Designing for

An updated HUD guide demonstrates that a durable house is also a dry house

BY JAY CRANDELL AND JAMIE LYONS

Have you Googled "housing durability" lately? Probably not. But you might be surprised that one of the most popular downloads on the U.S. Department of Housing and Urban Development's (HUD) website is a guide we were commissioned to write called *Durability by Design*. It's a collection of best design practices for housing durability from the ridge vent to the footings, and it covers moisture, UV radiation, corrosion, mechanicals, insects, and other topics. According to Dana Bres of HUD, who was instrumental in creating both the original guide and its recent update, one reason it's been so popular is that "the practices which make for good durability are often the same ones that make houses more sustainable and efficient. In searching for those details, builders and designers find us."

It struck us that the original 2002 publication is kind of like a time capsule that shows the building methods and materials commonly used in that era. "Era" makes it sound long ago, but homes really do work a lot differently today than they did a decade ago, and this affects durability. We've seen these changes along the way through our work in building consulting, training, research, inspections, and forensics, but updating this 12-year-old durability guide really put the changes into focus for us.

Here we highlight some of the most important topics in the new version of the guide. We hope you'll give the new guide a read and find it as interesting as we did in producing it. □

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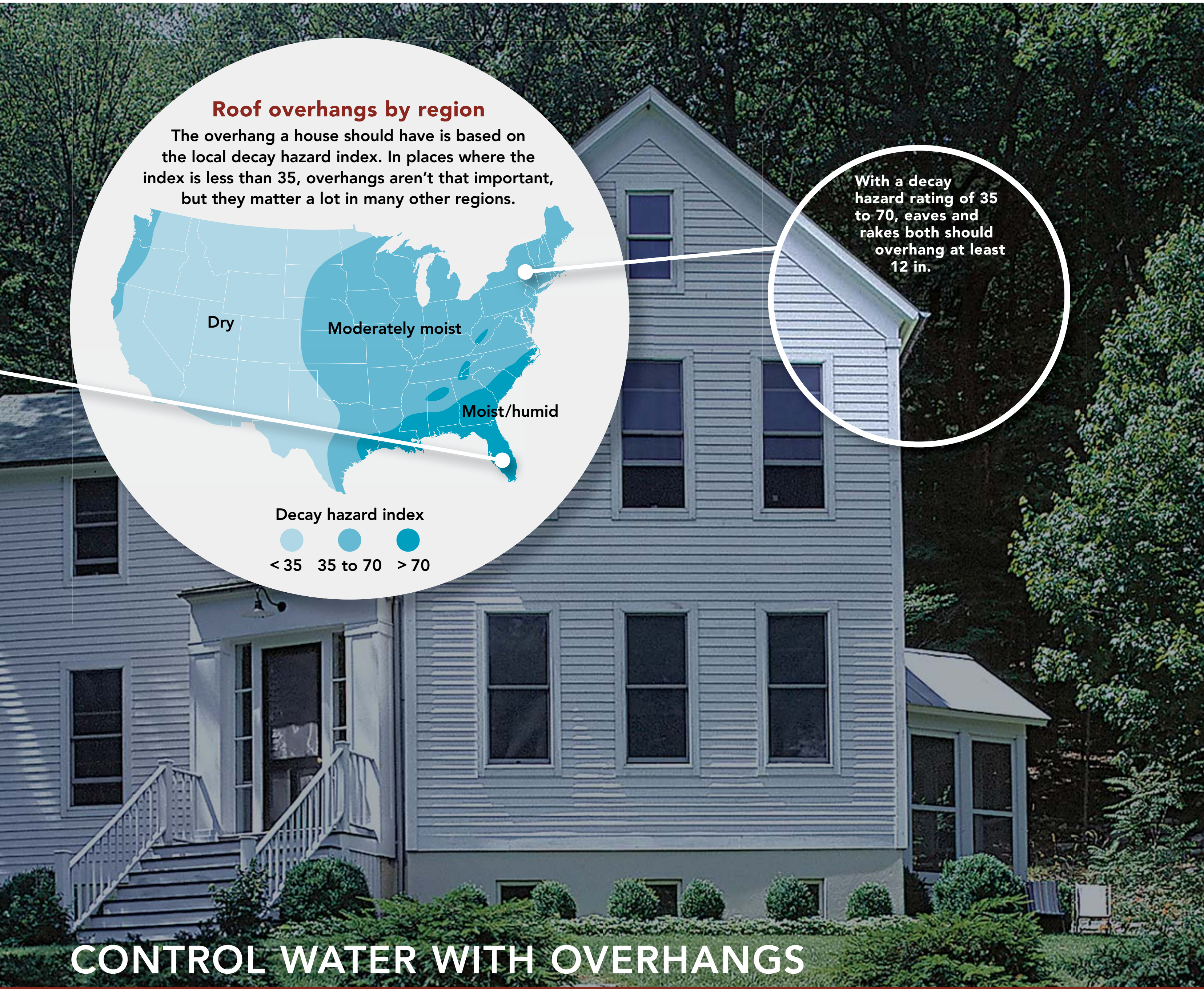
With a decay hazard rating over 70, eaves should overhang at least 24 in. and rakes at least 12 in.

