

Tile Roofing

Clay or concrete, a tile roof will outlast the next generation

by J. Azevedo

In an 1895 technical book on tilemaking, author Charles Davis listed as a disadvantage of tile roofing that it is "anything but handsome." He was not the first to make disparaging remarks about the appearance of tile. Its popularity has cyclically risen and fallen in this country for the past 300 years. The recent resurgence of tile in the residential American roovescape—along with the consequent assumption that many homeowners must find tile to be quite handsome after all—reminds us that tastes do change. And in the case of tile's return to favor, changing taste coincides with good sense—the advantages of tile roofing far outweigh its disadvantages.

All tiles worth considering come with a 50-year guarantee, a measure of their durability in all climates. In wet climates, tile will not rot. Moss and fungus cannot get a foothold, bugs find it unappetizing, and rodents and squirrels chip their teeth on it. In cold climates, although tile will not shed snow as a metal roof will, well-made tile will withstand repeated freezing and thawing (most Swedish houses are roofed with tile). In coastal areas or cities, tiles can be used with impunity because they are unaffected by salt spray or pollution. In hot, dry areas, tiles will not split or crack. Also, tile roofing is available in light colors to reflect the sun's rays. A tile roof will not stop a fire that starts in your kitchen, but it will keep a fire in your neighbor's kitchen from spreading to your house through his roof. With its Class A fire rating, tile has the approval of every fire code from Boston to Los Angeles.

Finally, tile roofing in its many forms has been around so many years that its use in a new house can recall a certain region or historical period. Some tile profiles are synonymous with California missions or French country estates or oriental temples. Yet, not every tile has a singular connotation. A modern concrete tile with a profile loosely based, for example, on a Mediterranean tradition can look quite at home on a house in the Northwest. In fact, the array of tile profiles and colors available today give tile the virtue of versatility. Tile roofing can ripple lightly across the roof or sit elegantly in solid silence; it can form neat symmetrical vertical ribs or take

playful dips and leaps. If only Charles Davis could see them now.

It began with clay—Clay-tile roofing originated in neolithic China and later, independently, in the Middle East. From these two loci, tile roofing spread throughout the Orient and Europe. In China, tile roofing has become vernacular. The Japanese adopted tile roofing, adapted it to their harsh climate, and now

have a major tile industry, including the largest clay-tile factory in the world. The ancient Greeks and Romans roofed their buildings with tiles of clay or, to show off, marble, and the Europeans picked up the clay-tile idiom and carried it to the present.

European settlers brought the tradition of tile roofing to America, starting at both coasts and working towards the middle. On the East Coast, Dutch settlers first imported tiles from their homeland but by 1650 were making them here. In the West, Spanish missionaries brought tile roofing along with their religion.

