by Michael Byrne

Durable Substrates for Thinset Tile

The author applies a two-part waterproofing membrane to tile backerboard in a steam room installation.

An attractive tile job depends most on what you can't see

When a ceramic tile installation fails, it's rarely because of a problem with the tile itself. More than likely it's because the installer used the wrong setting materials for the job or didn't follow correct installation procedures. This article focuses on setting beds for ceramic tile installations in wood-frame houses.

In the past, when most tile jobs were installed over mortar setting beds, the tile subs used the thick mortar beds to correct substrates that were out of plumb or level. But in today's fast-track thin-bed market, an attractive outcome depends more on the skill of the framing carpenter than the tile installer. You can't expect even the most highly skilled tile installer to straighten out a poor substrate with a thin layer of tile adhesive.

Also, wood-frame buildings move in

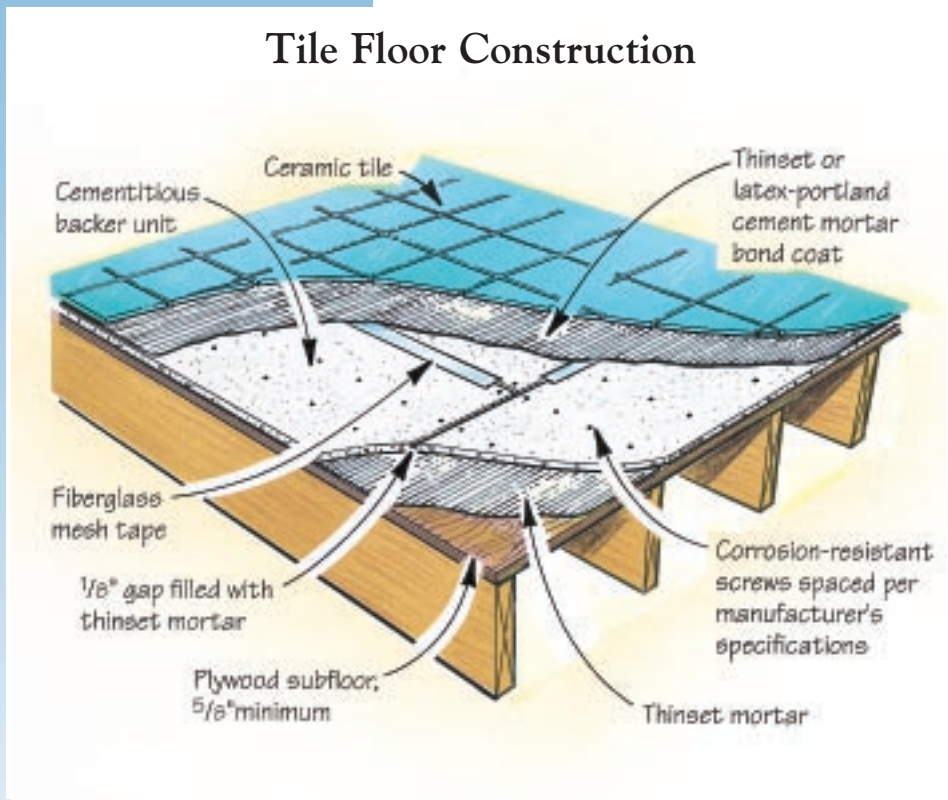

Figure 1. *Floor framing for tile must be level to within 1/8 inch in 10 feet. Space joists no more than 16 inches on-center, and make sure deflection is limited to L/360. Leave 1/8-inch gaps between plywood subfloor panels (1/4 inch at walls). Install the backerboard over a thin setting bed of thinset mortar, making sure that none of the CBU edges align with the plywood joints.*

predictable ways as seasonal moisture levels change. Since tile is inherently inflexible, a successful tile job must take building movement into account.

There is no single substrate that will work as a universal setting bed for every tile application. The trick is to understand the strengths and limitations of each substrate material and to choose the right combination of materials for each particular installation.

