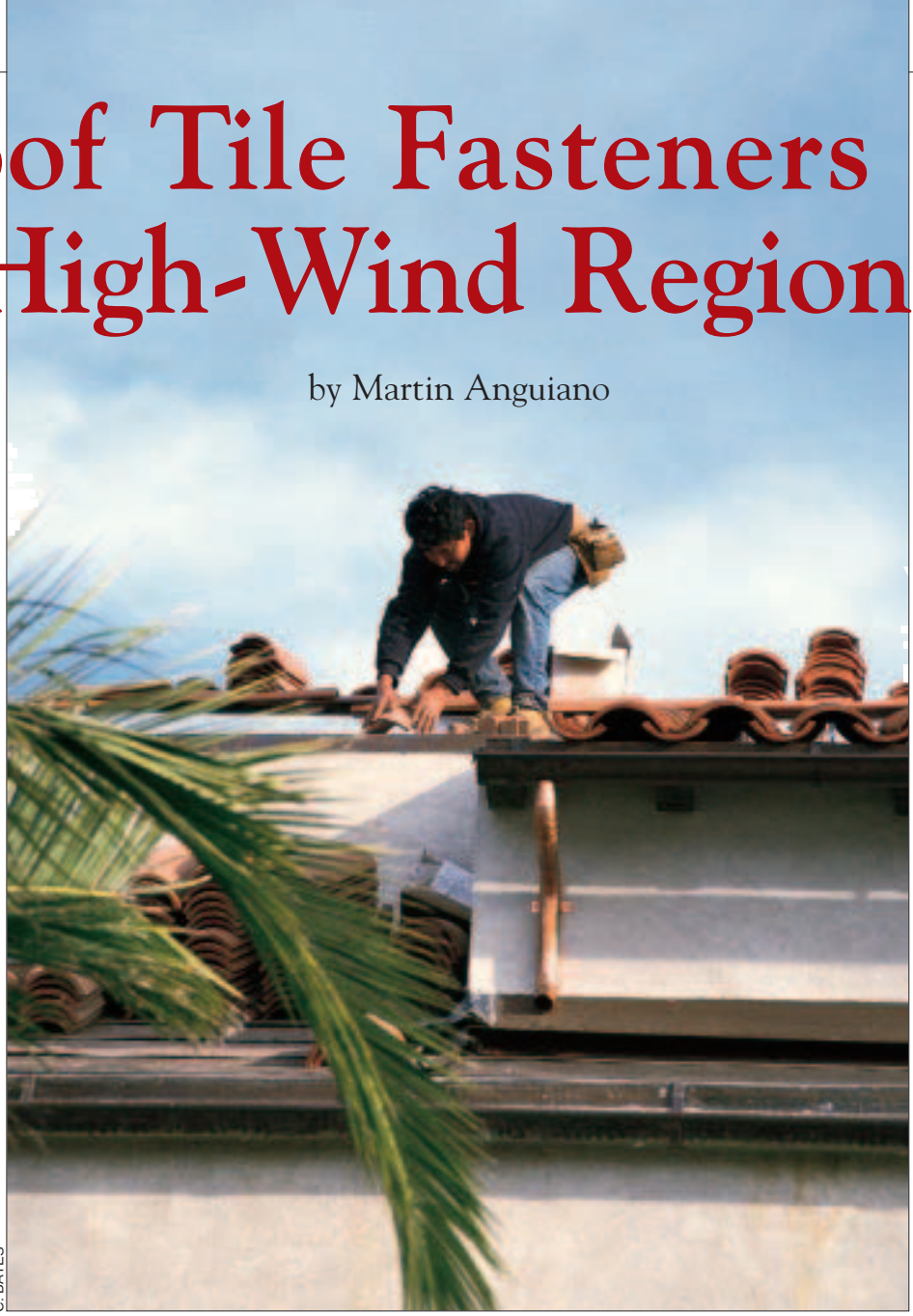
Roof Tile Fasteners for High-Wind Regions

by Martin Anguiano



C. BATES

When it comes to securing roof tiles in high wind locales, current practice is ahead of the codes

Recent hurricanes and earthquakes, as destructive as they were, have created ideal conditions for studying roof tile attachment systems. Since we work on tile roofs in an area subject to both earthquakes and high winds, we have to know what the codes require — and what *works*. We've learned that when it comes to tile roofing, the minimum building code requirements don't always survive the maximum stresses these roofs face.

