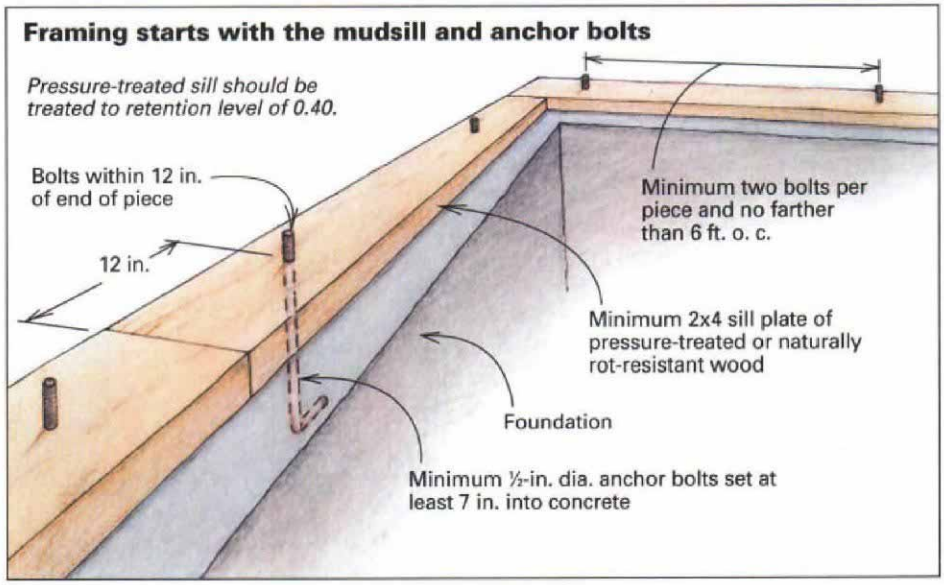
Avoiding Common Framing Errors

By paying attention to some basic details, you can avoid the framing mistakes that building inspectors encounter most frequently

by Rick Tyrell



When it comes to building inspectors, I'm like the teenager who thought his father was a poor simpleton who knew nothing about anything. A few years later, after the son had a child of his own, he was amazed at how much the old man had learned in such a short time. The truth is, I'm amazed by how much building inspectors have learned since I began working in construction 12 years ago.

As a builder/remodeler, I sometimes thought that building inspectors pushed points in the code that didn't seem all that important. But after years of learning—from my own mistakes and the mistakes of others—I now understand that the code really provides only minimum requirements for health and safety. It's important to remember that if there is a code violation, the builder assumes all responsibility, and the building official assumes none.

Remember, too, that the importance of some code issues isn't obvious until the integrity of a structure is tested by some sort of a natural disaster. Hurricanes are perfect examples. Most people in a storm's path aren't aware of any code violations until their buildings collapse during the storm. Improperly secured plywood blows off roofs. Some buildings blow off their foundations because of inadequate anchoring.

The house must be anchored firmly to its foundation—According to the code, sill plates must provide a minimum protection against termite and decay damage and must be of pressure-treated lumber or naturally rot-resistant wood such as heartwood of redwood, black locust or cedar (drawing above).

Before I knew better, I used pressure-treated lumber that was treated to 0.25, which refers to the retention level of the wood preservatives that are forced into the wood. However, I should have used lumber that had a retention level of 0.40. According to the Southern Forest Products Association, 0.40-retention, or ground-contact, lumber is required anytime treated lumber comes in contact with concrete that contacts the ground. To know if lumber has been treated to level 0.40, read the grade stamp on the lumber or the tag stapled to the lumber. (For more on grade stamps, see *FHB* #103, pp. 70-73.)

Once the sills are in place, they must be anchored to the foundation. According to the Council of American Building Officials' (CABO) model code, anchor bolts may not be placed less than 7 in. into concrete, must be a minimum of ½ in. in dia. and must be spaced no farther than 6 ft. o. c. Also, each section of sill must have at least two bolts that go through a minimum 2x4 stock, and the bolts must be placed within 12 in. of the ends of the sills.

Top plates require offset joints and adequate fastening—I remember photographs of damage inflicted by hurricane Hugo. One photo showed a wall that had let go because a joint in the double top plate was inadequately offset from another. The whole wall gave way between those two joints.

