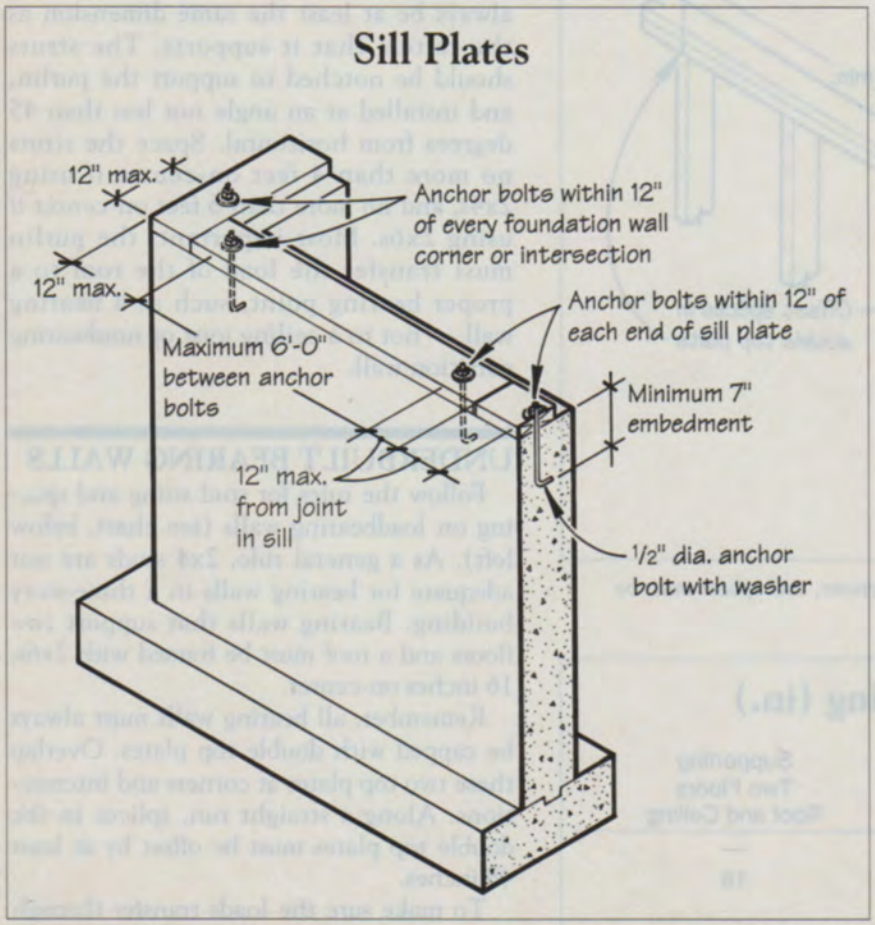
by Ralph Pimentel

Ten Common Framing Flaws

A building inspector's list of typical framing errors and simple solutions

Regardless of the quality of construction, all buildings look good on the day they are completed. They all have plumb walls, flawless ceilings, level floors, and flat rooflines. Yet the true measure of a building's worth is not its first appearance, but its ability to maintain an upright posture over time. Sometimes a building's performance falls short of expectations within six months; for others, the flaws are not noticeable for years. Still other houses show no signs of failure even after decades of use and exposure. Why is it that some houses are able to retain their postures while others literally quake under pressure? The answer lies in something called "structural integrity," a quality determined by how closely a builder follows "acceptable framing practice."

As a building official with more than 10,000 inspections under my belt, I've witnessed countless errors during framing inspections. Here's my list of the ten most common framing errors I encounter. Some of these relate more to the safety of the inhabitants than to the integrity of the building. But all of them must be addressed at the framing stage.



Sill plates hold back the lateral wall pressures from wind, quakes, and shifting soils. All sill plates must be properly bolted to the top of the foundation, as shown.

