INTERIORS
STAIRS

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STAIR DESIGN

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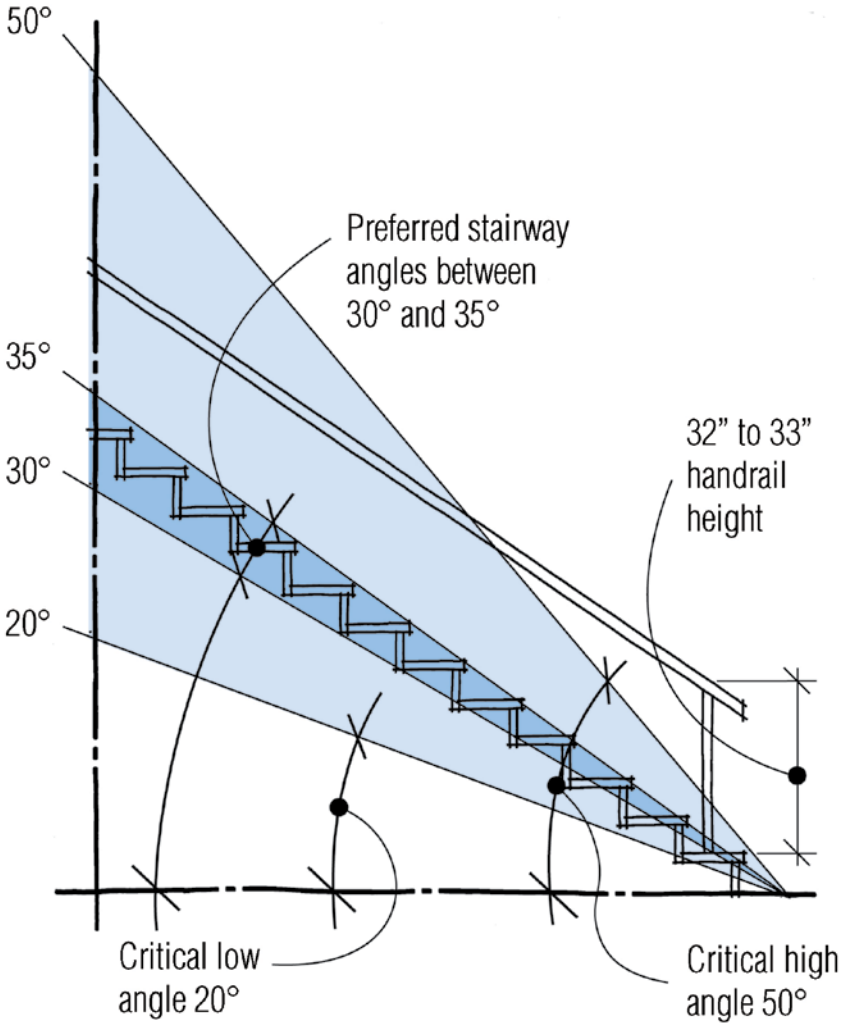
Local codes may vary, but most are consistent with the guidelines established by the FHA. The preferred angles shown in **Figure A** are the safest and most comfortable.

