Building Science and the Code Moisture Control

Billy Hinton

Chuck Murray

Bill Warren

The Problem

- Moisture control in buildings can easily become a problem with modern buildings which may lead to mold, mildew, rot, and poor air quality.

Topics of Discussion

- The work of the NC Building Code Council Moisture Ad-Hoc Committee
- Summary of problem areas
- Actions being planned

- Moisture vapor retarders

NC Building Code Council Moisture Ad-Hoc Committee

- This committee was formed due to the increasing concern nationwide with moisture problems in buildings.
- Members of the NC Building Code Council, design professionals, code officials, and building scientists serve on this committee.

Summary of Conditions Leading to Problems

- Poor drainage away from foundations
- Inadequate flashing of windows and doors
- Conventional ventilation of crawl spaces in warm/hot humid climates
- Poor maintenance of the building envelope

Poor Drainage Away From Building Foundations

- Inadequate grade sloping away from the building foundation
- No gutters to direct water draining from the roof away from the building
- Underground irrigation installed next to the home for shrubs and flowers
  - Water ponding against the foundation wall
  - Crawl spaces that collect water

Inadequate Flashing of Windows and Doors

- Incorrect flashing methods or no flashing of windows, doors, or penetrations
  - Bulk water from storms enters into the building walls, roof, and foundation where weatherproofing is not continuous.
  - Wall cavities cannot dry if vapor retarders are present on both the interior and exterior of the wall.

Ventilated Crawl Spaces in Warm/Hot Humid Climates

- Summer air in a warm/hot humid climate is frequently moisture laden.
- The crawl space is generally coupled to the earth which tends to maintain a crawl space and exposed surfaces at a cool temperature.

Ventilated Crawl Spaces in Warm/Hot Humid Climates

- Moisture-laden air coming in contact with a cool/cold surface in a crawl space will result in condensation forming on the surface. (wetting)
- Mold must have four items to flourish:
  - Food,
  - Oxygen,
  - The right temperature (between 40 and 100 degrees F), and
  - Water.

Poor Maintenance of the Building Envelope

- Caulking and other sealants degrade over time.
  - Windows and doors must be periodically recaulked.
- Exterior siding and roofing must be maintained.
  - Paint and reroof as needed.

Actions Being Planned

- Prescriptive design for unvented crawl spaces to be added to the NC Building Code
  - Bill Warren's work effort
- Rethinking of current vapor retarder requirements
  - Additional modeling of specific wall types for vapor flow and drying potential due to bulk water leaking into the wall is needed.

Actions Being Planned

- Add improved guidance to the Building Code for weatherproofing and flashing.
  - Add reference to ASTM E 2112 Standard Practice for Installation of Exterior Windows, Doors, and Skylights.

Actions Being Planned

- Emphasize the need for draining storm water away from buildings to building contractors and code officials.
  - The code requires that the grade away from foundation walls shall fall a minimum of 6 inches within the first 10 feet.
    - (Reference IECC 2000, R401.3 Drainage.)

Actions Being Planned

- Increase minimum floor framing vertical clearance above grade from 12 inches to 18 inches.
- Increase thickness of flashing materials to increase longevity and reduce the potential of damage during construction.

Actions Being Planned

- A weather resistant membrane or asphalt saturated felt will be required over water repellent sheathing materials in walls of brick veneer or concrete masonry veneer.

Moisture Vapor Retarders

- What is a vapor retarder?
  - A material having a permeance rating of 1.0 or less when tested in accordance with ASTM E96.
- What is permeance?
  - A measure of resistance to vapor flow.
    - Water vapor is a gas.