ONLINE EXTRA To download a PDF of the new *Durability by Design* guide, visit newportpartnersllc.com.

Photo this page: Sara Cook. Photo facing page: Ken Gutmaker.

Durability



Rainwater control has always topped the list of durability-fostering details. The improved insulation and air-sealing of today's exterior walls means that they have a greater sensitivity to moisture. Keeping rain from hitting walls, which is the job of roof overhangs, is more important than ever. In the revised guide, we place the important factors for rainwater management into a clear decision-making framework that includes recommendations for roof-overhang width based on risk of decay—which differs by region—as a way to reduce the risk of water intrusion in walls.

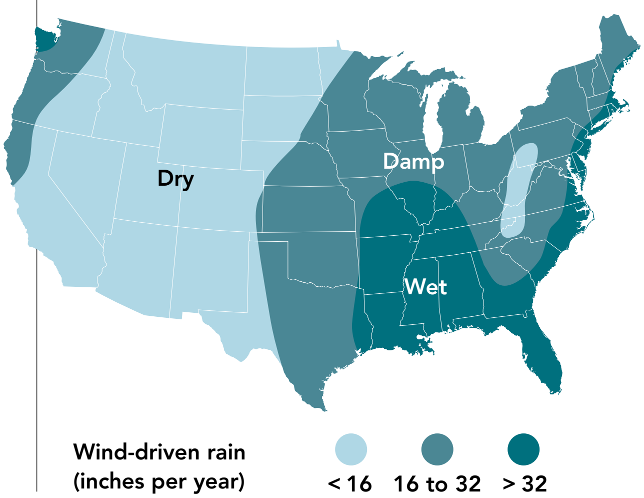
DESIGN WALLS BASED ON LOCAL RAINFALL

Although a wall's durability and performance depend on far more than its exterior cladding, the design and installation of that cladding and its underlayment are critical factors in protecting a building from rainwater and moisture accumulation. The revised guide lays out a three-step procedure for selecting a durable and climate-appropriate method of constructing exterior walls to ensure performance in specific climates.

STEP 1

ASSESS THE SITE'S CLIMATE

Begin by categorizing the climate based on the potential for wetting of walls, especially wetting from wind-driven rain. These classifications are a bit subjective, as there aren't clearly defined criteria in the United States for assessing the effects of wind-driven rain. As a proxy, we use a wind-driven-rain map in the revised guide to help classify the severity of the climate.



STEP 2

ASSESS BUILDING EXPOSURE

The terrain surrounding a building affects its exposure to wind-driven rain, as does the ratio of roof overhang to the height of the wall below. Increased shielding of the site against wind tends to reduce the effects of rain. Similarly, wide roof overhangs relative to wall height effectively reduce the exposure.