UNBOLTED SILL PLATES

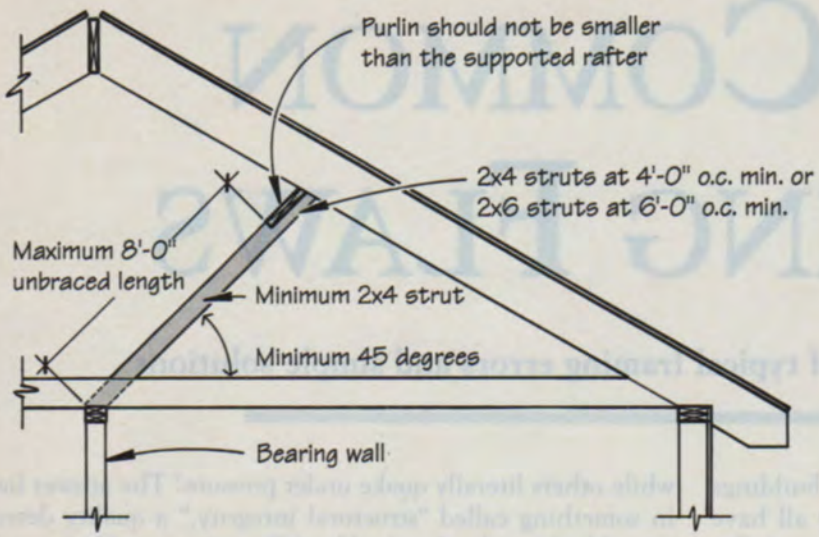
Sill plates are the first line of defense in holding back the lateral wall pressures from wind, quakes, and shifting soils. Without proper bolting, the rim joist will do the twist, while foundation walls do the limbo.

All sill plates must be properly bolted to the top of the foundation, whether it's a block or concrete wall, spread or trench footing, or a concrete slab. Steel anchor bolts should be a minimum of 1/2 inch in diameter, embedded not less than 7 inches into the concrete, and spaced not more than 6 feet apart. An anchor bolt should be located within 12 inches of the end of each sill plate and each end of a section of the foundation. Once properly bolted down, the sill plates should also be fastened well to the wall framing, and not just by nailing through the band joist or the bottom wall plate: Lap the plywood sheathing over the sill and fasten it with plenty of 8d nails.

OVERSPANNED MEMBERS

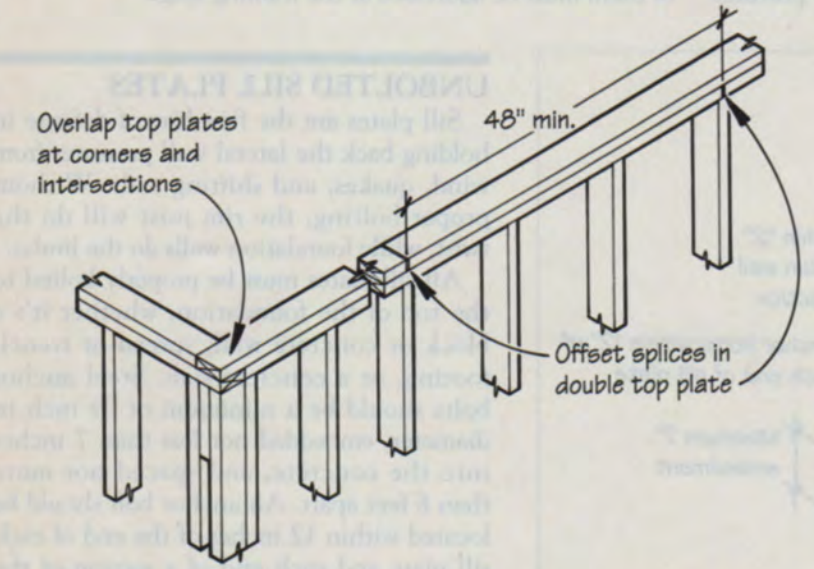
Whether it's a floor joist, ceiling joist, or roof rafter, each framing member has a specific allowable span, which must not be exceeded. Depending on the species and grade of the wood, a critical *modulus of*

Purlin Design



A properly constructed purlin must be at least the same dimension as the rafters that it supports. Supporting struts should be notched into the purlin and installed at an angle not less than 45 degrees to transfer the load of the roof to a bearing wall.