Backerboards

Cement backerboards were developed specifically for use as setting beds for ceramic or natural stone tiles. This makes them the first choice for quality thin-bed installations — provided that they are applied over a properly prepared structure.

Backerboards, often referred to as cementitious backer units, or CBUs,

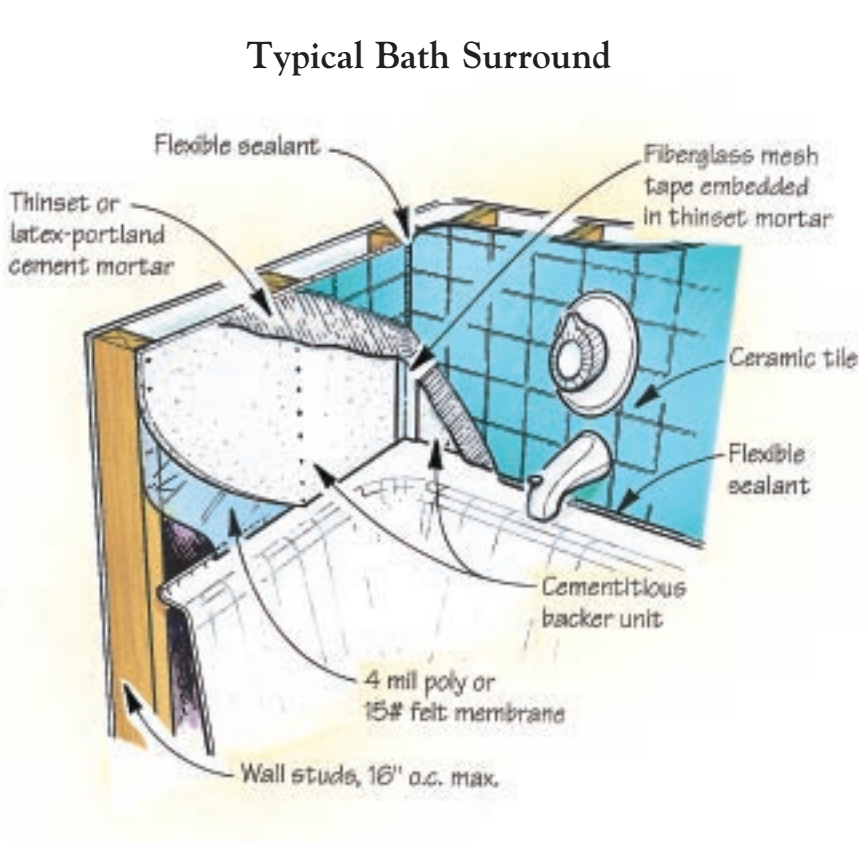

Figure 2. *Because tile and cement backer are moisture-permeable, the framing in a bath or shower surround must be protected with a membrane of 4-mil poly or 15-pound felt. Reinforce backerboard joints and corners with thinset mortar and mesh tape. Tile corners, perimeters, and penetrations should be protected with a flexible sealant expansion joint.*

When Mortar Makes Sense

Although not used as much as in years past, mortar still has a prominent place in tile work. For those installers who know how to float mortar beds, out-of-plumb or -level substrates are a piece of cake. On wet installations involving a floor drain, the mortar bed method is the only practical way to achieve a sloping surface. On remodel work in older structures, mortar is often the only practical way to level a floor or plumb a wall for tile.

In spite of their perceived high cost, mortar beds can be effective, accurate, and economical setting beds if they are planned from the beginning of the project. The best mortar bed installations start with at the design phase, and require good communication between the tile installer and the framers and other subs, to work out the subfloor elevation and the location of plumbing and electrical fixtures.

Unlike with the thin-bed method, which requires a high degree of accuracy and premium materials at each step of construction, structures supporting mortar beds can be made of lesser grades of materials and built to more forgiving tolerances. This is especially true on wet installations, since the waterproofing system can be constructed of generic materials whose lumps and bumps are easily covered over by the thickness of the mortar. The main consideration is that the framing must allow for the extra thickness required by the mortar bed.