FIGURE A: SAFE ANGLE FOR STAIRS

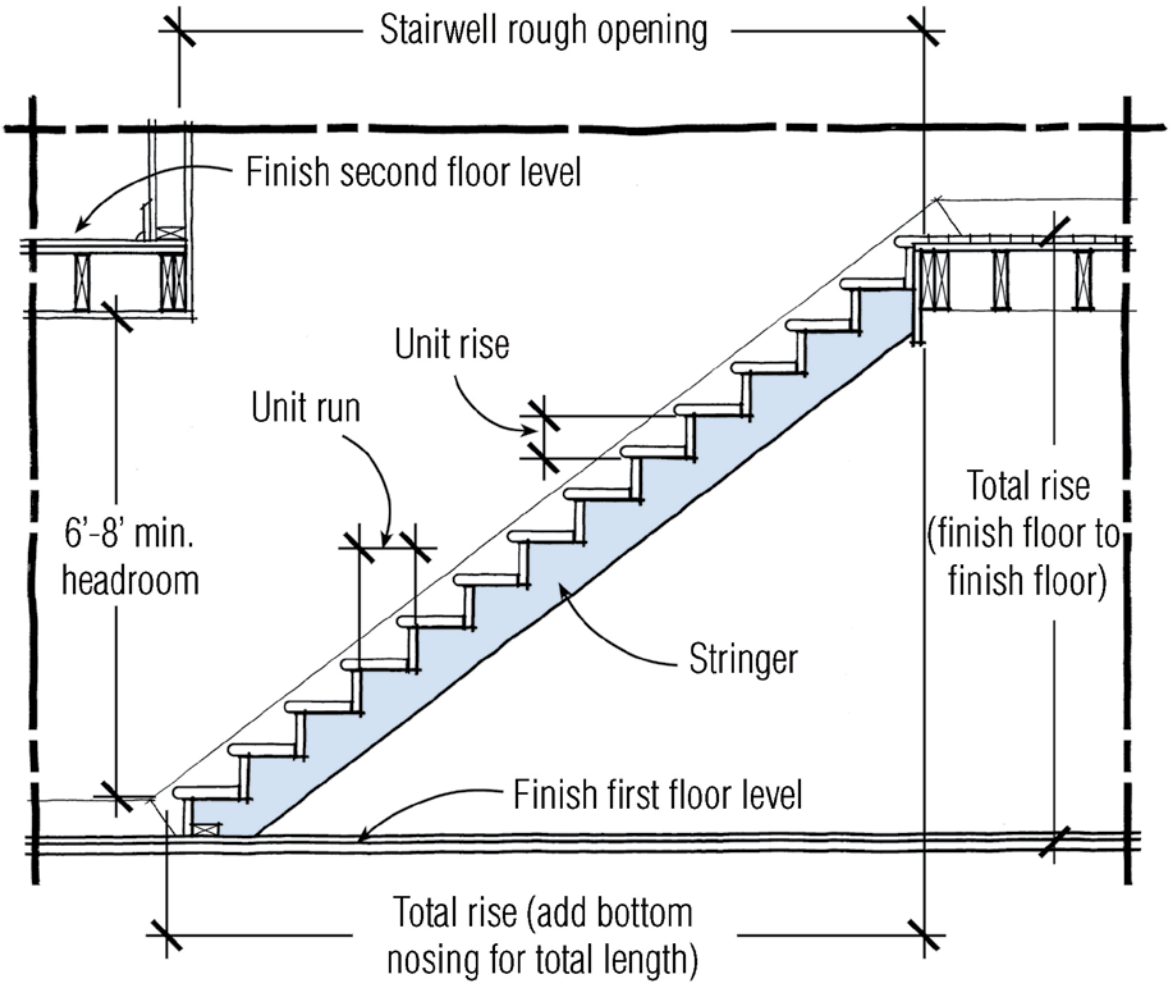


The preferred angle for stairs according to most codes falls between 30 and 35 degrees.

Headroom

The minimum distance from the tip of any nosing (the nosing line) to the ceiling directly above should be 6 ft. 8 in. (**Figure B**). For basement or utility stairs, the minimum is typically 6 ft. 4 in.

FIGURE B: STAIR LAYOUT



Unit rise = Total rise ÷ Number of Risers
Unit run = Total run ÷ Number of Treads

Stair Width

Most residential codes require stairs to be 36 in. wide. However, they allow railings to project 31/2 to 41/2 in. into the width on either side. They also allow trim, such as finished stringers, up to 11/2 in. thick.

Tread and Riser Dimensions

It is critical for safety that the rise and run of every step in a stairway is consistent. Codes allow up to 3/8 in. variation between the smallest and the largest riser and tread, but even this will be noticeable by clients and will reflect poorly on workmanship.

Risers. The maximum riser height allowed ranges from 73/4 in. (IRC) to 8 in. (UBC). The optimum for comfort is considered 7 to 71/2 in.