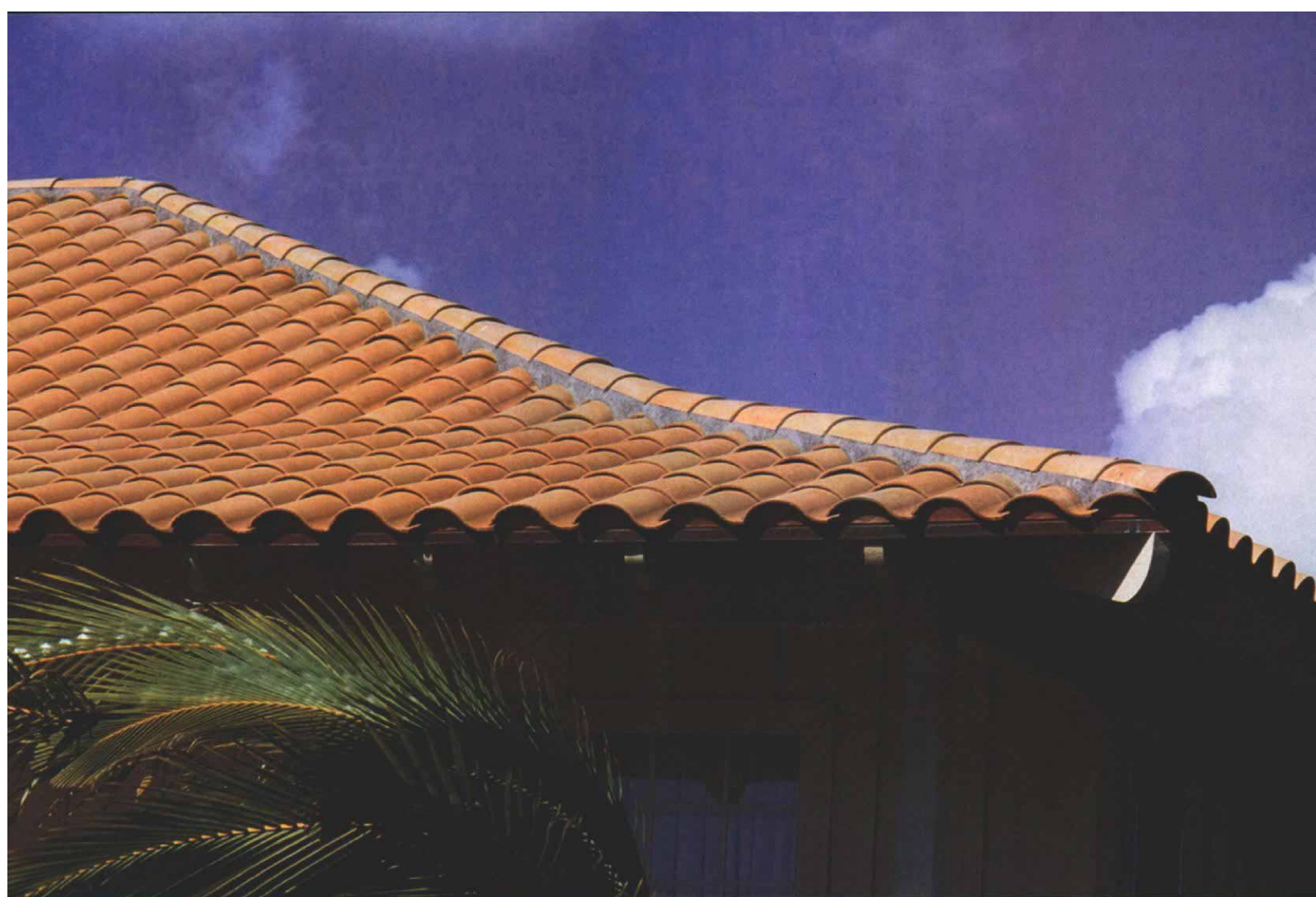
In California, tile folklore recalls how Indians made the first mission tiles from riverbank clay, formed across the curve of their thighs. Modern manufacturing methods, less sensual but more precisely controlled, generally start with shale, which is crushed to a fine powdery clay. The clay is mixed with water and kneaded (pugged) to the consistency of cookie dough.

To form simple clay tiles, moist, plastic clay is extruded through a die, like dough through a cookie press, and sliced into lengths. More complicated shapes come from pressing the clay into molds. Some ornamental tiles are even sculpted by hand. The formed tiles dry in a room kept at the temperature of a warm summer afternoon, and from there they go to a kiln for firing. For their trip through the kiln, the tiles are either stacked on a refractory (like a small railroad car) that is pulled through a tunnel kiln, or laid on ceramic rollers that convey individual tiles through a roller-hearth kiln. Regardless of the method, the object is to raise the temperature of the clay to the point of vitrification (about 2000° F), at which point the clay minerals lose their individual identity and fuse.

Clay tiles are available in colors to suit any taste, from subtle to outlandish. Right out of the kiln, the tile has the natural earth-tone of the original clay. A nearly pure clay will fire to buff, while iron-oxide impurities impart the terra-cotta color typically associated with Spanish tiles. Manufacturers can also mix clays to get a range of natural colors.

To make variegated tiles, a manufacturer can inject a burst of gas into the kiln, giving the tile a random scorched streak called "flash." Another way to color tiles is to spray a





High-profile tiles are typically made of clay, in either the traditional two-piece mission-barrel style, or the one-piece "S" tile shown here. To discourage nesting, this roof has clay plugs, known as "birdstops," under the courses of tile adjacent to the eaves.