Splicing Top Plates in Bearing Walls



Double top plates must be lapped at corners and intersections, and splices must be staggered by at least 48 inches.

Maximum Stud Spacing (in.)

Stud Size	Supporting Roof and Ceiling Only	Supporting One Floor Roof and Ceiling	Supporting Two Floors Roof and Ceiling
2x4	24*	16	—
2x6	24	24	16

*Shall be reduced to 16 inches if Utility grade studs are used.

Adapted from CABO Table R-402.3d

elasticity and an equally important *fiber stress in bending* determines the allowable span (see "How to Use Span Tables," 4/94). When overspanned, the member will fail under what might otherwise be an acceptable live and dead load. Sagging rooflines, cracks in ceilings and walls, and bouncy floors all attest to this error.

Builders must never assume that just because their client doesn't own a waterbed or a piano, they can get away with smaller floor joists. You may be right about this client, but you can't speak for the next owner. Keep in mind that a house will serve generations, and should be built to accommodate a variety of lifestyles.

INADEQUATE PURLINS

Many a sagging roof and wavy ceiling can be attributed to improperly built roof purlins. A purlin is a horizontal brace supporting rafters that is in turn supported by a "strut" — a diagonal brace that redirects roof loads to a proper bearing point. This strut is crucial to the whole assembly. Unfortunately, it is one of the most misunderstood framing members in a house.

A properly constructed purlin must always be at least the same dimension as the rafters that it supports. The struts should be notched to support the purlin, and installed at an angle not less than 45 degrees from horizontal. Space the struts no more than 4 feet on-center if using 2x4s, and no more than 6 feet on-center if using 2x6s. Most important, the purlin must transfer the load of the roof to a proper bearing point, such as a bearing wall — not to a ceiling joist or nonbearing partition wall.

UNDERBUILT BEARING WALLS

Follow the rules for stud sizing and spacing on loadbearing walls (see chart, below left). As a general rule, 2x4 studs are not adequate for bearing walls in a three-story building. Bearing walls that support two floors and a roof must be framed with 2x6s, 16 inches on-center.

Remember, all bearing walls must always be capped with double top plates. Overlap these two top plates at corners and intersections. Along a straight run, splices in the double top plates must be offset by at least 48 inches.

To make sure the loads transfer through the bearing wall to the foundation, all bearing walls must have full bearing on

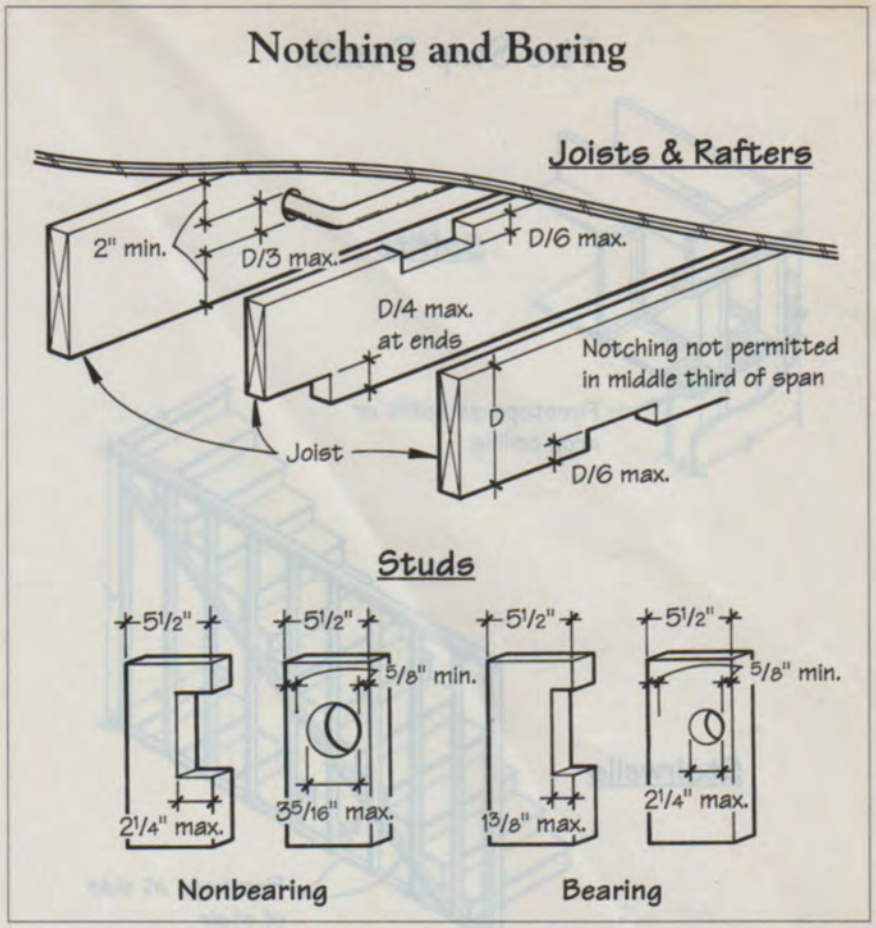
nominal 2-inch-thick plates or sills. Size the plates at least as wide as the wall studs.