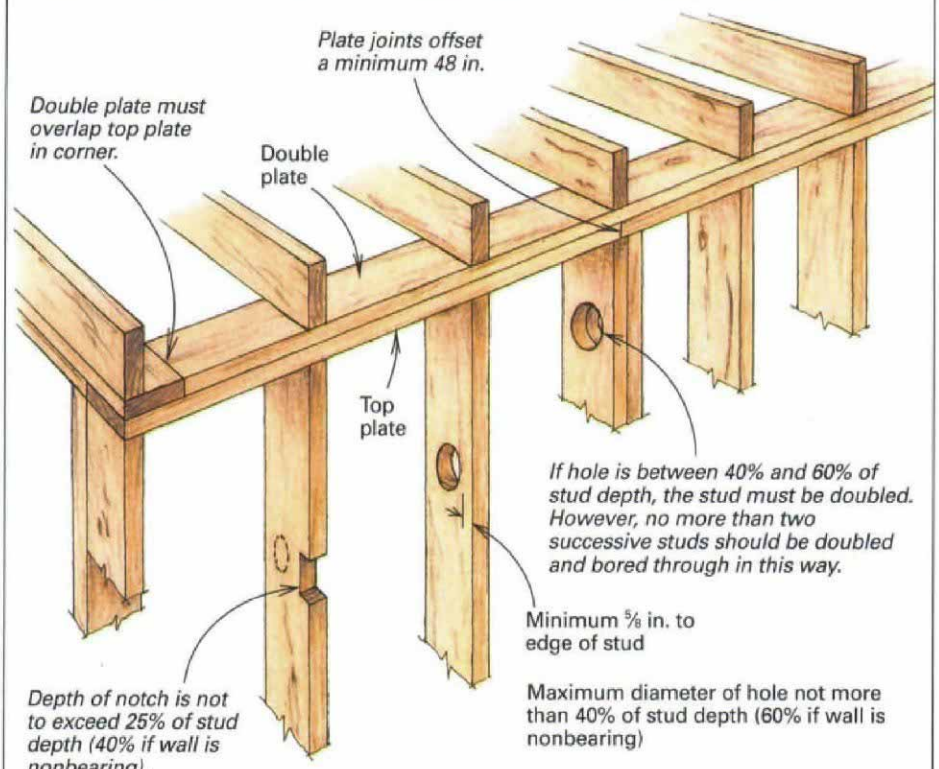
Improper fastening and offsetting of double-top-plate joints are the most common errors found in bearing-wall construction. By code, the double plate must overlap the top plate in the corners. Joints in the top plate must be offset by a minimum of 48 in. from joints in the double plate (drawings facing page). Overlapping provides a continuous tie in the walls.

Most of my residential-framing experience has been limited to framing 16 in. o. c. and to double top plating. When you're framing this way, there are no limitations on how close rafters, floor joists or bottom chords of roof trusses must be to the supporting studs underneath. If you frame using a double 2x6 top plate, you can space your studs up to 24 in. o. c. and place a supporting member at any point above it (chart facing page). If it's a 2x4 frame that's 24 in. o. c. and has a double top plate, whatever is supported above it must be within 5 in. of the stud below it.

For a single top plate to be allowed, it must be spliced with a 3-in. by 6-in. by ⅛-in. steel plate at all joints (bottom drawing, facing page), in-

Drawings: Christopher Clapp

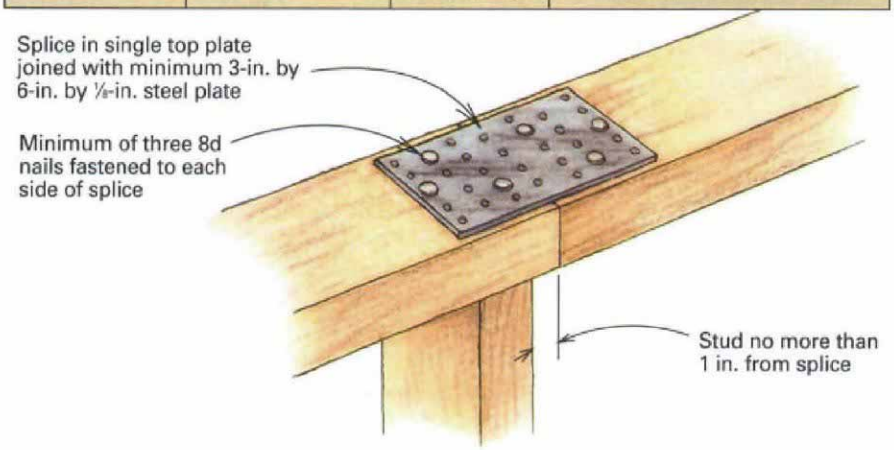
Whether load-bearing or not, stud walls need to stay sturdy