Reference the table at right to determine a building's exposure level based on the climate, the roof-overhang ratio, and the wind. The exposure level provides a basis for selecting an appropriate exterior-wall assembly. We can drill down further by applying the exposure levels in the table to specific walls of a house or even elements such as glazing. By understanding the exposure at this simplified level, a builder or designer can make decisions about flashing details or consider the benefits of using wider overhangs.

BUILDING EXPOSURE LEVELS

Wind exposure	Overhang ratio*	Site climate		
		Wet	Damp	Dry
Little or no wind protection from surrounding buildings and/ or natural obstructions	0	High	High	Moderate
	0.1	High	Moderate	Low
	0.2	Moderate	Low	Low
	0.3	Moderate	Low	Negligible
	0.4	Low	Low	Negligible
	≥ 0.5	Low	Negligible	Negligible
Wind protection from surrounding buildings and/ or natural obstructions	0	High	High	Moderate
	0.1	High	Moderate	Low
	0.2	Moderate	Low	Negligible
	0.3	Low	Negligible	Negligible
	0.4	Low	Negligible	Negligible
	≥ 0.5	Negligible	Negligible	Negligible

*Find the overhang ratio by dividing the roof overhang by the wall height.

Photo: Charles Bickford. Drawings facing page: Christopher Mills.

STEP 3

SELECT A WALL ASSEMBLY

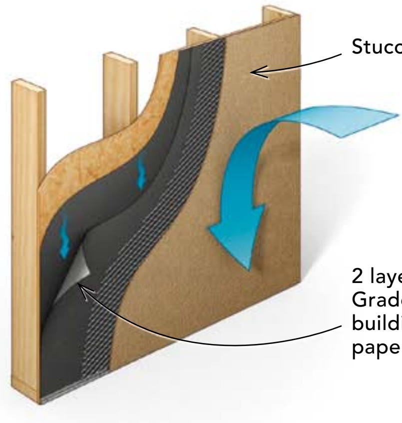
Based on the building exposure level determined in step 2, use the table at right to select an appropriate exterior-wall assembly. With a reasonable level of installation quality and maintenance, a wall rated "good" has a low risk of failure during its likely service life. A "fair" wall may require more careful attention to detailing, installation quality, and maintenance, and it has a tolerable risk of failure during the likely service life. "Not recommended" means that the wall shouldn't be used on a wood-framed house in that climate.

RELATIVE PERFORMANCE OF EXTERIOR-WALL ASSEMBLIES

Exposure level	Concealed barrier	Drained cavity	Basic rain screen
High	Not recommended	Fair	Good
Moderate	Fair	Good	Good
Low	Good	Good	Good
Negligible	Good	Good	Good

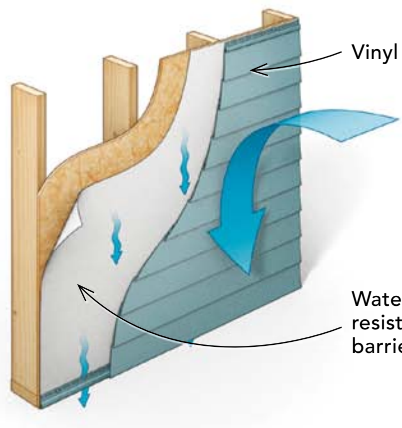
Concealed barrier

The concealed-barrier method relies on porous cladding material adhered to or placed directly on an internal water barrier or drainage plane. A common example is conventional stucco applied over two layers of Grade D building paper. This method relies primarily on deflection of rainwater, but it also has some ability to absorb and retain moisture, which can dry out later. These walls allow water to seep out through weeps at the bottom, but there is no open pathway to allow water to drain freely. Also, moisture stored in the cladding from a recent rain can be driven into the wall by the sun as vapor, especially when the wall uses a vapor-permeable water-resistive barrier (WRB) material such as building paper and many housewraps. Synthetic stone is another example of a concealed-barrier cladding.