Treads. The minimum tread width allowed ranges from 9 in. (UBC) to 10 in. (IRC). The optimum for comfort is 10 to 11 in.

To find the right combination of rise and run, use one of the following rules of thumb (local codes may have other restrictions):

- The sum of two risers and one tread equals 24 to 25 in.
- The sum of one riser and one tread equals 17 to 18 in.
- Riser height multiplied by tread width should equal 70 to 75 in.

Common Stair Flaws

Most stair problems can be traced to a mistake in the framing layout. Typical mistakes include the following:

Wrong total rise. Layout calculations must be based on the distance from finished floor to finished floor, not subfloor to subfloor. Otherwise, if finish flooring thicknesses differ, the top or the bottom step will be a "trip step" that's shorter or taller than all the rest.

Failure to drop the stringer. To equalize the heights at the top and bottom risers, the bottom of the stringer must be cut to lower it by the thickness of the tread material minus the thickness of the finished flooring on the lower level.

Not enough headroom. The solution is to recut the stringer or it may require reframing the stair opening.

Improperly located landing. If the rough landing is too high or too low, the stairs above the landing will not match the pitch of the lower flight, or there may be trip stairs at the landing or at the top or bottom of the floors.

CALCULATING RISE AND RUN

Total rise is the height from finished floor to finished floor. If the two floor thicknesses differ, find the total rise: Measuring subfloor to subfloor, add the thickness of the second-story finish floor, then subtract thickness of the finish material for the first floor.

Unit rise and run. Find the total rise from finished floor to finished floor and divide by the number of risers to get the unit rise (**Figure B**). The fewer risers used, the smaller the stair opening needed. The result must equal a number between 7 and 7.5 to meet code (see **Risers**, above).

Once the unit rise has been determined, select a suitable unit run (tread width) using the rules of thumb above. Select the smallest acceptable tread width if space for stairs is tight.

Total run. Subtract 1 from the total number of risers to find the total number of treads. Then multiply the number of treads by the unit run to find the total run of the stairway. Add the overhang of the bottom tread for the total horizontal distance required on the lower floor.

Bottom riser. When laying out the stringer, the top and bottom risers will have to be adjusted. The distance between the first-floor subfloor and the first level cut in the carriage equals the unit rise minus the tread thickness plus the thickness of the first-floor finish.

Top riser. The distance between the top of the second-floor subfloor and the last cut on the carriage equals the unit rise plus the tread thickness minus the thickness of the second floor finish.

Tread overhang. Most codes require the overhang of the tread, or nosing, to be 3/4 to 1 1/4 in. Nosings should be rounded.

Don't even think about calculating a stair's rise until all floor finishes are decided upon. Add the thickness of the upper floor covering and subtract the lower floor's covering to get total rise. Divide by the number of risers to get unit rise.

