pressure with strong adhesives (APA)**
- **Commonly used wood species: Douglas fir, western larch and hem-fir**




Oriented Strand Board (OSB)

- **OSB is manufactured from waterproof heat-cured adhesives and rectangularly shaped wood strands that are arranged in cross-oriented layers (APA)**
- **Commonly used wood species: southern pine, lodgepole pine, and "aspen/poplar"**




Plywood vs. OSB

- No differentiation between plywood and OSB in 2009 International Residential Code
- Must meet minimum voluntary performance standards when tested for three basic performance qualities:
 - Strength and stiffness
 - Dimensional stability
 - Bond durability
- Once all three performance thresholds are met, the two products are considered equivalent




2009 IRC Definitions

- **WOOD STRUCTURAL PANEL.** A panel manufactured from veneers; or wood strands or wafers; bonded together with waterproof synthetic resins or other suitable bonding systems. Examples of wood structural panels are plywood, OSB or composite panels.




Plywood vs. OSB → Moisture

- Plywood and OSB are *hygroscopic* building materials
 - Materials will absorb or desorb moisture depending on moisture present in surrounding environment
- Plywood and OSB have comparable vapor permeance values at ambient conditions
 - As relative humidity (RH) increases, permeability increases
 - Vapor permeance for plywood increases at a significantly faster rate than for a similar OSB panel
- With high RH, moisture transport is *more efficient in plywood than in OSB*



OSB → Moisture

- OSB panels have (compared to plywood):
 - Greater resistance to moisture infiltration
 - Decreased ability to exfiltrate moisture from the panel
 - Increased tendency for moisture to move laterally within the panel
- In wet conditions, OSB will experience a *greater potential for structural deterioration over time*




Insulation



Thermal Insulation


- Primary objective is to slow the rate of heat loss through the building envelope
 - Slower rate of heat loss / gain = energy efficiency
 - More stringent building codes and changes in industry best practices have increased the amount of insulation in the building envelope
- Drying out of a wall assembly requires energy
 - With less energy flowing through a wall assembly, the likelihood of the wall drying once wet is decreased
 - Lower drying potential = Moisture sensitive



Conductive Heat Loss

- **$Q = U \times A \times \Delta T$**
 - Q = heat flow (Btu / hr)
 - U = thermal conductivity (U = 1 / R)
 - A = surface area (square feet)
 - ΔT = temperature difference across component ($^{\circ}F$)


$Q = U \times A \times \Delta T$



Conductive Heat Loss


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What is a *Rainscreen*?

- A rainscreen is a *system* that provides an air space within a wall assembly to promote drying of that assembly once wet
 - Accelerates the evaporation of undrained moisture behind exterior cladding
 - Helps to dry wall that accumulates moisture seasonally
- How big of an air space?
 - 1/4" to 3/4" w/ventilation openings at top and bottom of wall



What is a *Rainscreen*?

- Common rainscreen products / systems
 - Furring strips
 - Three-dimensional mesh
 - Wrinkled or modified house wraps?



What is a *Rainscreen*?



What might be a *Rainscreen*?



What is a *Rainscreen*?

- Rainscreen systems can be used for many different cladding types (siding, stucco, etc.)
 - Effective with “reservoir” type claddings
- Note: Rainscreen systems are *above code* options



Summary

- Code requirements addressing EP & MSV have changed significantly over the past 10 years
- Properties of materials used in EP & MSV assemblies have also changed, affecting assembly durability and performance
- Above code design / installation practices can reduce risk
- Continued EP & MSV wall failures will lead to further changes in code requirements and best practice