Supporting rafters, joists and trusses with standard stud-frame construction. *Top plate, stud size and spacing affect the location of rafters, joists and trusses above.*

Wall construction for one- or two-story houses

Stud size	Stud spacing	Top plate	Location of members above
2x4	16 in. o. c.	Single	Within 1 in. of support
2x4	16 in. o. c.	Double	Anywhere
2x4	24 in. o. c.	Single	Within 1 in. of support
2x4	24 in. o. c.	Double (2x4)	Within 5 in. of support
2x6	16 in. o. c.	Single	Within 1 in. of support
2x6	16 in. o. c.	Double	Anywhere
2x6	24 in. o. c.	Single	Within 1 in. of support
2x6	24 in. o. c.	Double (2x6 or greater)	Anywhere



eluding comers. There also must be a minimum of three 8d nails fastening each side of the splice. Even after this, rafters, joists or trusses must be within 1 in. of the supporting studs below them.

When notching and boring, be careful not to go too far—I once worked on a project that looked as if the plumber had just gotten his first Sawzall: All the notches and holes were cut in the centers of the floor joists. So much of the structural integrity of the joists was compromised by this butchering that the building inspector made us pull out the floor.

With a little planning, some of this notching and boring could have been avoided. Or we could have avoided the extra work if we had used headers to make an opening in the joist so that no strength was lost. Now I hand out three pages of drawings to my electrical and plumbing subs that show exactly where notches and holes can and can't be cut.

Rules for notching and boring differ depending on whether the wall is a bearing wall or a nonbearing wall. Notching in a bearing-wall stud may not exceed 25% of the stud depth (drawing top left). Notching in a nonbearing wall may not exceed 40% of the depth. If a wall was framed with 2x4s, the notch in a bearing wall may not exceed ⅞ in., as opposed to a 1⅜-in. notch in a nonbearing wall.

There also are considerable differences when it comes to boring holes in bearing and nonbearing walls. The diameter of a hole bored in a bearing wall may not exceed 40% of the stud depth. A bored hole in a nonbearing wall may not exceed 60% of the stud depth. Using a 2x4 as example, the maximum-diameter hole you may drill in a bearing wall is 1⅜ in., vs. 2⅛ in. for a nonbearing wall. In both bearing and nonbearing walls, all holes must start at a minimum of ⅝ in. from the edge. Boring and notching in the same cross section of a stud is prohibited in any case. Also, a bearing wall may have a hole whose diameter is greater than 40% of the stud (but less than 60%), if the stud is doubled and the hole doesn't carry for more than two successive studs. If the top plate is notched more than 50%, usually to allow for plumbing or venting, it must be reinforced with a minimum of 24-ga. steel or its equivalent.

Joists and rafters carry their own rules—There are specific rules on notching and boring floor joists and roof rafters. No notching is allowed within the middle third of the member. Notching at the ends of floor joists, either at the top or at the bottom, may not exceed one-fourth of the depth of the joist. Notches elsewhere may not exceed one-sixth the depth of the member itself (drawing p. 68). Rafters and ceiling joists

may be notched at the ends but never more than one-fourth of the depth of the member. Notching on the top of the rafter or ceiling joist may not exceed one-third of the depth and may not be farther from the face of the support than the depth of the member.

The rule for boring holes in ceiling joists and roof rafters is easy to remember because the rule is the same for both. All holes must be a minimum of 2 in. from the top and bottom. The hole may not exceed one-third of the depth of the member. Using a 2x10 for example, one-third comes out to 3⅜ in.

Rules for engineered wood are evolving— The phrase *engineered wood* refers to combinations of lumber, plywood, metal, glue and oriented strand board (OSB), such as glue-laminated wood, laminated-veneer lumber, wood I-joists and trusses. The Building Officials and Code Administrators Inc. (BOCA) model code says that "cuts, notches and holes bored" into engineered wood "shall be based on research and investigation" funded by companies applying for code approval of their engineered wood. This process is still under way, so until the code is clear on the use of engineered wood, we have to rely on the manufacturers' guidance. The code is clear on the use of manufactured trusses, however. They may not be cut or modified unless so specifically designed.