Landings

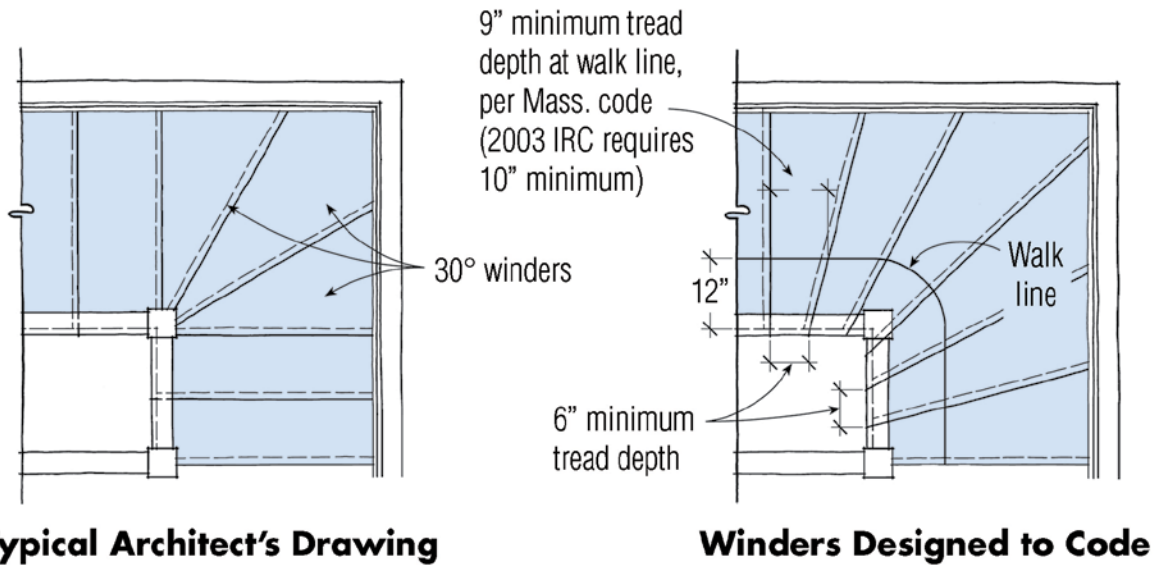
Most codes require a landing in any stairway with more than 16 risers. The landing's finish surface must fall at the same stair rise increment as any other tread. Make sure to frame the landing to allow for variations in flooring and tread thicknesses.

Landings cannot be less than 36 in. in either direction.

Winders

The minimum width of each winder must equal the minimum for other treads, when measured 12 to 15 in. from the narrow end of the winder. At no point should a winder be less than 6 in. wide (**Figure C**).

FIGURE C: WINDER STAIRS



Stair codes require that winders be no less than 6 in. at the narrowest point. The net run of the treads, measured at the walk line, should be constant from the top to the bottom of the stair. The walk line is an imaginary line that represents the path the center of your body takes when climbing and descending a stair — typically 12 to 15 in. in from the centerline of the handrail.

Circular Stairs

The smaller radius of a stairway must equal at least twice the width of the stairway — 6 ft. for a standard 36-in. stair. At the narrow end, the treads must be at least 10 in.

Spiral Stairs

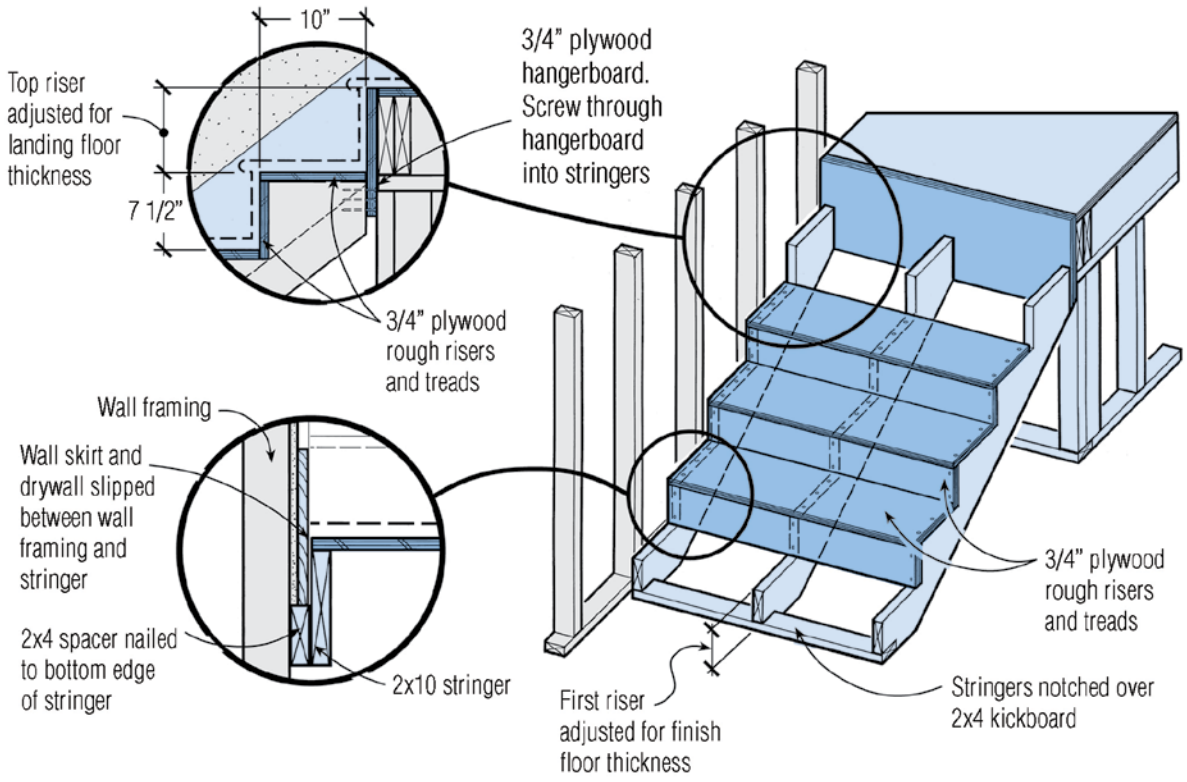
Spiral stairways must be at least 26 in. wide, measured from the supporting column to the handrail. Treads must be at least 71/2 in. wide, measured 12 in. from the narrow end. The maximum allowable rise is 73/4 in. (IRC) or 91/2 in. (UBC). Headroom should be 6 ft. 6 in. In general, these cannot be used as a primary egress under most fire codes.

