

Crawlspaces

To avoid moisture problems, either condition or isolate the space

That Work

BY JUSTIN FINK

Years ago I was working with a builder on a job in New England where a small crawlspace foundation was being poured for an addition to an old house. The builder had set metal foundation vent openings into the foundation formwork, but told me that as soon as the building official did his final inspection he planned to seal the vents from the inside using rigid foam. Warm outdoor air, he explained, holds more moisture than cooler crawlspace air. When that humid outdoor air enters through the crawlspace vents, it condenses on the cool surfaces and can lead to rot, mold, and poor air quality.

Yet, according to a report published by the U.S. Department of Energy, builders and designers often stick to this failure-prone “vented crawlspace” approach because they believe the code doesn’t allow them to build an unvented one. Therein lies the confusion.

First, vented crawlspaces can work, as long as they’re detailed correctly—most aren’t. Second, the building code typically does not allow “unvented” crawlspaces, but it does allow the construction of sealed, “conditioned” crawlspaces. A successful crawlspace, from a moisture perspective, must be either part of the conditioned envelope of the house, or completely separated from it. Anything in between is a recipe for disaster.

Unvented? Say “conditioned”

As building scientist Joseph Lstiburek warns, the term “unvented” has led to a lot of crawlspace problems over the years. “Unvented implies that you just don’t install vents. Wrong. Big time wrong,” he wrote in a Building Science Corporation article. “There

has to be a means of removing moisture from the crawlspace when the crawlspace is connected to the house. ...Houses are ‘conditioned’ and conditioning means controlling temperature and relative humidity.”

The way to control temperature and relative humidity is to exchange crawlspace air with the living space above the crawlspace in some way instead of relying on air flowing through from the exterior. But in order to perform as intended, the crawlspace needs to be protected against moisture, insulated, and air-sealed to isolate the space from the exterior.

This is relatively easy in new construction, but can be difficult in retrofits. Approaches vary, but perhaps the most popular is to insulate with spray polyurethane foam or rigid foam board applied to the walls of the foundation (on the inside or outside face) as well as the rim board of the floor framing. The floor of the crawlspace doesn’t need to be insulated, but it must be covered with a continuous layer of at least 6-mil polyethylene sheeting sealed at all transitions and seams.

Risk is tied to region

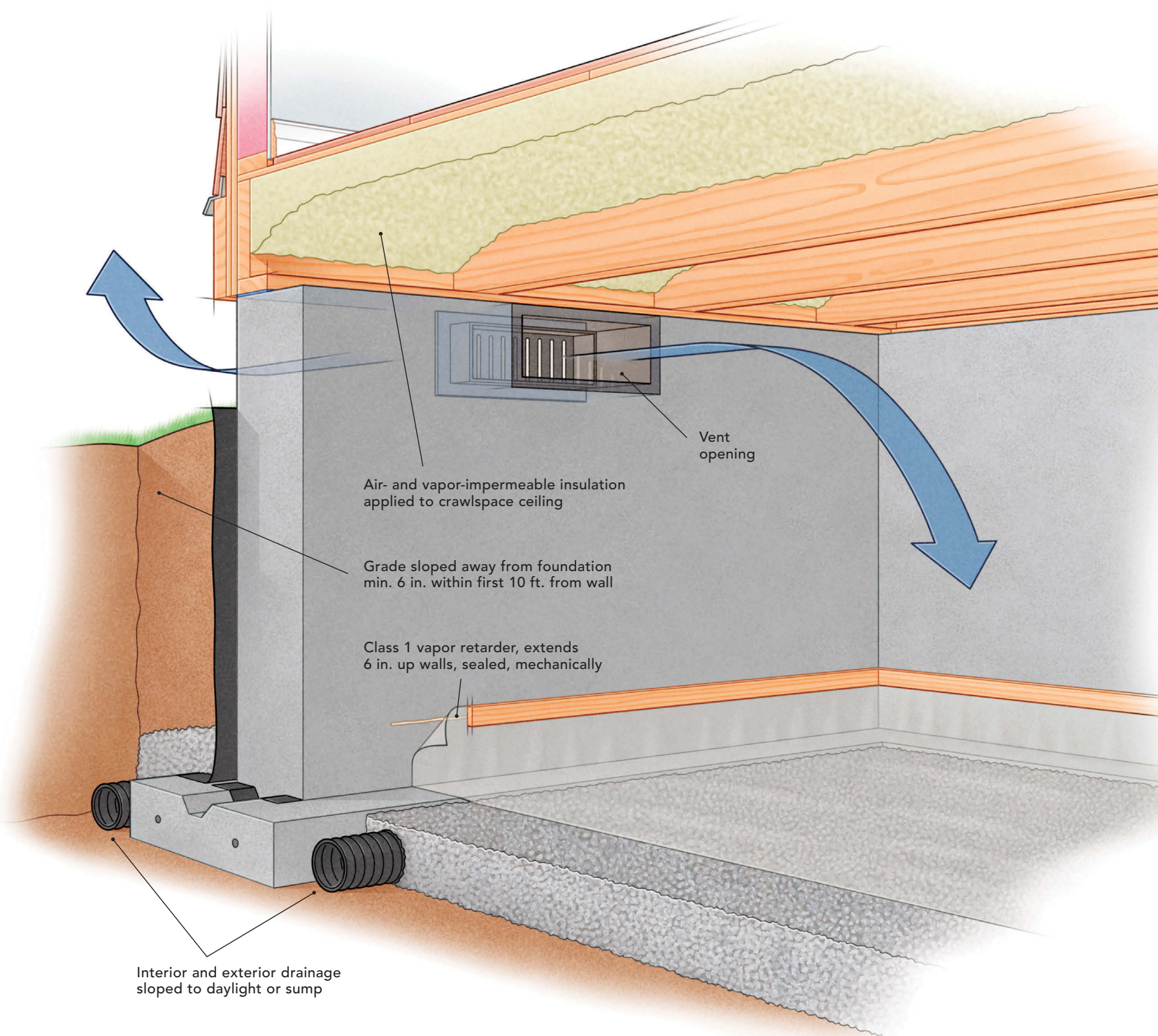
Declaring that all vented crawlspaces are dangerous is misleading. In fact, vented crawlspaces in arid climates tend to fare well all year long. This can also be true for regions where summers are hot and dry even if winters are cold and damp.