IMPROPER NOTCHING AND BORING

Nothing can be more dangerous to a structure than a plumber with a Hole Hawg, or a "tinner" with a Sawzall. Make sure every carpenter and sub understands he must leave notches out of the middle third of the length of every joist and rafter. Outside of this section, notches should never exceed one-sixth the depth of the joist. For example, in a 2x10 joist, a notch should not exceed 1½ inches deep. Bored holes in floor and ceiling joists should never exceed one-third the depth of the framing member, and should never be made in the lower or upper 2 inches of a joist.

Similar rules apply to 2x6 studs, though the notches and holes allowed in nonbearing studs are larger than for bearing studs. If you double a 2x6 bearing stud, however, you're permitted to notch it as if it were nonbearing as long as you don't cut through more than two successive double studs.

Illustrations of proper notching and boring would make good tattoos on the arms of all job foremen.

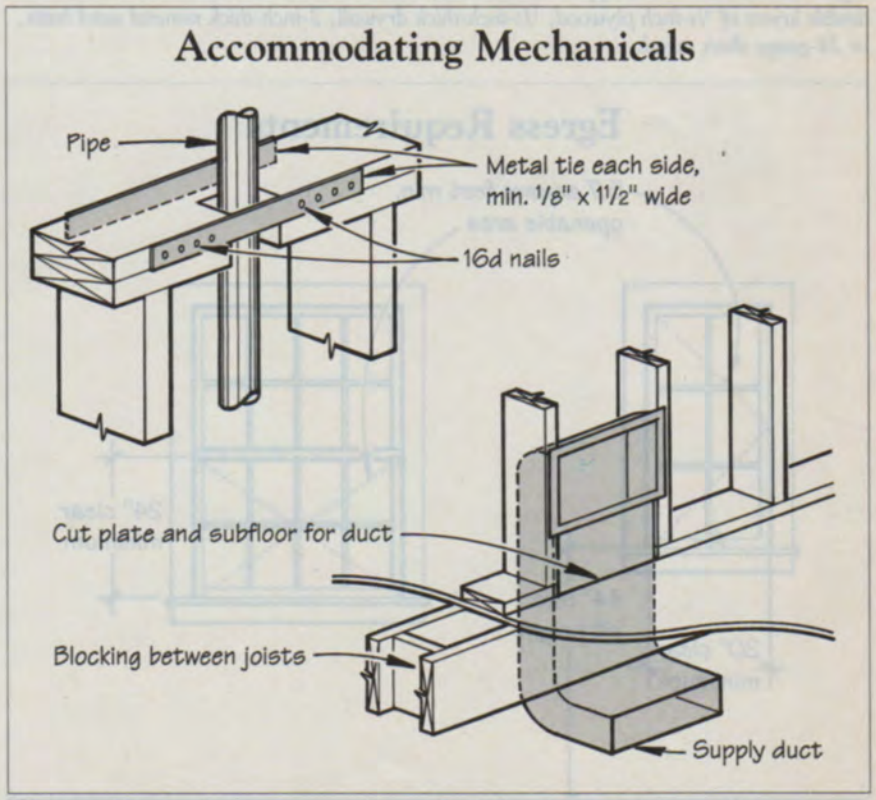


Never notch in the middle third of a joist span, and limit the length of notches to one-third the depth of the member. The rules for notching and boring studs differ for bearing and nonbearing walls.

