Concrete and Masonry Fasteners

A survey of anchors reveals some surprising alternatives to lead and plastic

by Kevin Ireton

"If a horse can't eat it, then I don't like it." That's what Richie Allen, then a first baseman for the Philadelphia Phillies, said when Astro-Turf was installed at the Houston Astrodome. As a carpenter, I've always had similar feelings about concrete. If my saw can't cut it and if I can't hammer a nail into it, then I don't like it. But just as Allen had to play on AstroTurf, I've had to work with concrete.

I've never been comfortable fastening material to masonry—attaching a ledger board to a foundation wall to support a deck, installing a threshold on a concrete slab or hanging kitchen cabinets on a brick wall. Like most residential carpenters, I usually chose lead anchors, also called lag shields. These were the only anchors I knew about, and the only ones available in most hardware stores and lumberyards, except for plastic anchors, which I always thought were pretty wimpy. Powder-actuated fasteners (see *FHB* #21, pp. 30-34) weren't appropriate because I didn't want to risk splitting the wood, or blowing out the concrete and having to use additional fasteners in one place.

I recently discovered that there's a whole industry out there devoted to concrete and masonry fasteners, with trade associations, testing and regulatory agencies, manufacturers, importers, distributors, and lots of nifty fasteners (some of the manufacturers, and the types of fasteners they make, are listed in the chart on p. 57). But most of the applications for these fasteners fall into the domain of commercial/industrial construction, and that is where the marketing efforts are aimed. Many residential builders don't know about all the different masonry anchors available or where to buy them, which is a shame.

Concrete screws **work like woodscrews. After drilling a pilot hole (top), the drill bit is retracted into the shaft of the installation tool, a Phillips-head bit is inserted and the screw is driven into the hole (middle), cutting its own threads in the concrete (bottom).**

Drills and drilling—The hardest part of any anchor installation is drilling into concrete. I've drilled plenty of holes with my standard electric drill. But if you have to drill a lot of holes at one time, especially in the larger sizes (over ¼ in.), buying a hammer drill is a good investment. These heavy-duty tools combine a high-speed reciprocating action with the drilling operation. The impact of the drill bit works to shatter any aggregate that gets in the way, and the reciprocation helps remove dust and debris.

Most tool manufacturers now make ⅜-in. hammer drills, which can drill up to ½-in. dia. holes in concrete, more than big enough for most residential jobs. Look for a hammer drill that's variable speed and reversible, and be sure to get a side handle and depth gauge.

Selecting the right drill bit is even more important than what drill you use. Part of my distaste for drilling into concrete stems from buying cheap bits, ruining them in the first few holes, then continuing to use them. In order to bore into concrete or masonry, a drill bit needs to have a carbide tip, and carbide-tipped tools are expensive. For years I balked at paying the price for mid-range and top-of-the-line carbide drill bits. Now I know better.

If you're going to use the bit in a hammer drill, be sure to buy one that's designed for this use. Carbide bits for standard rotary drills won't stand up to the impact of a hammer drill.

Most masonry drill bits are coated for corrosion resistance. In general the bright finishes, like zinc, are there to appeal to consumers and

All fasteners are shown actual size.

begin to flake off after a few uses. Bits for commercial use usually have a black finish, so buy these if you can. They're probably better bits.

Stay away from drill bits with fast-spiral flutes (facing page, bottom), which look more like a bolt thread than a twist bit. They're the cheapest bits to manufacture and to buy, so they abound in hardware stores. Often you'll want to drill, in one operation, through wood into concrete, and the fast-spiral bits don't work well in wood. The flutes are too small to auger large chips of wood out of the hole.

Once you've got a decent drill bit, the next priority is not to ruin it. Drill slowly and let the drill and bit do the work. Don't lean all your weight on the drill to speed things up—this will overheat the bit and destroy its temper.

If progress stops partway into a hole, it means that you've hit a piece of aggregate or rebar. Pull the bit out and look at the tip. If there are metal shavings on it, you hit rebar. Don't try to drill through it, you'll just hurt the bit. Cut your losses and drill somewhere else.

If there aren't any metal shavings on the bit, you probably hit a piece of aggregate. Put an awl or drift punch in the hole and hit it with a hammer. This will fracture the stone, and then you can continue drilling. Although it's more important with some anchors than it is with others, it's always a good idea to clean out the hole before you set the anchor.