Most makers of engineered-wood materials are in sync on cutting and notching, although each offers its own set of guidelines. For instance, Willamette Industries (800-942-9927) offers an installation guide for use of its StrucJoist and StrucLam products. It cautions against any notching of its structural laminated beams. Willamette's technical department suggests that ¾-in. holes may be bored through a laminated beam as long as the holes aren't over a support, aren't too numerous or lined up, and are located in the center of the beam. If you need to bore a larger hole, technical representatives will advise you on how to proceed.

Willamette offers a hole chart for boring through its structural-wood I-joists. In no case should the flanges of a wood I-joist be cut or bored through nor should holes be cut in the plywood or OSB web directly over a support.

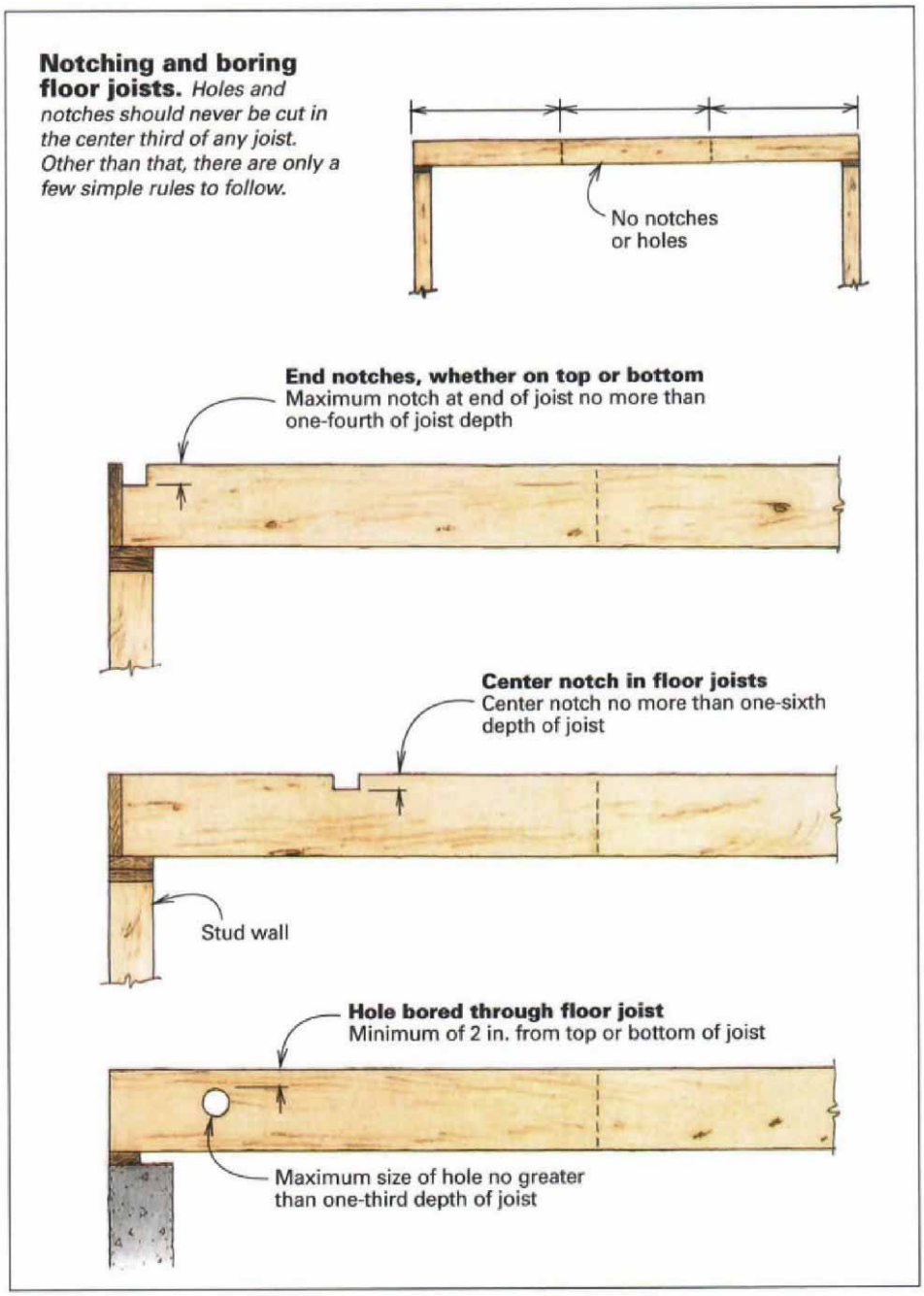
Bird's mouths and collar ties are common areas of mistakes—Thinking back, I realize that most of the framing errors I've made had to do with rafter cutting. Specifically, my mistakes involved cutting bird's mouths, the notches in the ends of rafters where they rest on top plates. One reason so many errors pop up in rafter cutting is that although there are rules for notching rafters for wiring, there are no code requirements for cutting bird's mouths. I worked with one builder who believed that the seat cut of a bird's mouth should always equal the width of the wall plate on which it rested. He thought that by following this procedure, if the inside wall called for a cathedral ceiling, the drywall would go right to the edge of the wall. His method worked fine on a low-pitched roof. But with a 12-in-12 pitch roof, the bird's mouth would have to be so deep that it would eat up all but about 1 in. of a 12x12.