We've repaired and replaced wind-damaged century-old Spanish clay tile roofs as well as new clay and concrete tiles installed with exacting fastening specifications. In every case, design problems and poor workmanship were the main reasons for tile roof failures.

Why Tile Roofs?

Clay and concrete tile roofs are popular in the arid West primarily because they won't burn. But tile also gives years of service, acts as insulation and ballast in the summer, and adds traditional architectural beauty. In some locales the building codes require tile. In our area we typically install or repair clay S tiles, clay two-piece barrel tiles, concrete double-S tiles, and concrete flat tiles.

On the downside, tile roofs, whether clay or concrete, are not completely waterproof. As part of a system, the tile's main purpose is to "shed" water and protect the underlying waterproof membrane from the damaging effects of the ultraviolet sunlight.

Figure 1. ***Mortar systems*** *are popular because they don't penetrate the underlying waterproof membrane with nails. Unfortunately, they are also prone to destruction from high wind, as evidenced by the eaves damage on this house.*

Blow the House Down

Hurricanes give tile roof systems a real test. Not only are the winds over 100 mph, but they are more turbulent and change their angle of attack as the storm passes. Most dangerous of all, they carry large amounts of debris, which turn into missiles that break tiles, cascading into yet more damage.

When wind flows over a roof's surface, it creates a negative pressure similar to that over an airplane's wing. Combined with the updraft from the wind hitting the structure, this creates enormous uplift forces on the roofing. As the wind blows, it also forces itself underneath the tile at eaves, rakes, and other projections. Eventually, even heavy roof tiles that are improperly fastened will work loose, break, or fly away.

Inadequate fastenings, the height of the structure, the number and size of overhangs, roof slopes and profiles, the angle the building sits in relation to the wind, and even the fit of one roof tile onto another all have a bearing on which roof tiles blow off.

Shake the house down. In an earthquake, seismic forces travel up from a building's foundation, along its shear walls, through the roof, and back down again. A roofing material is able to survive in proportion to its ability to move or "give" with the event. Rigid tile attachment systems that anchor tiles directly to the roof are more prone to cracking and breaking.

Anchoring Systems

In areas with no wind and no earth movement, tiles have for centuries been "loose laid" on wooden battens. The weight of the tile itself held it in place.

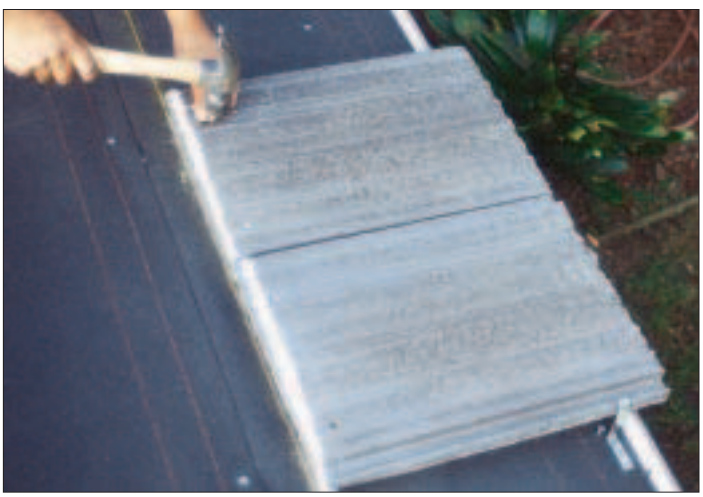


Figure 2. ***Direct-nail attachment*** *is stronger than mortar, but creates lots of holes in the protective roof membrane.*

Mortar-set systems. As the slope of the roof increases, or in areas where wind velocities approach 80 mph, a "mud on," or "mortar set," system has been the accepted attachment method. The tile is set in a mortar bed (usually a trowel-shaped "patty") over a built-up membrane — typically a mineral-surfaced cap sheet set in hot asphalt over a nailed base sheet.