Low-profile tiles are designed to interlock at the edges to keep out the weather. These variegated concrete tiles have been colored with a slurry of cement and iron-oxide pigments.



Flat tiles can be colored and textured to resemble traditional roofing materials such as slates, or the wooden shakes suggested by the dark, striated patterns of the concrete tiles on this roof.

thin creamy layer of clay (called a slip) onto the tile before firing. The tile will then take on the color of the slip. The most dramatic, and most expensive, way to color tile is with a glaze (photos, p. 41). The metallic pigments in the glaze, when fired, melt to a glossy, vitreous, richly colored surface, much like that found on ceramic tile used indoors. Manufacturers who offer glazed roof tiles stock a range of deep brilliant colors and can also brew custom colors.

The long history of clay-tile roofing has produced a variety of styles (drawings, p. 36). The industry typically divides them into three groups: high profile, low profile, and flat. Today you'll find examples made of clay or concrete in all three categories.

Currently, the most popular style is the high-profile "mission" (top photo, previous page). It comes in either the traditional "two-piece barrel" (the concave trough—or *tegula*—and the convex cap—*imbrex*—which is a trough tile turned upside down) or the newer "one-piece S," which joins the trough and cap into a single tile.

Low-profile tiles have a more precise, interlocking look (photo below). Most low-profile tiles are made of concrete, and are characterized by linear bevels, arches and grooves. They are made to interlock along their edges (drawing, facing page) to keep out wind-driven rain and snow.

Flat (or shingle) tiles are just that. They range from simple unglazed rectangles of clay or concrete to textured and glazed flat tiles meant to resemble the variable topography of slates or the coarse pinstripes of thick wooden shakes (bottom right photo, previous page). Like the low-profile tiles, flat ones typically have interlocking edges to keep out the weather.

A few manufacturers can do custom work to match an existing tile that has gone out of production, or to produce decorative finials or other roof ornaments. Ludowici-Celadon, Inc.

(P. O. Box 69, New Lexington, Ohio, 43764) and Vande Hey Raleigh (1665 Bohm Dr., Little Chute, Wis. 54140) are two such companies.

Concrete-tile roofing—Compared with clay, concrete tile is the new kid, with a history of just over 150 years. A German farmer is credited with making the first concrete tiles in the early 1800s for his barn. Commercial production started in Bavaria in the mid-19th century. When concrete-tile roofing spread to the rest of Europe around the turn of the century, manufacturers began to add color to the tiles. Still, acceptance of the new product was slow to come. A 1930's book on tiling noted that concrete tile, "...generally considered a new industry, is subject to a good deal of prejudice," which the industry countered with a vigorous public relations campaign. One company even named itself "The Everlasting Tile Co." Europeans no longer need to be convinced—90% of European houses are roofed with concrete tile. The same holds true in Australia.

In the U. S., concrete tile has been around since the early part of this century, but the industry languished until recently. In the early 60s, the Australians first brought their enthusiasm for concrete tile to California, along with machines for making high-quality extruded-concrete tiles. Since then, concrete tiles have become firmly established in the roofing market. Now more than 30 major plants and many smaller ones sell concrete tile throughout the U. S. and Canada.

The typical concrete tile (drawing facing page) measures 13 in. wide, 16½ in. long and about ¾ in. thick. It weighs about 10 lb. Along both edges runs an interlocking channel, and across the front, underneath, are two or more transverse baffles that rest on the tile below and block blown rain and snow. At the back, projecting lugs allow the tile to be hung on roof battens. The surface texture is either orange-peel smooth or, for tiles that are meant

to simulate wood shakes, striated. (For a look at how these tiles are made, see the sidebar on the facing page.)

Color was added to concrete tiles originally to mimic the terra-cotta of clay tiles, the grey-browns of wood shakes, or the grey-greens of slate. Most people still prefer these earth-tones, yet tiles are also available in striking blues, greens and even white.

Concrete tiles are colored by one of two methods. The first is to add iron-oxide pigment to the batch mix, which produces a uniform color all the way through the tile. A less expensive method is to coat the tile with a slurry of cement and iron-oxide pigment. Use of this technique also allows the manufacturer to add highlights of a second color, creating a shaded or variegated effect.