— *M.B.*

come in two types: skin-reinforced (such as Durock and Wonderboard) and fiber-reinforced (Hardibacker). Skin-reinforced CBUs have a sand-and-cement core reinforced with a skin of woven fiberglass mesh; fiber-reinforced boards are manufactured with reinforcing throughout. Both types are made in a variety of sizes and thickness, depending on the manufacturer (see "Sources of Supply," page 45).

CBUs can be cut with hand tools using the same score-and-snap techniques used for regular drywall, or they can be cut with power tools (see "Working With Tile Backerboard," 10/94). CBUs are not affected by moisture, which makes them ideal for most dry interior tile applications. But since moisture will pass right through a CBU, in wet applications (a shower surround, for example) a waterproofing membrane must be used to guard against structural damage. Also, not all CBUs are suitable for exterior applications. If you need an exterior tile substrate, make certain the CBU you select has been certified by the manufacturer for exterior use.

CBUs can be fastened with galvanized roofing nails or with special CBU screws. Although roofing nails are a lot cheaper, I prefer to use CBU screws (such as Buildex "Hi-Lo S Rock On" screws), which are corrosion resistant, very strong, and able to cut their own countersink. Ordinary drywall screws should never be used to fasten CBUs, for a number of reasons: First, in wet applications, drywall screws will rust. Second, regular drywall screws are not very strong (the heads frequently shear off as the screw head contacts the face of the CBU). Third, regular drywall screws cannot cut a countersink, which allows the head to sit flush with the surface — a very important consideration when installing tiles.

Framing tolerance. CBUs take a lot of the skill that used to be the province of the tile installer and put it in the hands of the people framing the structure. In other words, with CBUs, the carpenters shoulder much of the responsibility for keeping the finished tile underlayment smooth and flat. For this reason, studs and joists have to be installed with tile tolerances in mind — no variations greater than 1/8 inch in 10 feet (the industry standard for tile installations).

Glass-Mat Gypsum Board

Don't confuse CBUs with glass-mat gypsum backerboards, such as Dens-Shield, which is a lighter-weight tile backer with a gypsum core. As a contractor, I always choose materials I know I can depend on all the time. I've been using CBUs long enough to know how to install them properly to get the performance I expect. Glass-mat gypsum boards are relatively new in the tile market, and they definitely show a lot of promise. One notable feature of Dens-Shield, for example, is that it incorporates a waterproof skin on the surface of the board. Because of its gypsum core, Dens-Shield is also easier to cut and lighter than cement backer.

My main concern with glass-mat gypsum boards in kitchen and bath applications is leakage — at seams and corners, where leaks are most likely, and around fastener holes. Whereas water will not damage cement backer, I'm not as confident of a gypsum core. Before using glass-mat board around a tub, for example, I would like to see the manufacturers develop a proprietary installation system that guarantees a waterproof skin.

Like many other products developed for the thin-bed tile installation process, glass-mat gypsum boards continue to be refined. In the meantime, in my opinion glass-mat board is fine for dry, light-duty installations.

Installing Backerboard on Floors

Install CBUs for floors over minimum 5/8-inch exterior-grade plywood on joists spaced no more than 16 inches on-center (see Figure 1, previous page). According to ANSI specs, surface irregularities on the plywood can't exceed 1/8 inch in 10 feet, and the deflection of the finished floor (when loaded) must not exceed 1/360th of the span.

Because of the need for high compressive strength and support, CBUs on floors must be bedded in a layer of latex-modified thinset mortar spread evenly with a notched trowel. Usually, a 1/8-inch gap is left between panels (always check the manufacturers instructions for product-specific recommendations). Then, after the panels are secured with screws, the joints between panels should be filled with thinset mortar and covered with 2-inch open-weave fiberglass mesh tape. (This can be done immediately or as the tiles are being installed.)