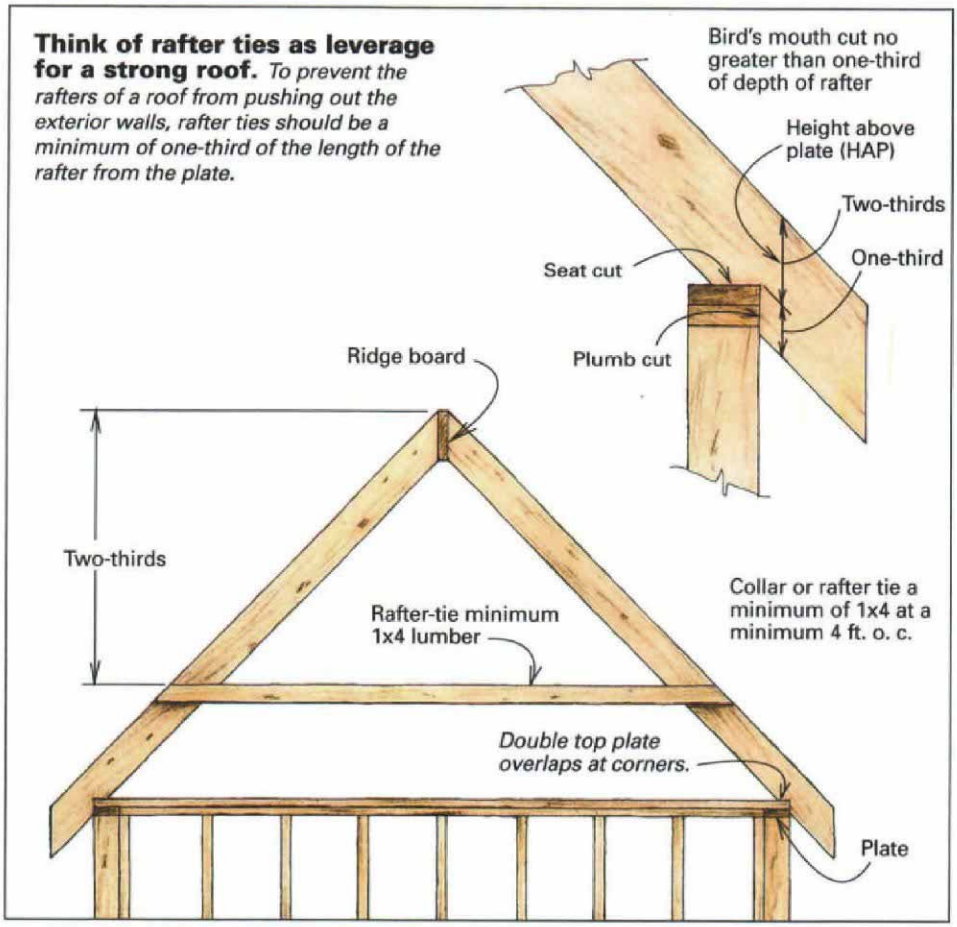
It was not until I read and studied Marshall Gross's book on roof framing *(Roof Framing;* Craftsman Books, 1984) that I fully understood and could solve roof-framing problems. Gross's simple solution is to leave two-thirds of the rafter material above the seat cut. In a 2x4, a 3-in-12 rafter would have 2⅜-in. height above plate (HAP) left in the member after the bird's mouth was cut (drawing left, facing page). A 12-in-12 pitch roof would have a 3½-in. HAP. This measurement is made from the top of the plumb cut.