Moisture Vapor Retarders

- Typical Permeance Values for Common Building Materials
  - 3/8” gypsum wall board 30
  - 4 mil polyethylene 0.08
  - Blanket thermal insulation back-up paper, asphalt coated 0.4

Moisture Vapor Retarders

- Typical Permeance Values for Common Building Materials
  - Commercial latex paint 5 to 8
  - Latex vapor retarder paint 0.45
  - ¼” plywood (interior glue) 1.9
  - ¼” plywood (exterior glue) 0.7

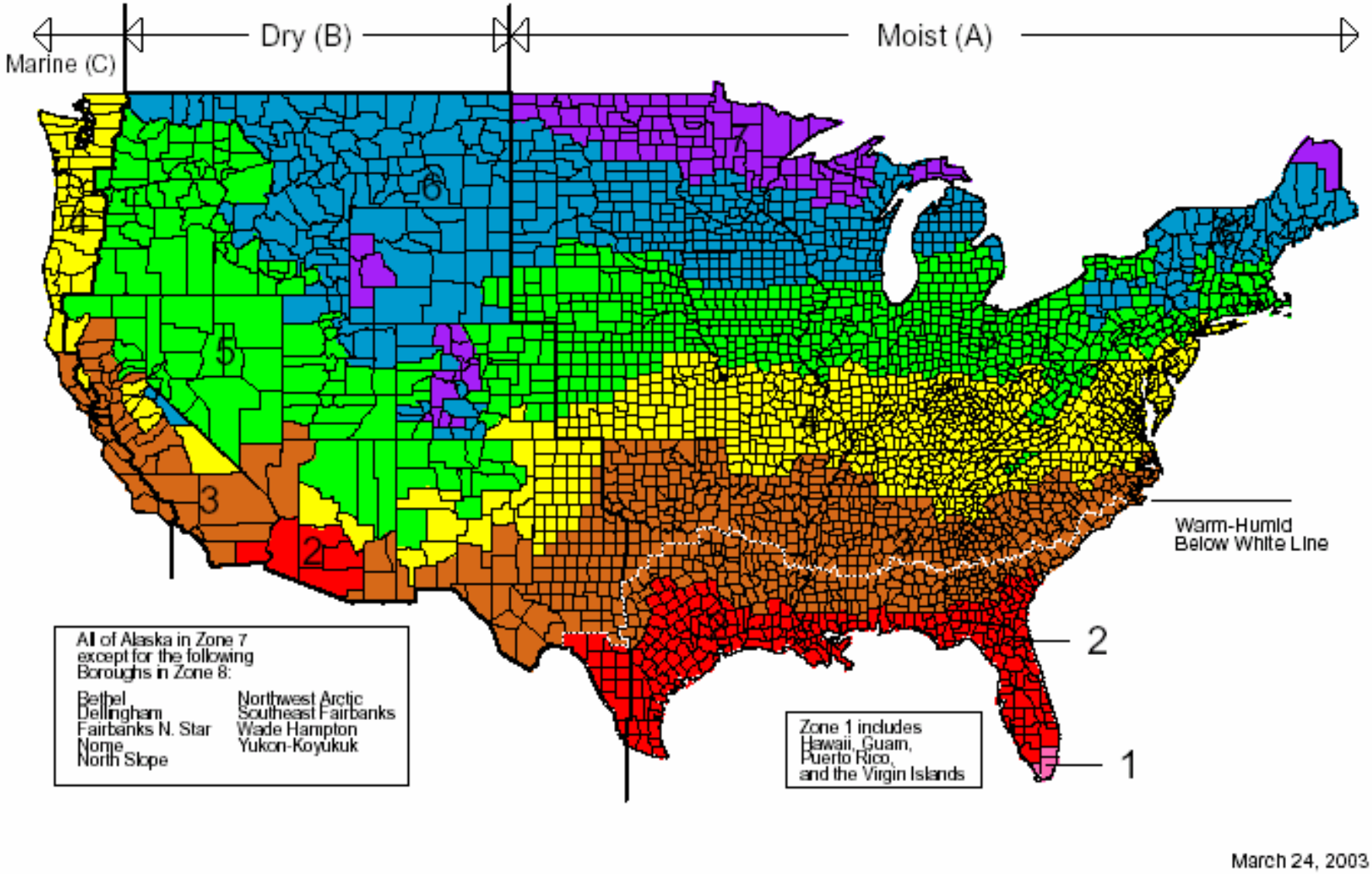
Moisture Vapor Retarders

- IRC 2000, Section 322.1 Moisture Control. In all framed walls, floors, and roof/ceilings comprising elements of the building thermal envelope, a vapor retarder shall be installed on the warm-in-winter side of the insulation.