Don't try to correct serious surface irregularities or an out-of-level situation by loading the underside of a CBU with excess thinset mortar. The result will be that the mortar will powder and crumble, creating a weak spot under the tile. Thinset mortar achieves its maximum strength only in thin cross-sections. Use carpentry or a self-leveling compound to make corrections.

To prevent cracks in the tile, avoid locating a CBU edge directly above a plywood edge, and never place CBU panels so that more than two corners meet. For the speediest installations, secure whole panels first, larger cut pieces next, and smaller filler pieces last. If you are a one-man operation, make the cuts as you go. If you are working a crew, break up the team so that one person is responsible for mixing and spreading thinset mortar, one person positions the boards and secures them with fasteners, and a third takes care of the cut pieces. (It's a good idea to cut CBUs away from the installation site, to avoid crumbled pieces under the sheets.)

For wet-area floors, I usually upgrade the substrate by adding a sheet membrane on top of the CBUs (for more on this, see "Membranes for Ceramic Tile," 1/96).

Installing CBUs on Walls

Most wall tiles in the United States are installed on tub or shower walls. This means that waterproofing has to be provided to prevent moisture or water from damaging the structure, and that all the materials used in the tile installation must be unaffected by water. Lots of tile is still installed over moisture-resistant gypsum boards, but the manufacturers of such boards emphatically recommend that greenboard not be used for wet-area tile installations. For a tub or shower wall, use cement backerboard with a membrane of 4-mil poly or 15-pound felt behind the CBUs (Figure 2, page 41).

Although walls don't carry the same kind of loads as floors, they still need to be sturdy enough to resist flexing. Wall tile installations require 16-inch stud spacing with horizontal blocking to support CBU panel edges where needed. Steel studs should be no lighter than 20 gauge.

Countertops

For normal-duty residential counters, install a layer of CBUs over a 3/4-inch exterior-grade plywood base (Figure 3, next page). For sink tops and other wet areas, put a 4-mil poly or 15-pound felt membrane on top of the plywood, extending it into the sink cutout, over the drip-edge of the counter and up the wall behind the backsplash. Then apply a leveling coat of mortar on top of the membrane.

Plywood as a Tile Substrate

Plywood underlayment used to be a reliable setting material for floors when I was setting tiles in Northern California 15 years ago. In my opinion, plywood quality was much better then than it is now. Also, the area in which I did business had a stable climate with no wild temperature swings that could

The OSB Question

by Don Jackson, Managing Editor

We've recently received questions from several readers about the use of OSB under ceramic tile: Is OSB a proper underlayment material? Can I use OSB as the subflooring underneath my tile underlayment?

Because of the confusion around the issue, I asked some of the major players in the tile industry what they advise. First, I found no one who thinks that tile should be bonded directly to OSB; OSB should *never* be used as a tile underlayment. Second, there's a general consensus that OSB should not be used even as subflooring in a tile installation.

"It's problematic," said Jim Reichert of U.S. Gypsum, maker of Durock, "because OSB swells when it gets wet." As the OSB swells and deforms, it cracks both backerboard and tile, which are inflexible materials. This usually results in tile cracks that follow the OSB joints or the backerboard joints.

The same concerns were raised by technical staff at Laticrete and Tec, both manufacturers of tile mortars and adhesives, at James Hardie Building Products, maker of Hardibacker fibercement board, and at Georgia Pacific, maker of Dens-Shield tile backer. All of these manufacturers adhere to TCA and ANSI standards, which exclude the use of OSB subfloor under tile.

One notable exception was Custom Building Products, maker of Wonderboard cement backer and a complete line of thinset adhesives. Custom will warrant the use of their products over APA-rated Exposure 1 OSB as long as strict installation guidelines are followed. (Custom also goes beyond other standards by allowing for 19.2-inch spacing of wood I-joists.) After reading the warranty, I questioned how one section could allow for OSB subfloor while another section stipulates that the work must meet ANSI A-108 standards for tile installation (which exclude OSB).