SEVERED PLATES AND INTERRUPTED JOISTS

As soon as a sub starts to hack away at a top plate to make way for a return air duct or a plumbing vent, warning lights should flash and sirens scream until the plate has been properly resecured. Metal plates (⅛ inch thick by 1½ inches wide) must be nailed on each side of the severed top plates to restore the structural integrity of the walls. This is especially important when several stud bays are opened up for a common 24- to 36-inch return-air grille. The prudent builder will also install straps where bottom plates have been cut away. This not only minimizes wall movement, but prevents an industrious laborer from sweeping a ton of crud into the return air plenum.

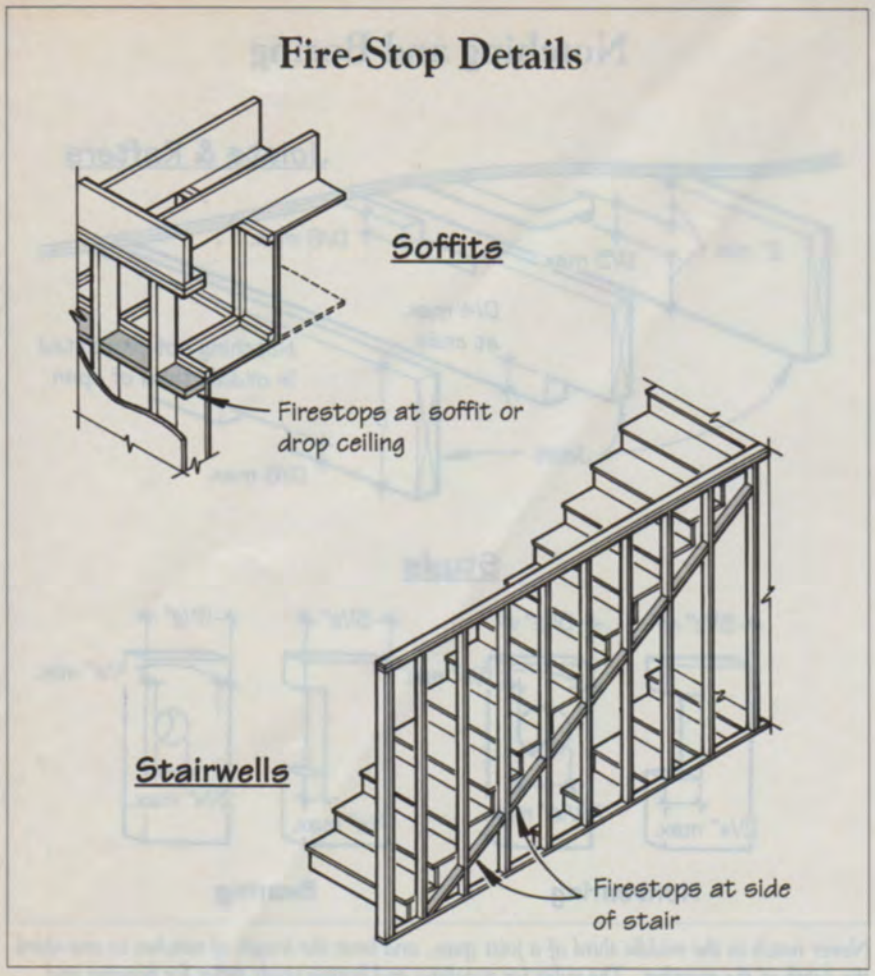
Joists supporting partitions should not be cut to accommodate mechanicals. Instead, double the joist with blocking in between to create a cavity.