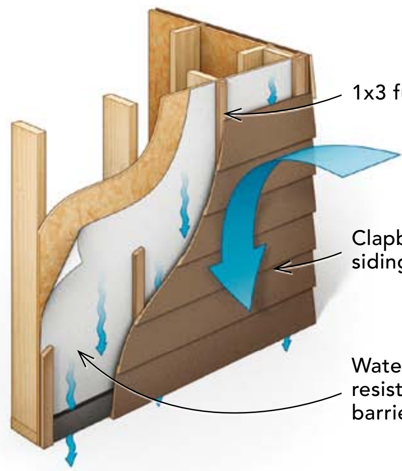
Drained cavity

Drained cavities increase the life of exterior finishes on wood surfaces by promoting drying. The method relies on deflection, drainage, and drying to protect the wall from moisture damage. In general, a cavity separates the cladding from the surface of the underlying WRB. A minimum cavity depth of ⅜ in. is often recommended, but this may vary. While wood siding might be nailed over spacers to create such cavities, vinyl siding placed directly on the WRB creates a cavity whose continuity is broken at points of contact, and masonry veneer is laid with a minimum 1-in. cavity depth to allow space for drainage as well as placement and mortar excesses. The drained-cavity approach also can be applied to portland-cement stucco with use of a drainage mat or metal lath placed over spacers to create the cavity.



Basic rain screen

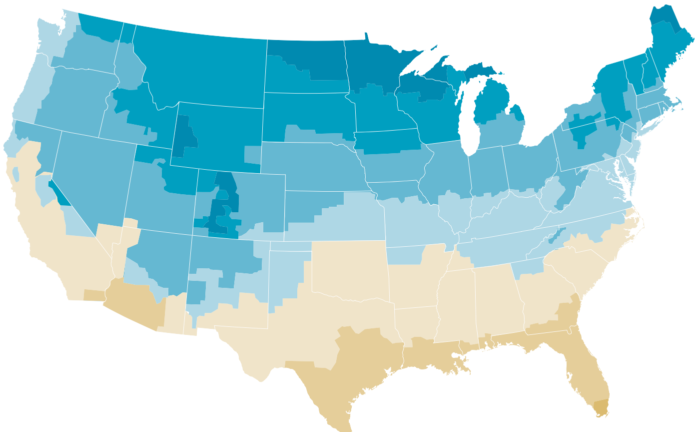
A rain screen is similar to the drained-cavity method, but it has added features to reduce air-pressure differentials across the cladding system that can occur during wind-driven rain. Pressure differentials can draw water into the drainage cavity. At a minimum, this approach uses a rigid air barrier such as sheathing behind the cladding that is able to resist wind pressures. This reduces wind pressure across the cladding (which is not airtight) and is less likely to result in water being sucked behind the cladding. Also, the cavity between the cladding and the water/air barrier must be compartmentalized by use of airtight blocking or furring at corners of the building. This feature prevents water from being sucked into the cavity due to a pressure difference on an adjacent wall. Although the rain-screen method offers improved performance, the simpler drained-cavity method is usually considered a more practical alternative for typical home-building applications.



INSULATE WALLS TO AVOID CONDENSATION

Preventing water vapor from condensing into liquid in walls is incredibly important for durability. Recently added to the International Energy Conservation Code (IECC), continuous rigid exterior insulation combined with traditional batt or blown cavity insulation is detailed as an option for many climate zones. This change can affect how moisture in walls behaves in ways that the code did not seem to anticipate.

We can prevent condensation in walls by keeping the interior of their sheathing from falling below the dew-point temperature. In the prescriptive wall assemblies, the continuous exterior insulation must hold enough heat in, or the cavity insulation must let enough heat through, to keep the sheathing interiors warmer than the dew point. Durability requires a climate-specific look at the ratio between the R-values of the exterior insulation and the cavity insulation, as well as the permeance of the vapor retarder.