According to Custom's Tom Domenici, although ANSI refers to plywood, Custom interprets ANSI's use of the APA "Exposure 1" designation to open the way for consideration of OSB. "We're not driving the industry in this regard; we're just trying to accommodate the wave of the future, and recognize new systems. In about three years, probably 50% of new residential floors will include OSB subflooring. From our perspective, Exposure 1 OSB as a subfloor would be acceptable under 1/2-inch Wonderboard. We're talking about interior, dry, residential areas. With that in mind, we're comfortable with it."

USG's Reichert pointed out that there are undoubtedly tile jobs over OSB subfloor that have held up well because there is no moisture present. "But most tile goes in kitchens and bathrooms, so why take the chance? Tile is a lot less forgiving than carpet. Instead of trying to save a few cents per square foot, why can't the builder use OSB for most of the house and switch to plywood for the tiled rooms?"

Sounds like good advice.

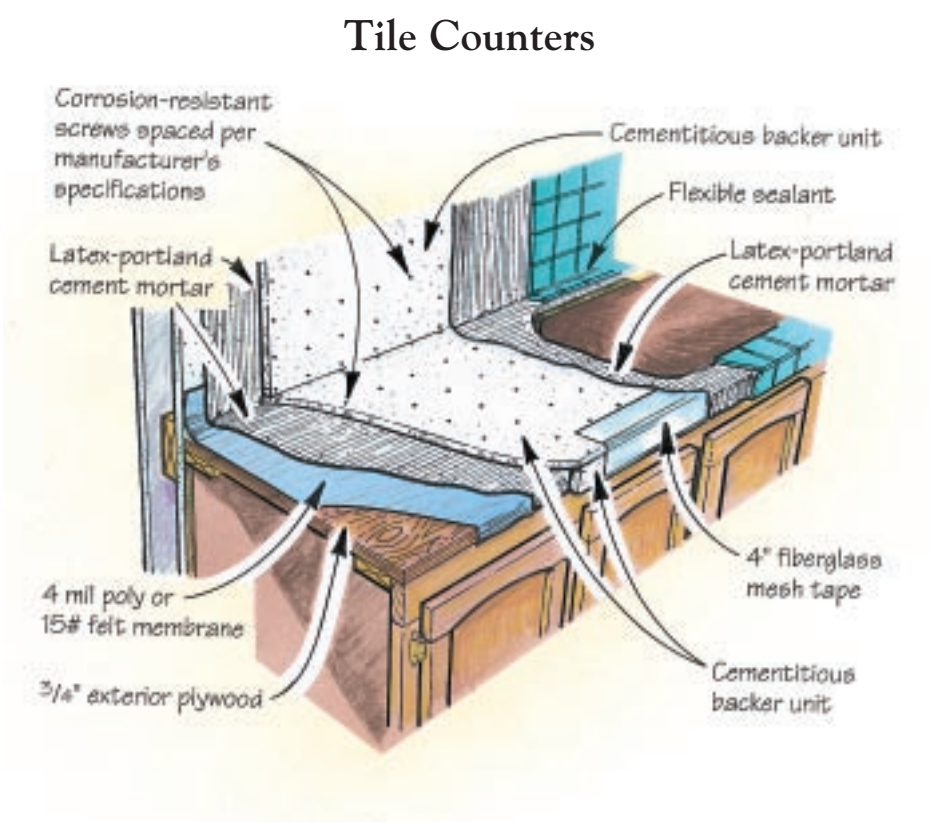

Figure 3. *For sink tops and other wet counters, it's a good idea to install a waterproof membrane over the plywood. This prevents the plywood substrate from picking up moisture and swelling, which will crack the tile.*

cause plywood to expand and contract.