A study of crawlspace performance in marine and cold climates of the Pacific Northwest published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers in 2010 concluded, “The combination of relatively dry summers with low dew points (even in the marine climate) allows vented crawlspaces to perform adequately.” Over the 18 months they monitored the moisture content of framing facing the crawlspaces in their study, the authors found “moisture content was below 13% in all cases, well below the 20%+ level normally needed to induce mold or decay.” □

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A VENTED CRAWLSPACE CAN WORK IF DONE RIGHT

Although vented crawlspaces have earned a bad reputation over the years, they do have their place, particularly in flood-prone areas where a sealed approach won’t work or in very dry regions where it’s not necessary to condition the crawlspace. But many vented crawlspaces are doomed to fail from day one. Most include the use of fiberglass-batt insulation on the underside of the floor (the crawlspace ceiling) in an effort to separate the conditioned living space from the unconditioned space below. But fiberglass batts are air and



vapor permeable, so they do little to prevent humid crawlspace air from reaching the relatively cool framing lumber and sheathing of the floor. Moisture content in the lumber climbs, has little opportunity for drying—especially if the interior flooring is vapor impermeable—and rot sets in.

The key to a successful vented crawlspace is to treat the assembly as if the house is built on piers. Instead of fluffy insulation, choose air- and vapor-impermeable insulation such as rigid foam or spray polyurethane foam. If the humid air can't

reach the framing, you'll never have rot. Still, it's a good idea to install a Class 1 vapor retarder on the crawlspace floor, sealing all the seams and around the perimeter. Including the vapor retarder not only reduces the amount of moisture coming up from the ground, it also allows you to downsize the vent openings from the model-code-required minimum of 1 sq. ft. per 150 sq. ft. of crawlspace floor area when there is no vapor retarder to 1 sq. ft. per 1500 sq. ft., which can reduce the amount of moisture-laden air allowed into the space.

Grade sloped away from foundation min. 6 in. within first 10 ft. from wall

Air-sealed and insulated perimeter framing

Termite inspection gap (if not in a termite area, do not leave a gap)

Foam insulation

Floor register

Conditioned-air supply

INSIDE A SEALED AND CONDITIONED CRAWLSPACE

A safe, stable, happy crawlspace is one that is air-sealed, insulated, and included in the conditioned boundaries of the home. Whether building new or retrofitting, these are the details to get right.

Interior and exterior drainage sloped to daylight or sump

Min. 6-mil poly vapor retarder, sealed at seams and edges

WALL INSULATION

Sealed and conditioned crawlspaces should be insulated on their walls, and sometimes their floor, but not in the floor framing. Choose an insulation that isn't sensitive to water and effectively blocks the flow of air to prevent humid crawlspace air from coming into contact with the cool concrete surfaces.