Regardless of the coloring method, tiles are additionally sprayed with a clear acrylic sealer. The sealer not only helps the tiles cure properly but also makes sure that any efflorescence (the white powder-free lime—that surfaces as concrete ages) is driven out the underside of the tile rather than out the top where it would spoil the appearance. As a side-effect, the sealer gives the tile a slight gloss. However, the gloss wears off in a few seasons, and the color softens to its true matte finish. Before or after the tiles are installed, they can be painted with standard acrylic paint to change their color, much like painting a stucco house. Painted tiles require periodic rejuvenation.

Installing the tile roof—Because tile lasts so long, all other components of the roof should be designed to give equally long service. Tile manufacturers all specify these details in their brochures. Some list minimum standards and secretly hope their customers will use better materials if they can afford them. Other manufacturers, who have seen their own tiles outlive the flashings and felts, now specify only the higher-grade materials—copper flashings, heavy felts (coated base sheets of more than 30 lb., built-up membranes or single-ply roof membranes), and copper nails. For slopes that are less than 3-in-12, tile roofing should be considered decorative only. The real roof is installed underneath.

The procedure for installing a tile roof varies somewhat with the tile pattern, and each manufacturer covers the specifics in their installation instructions. Basically, the roof is first felted, and horizontal and vertical guide lines are chalked to indicate the courses. Layout is critical because any deviations stand out against the pronounced vertical pattern of most tile roofing. If the tile is designed with lugs to hang on battens, those battens are nailed on now (some manufacturers approve of hanging their tiles on spaced sheathing over heavy felt underlayment draped over the rafters). Then the tiles are loaded onto the roof so that they are evenly distributed and within easy reach.

The first course rests on either a raised fascia, a cant strip, special under-eave tiles or, in



Low-profile concrete tiles. After the roof is felted, horizontal battens are affixed to the roof sheathing. Lugs at the top of the tiles bear against the edge of the battens to hold them in place. In seismic zones and windy areas, the tiles should also be nailed down.

Making concrete tile

Back in the 1920s, commercial concrete tiles were made by hand. Workers would pour a "moderately stiff paste" of mortar into wooden or metal molds and then strike off the surface with a profiled screed. The green tiles cured in the molds for a week or more before they were separated and shipped. Today the process is automatic. To see the process firsthand, I visited the SpecTile (now Monier) tile plant in Salem, Oregon.

As I watched the blue Skandia tile extruder whirl and thump, then general manager Rick Olson explained to me what was going on. A conveyor belt fed concrete into the hopper of the extruder. The concrete was not the slurry mix I have poured for walks and walls but a rich, dry mix (5% to 8% water; 20% to 25% cement) that felt more like castle-building beach sand. The dry mix makes a stronger tile that cures more quickly. However, such a dry mix cannot be worked by hand to the required density. That takes high pressure from the extruder.

The extruder plopped a measured amount of concrete mix onto a steel tile mold, called a "pallet," formed to produce the complex profile of interlocking ridges, baffles and lugs on the underside of a tile. The top of the tile was rolled roughly to shape. Then, a cam grabbed the bottom of the pallet and forced it under tremendous pressure beneath a forming die that shaped and troweled the top profile. As the continuous mat of pallets emerged from the extruder, a guillotine knife sliced between the pallets to separate them into individual tiles (photo right) while another arm

punched holes for the nails. Their Swedish-designed, automatic tile-making system had been rated at one tile per second, but Rick told me they were pushing the equipment to 72 tiles per minute and that the extruder might be capable of cranking them out even a little faster.

Rick stopped the machine and pulled a newly formed tile off the tie line. "Here's one way to tell a quality tile," he said, pointing to the interlocking edge. The baffles and interlocking edges were crisp, knifelike edges.

The line of palletted tiles, resembling a nearly gridlocked freeway at quitting time, slid along tracks to the coating machine.



Photo: J. Azevedo

There, a pigmented cement batter drizzled onto a spinning horizontal brush, which flicked the slurry onto the tiles passing underneath. The dry-mix tiles sucked up the slurry, bonding the color to the surface. Another coating machine added a highlight color, or "flash," to the tiles. Finally, the tiles were sprayed with an acrylic sealer.