Lead shields and anchors—For years lead was the cornerstone of the masonry-fastener industry. Its malleability lets these anchors conform to the rough surface of concrete or masonry. Unfortunately, that same malleability limits their holding power and also makes them susceptible to working loose through vibration. A lot of lead anchors are still available today, including single and double-wedge expansion shields, lag-screw expansion shields and wood-screw anchors (facing page, bottom). The latter two are what you'll get when you go into most hardware stores and ask for concrete anchors.

The big drawback to lead anchors is that they require hole spotting. This means you have to drill a screw or bolt-size hole through whatever you're mounting, hold the piece in place on the concrete or masonry surface, and mark the hole. Then you put the piece down and drill a larger hole in the concrete for the lead anchor. And since drill bits tend to skate around on concrete before boring in, it's easy to end up with a misaligned anchor.

One of the manufacturers I spoke with referred to lead anchors as dinosaurs, but, he said, they're still made because they're so popular in consumer markets. Tradition makes them sought after, though, not design. There are better anchors out there.

Flush anchors—Also called drop-ins, these machine-thread anchors are made of lead, steel and a variety of alloys. The steel anchors (below left) are some of the strongest available. Most operate by means of internal wedges that expand the outer sleeve. Some require a setting tool to install, others use the machine bolt to expand them in the hole. Hole depth is critical with machine-thread anchors, but this also means the anchors install flush with the surface, which is an advantage in certain circumstances.

Wedge and sleeve anchors—In addition to being much stronger than lead, the major advantage of these anchors is that you can drill one hole, the same size, through both materials you're fastening. If you were hanging a cabinet on a concrete wall, for instance, you would simply drill through the mounting rail into the concrete, insert the anchor and tighten it.

Both wedge and sleeve anchors are made of steel—a resilient material, like concrete itself—and achieve their strength by actually compressing the concrete. They work by means of a threaded rod with a cone-shaped tip (below right). The tip end is inserted into the hole, and a nut or screwhead is tightened on the other end. With wedge anchors, the cone-shaped tip pulls against a short sleeve with barbs in it that wedge in place near the bottom of the hole. They are extremely strong and impossible to remove once installed. They're often used in highway bridge renovation to anchor guardrails.

Wedge anchors can be used to anchor sill plates to foundation walls. I know at least one builder who prefers them to poured-in-place anchor bolts because they allow him to put an anchor wherever needed to straighten crooked plates. You can get a box of 25 ½-in. by 5½-in. wedge anchors for about $25 to $30.

With sleeve anchors, the cone-shaped tip pulls against a long metal sleeve with slots cut in it. The slots cause the sleeve to flare outward and exert considerable pressure against the sides of the hole. These anchors aren't as strong as wedge anchors, but have the advantage of being available with different head styles. You can get them with a stud bolt and nut, a hex head, a round head or with a flat slotted head.

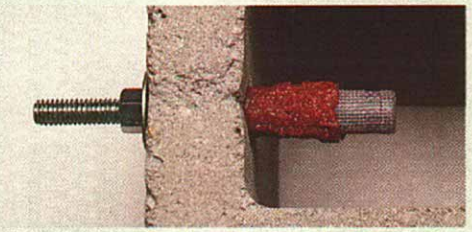
Sleeve anchors provide a larger bearing surface than wedge anchors and so will work in a wider variety of applications. In their technical notes on brick construction, the Brick Institute of America (11490 Commerce Park Dr., Reston, Va. 22091) rates sleeve anchors as the most versatile for brick masonry.

Occasionally wedge and sleeve anchors will

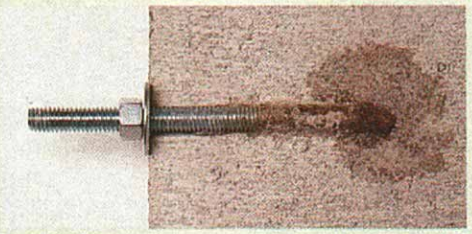
spin in the hole without grabbing, usually because the hole is too big. If this happens, use a hammer or a flat bar to pry outward on the anchor while continuing to turn the nut or screwhead. You have to be careful not to tighten wedge and sleeve anchors too much or you'll strip them. Most manufacturers recommend turning the nut or screwhead three to five turns after the anchor first engages.

Chemical fastening systems—The newest and fastest-growing species of fasteners is the adhesive chemical anchor, which comes in two forms, caulking-type tubes and glass capsules. Both involve setting a threaded rod, or sometimes just a piece of rebar, into a hole half filled with a mixture of resin, quartz aggregate and a hardening catalyst. Curing time varies from ½ hour to 24 hours, depending on the temperature of the concrete. The resulting bond is incredibly strong because the epoxy-like mixture flows all around the threaded steel and into the pores of the surrounding concrete or masonry.