Moisture Vapor Retarders

- IRC 2000, Section 322.1 Moisture Control.
- Exceptions:
- 1. In construction where moisture or freezing will not damage the materials.
- 2. Where the framed cavity or space is ventilated to allow moisture to escape.
- 3. In counties identified with footnote “a” in Table N1101.2.

Map of DOE's Proposed Climate Zones



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Vapor Flow Via Diffusion vs. Infiltration/Exfiltration

- Vapor flow through walls due to direct air leakage by infiltration and exfiltration is an order of magnitude greater than vapor flow by diffusion
  - Walls are not built air tight.
  - Walls are going to leak air.
  - Walls are going to leak water.

Vapor Retarders

- Many construction materials used today as exterior sheathing materials are effective vapor retarders.
- The code requires a vapor retarder on the warm-in-winter side of the insulation except in hot and humid climates.
  - Many walls then may have both an interior and an exterior vapor retarder.

Vapor Retarders

- A wall with interior and exterior vapor retarders effectively traps moisture in a wall cavity once bulk water leaks into the wall.
- Wall cavities must be allowed to dry if they become wet.
  - Otherwise, mold, mildew, and rot may occur.

Vapor Retarders

- The design of an exterior wall system should not include a vapor retarder on both the interior and exterior of the wall.
  - Cold climates – Install on the interior
  - Hot and Humid climates – Install on the exterior
  - Mixed Climates – Generally installed on the interior

Vapor Retarders - Crawlspace

- Crawl Space
  - The crawlspace floor “should” have a vapor retarder installed to slow ground moisture from evaporating into the crawlspace and evaporating condensing there.

Vapor Retarders - Crawlspace

- IRC 2000, Section 408.1 Ventilation. The under-floor space between the bottom of the floor joists and the earth under any building (except space occupied by a basement or cellar) shall be provided with ventilation openings through foundation walls or exterior walls. The minimum net area of ventilation openings shall not be less than one square foot for each 150 square feet of under-floor space. One such ventilation opening shall be within 3 feet of each corner of said building.

Vapor Retarders - Crawlspace

- IRC 2000, Section 408.1 Ventilation.
- Exceptions:
  - 1. Where warranted by climatic conditions, ventilation openings to the outdoors are not required if ventilation openings to the interior are provided.
  - 2. The total area of ventilation openings may be reduced to 1/1,500 of the under-floor area where the ground surface is treated with an approved vapor retarder material and the required openings are provided so as to provide cross-ventilation of the space. The installation of operable louvers shall not be prohibited.

Vapor Retarders - Crawlspace

- IRC 2000, Section 408.1 Ventilation.
- Exceptions:
  - 3. Under-floor spaces used as supply plenums for distribution of heated and cooled air shall comply with the requirements of Section M-1601.4.
  - 4. Ventilation openings are not required where continuously operated mechanical ventilation is provided at a rate of 1.0 cfm for each 50 square feet of under-floor space and the ground surface is covered with an approved vapor retarder material.

Vapor Retarders - Crawlspace

- IRC 2000, Section 408.1 Ventilation.
- Exceptions:
  - 5. Ventilation openings are not required where the ground surface is covered with an approved vapor retarder material, the space is supplied with conditioned air, and the perimeter walls are insulated in accordance with N1102.1.7.

Vapor Retarders - Slabs

- Concrete Slab on Grade
  - Homes built on a slab require a vapor retarder under the slab to slow ground moisture from evaporating into the home.

Vapor Retarders - Slabs

- IRC 2000, Section 506.2.3 Vapor Retarder. An approved vapor retarder with joints lapped not less than 6 inches shall be placed between the concrete floor slab and the base course or the prepared subgrade where no base course exist.

Vapor Retarders - Slabs

- IRC 2000, Section 506.2.3 Vapor Retarder.
- Exception: The vapor retarder may be omitted:
  - 1. From detached garages, utility buildings and other unheated accessory structures.
  - 2. From driveways, walks, patios, and other flatwork not likely to be enclosed and heated at a later date.
  - 3. Where approved by the building official, based on local site conditions.

Additional Information

- www.eere.energy.gov/consumerinfo/refbriefs/bd4.html
- www.buildingscience.com
- www.schs.state.nc.us/epi/oii/mold