At this point the tiles had their final shape and color, but they still needed to be cured. We walked around back of the line to the insulated curing chamber, a space perhaps the size of an average house, warmed by the heat of curing concrete. Normally tiles spend 12 hours in this womb before being pushed out once more into the world.

Out of the curing chamber, the tiles rode the conveyor to the "depalletizer," where the pallets were separated from the tiles and returned to the extruder for another cycle. The cured tiles continued down the conveyor to where they were inspected for defects, stacked on recyclable wooden shipping pallets, shrink-wrapped, and moved out to the yard with a fork-lift. Olson, obviously proud of the company's quality control, told me that they must reject only one half of 1% in the plant, most of those for color problems.

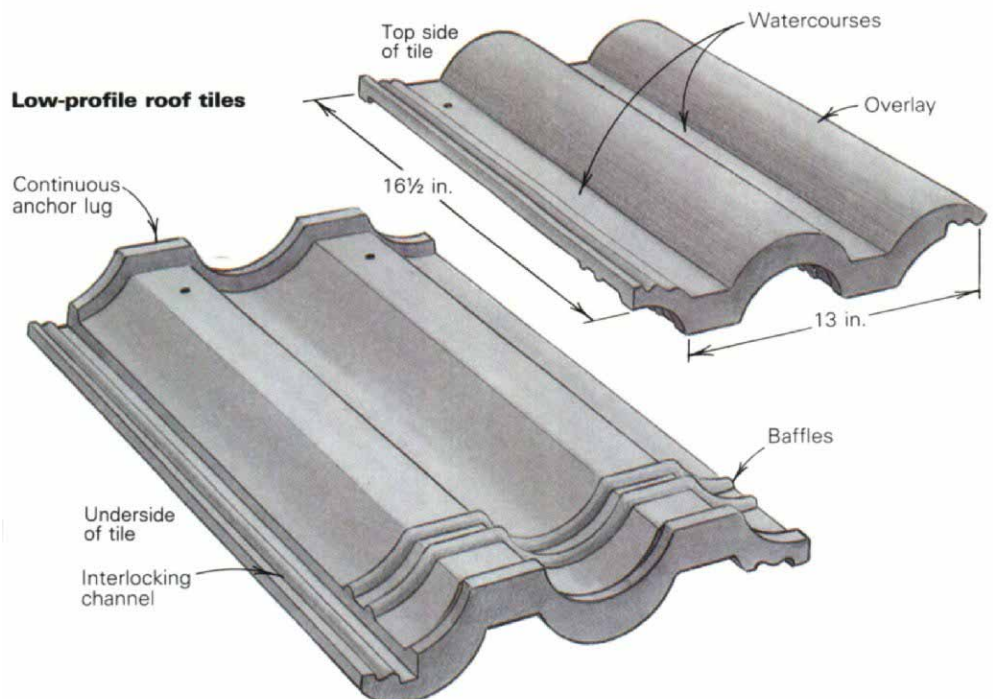
As we walked around the yard, among white plastic cubes of bundled tiles, I asked Rick about business. "Well, these are all sold. I guess we could make more, but our employees like to spend nights and weekends with their families," he joked. And what about problems? "Our biggest problem is finding enough qualified installers who are willing to do a quality job." —J. A.

the case of mission-barrel tiles, a "birdstop" that also plugs the curved voids under the eave course (top photo, p. 37). Once the eave course is laid loose, checked for fit, and then nailed, successive courses are lapped over the one below as the roofer works diagonally up the roof.

Before the turn of the century, tiles on European roofs were fastened with two oak pins. Nowadays, nails will do just fine. The nails should be corrosion resistant at least; copper is better, especially in areas near the coast or affected by pollution. With standard concrete tiles on low-pitched roofs (less than 5-in-12) with battens, the field tiles need not be nailed. Their weight alone will keep them in place. The nailing schedule increases with pitch. In areas with high winds, all tiles are nailed and their butts secured with metal clips (available through your tile supplier).