STAIR CARRIAGE DETAILS

Most codes call for stringers every 30 in. for 1 1/8-in.-thick treads and every 31 in. for 1 1/2-in.-thick treads.

To strengthen the entire carriage, glue and screw 3/4-in. plywood subtreads and subrisers to the stringers (**Figure D**). Remember to subtract the plywood thickness when laying out the stringers.

FIGURE D: STAIR CARRIAGE

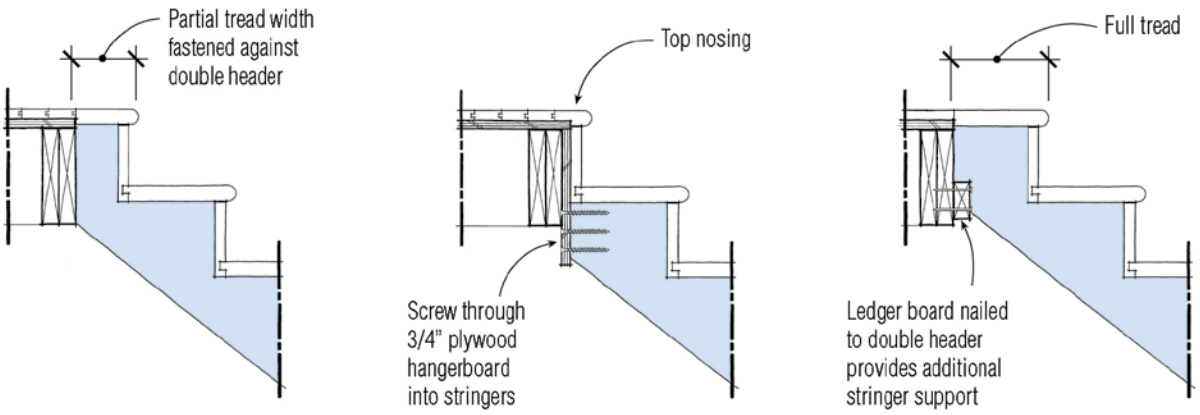


Space the stair undercarriage out from the wall framing with a 2x4 running along the lower edge of the inside stringer. This provides room for the drywall and the wall skirt.

To simplify trimming the stairs, space the undercarriage of the stairs away from the wall, leaving a space between the drywall and the rough stringer for the wall skirt (**Figure D**). The drywall is installed first and the side trim slipped in later. Otherwise, the trim needs to be cut around each step and the bearing of the stair treads is compromised.