Minimum insulation ratios for U.S. climate zones

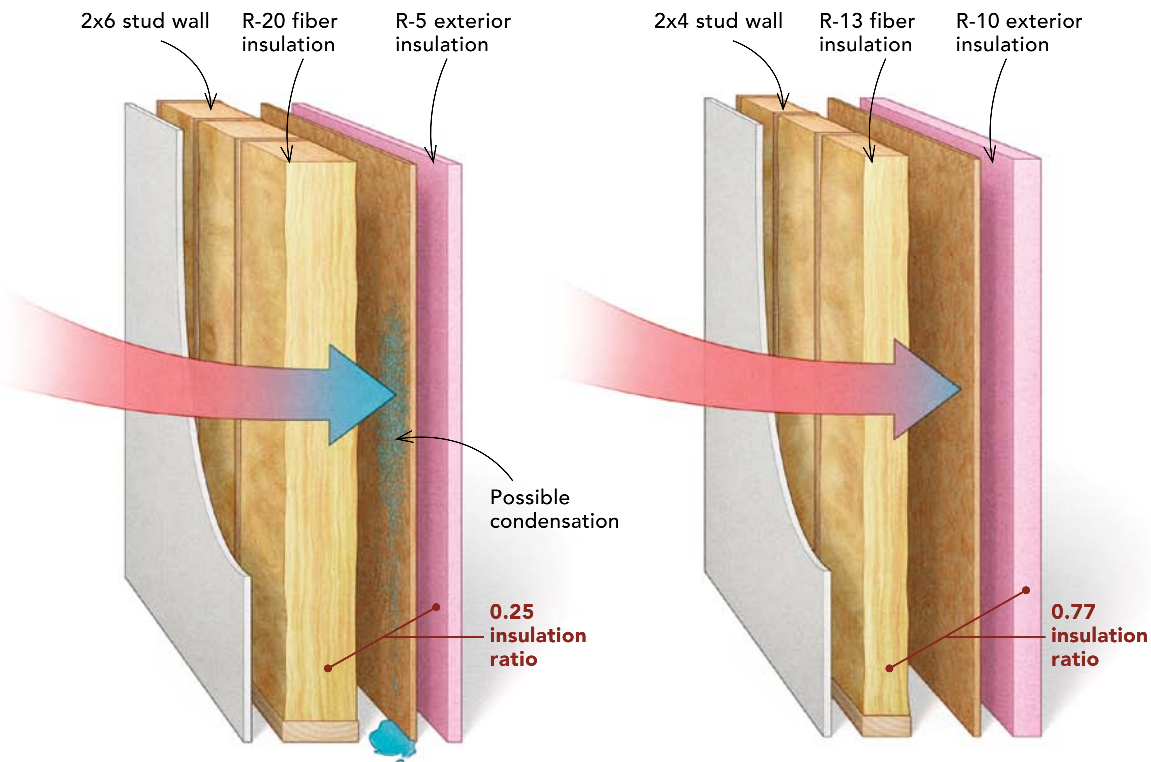
Climate zone	Class II interior vapor retarder	Class III interior vapor retarder
1 to 3	No limit	
4	0.2	
5	0.2	0.35
6	0.25	0.5
7	0.35	0.7

MATCH THE INSULATION TO THE VAPOR RETARDER

The insulation ratio is the R-value of the exterior insulation divided by that of the cavity insulation. For example, R-5 (1 in. rigid foam) ÷ R-20 (6 in. fiber insulation) = 0.25. Used with low-perm exterior foam insulation, Class I vapor retarders such as plastic can trap moisture. Class II (kraft-paper-faced batts) or Class III vapor retarders (many paints) allow drying to the inside. Using the map and the chart above, match the type of vapor retarder to the insulation ratio and the climate zone to avoid condensation.

THINK BEYOND THE BUILDING CODE

Both the walls below meet code, but one might have condensation in a cold climate. One option in the 2012 IECC for all climate zones is an R-20+5 wall. However, its insulation ratio of 0.25 can cause condensation in zones 5 and up if used with a Class III vapor retarder. The IECC considers an R-13+10 2x4 wall to be thermally equivalent to an R-20+5 wall. With an insulation ratio of 0.77, this wall should perform well up to zone 7 with a Class II or Class III vapor retarder.



Bottom drawings: Christopher Mills