One of the chief advantages of chemical anchors is that they don't stress the base material into which they're set. They can be used near the edge of a concrete wall or slab, where an expansion bolt would be liable to break the concrete. Chemical anchors are also highly resistant to corrosion and vibration.



Chemical anchoring. **In hollow walls, a tubular screen contains the adhesive.**



In solid masonry, glass capsules are shattered by a bolt, which releases their chemicals.

To install chemical anchors, you have to drill a hole to the specified depth, then clean out all the debris, using a vacuum cleaner, compressed air, or a blow-out bulb. Cleaning out the debris is a very important step.

Tube systems work in a couple of ways. The simplest has all the ingredients in a single tube that fits a standard caulking gun (below left). Just before using it, you mix the ingredients by moving an internal agitator, either by hand or with an electric drill.

A much more sophisticated system, called Polly-All (Ackerman Johnson Fastening Systems) involves a pneumatic caulking gun that holds two tubes, one with resin, the other with catalyst. As you squeeze the trigger the chemicals are automatically dispensed in the proper amount and mix outside the tubes.

The equipment for this system is expensive (over $450 for the pneumatic caulking gun alone), but since the epoxy is mixed outside the tubes you can use a portion of a tube and save the rest. It is worthwhile if you are doing a lot of chemical anchoring. The manufacturer is working on a less expensive, manual version of the gun.

Both systems allow you to squirt epoxy wherever you need it, in whatever amount you need. With the use of a tubular screen, they will also work in hollow walls (top photo at left), like concrete block. The tubular screen contains the epoxy just enough to keep it from running out of the hole, and also lets it mushroom inside the hollow space for a more secure anchor.

The other type of chemical anchor comes in long capsules made of glass (below right). They're filled with a pre-measured amount of

elastic monomer resin, quartz aggregate and a hardening catalyst separated in its own little vial. After drilling the hole to the specified length and cleaning it carefully, you insert the capsule. Then you chuck a sharpened piece of threaded rod or rebar into your drill (using a special attachment sold by the manufacturers) and slowly drive it into the capsule, which shatters. The glass shards become part of the aggregate. After the rod is fully inserted, let it spin for an extra second or two. This ensures that the glass is ground up and that all the ingredients are well mixed. It's important with all the chemical anchors not to move the insert while the epoxy is curing.

Glass capsules are sold in boxes of 10. A 4-in. capsule and the appropriate threaded rod (sold separately) cost about $3.

Concrete screws—About 10 years ago, Buildex (Illinois Tool Works, Inc.) developed the TAPCON, a blue-coated screw made of steel so hard that it can be screwed into concrete. You still have to drill a pilot hole for these screws, a precise one in fact, but you don't need any kind of anchor. The screw cuts its own threads in the concrete. TAPCONs became so popular that Buildex couldn't keep up with the demand, so they licensed other companies to manufacture and market them under the TAPCON trademark.

Since then, many companies have developed their own concrete screws (below left), and for good reason. Concrete screws are stronger than nearly all the lead and plasic anchors used in residential construction. They're faster and easier to install. They're reusable and fireproof. The only reason more builders don't use them is that most builders don't know about them.

Concrete screws are expensive. The 2¼-in. #14s that I bought at my local hardware store cost $0.60 each. But compared to the cost of other anchors, and considering how quickly they can be installed, they're worth it. Builders who use them buy them by the box, which undoubtedly works out to be cheaper than what I paid. Some manufacturers even throw in a drill bit with each box of 100 screws.

Concrete screws are available in lengths ranging from 1¼ in. to 4 in. and in either hex head or Phillips head. The hex heads, and the drivers they're installed with, hold up a little better under the high torque these screws are subjected to. High torque also means that if you've got a choice, you should use a screw gun to install them (because of the clutch), not a regular drill.

You can get special installation tools for concrete screws that have a drill bit, an integral hex-head driver and a Phillips-head bit attachment all in one (below left). You're probably better off using a hammer drill and a screw gun, if you've got both. If you don't, the installation tool will save a lot of time.

Concrete screws will work in block and brick (into the unit itself, not the mortar joint), as will most of the fasteners discussed in this article. But since these materials aren't as strong as concrete, fasteners anchored into them won't produce shear and withdrawal values as high as those into concrete. Also since bricks range from very hard and brittle to soft and crumbly, none of the fastener manufacturers list strength values for anchoring into them.