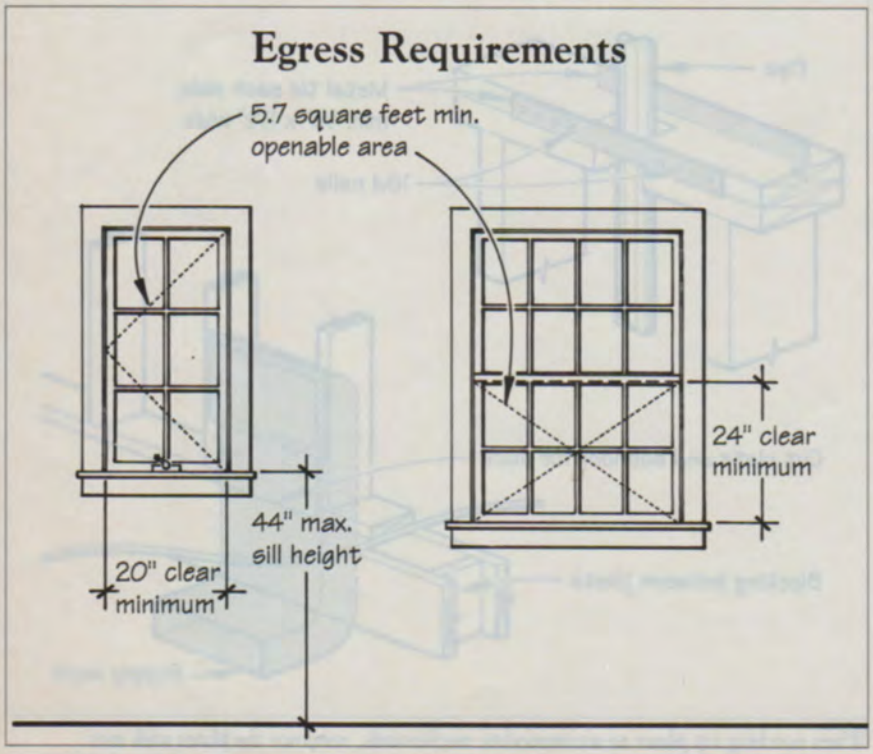
When notching top plates to accommodate mechanicals, reinforce the plates with two ⅛-inch-thick metal plates. Joists supporting partitions should not be cut to accommodate mechanicals. Instead, double the joist with blocking in between to create a cavity (bottom).

IMPROPER FIRE STOPS

If a fire ever breaks out in a building, it can weasel its way into the concealed cavities in the framing and race unrestrained through a



Fire stops prevent a fire from racing unrestrained through open framing cavities such as soffits and stairwells. Use approved materials, such as nominal 2-inch-thick lumber, double layers of 3/4-inch plywood, 1/2-inch-thick drywall, 2-inch-thick mineral wool batts, or 24-gauge sheet metal.



A window in any bedroom must be big enough to allow someone to escape easily. Make sure you meet minimum dimension requirements as well as the minimum square footage rule.

building. To prevent this, builders must install fire stops in any concealed cavity taller or longer than ten feet. Common areas for fire stops include soffits, furred-out spaces, and floor-to-wall and ceiling-to-roof intersections. Approved fire-stop materials include nominal 2-inch-thick lumber, double layers of 3/4-inch plywood, 1/2-inch-thick drywall, 2-inch-thick mineral wool batts, and 24-gauge sheet metal. Cardboard, T-1-11 siding, and rigid foam are *not* approved fire-stop materials.

All fire stops should be meticulously cut and installed to fit the opening perfectly. A poorly cut fire stop — one that leaves voids more than 1/8 inch wide — will provide only limited protection if it's ever put to the test. For irregular openings, use a fire-stopping compound. These products are "intumescent," meaning they expand to many times their original volume when heated, and can fill the void where a plastic pipe or cable insulation has melted away.