Foam-insulation materials, either spray-applied or in board form, are ideal choices for this application. The greater the permeance of the insulation, the better it will allow for inward drying. Because vapor permeance varies by type of insulation, the thickness of the insulation will vary, too. According to research sponsored by the Building America program, the following insulation options and thicknesses meet the vapor-permeability requirements for the walls of a crawlspace:

- 2 in. of unfaced extruded polystyrene (XPS; R-10)
- 4 in. of unfaced expanded polystyrene (EPS; R-15)
- 3 in. of closed-cell spray polyurethane foam (R-18)
- 10 in. of open-cell spray polyurethane foam (R-35)

Be sure to check with your local building department to determine if your chosen insulation requires a layer of gypsum or equivalent fire-retarding layer to protect the foam, and that the R-value meets local energy-code requirements.

FLOOR COVERING

Generally speaking, crawlspace floors don't need to be insulated to perform well. They do require a vapor-diffusion-resistant groundcover, though, such as heavy-duty polyethylene sheeting carefully detailed around all piers and other obstructions and taped at all seams and boundaries. This poly sheeting, which serves as the vapor retarder and air barrier, should be at least 6 mil thick, but twice as thick or more is even better. Although not an easy task for a remodeling situation, best of all is to lay the poly, tape the seams, and then pour a thin layer of concrete over it and seal the perimeter and control joints to ensure it stays protected over the long haul.

If the floor of the crawlspace is below the level of the exterior grade, it's best to include a drainage system and slope the floor toward the drain or collection point, just like in a basement. As always, pitching the exterior grade away from the foundation is a must.

AIR "CONDITIONING"

To satisfy building-code requirements and eliminate moisture problems, the air in sealed and insulated crawlspaces must be conditioned. There are several methods to choose from, and all will work. The choice depends on budget, availability of a furnace or central air conditioner, desired energy use, and more.

Provide supply/return air

By connecting the crawlspace to the ductwork of a furnace or air-conditioning system, it's possible to condition the crawlspace air, removing moisture. If there are already ducts running through the crawlspace, this is an attractive solution, and likely the most common approach to a healthy crawlspace. This strategy works well for removing moisture as long as the heating and cooling equipment are sized properly for the house they're operating in. An oversize air-conditioning system, for example, can meet the temperature set point faster than it can actually remove excess humidity from the air. As a rule of thumb, Building Science Corporation (BSC) recommends that the air handler should run for at least 5 minutes per hour.

When using this supply-air approach, you need to deliver 50 cfm (cubic feet per meter) of airflow for each 1000 sq. ft. of underfloor area. You also need to provide a planned pathway for airflow between the living space and the crawlspace, such as a jump duct or transfer grille, to equalize pressure between the two spaces. BSC recommends a minimum of two 4-in. by 8-in. transfer grilles. Note that in order for this approach to succeed the crawlspace must be properly sealed and insulated.

Some argue that trying to condition the air in the crawlspace based on the conditions of the living space above can be trickier than it sounds, because the conditions are different.

Exhaust air to the exterior

If you don't have ductwork or an air handler, then exhaust-only crawlspace ventilation can be an attractive solution. The idea is to install a small fan in the crawlspace that exhausts to the exterior. Replacement air enters the crawlspace by way of grilles in the floor or through short ducts and grilles in partition walls, bringing conditioned air into the crawlspace.

According to BSC's Joseph Lstiburek, the exhaust-only approach works well for houses with moldy crawlspaces that are being retrofitted. "Sometimes there are limited funds available to completely decontaminate a moldy crawlspace," he wrote. "Continuously depressurizing the crawlspace relative to the house uncouples the crawlspace from the house. Of course the original moisture problem causing the crawlspace mold needs to be addressed. An exhaust fan does not solve ground water problems. But installing a ground cover, sealing crawlspace vents and running an exhaust fan to the exterior does address most other issues."

Add a dehumidifier

According to building scientist Allison Bailes III, choosing a dehumidifier to condition a sealed and insulated crawlspace is a no-brainer. "It's controlled by the conditions in the crawlspace, not the house above, so this method will do the best job of keeping the crawlspace dry," he wrote in a blog post. "If you want dry air in your crawlspace, a dehumidifier is the way to go." If you go with this approach, the IRC requires dehumidification sized to provide 70 pints of moisture removal per day for every 1000 sq. ft. of crawlspace area.

Bailes suggests that a standard off-the-shelf dehumidifier may be sufficient to keep a small crawlspace dry. For medium to large crawlspaces, it's best to go with a more robust model, like the ones made by Therma-Stor (see pp. 60-65).

