

BY TED CUSHMAN

A Crawlspace Moisture Mystery

There was a packed house at January's International Builders' Show (IBS) in Orlando, Fla., for a three-hour master class on building science titled, "How Do I Avoid This? Conquering Home Performance Errors Before and After Construction." Five speakers took turns at the podium digging into complex issues of moisture and energy in modern homes: nationally known building scientist Joseph Lstiburek; DOW Building Solutions expert Brian Lieburn; Vermont-based consultant Peter Yost; Austin, Texas, builder Matt Risinger (Risinger Homes); and Greenville, S.C., builder Todd Usher (Addison Homes).

Peter Yost (who described himself as "the Northern guy") opened the session by reciting this

basic principle: "Things get wet, and heat dries them out. Energy-efficiency measures reduce heat loss. So energy and moisture have to be managed with equal intensity."

With that opening summary, Yost neatly tied the rest of the lessons together. All of it was interesting. But for builders in the warm, humid Southeast, the most directly relevant portion may have been Todd Usher's story of the moisture problems his company encountered and overcame after they switched to building sealed (or "encapsulated") crawlspaces about a decade ago.

Raised floors over crawlspace foundations are typical in Usher's market, as they are in much of the Southeast and mid-Atlantic and also in

At right, a view of an Addison Homes "encapsulated" crawlspace, showing the company's current standard features: a 20-mil poly ground cover; 1.5-inch foil-faced insulation on the walls; and an "inspection strip" at the top of the block walls to allow termite inspections. The masonry-wall top is coated with waterproofing to prevent vapor intrusion.





During construction, the waterproofing crew applies a temporary ground cover (2) and applies waterproofing to the wall top and the tops of the interior masonry piers (2, 3). The waterproofing provides a capillary break that keeps moisture from escaping out of the foundation into the underfloor air.

parts of the Midwest. Traditionally, those foundations have been vented to the outdoors, with insulation installed as needed in the floor joist systems between the crawlspace and the occupied space above.

It's a time-honored practice. But common as they are, those traditional crawlspaces are a well-known source of moisture problems. They also waste energy. So starting with the 2003 and 2006 versions of the International Building Code (IBC) and the International Residential Code (IRC), local building officials have allowed unvented, conditioned crawlspaces, which bring the underfloor space, and any equipment or ductwork located there, within the climate-controlled envelope of the home (see "Building a Sealed Crawlspace," Oct/03, and "Fixing a Wet Crawlspace," Aug/04).

Seeing the opportunity to save energy while also managing moisture more effectively, Todd Usher, like many other builders, went ahead and made the switch. "The last vented crawlspace that Addison Homes built was nine years ago," Usher told the audience of builders at IBS. "Everything since then has been encapsulated and conditioned. Essentially, we're building a mini-basement. We install insulation on the interior of the crawlspace walls, and a 20-mil vapor barrier along the floor of the crawlspace and up the walls behind the insulation."

The change did save energy. But when it comes to moisture, as Usher learned, sealing up the crawlspace is no simple solution.

Damp surprises. "We aren't allowed to have power in the house until drywall is hung," Usher noted, "so we can't turn on the HVAC and start pulling moisture out of the house until it's almost finished." That's long after the crawlspace is capped by the floor system, trapping any ground moisture into the air beneath the house. "With one of our first sealed crawls, after we framed in the floor, we noticed there was a shower happening underneath the house," said Usher. "We had to go in and remediate some mildew."

Lesson learned: After that mishap, the company's routine has been to install a temporary sacrificial ground cover to keep moisture out before decking over the crawlspace, and to leave temporary vents to the outside open (see photo 4, facing page) to air out the space until the power is on, the HVAC is working, and the space can be conditioned. Once the air conditioner is operating, they seal up the vents and install a clean, permanent ground cover in the space.

"For this temporary purpose, we don't have to worry about the code-required number of vents," said Usher. "We just put in as many as we want. And ever since we started doing that, we haven't had that problem with moisture during construction."

A humidity mystery. But Addison Homes did encounter an ongoing moisture problem in one of its earliest homes built over a sealed crawlspace—after the mechanical system was operating and the home was occupied, Usher said. And that experience also taught the builders an interesting lesson.



The walls of the crawlspace shown above have been insulated and waterproofed, and a temporary ground cover is in place. Temporary foundation wall vents are left open until the house is drywalled, power is turned on, and the HVAC system is operational so that the space can be conditioned.

"This was an older customer who wanted a zero-step entry," said Usher. "They wanted easy access, not only from the garage and the front door, but also through the back of the house. So we backfilled this whole foundation right up to just below the framing."