Attaching stringers. Since stringers carry the entire load of the stairs, they must be securely fastened at the top (**Figure E**).

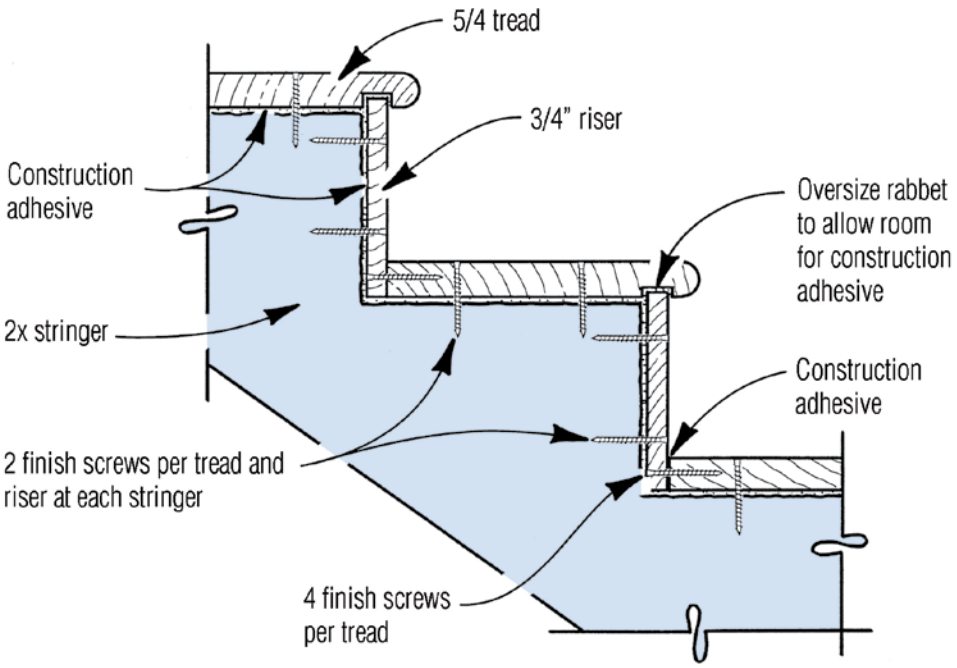
FIGURE E: STRINGER ATTACHMENTS



Depending on the depth of the second floor framing, it may be difficult to secure the stringers to the header at the top of stairs. Three different methods, each with a different way of handling the top tread, are shown here.

Attaching treads. Stair squeaks are caused by movement of the tread against the undercarriage. Use construction adhesive and screws to attach subrisers and subtreads to the stringers, and to attach the finish treads and risers (**Figure F**).

FIGURE F: ATTACHING TREADS

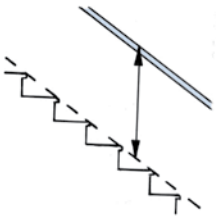
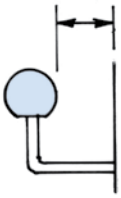
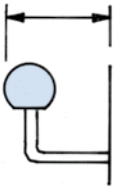
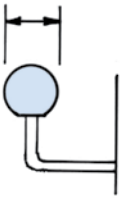


Use finish screws, construction adhesive and careful joinery to build squeakless stairs. The dado to receive the riser hides any gap between the top of the riser and the tread, but is not itself integral to solving squeaks.

HANDRAILS

Handrails must go on at least one side of a closed stair. **Figure G** shows the required dimensions for stair handrails.

FIGURE G: CODE REQUIREMENTS FOR HANDRAILS

Where Required:		**On Stairs with Three or More Risers**
Height above tread nosing:		30" to 38"
Minimum finger space:		1 1/2"
Maximum projection into stair width:		3 1/2"
Maximum handrail size:		1 1/4" to 2" diameter for circular shape
		Any other shape with a perimeter dimension of 4" to 6 1/4", with largest cross section not exceeding 2 1/4" Any approved rail of equivalent graspability*
Design strength:		200-lb. concentrated load applied at any point in any direction

*Codes typically allow the "equivalent graspability" standard (see **Figure H**)

There may be slight variations between the model codes on handrail design and construction. Be sure to consult the code that applies in the local jurisdiction.