With mission-barrel tiles, the fastening is a little more complicated (drawing next page). The trough tiles rest on the sheathing, so they can be nailed, but the cap tiles ride on the trough tiles, well above the sheathing. These tiles are generally fastened with copper wire that is either nailed back to the sheathing or tied to vertical copper strips running below

The anchor lug at the top of the tile rests on furring strips or sheathing, while the baffles at the bottom of the tile match and engage the lower course of tiles, preventing rain or snow penetration. The interlocking channels intercept rain blown from the side and direct it down the roof.



the tiles. Another method is to use tile nails, some of which look like gate hooks. Still another option is to nail vertical battens to the roof and nail the caps to these raised strips.

At the ridge or hip, concrete tiles are butted against a raised stringer. The joint is sealed with a flexible flashing, such as lead, and capped with ridge trim tiles affixed to the stringer. In place of flashing, some roofers prefer to point mortar under the edges of the ridge tiles to close off the watercourses. Care must be taken not to pack the joint fully because the mortar would then wick water up into the ridge. Clay tiles may be detailed the same way although some manufacturers offer special tile fittings to close the ridge and hip. With mission-barrel tiles, ridge and hip caps are usually mortared down. In heavy snow areas a tile roof, like any other kind, needs either extra felt or flashing that extends 2 ft. above the line of the exterior wall, or a ventilated roof deck (sometimes called a cold roof) to prevent damage from ice damming.

Once a tile roof is laid, it should need little or no maintenance. In fact, it is best to stay off of it. While tiles are strong enough to support careful foot traffic, someone clomping around on the roof risks breaking a tile. If you must walk on a tile roof, pick your way carefully across the reinforced or supported section of each tile, toward the nose (over the lugs) of concrete tiles and in the troughs (or "pans") of clay tiles. Mortared hips and ridges also

make good paths. Consider laying down a sheet of plywood to distribute your weight, or fill burlap sacks with sawdust and walk on these "pillows."

The question of weight—Try this experiment. Go up to one of your friends and say, "I'm thinking about putting on a tile roof." Chances are your friend will reply, "But aren't they heavy?"

