LAYING AN Electric-Radiant Tile Floor

This electric-resistance mat can warm a tile floor without greatly raising the floor height

by Michael Byrne

Radiant heat under ceramic and stone tiles has been in use for thousands of years. Architectural remains in Europe and the U.K. show how this was done: Roman builders constructed below-grade fire pits and extensive flue systems that carried heat to floors and bathing facilities. Even when compared with other ancient Roman excesses, these systems were models of inefficiency and gross consumption. Imagine a labor force of hundreds stripping forests, sawing and stacking cordwood, and stoking the fires just to keep one senator's tush from getting chilled!

Today, radiant tile warming systems, when properly specified and installed, consume a relatively small amount of energy in exchange for the comfort they can provide. The electrical-resistance mat shown in this article, the SunTouch from Watts Radiant (888/432-8932; www.suntouch.net), has been tested to ASTM standard C627 by the Tile Council of America for use with ceramic tile. The mats come in a variety of sizes that can be combined to cover different room shapes and sizes, and are accompanied by clear electrical and tiling instructions. This article will not touch on the electrical part of the installation other than to point out how the main power supply cable is routed across the floor. Of particular interest to tile installers is a device available through the manufacturer

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Figure 1. The original bathroom was dark and carpeted. The new space is lighter and airier — and warm on the feet.

that constantly monitors the integrity of the cable, sounding an alarm if either the cable or the resistance wire is damaged during the installation.

Bathroom Makeover

The project shown here is located in a hall bathroom that was covered with tiles from the '70s; the chilly floor was kept covered with carpet — a practice that is neither practical nor sanitary (see Figure 1). The remodel began with stripping the bowed wall coverings and removing the floor tiles and old underlayment. The tub walls would be finished with 3x6 glazed porcelain ceramic tiles, the bathroom walls with wainscot planking, and the floor with 1 3/8-inch unpolished marble mosaic tiles mesh-mounted into roughly 12-inch-square sheets.

Had tiles 10 inches or larger been specified for the floor, I would have installed the tiles directly over the electrical resistance matting with a medium-bed latex-modified thinset mortar, and saved the time and expense of encapsulating the matting with a self-leveling compound (SLC). At 10 inches or greater, a single tile can bridge over three or more resistance wires, which helps to keep all the tiles on a smooth, even plane. Smaller tiles, especially those that may only be able to bridge one wire at best, tend to tip to one side or the other, creating an uneven surface finish. So on this job, I installed an SLC over the resistance matting and allowed it to harden before setting the tile. Another advantage of using the SLC is that it protects the wires from impact that could cause a break or other problem.

Because the bathroom would not be heavily used, I decided not to install any type of waterproofing membrane. On the other hand, because of the cycling of the radiant heating system, I still needed a perimeter movement joint, which would be concealed beneath the bottom of the wainscot behind the baseboard. At the tub and threshold, I would leave a 1/8-inch joint and fill it with a resilient caulk color-matched to the grout.

Floor Prep

After removing all the old nails and vacuuming the 1 1/8-inch-thick plywood subfloor, I began the installation by applying a primer — a companion product to the SLC used on this job — with a long-necked roller (Figure 2, next page). This SLC, Level Quik RS (Custom Building Products, 800/272-8786; www.custombuildingproducts.com) has a high compressive strength — about 2,500 psi — but its bond strength is very low unless the primer is used. The primer soaks in quickly, so the work can continue as long as I don't get any dust or dirt on the plywood.

I prefer to use an SLC that requires the addition of a reinforcing mesh, which adds considerable tensile strength to the installation and helps prevent tile cracking. The only downside of the mesh is that is sharp enough to damage the resistance matting if I'm not careful. Actually, this matting is quite strong

Floor Prep

Figure 2. Before installing the heat mat, the author rolls a primer on the clean subfloor to ensure good adhesion of the self-leveling compound. After nailing down diamond mesh, he rolls out the radiant mat.

Installing the Mat

Figure 3. Roofing nails (far left) and hot-melt glue (photo, page 1) help the mat lay flat, so that the resistance wires stay below the surface of the self-leveling compound. A groove cut in the plywood accommodates the power supply cable.

Pouring the Self-Leveling Compound

Figure 4. Despite its name, self-leveling compound should be persuaded by hand to produce the flattest surface. Rather than dump it all in one place, the author is careful to spread the mix as he pours it out.

and should hold up to the usual job-site abuses. Still, it's a good idea to use the alarm device to make sure the wires are intact.