Toggle bolts—When you're anchoring into concrete block or hollow brick, you should drill into one of the webs if you can. But if your drill bit penetrates one of the voids, consider using a toggle bolt (below right). These are long thin bolts with large wing-shaped mechanisms called toggles that screw onto them. The toggle is spring loaded and folds flat against the bolt so that it can be slipped through a hole in the hollow block. Once inside, the toggle springs open and can be tightened against the block.

One problem with toggle bolts is that you have to drill a hole much bigger than the bolt in

Concrete screws

Toggle bolts

This toggle-bolt variant has plastic straps that hold toggle in place without bolt. At left, ready for installation; above, installed.

order to get the toggle in. I discovered some T-anchors, made by Diversified Fastening Systems, Inc., that don't have that problem. These have a flat piece of steel pinned through the end of the bolt. The bolts have a slot cut in the end into which the flat piece of steel can be pivoted parallel to the shank of the bolt. In this position, the T-anchor will fit through a hole the same size as the bolt itself. Because the flat piece of steel is pinned a little off center, gravity opens the T-anchor once it clears the hole.

Another nifty variation on the toggle bolt was first manufactured by Unifast under the trade name Kaptoggle, though a similar version is now also made by Toggler. With this toggle bolt you still have to drill a hole that's bigger than the bolt. But the advantage with this fastener is that the toggle is installed separately and will stay in place without the bolt, which means you can remove or change things without the toggle falling down inside the block.

The toggle comes attached to a pair of ribbed plastic straps. You insert the toggle into the hole, while holding onto the straps. Once it's inside it opens up against the block, just as the other toggles do. Still holding onto the straps, you slide a plastic cap down the straps until it engages the hole, and its flange is against the block. Then you simply break off the straps, and the cap and toggle are locked in place.

Hammer-driven fasteners—The two most significant features of these fasteners are that installation is usually simpler and removal more difficult (an advantage where vandalism is concerned). With one type of hammer-driven fastener, you still have to drill a hole in the concrete or masonry. But once the hole is drilled, installation is quick. All you do is insert the fastener and hammer an integral pin down the center of it, which expands the sleeve inside the hole.

These fasteners come in a wide variety of styles, including steel stud anchors, zinc alloy and aluminum pin anchors, and nylon nail anchors (below). All the ones I tested drove in easily and seemed to hold well. I especially liked the zinc alloy and aluminum anchors. Their strength and cost fall nicely between the plastic and steel. And there was something satisfying about the way the pin and sleeve head meshed together like a well-peened rivet.

One recent innovation in hammer-driven fasteners, the Rawl SPIKE (The Rawlplug Co.), looks like a blunt nail with a crook near the end. It's made of grade 8 hardened spring steel and results in great holding power, much stronger than most plastic and lead anchors, especially in withdrawal. You have to drill a hole first, but then you just drive it in. Like the concrete screw, the Rawl SPIKE is simple and effective.

Some companies make an installation tool for hammer-driven fasteners. It looks like a motorcycle throttle grip and has a steel piston running down the middle of it. You insert a pin or threaded stud in the bottom, place the unit against the wall, and hit the piston with a hammer. One of the problems with driving nails into concrete is that they're very unforgiving of a glancing blow. If you don't hit the nail squarely on the head, it will bend. Because of its piston, the installation tool precludes this problem. But after pounding in a few of these with only limited success, I decided I'd rather take the time to drill. You're more certain of a secure anchor if you use one that requires a predrilled hole, and drilling is a less intense operation than swinging a hammer with all your might.

Cut nails and spiral masonry nails round out the hammer-driven category of fasteners. These are tough to drive (a 22-oz. or 28-oz. hammer helps), and they don't always hold. You have to be careful not to overdrive them; one blow too many will fracture the concrete, loosening the nail. But nails are fast and cheap. In basements all over the country, paneling is installed over furring strips nailed to concrete walls. If you use nails on brick masonry, be sure to nail into a mortar joint and not into the bricks themselves.