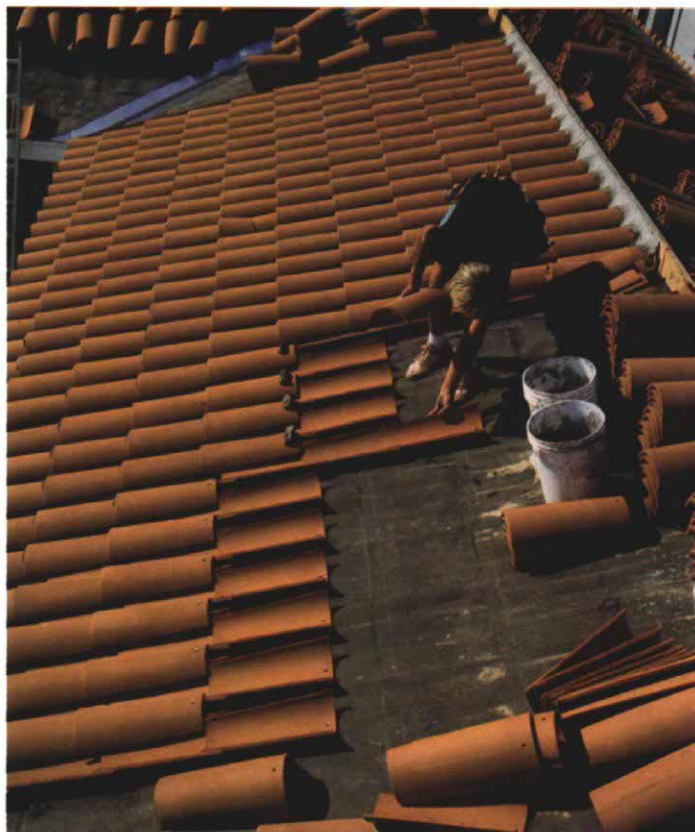
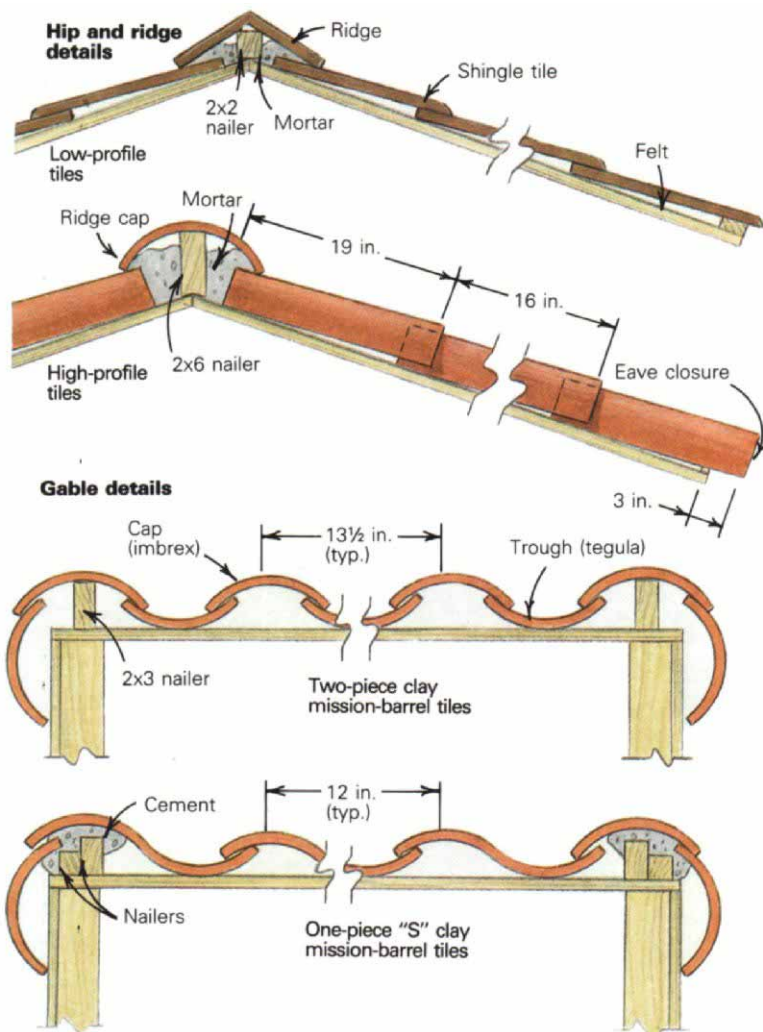
The answer to that question is, of course, "Certainly." A typical tile roof weighs about 900 lb. per square—at least three times as much as wood or composition shingles. In the past, tile's reputation for being heavy has discouraged its use, but a heavy roof is not necessarily a bad roof. In the case of new houses, most are designed to carry three composition roofs: the original plus two re-roofs at intervals of 15 years. A tile roof weighs about the same. For new construction, then, a tile roof will not require any special framing. If you like tile, don't let its weight deter you.

When considering re-roofing an old house with tile, an owner should consult a building inspector or engineer to see if the structure was designed to handle the weight. While most houses can support a tile roof, an occasional old house that was built to minimum standards may have to be reinforced before tiling. Usually, this reinforcement takes the form of a braced purlin at mid-span, and the structural work adds a few hundred dollars to the

roofing expense. An alternative would be to choose one of the lightweight-concrete or hybrid fiber-cement tiles on the market. At 40% to 60% of the weight of standard concrete or clay tile, these materials generally need no additional bracing. But watch the costs. Bracing can be cheaper than the premium charged for these lightweight materials.

During an earthquake, the rolling and shaking of a house has been known to flip unsecured tiles off the roof. Also, on tall houses especially, the weight of any heavy roofing sets up extra stress in the frame as the house whips back and forth. For those of you building in earthquake country, consider taking the precaution of securing at least every other row of tile with nails. And make sure that the house has enough shear strength to resist wracking. Check with your local building department or consult with a structural engineer if you are in doubt about the ability of your house to bear the weight of a tile roof during an earthquake.

I was curious about the effects of the 1989 earthquake in Santa Cruz, California, on tile roofs, so I called the building department there to find out how tile roofs fared during the shake. I was told that, in general, tile roofs held up well. Any tiles that were shaken loose were unsecured and were typically on roofs steeper than 5-in-12. Tall houses with tile roofs showed no structural damage, reflecting the soundness of the tough engineering requirements that have been in force there for some time.