Since the introduction of cement backerboards, I am reluctant to recommend plywood as a ceramic tile underlayment, although there are many builders who continue the practice. In situations where the plywood underlayment has already been installed and the budget allows, I recommend a rip-out and replacement with CBUs or an extra CBU underlayment on top.

This is more than the opinion of one tile installer. According to ANSI (the American National Standards Institute), in its *Specifications for the Installation of Ceramic Tile*, plywood is "dimensionally unstable" and not an ideal backing for ceramic tile (ANSI A108, AN-2.5.3.2.1). Nevertheless, having issued that caution, the ANSI specs go on to detail conditions under which plywood can be used as a tile underlayment.

If you are going to use plywood underlayment, shop for an adhesive that has a warranty (TEC, Laticrete, and Custom all offer warranties), and follow the manufacturer's instructions carefully. If you cut corners and there are problems, it is unlikely that your installation will be covered by the warranty. The Tile Council of America's *Handbook for Ceramic Tile Installation* recommends a minimum 5/8-inch subfloor and a minimum 5/8-inch underlayment for tile installed with epoxy mortar (Figure 4). For thin-bed countertops, the TCA recommends a minimum 3/4-inch exterior plywood (Figure 5). This is a countertop detail I would use only for dry, light-duty counters — not counters in kitchens or baths.

You should choose your plywood carefully. I've had bad experience with some of the pine plywoods — the resin acts as a bond breaker. OSB is even more problematic, and should be avoided altogether as either underlayment or subfloor in a tile installation (see "The OSB Question," previous page).

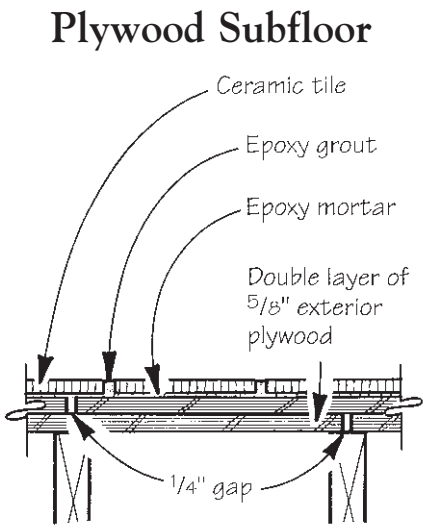

Figure 4. *For dry installations, exterior-grade plywood is an acceptable underlayment for tile. Make sure you use a tile adhesive warrantied for use with plywood.*

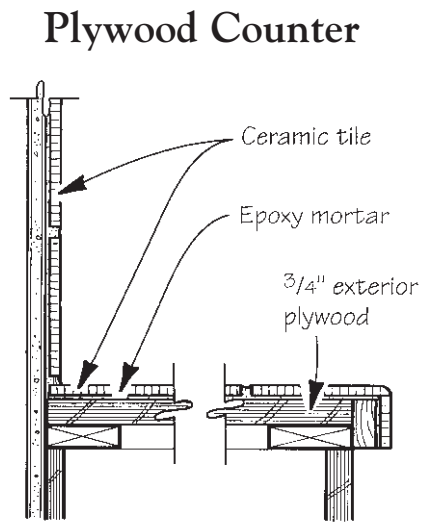

Figure 5. *For dry, light-duty counters, 3/4-inch exterior-grade plywood will work as a tile underlayment. Avoid pine plywoods; the pitch acts as a bond breaker, according to the author.*

Drywall Under Tile

Although greenboard makes a bad shower wall substrate, either greenboard or ordinary drywall can be used for *decorative* tile in completely dry installations. This means the only moisture the tile would experience is an occasional wipe with a damp cleaning rag. For *functional* wall tile — a kitchen backsplash, for example — stick with CBUs.

Expansion Joints

Expansion joints are required on all tile installations wherever there is a change in plane and where tiles meet another surface. Residential floors usually don't require expansion joints within the field of tiles (sunrooms are an exception), but need them around the perimeter, where the tile meets the wall. Expansion joints should also be provided at corners — where the walls of a bath surround meet, or where a

counter meets a backsplash.