This system relies on the mortar to create a bond between the tile and the roll roofing. Soaking the tile before installation reduces chances of dry tile drawing out the moisture in the mortar, but it still requires a skilled craftsman to do the installation. In high winds, the predominant failure is between the mortar and tile, but it can also happen between the mortar and membrane (see Figure 1). After disastrous experiences in recent Florida hurricanes, the mortar-set system is no longer recommended in high-wind areas.

Nail-on systems. With the "nail on" or "direct nail" method, each roof tile is nailed directly to the roof sheathing (for low-slope roofs) or to a wooden batten attached to the sheathing (Figure 2). In either case, there is a waterproof membrane underneath. Traditionally, one nail is used through the prepunched hole at the head end of the tile.

Nailing has several advantages over mud-on. It's faster by far: Nailing is much less labor-intensive than cementing tiles. Pneumatic nail guns, which can be adjusted to control the exact nail depth, make installation go even quicker. Unlike the mud-on system, nailed tiles can "give" a little in big winds, which helps equalize the pressure.

The type of nail used is probably the most important factor affecting the survivability of a nail-on roof. Smooth-shank nails work their way out in heavy winds, so either a ring-shank nail or a hot-dipped galvanized nail should be used. And two nails are better than one.

One perceived disadvantage of the nail-on method is the number of nails penetrating the "waterproof" membrane. In fact, leakage is not usually a problem with a well-installed tile roof.

Battens. With concrete tiles, battens — typically 1x2s — are required for pitches of 7/12 and greater. The code requires that every 4 feet there be a gap

Figure 3. ***The twisted-wire method*** *uses a double strand of 14-gauge wire fastened at the ridge and eaves with special anchors (left). Each tile is secured with an individual tie wire (below left) that is threaded through the open loops in the twisted wire (below).*

between batten strips, or that they be elevated with moisture-resistant shims every 4 feet so water can pass underneath them. Battens are also a big help when it comes to stacking tiles on a steep roof.

Tie Wires

Every time you attach a tile with a nail, you puncture the waterproof roof membrane underneath. As an alternative, a "twisted wire" system has been developed that uses fewer nails and, because it is not rigidly attached, yields without transferring the seismic load to the building.

Designed for 2/12 to 24/12 pitch roofs, the twisted-wire system consists of two wires (12-gauge galvanized, with stainless or copper also available) wound together with an expanded loop or eyelet approximately every 6 inches. The wires run from ridge to eaves between vertical courses of tile and are attached with approved anchors (Figure 3). The anchors are nailed or screwed into the roof at the ridge, eaves, and every 10 feet along the roof slope, and are threaded through the wire loops and bent over to secure the tie wire.

The individual tiles are secured to the twisted wire with separate tie-wires. We "prewire" the tiles on the ground before bringing them up on the roof; the individual tie wires on the tiles are then looped through the loops on the wire runs fastened to the roof. Depending on how rustic a look the designer is trying for, we may also add mud under and between the tiles.

Twisted-wire systems are specified in earthquake zones and areas with moderate winds. Damaged tiles fastened with the tie-wire system are easy to replace: you just fold back the damaged tile, untwist the wires, and add the new tile.

Butt Hooks and Other Clips

Nail-on and twisted-wire systems only attach the tile at the top — the butt end, or "nose," of the tile is free to rotate and break in a big wind.

Special wire clips, known variously as butt hooks, S hooks, nose clips, and tile locks, provide a hold-down for the exposed edge of each cover tile (Figure 4, next page). The clips secure the front of the tile to keep them from "chattering" or, more seriously, prying the nail out or snapping the tile at the attachment point.

These clips can be used with any combination of fasteners and are available in stainless, brass, and galvanized.

Hurricane clips. A less effective clip is the hurricane clip, or side strap. This is a locking device for the side edge of concrete, clay, and clay S tiles. Made of 18-gauge galvanized steel, the clip is bent to an L shape with the top curved to fit snugly over the side edge of the tile. The bottom of the clip is flat and is nailed or screwed to the sheathing or batten.

Hurricane clips should be used only as a backup fastener to help roofs survive high winds. It's hard to get these clips to fit snugly to the tile, so after several storms, they tend to bend and work loose. The first storm loosens the clip, the second deforms it, and on the third storm the clip lets go.