High-profile clay tiles. Tapered two-piece mission-barrel tiles have nail holes at opposite ends, depending on whether they are cap or trough tiles. The cap tiles above are secured with long nails. It's best not to walk on a tile roof—all the cap tiles behind the broken cap in row five will have to be pulled before it can be replaced.

What will it cost?—Not surprisingly, the cost of a tile roof will depend on the type of tile, the distance from the manufacturer to your site, the complexity of the roof, the quality of installation you specify, and who installs it. Like other premium roofing products, such as slate and metal, tile costs more initially than an ordinary composition roof but can have a lower life-cycle cost because it lasts much longer. Also, the appreciation in property value and lower maintenance must be figured into the calculation.

Concrete tile generally is the least expensive type of tile roofing. A basic concrete-tile roof installed by a knowledgeable roofer in an area where tile is common, such as the Sunbelt states, will cost about \$125 to \$150 per square (100 sq. ft.), with about half of that as materials and the rest labor. In an area where tile is still a new idea or with a roofer just getting started in tile, the cost will be higher. A complex roofline will cost more for both labor and materials. Premium flashing and fasteners will also add to the expense.

In the South and Southwest, the home of clay tile, a new roof of unglazed, one-piece mission tile will cost the same or a bit more than concrete. Two-piece mission-barrel tiles run a little more because there are more tiles to install. For most other areas of the country, where clay-tile plants are scarce, shipping adds considerably to the cost.

Glazed clay tiles stand on the top rung of the cost ladder. The tiles alone start at just under \$170 per square—about the same as treated shakes—with shipping, fittings, labor and profit on top of that. The most expensive glazed tiles that I've heard about top \$1,000 per square. Most people who are contemplating a tile roof cannot justify the additional cost of glazed tile versus unglazed. There are times, however, when least cost is not the object, and intangibles enter into the equation. The rich color and texture of some of the glazes on classic profiles may seduce an otherwise analytical voice that speaks of budgets and mortgages.

Finding the right tile—Your first step in selecting a roofing tile is to reconcile your taste with your budget. Once you have decided on a general category of tile, you will want to find a reputable manufacturer. Concrete tiles are now manufactured throughout the Sunbelt states, and plants are beginning to spread across North America and Hawaii. Clay tiles come from plants in California, Florida, Ohio, and New York. Glazed tiles are made in California and Ohio, and are imported from the Orient to West Coast ports. To find a nearby manufacturer, check with your local roofing-supply house. If you cannot find the tile you want, call or write the National Tile Roofing Manufacturers Association (NTRMA, 3127 Los Feliz Boulevard, Los Angeles, Calif. 90039; 800-248-8453). Tell them what you are looking for, and they will direct you to a manufacturer or help you find the tile that is right for your project.

Before you buy, check into the reputation of the manufacturer. If you choose a tile from a member of the NTRMA, the tiles will meet or exceed ICBO (International Conference of Building Officials) standards and have a 50-year warranty. If you choose a tile made by someone else, ask about their warranty and for a copy of their ICBO report. Whatever you do, walk away from a supplier who cannot or will not provide an ICBO report that matches the identifying marks on the tile.

As important as finding the right tiles is finding the right person to install them. The place to begin is with the manufacturer. Most manufacturers keep a list of roofers who have been trained to install roofing tiles. When you

talk with the roofer, start out with the standard questions about experience, licenses, insurance, and references. Then together go over a copy of the manufacturer's installation guidelines. If the roofer suggests varying some detail, check that it will not void the manufacturer's warranty. Ask the roofer about upgrading the flashings, fasteners, and felts. It seems false economy to scrimp on the details after committing to the investment in a roof that will outlive the next generation. Here may be the one insoluble disadvantage of a tile roof: it forces us to think beyond our own mortality. □

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Glazed clay tiles. Tiles made of clay can be finished with baked-on glazes in both custom or stock colors. This Japanese-style roof in glossy white is essentially the same as the interlocking S-type mission tile, but its trim pieces, such as the cylindrical hip starters and the belled ends of its hip and ridge tiles, give it an exotic flair.



While most tile roofs cap a house in earth-toned silence, the rich colors made possible by using vitreous glazes on ceramic tiles can make the impact of the roof the dominant element in the bearing of a house.