Installing the Mat

The matting is purchased to fit a specific floor size, and the manufacturer's instructions guide its orientation and placement. When planning a tile warming system, I follow three basic guidelines: no resistance wires within 6 inches of a wall (a waste of heat), no wires closer to the toilet than 12 inches (don't want to melt that wax ring!), and no wires where the floor will be covered with permanent furniture or furnishings (can cause hot spots or overheating). Before leaving the factory, each mat is checked and marked for its electrical resistance, which must be verified on site by the electrician before the matting can be installed. The resistance should also be rechecked before the SLC is poured and again before the tiles go in.

To help keep the wires, which are blue, flat against the plywood, I use roofing nails through the orange carrier netting (Figure 3, previous page). Once the mat has been unrolled and positioned, I stake it at the four corners, stretching the material as I go, then nail the interior with more nails. Because of the additional height added by the resistance matting, I need to keep this floor as flat as possible so the profile of the finished tiles is close to that of the strip flooring at the entrance to the bathroom.

The matting must be positioned so that the shielded cable linking the resistance wires to the power supply terminates as close to the junction box as possible. On this job, I pressed the cable into a relief I carved in the plywood underlayment to keep the thick cable below the profile of the matting. A much smaller wire, which connects the floor-level temperature sensor to the system thermostat, is also placed in this relief groove. This sensor provides more

Cutting Mosaic Tile

Figure 5. For cutting, the author clamps the small mosaic tiles to a workbench with an aluminum straightedge, using a thin piece of foam to protect the tile surface. He then dry-cuts to the line with a grinder.

precise control than the eye-level box-mounted thermostats supplied with other floor warming systems. To avoid damaging the system, no nails or bare-metal staples should be used to secure the cable, so I use a hot-glue gun.

Since I want the surface height of the SLC to be as low as possible, I give the floor the once-over and secure any errant sections of the carrier netting with a few dabs of hot glue (see photo, page 1). I could also staple the orange matting to the subfloor, but I happened to have left my stapler at the shop on this day. Had the system been installed over a concrete slab, I could secure the netting with either hot glue or double-sided tape.

Pouring the Self-Leveling Compound

Since no two SLCs are alike, specific installation instructions must be followed to the letter; however, there are general guidelines that apply to all. In particular, the wet-to-dry ratio is critical, especially where more than one sack of SLC is needed to complete the work. There should not be any variation in mixing. To assure that, I use an idiot bucket for the liquid and a small measuring cup for the reserve liquid.

The instructions for most SLC mixes suggest a narrow volume range for the liquid component. For example, if the instructions call for 5 to 5 1/2 quarts of water, I size the idiot bucket for 5 quarts, and use a one-cup measure for the reserve liquid. Using the minimum amount of liquid results in higher compressive strength, while using the maximum results in a less robust mix.

Rather than just dump the mix in one spot, I try to distribute the material while I am dumping (Figure 4, previous page). Time management is essential to a successful pour, so while I'm pouring out the first batch, my helper is mixing the next so that there's no time lag between batch pours. The entire floor must be covered in one shot, within five minutes. With SLCs, there is no finishing the other half tomorrow.

Not exactly self-leveling. Contrary to what the name suggests, most SLCs require human intervention if the surface is expected to be flat and smooth. I use a flat trowel to drag and drop material so that all portions of the floor are wet with mix. This allows the material to flow faster, an essential where the thinness of the pour, the galvanized mesh, and the resistance mat all conspire to slow down the SLC.

An important part of the prep process for SLCs is closing off any holes through which the material could flow; I use duct tape and backer rod for this task. Though you can't see it in the photos, I stuffed some fiberglass insulation to seal

Dry-Fitting the Tile

Figure 6. Before spreading any thinset, the author dry-lays the entire floor. This gets all of the tricky cutting done before the wet-setting begins. He labels each mosaic square in sequence so that installation proceeds smoothly. Note the missing accent tiles.

the gap between the closet flange and the plywood subfloor.

At a little over 40 square feet, this floor required just under two sacks of SLC mix. With SLCs, it's essential to have some material in reserve, just in case. Even if the supplier was only a block away, it's highly unlikely you could get a top-off batch ready before the first pours had begun to set.

With a decent helper, I can handle a four-sack installation; however, when the floor approaches 100 square feet, I hire a pumper to speed the process and use my helper to assist in distributing the mix. After rough-troweling, I keep a close eye on the floor and use a long-handled rake to even out any irregular areas. Once that is done, though, it is remarkable how smooth and flat the resulting floor can get before the material hardens.

Cutting the Tile

The mosaic floor shown here has a common design feature that required some individual white tiles to be removed and replaced with darker accent tiles. Because of this, and because cutting small tiles can be tedious and time-consuming, I prefer to dry-fit all the sheets before mixing any thinset mortar. I had the benefit of the overhanging wainscot and baseboard at the walls, so I only needed cut pieces against the tub and at the threshold. I adjusted my layout to yield same-size cuts at these locations and marked the sheets for cutting.