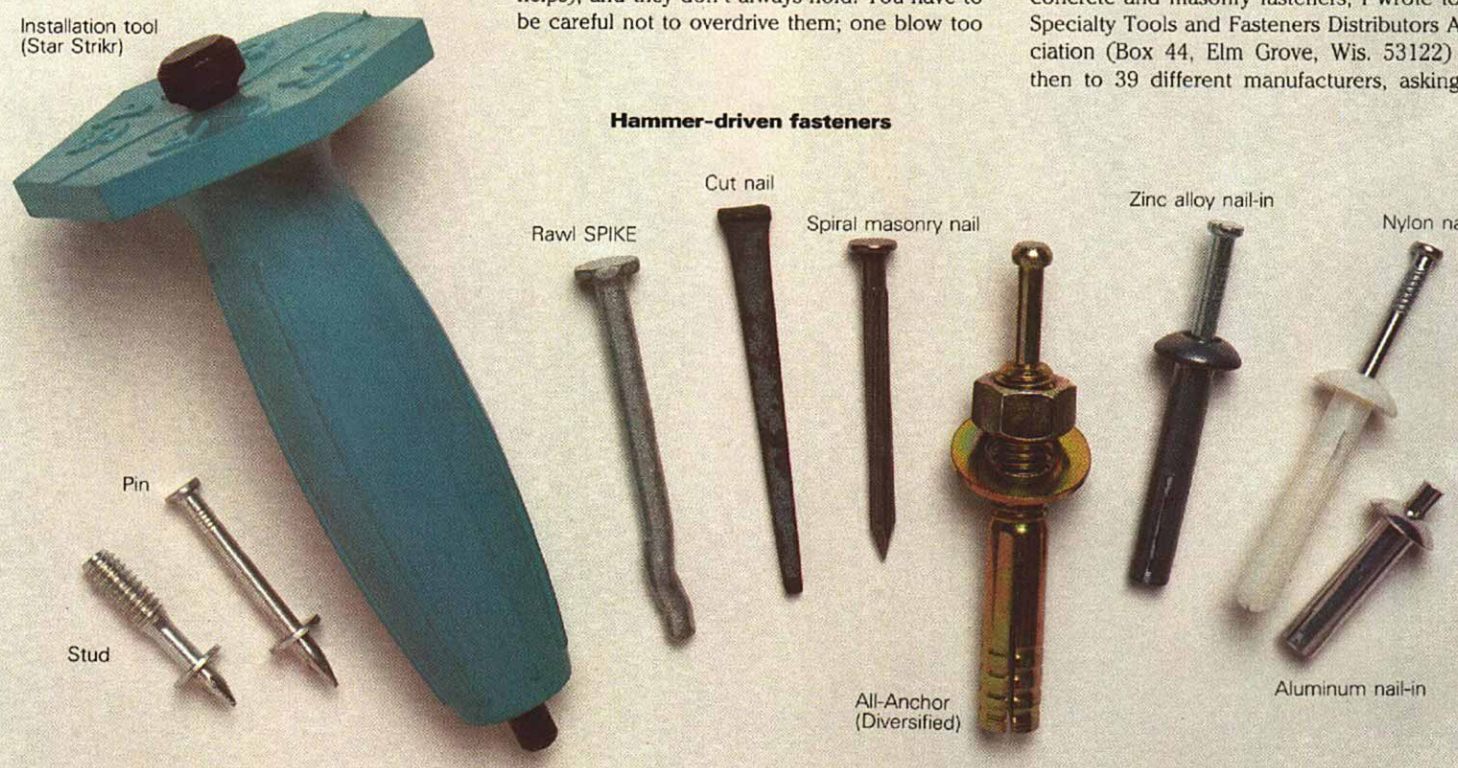
One trick that helps with all fastenings to concrete and masonry, but that is particularly useful with concrete nails, is also to use construction adhesive. Apply it to one surface, the furring strip for instance, press the two surfaces together, then pull them apart for a minute. This helps spread the adhesive, increases its initial tack, and also lets you see any low spots on the wall.

Plastic anchors—The truth is that nearly all the anchors I've listed will work for most residential applications. Because they were developed to support the greater loads found in commercial and industrial construction, most are far stronger than you'll need around a residential project. Among the biggest loads I can imagine supporting with masonry fasteners are kitchen cabinets. So I asked several manufacturers what they would recommend for this application. All of them said plastic anchors would work fine.

As with all the other fasteners, plastic anchors come in a variety of shapes, sizes and colors. There are cylindrical vinyl plugs, toggles, conical screw anchors and ribbed anchors, also called prong anchors (facing page). They all require hole spotting and drilling a bigger hole for the anchor than for the screw.