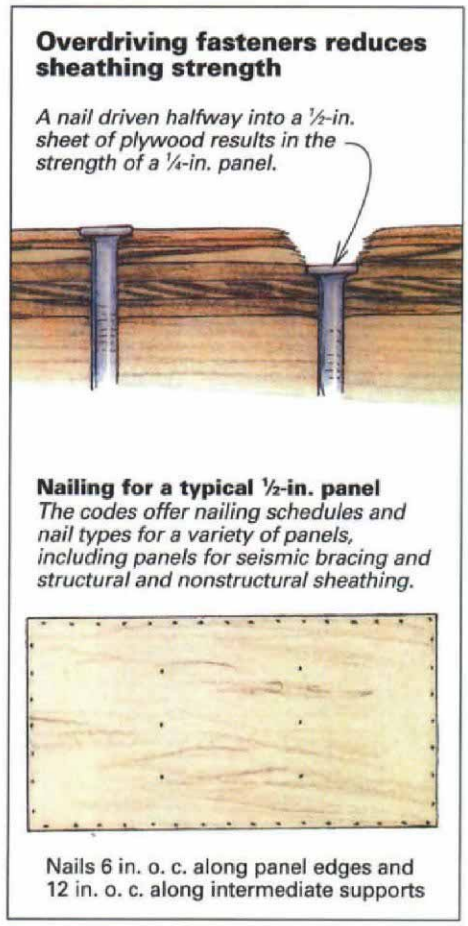
Another code violation that building inspectors cite frequently is improperly spaced or nonexistent rafter ties. Rafter or collar ties must be a minimum of 1x4 material spaced no more than 4 ft. o. c. The code only says that the rafter tie should be located as near the wall plate as is possible.

However, for a rafter tie to be effective, it must span a minimum of one-third the distance up the rafter from the top plate (drawing left, facing page). David Utterback, a code expert with the

Notching and boring floor joists. *Holes and notches should never be cut in the center third of any joist. Other than that, there are only a few simple rules to follow.*







Western Wood Products Association, compares rafter ties to using long-handled pruning shears. Grab the handles at the end, and you have plenty of leverage to cut off a limb. Grab the handles near the cutter, and it's much more difficult to cut a limb. So the closer the tie is to the bottom of the rafter, the greater the leverage.

Improper nailing can make itself known the hard way—People don't usually notice the result of improper nailing—too few nails or nails of the wrong size—until a disaster occurs. Once again, hurricanes Hugo and Andrew showed just how many buildings were improperly nailed together. Plywood was ripped off homes. Structures collapsed before the expected limits of the construction were reached. Later investigations showed that many of these losses could have been prevented with proper nailing.

All the codes contain fastening or nailing schedules for connections of structural wood. Nevertheless, it's common to see the wrong size or type of fastener used in framing. Common mistakes include using roofing nails to hold joist hangers and using nongalvanized nails for exterior applications. Although it's not a code violation, for best results in nailing subfloors and underlayment, use ring-shank instead of smooth-shank nails.

Another factor in structural failure has to do with fastener overdrive, or overnailing, from pneumatic nailers. Even if the nailing schedule is correct, power-driven staples and nails may misplaced (not fastened to the structural member) or overdriven because of excessive air pressure (drawing above right). Shear capacity also may be seriously compromised when fasteners are overdriven.

According to APA-The Engineered Wood Association, if more than 20% of the fasteners around the perimeter of a sheathing panel are overdriven, or if any are overdriven by more than ⅛ in., additional fasteners are required to maintain shear capacity. For every two fasteners that are overdriven, one additional fastener is required. If nails used in the original installation are spaced too closely to allow placement of additional nails, then approved staples must be used for the additional fasteners.

Another consideration, APA says, is the minimum nominal panel thickness required for shear design. If design shear for the construction requires a minimum $^{19}/_{32}$-in. nominal panel thickness and sheathing is $^{19}/_{32}$ in. with fasteners overdriven ⅛ in., the result is a $^{15}/_{32}$-in. panel. □

Rick Tyrell is a builder and writer in Prosperity, South Carolina.

Finding code information

Most libraries and all building-inspection offices have copies of the relevant model codes on Me for public use. I recommend that you go to the source whenever you're in doubt. If you need to ask a specific question that's not clear to you in the code, you may want to take advantage of promotional trade groups.

The Southern Forest Products Association (SFPA; 504-443-4464), APA-The Engineered Wood Association (APA; 206-565-6600) and the Western Wood Products Association (WWPA; 503-224-3930) have technical representatives to answer questions. Another valuable resource for me was Redwood Kardon's *Code Check* (The Taunton Press, 1995). This clipboard-type publication puts code issues together in a simple, logical format.—*R. T.*