Tile nail. A new clip that functions as both a nail and a nose clip is the Tile Nail by Newport Fasteners (1300 Gene Autry Way, Anaheim, CA 92805; 714/385-1111). This is a 12-gauge galvanized wire (also available in brass or stainless) approximately 10 inches long with a 1¼-inch tail and a hook on the other end

(Figure 5). The nail end is slipped through the hole in the tile and nailed into the sheathing 6 inches above the tile — far enough away so there is no fear of breaking the tile. The next piece slips into the "nose" hook, positively restraining it as well as setting the head lap distance for the next course. The nail is then "buttered" with roofing cement.

Tile Adhesives

Another way to keep winds from getting under the tile and causing "chatter" and loosening is to use a tile adhesive. The adhesive bonds the tiles together at the head lap where the wind can find its way in and begin to pry the tile loose.

In keeping with the "more is better" approach, some contractors in hurricane-prone areas are purchasing tiles with close-fitting tolerances and then gluing every tile with adhesive. Recently, some tile roofs in Guam that are completely wired, clipped, and glued withstood 140-mph winds during typhoon Yuri.

Newer tripolymer-based adhesives, like Tyle-Tye Chatter Damper (also available from Newport), remain flexible after application, and have been shown to work better than earlier brittle adhesives. Tyle-Tye can also be applied in wet conditions.

Design Criteria for Tile Roofs

Roof tile anchoring systems depend on several criteria that designers must balance between cost and effectiveness. The considerations include local wind velocities, the local seismic zone, and how many nail penetrations into the waterproof membrane are acceptable. Codes and regulations vary by region and, because of the recent devastating hurricanes and earthquakes, are currently being updated. But in all cases they should be considered minimum standards.

In fact, only recently have the building codes even tried to address the "engineered" performance values of clay and concrete tiles and their related fastening systems. At present, for high-wind areas and tall buildings, the Uniform Building Code requires one nail in the head of every tile, plus a nose clip for eaves tiles and an extra nail for rake tiles. In addition, the noses of all ridge, hip, and rake tiles must set in a bed of mastic.

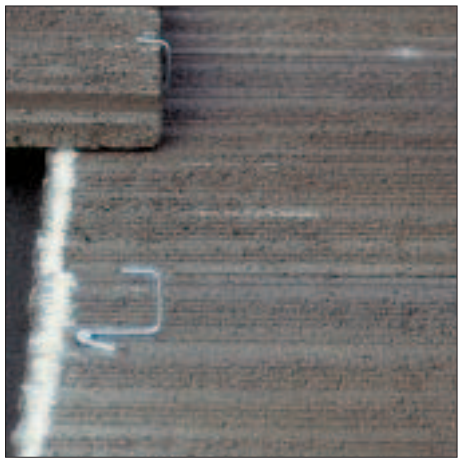


Figure 4. *Nose clips* *(left) hold down the front end of the tile. The same nail secures both the nose clip and the tile underneath. Hurricane clips (right) are L-shaped brackets that hook over the side of a roof tile. According to the author, these clips have a tendency to deform and work loose in repeated winds, so should only be used as backup protection.*

Figure 5. *The Tile Nail* *from Newport Fasteners has several advantages over a conventional nose clip. Because it is driven in a few inches away from the tile (above left), there is less risk of cracking the tile while nailing. Its length allows enough movement to keep the tile from breaking during high winds or an earthquake. Also, the nail holes can be patched with mastic to prevent leaks in the membrane (left).*

However, earthquake and hurricane damage since 1991 has pushed officials to develop more stringent requirements. Although not yet universally adopted, recommendations from the National Tile Roofing Manufacturers Association require *two* nails or a nail and a clip for *every* tile (depending on sheathing thickness, building height, and whether battens have been used). In many cases, perimeter tiles require *three* fasteners. These recommendations have recently been adopted by Palm Beach County. If you work in a high-wind or seismic zone, check with your local officials for new code developments. ■

Martin Anguiano owns Martin Roofing in Santa Barbara, Calif., specializing in tile roof applications.