IMPROPERLY SIZED EGRESS

A window in any bedroom must be big enough to allow someone to escape easily and, equally important, to allow rescue workers to enter. Too often, builders frame in a rough opening to the required dimensions, but the building codes are explicit that egress refers to the "openable area" of the finished window. In general, codes call for:

- Minimum 5.7 square feet of clear openable area
- Minimum 24 inches of clear openable height
- Minimum 20 inches of clear openable width
- Maximum 44 inches from the floor to the top of the windowsill

Don't forget to include a similar-sized egress out of a finished basement. Otherwise, a fire that blocks the stairway out of a basement will prevent someone from escaping. Most fire fighters will agree that if a person has not escaped by the time rescue personnel arrive on the scene, that person has little chance of survival.

POOR VENTILATION

Ventilation provides an obvious exit for moisture-laden air. Without it, trapped moisture will wreak havoc on a building, leading to rotted sills, blistered siding, and mold and mildew growth.

Moisture will always take the path of least resistance, so soffit and ridge vents, gable vents, power vents, and sidewall vents are all convenient and relatively inexpensive means of ventilating moisture from a building. Every attic, rafter space, and crawlspace should include exterior vents with a minimum total vent area of 1/150th of the enclosed attic floor area. For example, an attic with a 24x30-foot floor area (720 square feet) needs vent openings totaling at least 4.8 square feet.

Balanced soffit and ridge vent combinations create the most effective configuration for ushering moisture out of an attic. Crawlspace ventilation, while often overlooked, is especially important, due to the relatively high moisture content of soils. Good ventilation will also extend the lifetime of roofing materials and help keep paint on the house.

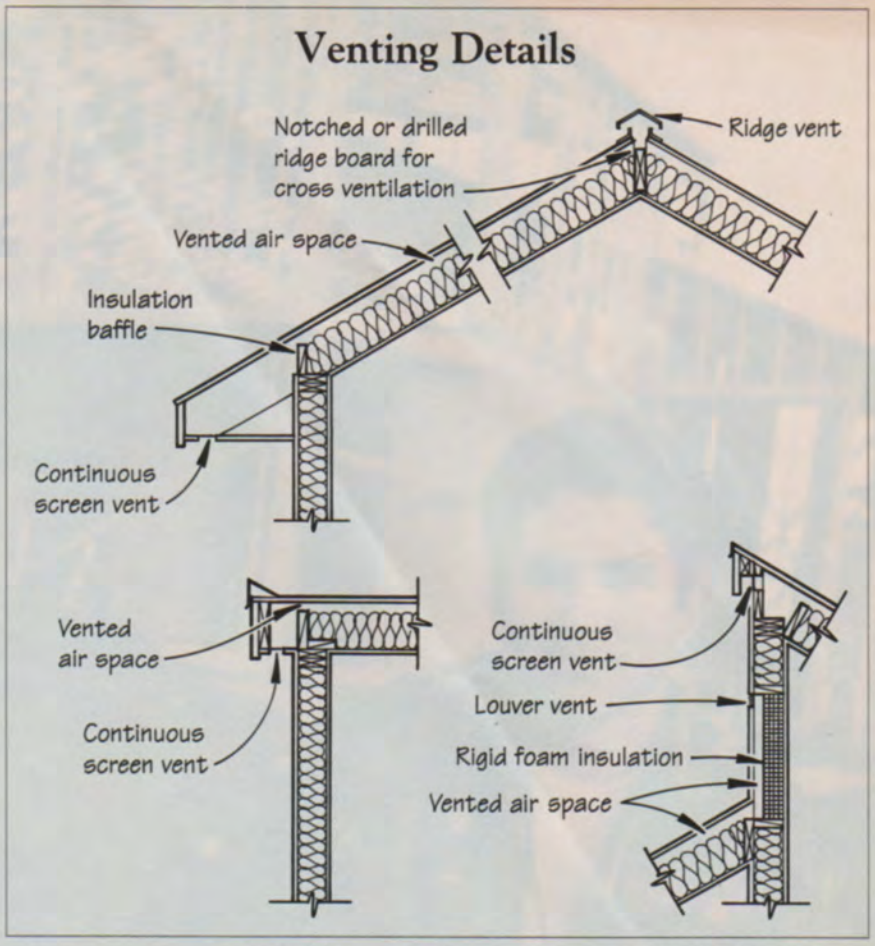
INADEQUATE HANDRAILS AND GUARDRAILS

Year in and year out, the leading cause of accidents in buildings is that simple set of steps. This is not to say that a handrail will prevent every fall, but at least it gives a person a fighting chance on the way down.