Although urethane sealants are more durable, for residential work I used sanded, colored caulks that match the grout in color and texture. These are available from Color Caulk in any grout color imaginable.

For complete information on sizing and locating expansion joints, refer to the TCA *Handbook*.

Self-Leveling Compounds

Self-leveling compounds (SLCs) made specifically for tile installations make great setting beds — they need only to be mixed with a measured amount of water, dumped on the floor, coaxed around with minimal troweling, and presto, instant substrate.

SLCs require some surface preparation before the material can be dumped on the subfloor. You'll have to scrape up excess construction debris, vacuum the dust, and dampmop the subfloor just before the SLC is applied. Since SLCs run downhill, all holes or cracks in the subfloor should be stuffed with resilient foam or fiberglass wool.

A major advantage of SLCs is that they do not need a thick cross-section to achieve high compressive strength: They can be used from feather edge to an inch or more in thickness. Although SLCs can be used to make up practically any thickness, most require building up thicknesses a bit at a time. If an installation requires a floor thickness greater than the recommended maximum pour, the first lift must be allowed to harden before the next lift is applied.

Although self-leveling compounds are very effective in bringing an out-of-level thin-bed substrate up to industry specs, I wouldn't recommend them for large floors that are more than 1/2 inch out of level. The reason is that these compounds can be rather expensive. For severely out-of-level floors, try filling in the lowest spots with pieces of scrap exterior plywood nailed or screwed to the subfloor, then apply the SLC.

Dealing with expansion and contraction. Like any tile installation, tile installed over SLCs needs expansion joints. This is especially true for radiant floors, where self-leveling compounds are commonly used. For a tile floor over an SLC, surface preparation should include lining the perimeter of the installation with a strip of resilient foam positioned at least an inch higher than the finished floor. The extra height ensures that none of the SLC compound will contaminate the expansion joint space. The excess can be trimmed after the material hardens. ■

Michael Byrne was a tile contractor for 20 years and is now executive director of the Ceramic Tile Education Foundation in Clemson, S.C.

Sources of Supply

Color Caulk
723 W. Mill St.
San Bernardino, CA 92410
909/888-6225
Smooth and sanded color-matched caulks

Custom Building Products
13001 Seal Beach Blvd.
Seal Beach, CA 90740
800/282-8786
Wonderboard cement backer, grouts, mortars, adhesives, self-leveling underlayment

Georgia-Pacific
133 Peachtree St. N.E.
Atlanta, GA 30303
800/225-6119
Dens-Shield tile backer

ITW Buildex
1349 W. Bryn Mawr
Itasca, IL 60143
800/323-0720
Hi-Lo Rock-On backerboard screws

James Hardie Building Products
10901 Elm Ave.
Fontana, CA 92337
800/942-7343
Hardibacker fiber-cement board

Laticrete International
One Laticrete Park North
Bethany, CT 06524
800/243-4788
Mortars, adhesives, additives, grouts, self-leveling underlayment, two-part waterproofing membranes

Mapei Corp.
1350 Lively Blvd.
Elk Grove Village, IL 60007
800/992-6273
One-part waterproofing membranes, thinset adhesives, self-leveling compound

The Noble Co.
614 Monroe St.
616/842-7844
Grand Haven, MI 49417
Sheet waterproofing membranes

TEC Inc.
315 S. Hicks Rd.
Palatine, IL 60067
800/323-7407
Mortars, adhesives, additives, grouts, self-leveling underlayment

U.S. Gypsum Industries
125 S. Franklin St.
Chicago, IL 60606
800/621-9622
Durock cement backerboard, Durock screws, Imperial Type P reinforcing mesh tape

For More Information

Tile Council of America (TCA)
P.O. Box 1787
Clemson, SC 29633
864/646-8453
Handbook for Ceramic Tile Installation
ANSI Specifications for the Installation of Ceramic Tile