"It was a beautiful sealed crawlspace," said Usher, "but we started getting problems. We had high relative humidity in the crawlspace, and that was keeping relative humidity in the house high. Then we started seeing buckling in the wood floors. But when we called our flooring contractor, he said, 'Oh, you did one of those sealed crawls. It's not our problem. It's your problem.'"

"We don't install a stand-alone humidifier in our crawlspaces," Usher went on. "We condition the space with the mechanical system. But when we had this issue, we went ahead and put a dehumidifier in the crawlspace to see if we could dry it out. And the dehumidifier ran constantly, but the humidity really didn't come down—it stayed at about 70%, and the house stayed at about 60%. And when you walked into the house, you could feel that it just wasn't comfortable."

Detective work. At that point in his story, Usher stopped to ask the audience to guess what the problem might be. "Missing a transfer grille for airflow?" suggested one. Good thought, said Usher; this house in fact didn't have a designated return air path, although it did have conditioned air delivered into the space.

"Duct leakage too high?" guessed another audience member.

Well, noted Usher, all the ducts were in the crawlspace, so duct leakage wouldn't be likely to pull in outdoor air.

"Capillary action?" suggested a third audience member. "The vapor barrier only goes partway up the wall, and the footings are still in the dirt. So water is going to migrate."

Bingo. At the time this house was built, said Usher, Addison Homes was building to the specifications of the EarthCraft green building certification program (earthcraft.org), promulgated by the Southface Energy Institute in Atlanta, Ga. (southface.org). That program called for a capillary break in the foundation. "It wasn't mandatory, but it was a way to score points," said Usher. "So we had put a capillary break on top of the foundation wall. We just had our crawlspace-sealing folks leave some of that extra membrane after they installed the wall membrane, and we would drape it over the block wall before we framed the house."

"Our termite inspection company wants us to leave a 4-inch termite inspection gap at the top of the wall," said Usher. So the piece of poly installed as a capillary break under the framed sill was left hanging loose, so that it could be lifted up for inspection. Moisture wicking up from the red clay soil, through the footings, and up to the top of the masonry wall was collecting on the underside of the poly and dripping back down into the crawlspace. "None of it was getting into the framing material," said Usher. "None of it was making the wood wet. But the foundation was drawing that



To safeguard the crawlspace's character as conditioned indoor space, Addison Homes provides access from inside the house with a floor hatch (5) and a small set of stairs (6), rather than providing a door to the outside. Exterior waterproofing and drainage (7) help defend the space against ground moisture.

moisture up from the footer into the crawlspace, and making the humidity in the crawlspace high."

"So what do we do now?" said Usher. "We looked at putting a capillary break on top of the footing, but there were logistical challenges: How do you put it down? What happens if it rains and there's mud on the footing? For a while, we had the masons put a capillary break between the courses of block, at about the height of the back-fill. But they didn't like that—they complained that the block wasn't going to stay together. So then we came up with a simple approach: When the waterproofers spray the outside of the wall, we have them spray the top of the wall too, and one course down on the inside [see photos 2 and 3, page 54]. Our crawlspace-sealing crew brings their poly up to that waterproofing line. We do the same thing on the piers. And we have had no more problems since."

Access hatch. Usher doesn't provide any door from the crawlspace to the outdoors. "If you put the access door on the outside," Usher explained, "people tend to do dumb things, like stick the lawnmower under there, or the gas cans, or the paint cans. And it's tough to seal a door for the exterior foundation wall."

So instead, Addison Homes installs a hatch with a small set of stairs to allow access to the crawlspace from the occupied first floor (see photos 5 and 6, above). "Now folks can really value the space," said Usher. "It's clean and dry, and they can store things down there." "Our trade contractors love our sealed crawlspaces," Usher noted.

"But we had to train people to take off their shoes before they go into the crawl. If you don't take your shoes off, you are going to be cleaning the mud off the ground cover."

One builder in the audience asked, "But couldn't you argue that an unvented crawl has been around for maybe 20 years, while vented crawlspaces have been around for hundreds of years, and a lot of them have functioned just fine? Is it really that vented crawls are bad, or is it that bad vented crawls are bad?" Usher responded: "I'm going to let Joe Lstiburek talk about the history of venting crawls."

Said Lstiburek: "Well, if you didn't insulate the crawlspace at all, and you didn't build with engineered wood (which is an insult to both engineers and wood), you'd be fine. You could build with real dimensional lumber and plywood; and if you had no insulation in it, and a plastic ground cover? Yay. Back to the Civil War. Not a problem."

"But it's just like Peter Yost said earlier," Lstiburek continued. "When you change the energy balance, everything changes. In the old days, we had an enormous energy exchange. So when things got wet, they dried out. But we changed the energy balance."

The moral of the story, said Lstiburek: "You can't get your money for nothing and your chicks for free—that's the second law of thermodynamics set to music."

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