The plastic toggle, pioneered by Toggler, will work in both hollow-wall and solid-wall applications. Its wings fold parallel to the shank so that it can be inserted into a hole. The wings open up inside a hollow wall. In a solid wall, they remain folded and act as an expansion anchor.

What does it all mean?—While researching concrete and masonry fasteners, I wrote to the Specialty Tools and Fasteners Distributors Association (Box 44, Elm Grove, Wis. 53122) and then to 39 different manufacturers, asking for



product literature and samples. I visited a half-dozen hardware stores and lumberyards, and made a lot of phone calls. At the last minute, I was still discovering anchors that I'd never seen before. And I won't be surprised to learn, after this article is published, that I've left out a few.

Nonetheless, some of the fasteners I've discussed ought to be a regular part of every builder's hardware arsenal, and the others are good to know about for those oddball situations that come up now and then.

I found no reason to recommend one brand of fastener over another. Most of the manufacturers have their products tested by independent laboratories and submit the results for approval by groups like the International Conference of Building Officials.

Your best chance of finding a large selection of concrete and masonry anchors in stock is at an industrial-supply house. If you don't have one near you, your local hardware store or building-supply yard can probably order what you need through a distributor. I turned up one industrial-supply company that sells mail order: Phillips Brothers Supply (2525 Kensington Ave., Buffalo, N. Y. 14226). All the companies mentioned in this article offer a variety of fasteners (see the chart at right), and if you contact them directly, they'll supply technical assistance and help you track down a supplier in your area.

If all else fails, and you can't find any of these fasteners, you can do what one custom builder in Idaho does: epoxy redwood plugs into holes drilled in concrete and use woodscrews. □

Sources of supply

Manufacturers	Fasteners: Lead anchors	Flush anchors	Wedge and sleeve	Chemical	Concrete screws	Toggle bolts	Hammer driven	Plastic anchors
Ackerman Johnson Fastening Systems, Inc. 136 Official Rd. Addison, Ill. 60101 (312) 543-2797	●	●	●	●	●	●	●	●
Albert Berner GmbH & Co. KG Moore Construction Fastening Products, Inc. 250 Barber Ave. Worcester, Mass. 01606 (617) 853-3991	●		●	●	●	●	●	●
Barrett Manufacturing Co. 4124 W. Parker Ave. Chicago, Ill. 60639-2173 (800) 621-7522	●	●	●			●	●	●
Buildex 1349 W. Brynmawr Ave. Itasca, Ill. 60143 (312) 595-3500					●		●	
Celtite, Inc. 150 Carley Court Georgetown, Ky. 40324 (800)626-2948				●				
Diversified Fastening Systems, Inc. P.O. Box 339 Charles City, Iowa 50616 (515) 228-1162		●			●	●	●	
Elco Industries, Inc. 1111 Samuelson Rd. P.O. Box 7009 Rockford, Ill. 61125 (815) 397-5151					●			
Hilti Fastening Systems P.O. Box 21148 5400 South 122nd East Ave. Tulsa, Okla. 74121 (918) 252-6000			●	●	●	●	●	●
Mechanical Plastics Corp. P.O. Box 328 Pleasantville, N. Y. 10570 (914) 769-8450						●		●
Ramset Fastening Systems 2100 Golf Rd. Suite 460, West Bldg. Rolling Meadows, Ill. 60008 (312) 640-0770		●	●	●	●		●	
The Rawlplug Co., Inc. 200 Petersville Rd. New Rochelle, N. Y. 10802 (914) 235-6300	●	●	●	●	●	●	●	●
Semco Plastic Co., Inc. 1366 Kingsland Ave. St. Louis, Mo. 63133 (800) 325-0622							●	●
Star Expansion Co. Mountainville, N. Y. 10953 (914) 534-2511	●	●	●			●	●	●
Unifast Industries 45 Gilpin Ave. Hauppauge, N. Y. 11788 (516) 348-0260	●	●		●	●		●	●
Upat Essve Inc. 1849 Peeler Rd., Suite D Atlanta, Ga. 30338 (404) 392-1699		●	●	●		●	●	
U. S. Anchor 1531 N. W. 12th Ave. Pompano Beach, Fla. 33069 (305) 782-2221	●	●	●	●	●	●	●	●
Wej-It Anchoring Systems P.O. Box 521120 Tulsa, Okla. 74152 (918) 743-1030	●	●	●			●	●	●

Editor's note: This is not a definitive list of manufacturers, but includes the major companies and any others that responded to our request for information and samples of their products.