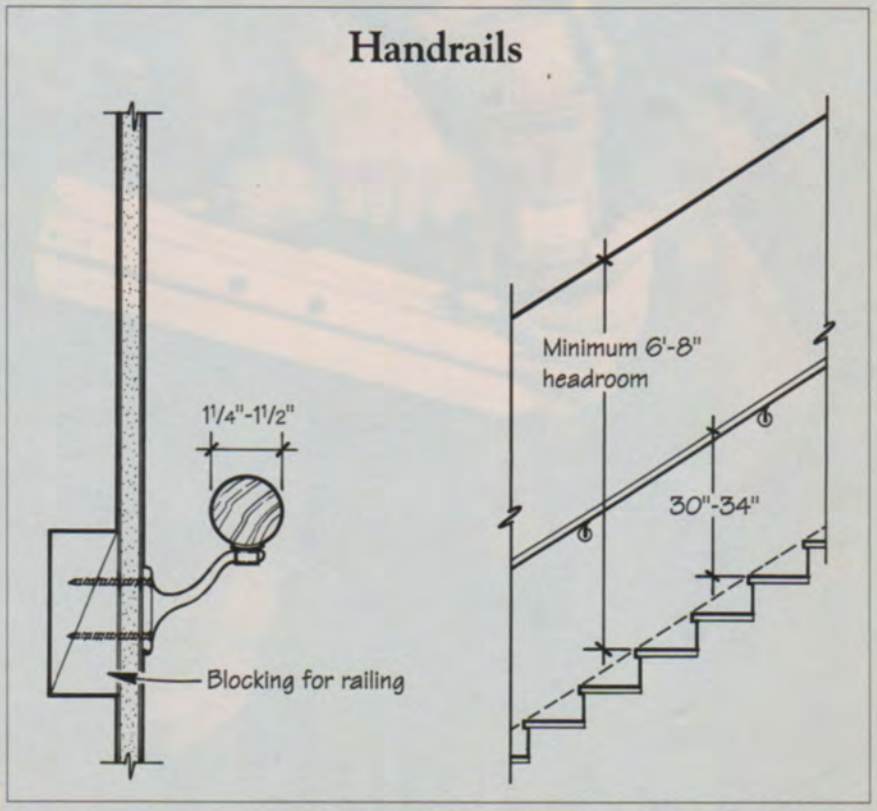
All stairs with more than one riser should be accompanied by a handrail (see "Getting a Grip on Railing Codes," 6/94). The handrail must be placed 30 to 34 inches above the nosing on the treads. Don't forget blocking for the handrail at the framing stage. The handrail should run continuously along the stairs, with a gripping surface from 1¼ to 1½ inches wide. Remember that one handrail is the minimum, but two is optimum. And don't forget to frame in enough headroom for the stairwell. A minimum of 6 feet 8 inches is required between the nosing on the tread and the stairwell ceiling.

All platforms that are more than 30 inches above adjoining grade must have a properly constructed guardrail — one that is able to withstand 50 pounds per square foot lateral uniform loading, and is at least 36 inches high. Intermittent rails or balusters must be installed close enough together so a 4-inch sphere cannot pass through. This design rule is aimed at preventing small children from sticking their heads between the balusters. ■

Formerly a municipal building official and building contractor, Ralph Pimentel now runs National Building Consultants, a commercial and residential inspection service in Topeka, Kan.



As a minimum, every roof should have a total ventilation area equal to 1/150th of the enclosed attic floor area. On pitched roofs, balance the vent openings at top (ridge or wall intersection) and bottom (soffit).



Handrails must run continuously along the stairs, with a gripping surface from 1¼ to 1½ inches wide. Only one handrail is required, but two are better.