When dealing with small, porous stone tiles, like the ones shown here, I prefer to dry-cut to minimize color variations in the finished job (Figure 5, previous page). This is because porous stone tiles can retain moisture, which can cause the grout to dry to a color different than grout surrounding tiles that are completely dry. For safe, efficient cutting, I always clamp small tiles tight. The thickness of the stone tiles varied slightly, so I used a sheet of 1/8-inch-thick packing foam to ensure uniform clamping. I clamped the tiles to the bench with one of my straightedges and a couple of spring clamps. I made sure each tile was fully supported by the plywood workbench before beginning the cut.

Dry-cutting any type of tile generates a lot of heat, much of which is carried away from the blade and the tile by the dust and chips. But if the cut is too deep, enough heat can build up to prematurely age the blade, or cause fractures in the tile. For this reason, I try not to hog off too much material. Instead, I bear down lightly and make several shallow passes. This helps extend the blade's life and reduces chipping.

Although it's not obvious from the photos, the cut is about 1/64 inch away from the line. Once the kerf bottoms out, I use the side of the blade to remove excess marble right to the line — similar to the old-school carpenter's practice of using a rough saw cut and finishing with a plane to trim the piece to its finished size. I leave a little bit when roughing a tile to account for slips, soft material, and other glitches that might ruin a piece if I start sawing right at the cut line.

Dry-fit first. I dry-fit the entire floor, marking the sheets sequentially so that I could stack them in the order they would be installed (Figure 6). This way, with all the cuts made and the tiles ready to install, I can fly through the task of setting the tiles without having to make frequent, disruptive trips to the tile saw. In the past, I used regular masking tape to mark the sequence, but that sometimes left a hard-to-remove residue on the tiles; I now use low-stick painter's tape instead.

Smooth Installation

Because the wall surfaces were so straight, thanks to the superb workmanship of the carpenter, and because we were

Setting the Tile

Figure 7. After placing the first mosaic sheet to a layout line marked on the tub, the author gently presses it into place by hand and with a rubber float. He takes care not to press excess thinset up into the grout lines, which would require time-consuming cleaning. Because the tiles were dry-fit first, the wet setting goes quickly.

Sanding the Surface

Figure 8. Rather than fuss with leveling the irregular stone tiles from below with extra thinset, the author smoothes out any unevenness in the surface with a belt sander.

careful to select a tub whose face was also very straight, this was one of the few installations I have done where no layout lines were used. Before removing the dry-fit sheets, I made a small registration mark on the tub so the first sheet was positioned in the exact spot needed to guide the remaining tile sheets.

When working with small tiles, I try for as accurate a placement as possible, since sliding mosaic sheets around in wet thinset is the ideal way to clog the grout joints with unwanted adhesive and create a nightmare cleaning task. When I am satisfied with the positioning, I use a soft rubber grout trowel to press the sheet down into the adhesive layer (Figure 7, previous page). In the past, when installing tiles over setting beds of fresh mortar, I would use a hammer and a beating block, and probably displace a bit of mortar, to get the thicker tiles to sit even with the rest. But on thinbed work over a hard setting bed, that technique would likely result in a few broken tiles.

Because all the tile sheets were prepared before I spread any thinset, it took less than an hour to cover the entire floor. One reason for such a quick install is that while I paid a lot of attention to aligning neighboring sheets, no time was wasted on setting the tiles at an equal height. That meant that there was more lippage than would be considered appropriate, but I followed with a fast, accurate technique that resulted in a perfectly smooth floor — sanding (Figure 8).

Though surface grinding of soft, unpolished stone is usually thought to require expensive, specialized equipment and rare grinding compounds, it can actually be rather easily accomplished with an ordinary belt sander and rough-grit carbide belts (50 to 80 grit for starters). Of course, experience goes a long way with this technique, but with a bit of experimenting — to avoid burnishing the tiles with too fine a grit, or gouging them with grit that is too rough for the density of the material being worked — most installers can learn the technique in less time than it would take to shim up errant tiles with adhesive.

Even though the relatively soft marble tiles shown here will quickly wear down the rough-grit belts, the waste material does not clog up the remaining finer grits the way wood does. I use a belt until I feel the drag lessen, then replace it with a new one. However, I don't throw out the old belts yet; instead, I re-use them for a second pass to remove scratches left by the first run of the sander. Often, this will leave a surface smooth enough for the honed look I prefer.

Once I was finished with the belt sander, I used a simple disc backing, chucked into a 300-rpm drill, and about a half dozen 200-grit carbide stick-on sanding discs to smooth out the remaining scratches. The resulting surface is incredibly smooth, and was a snap to grout.

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