Handrail Design

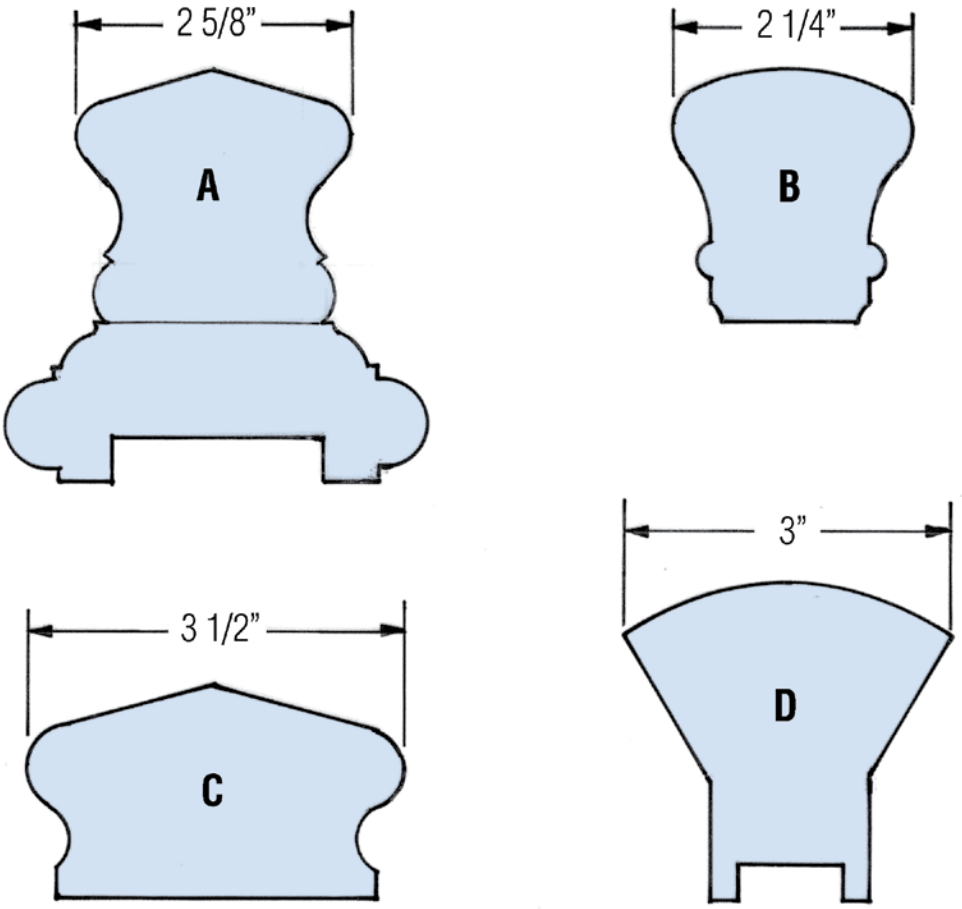
Handrail height. Handrail height is measured from the nosing line, an imaginary line that would be formed if a string was stretched to touch every nosing on a run of stairs (**Figure G**). The top of the rail should be 34 to 38 in. above the nosing line (IRC and UBC).

Handrail projection. Wall-mounted handrails should project no more than 3 1/2 in. into the minimum stair width.

Finger space. The space between the handrail and the wall should let anyone fit their hand around the rails. Finger space should be at least 1 1/2 in.

Handrail shape. The part of the handrail that a person grips shouldn't have sharp corners. Round handrails must have a diameter of 1 1/4 to 2 in. There are exceptions for traditional handrail shapes if they have what's called an "equivalent graspability" (**Figure H**).

FIGURE H: EQUIVALENT GRASPABILITY

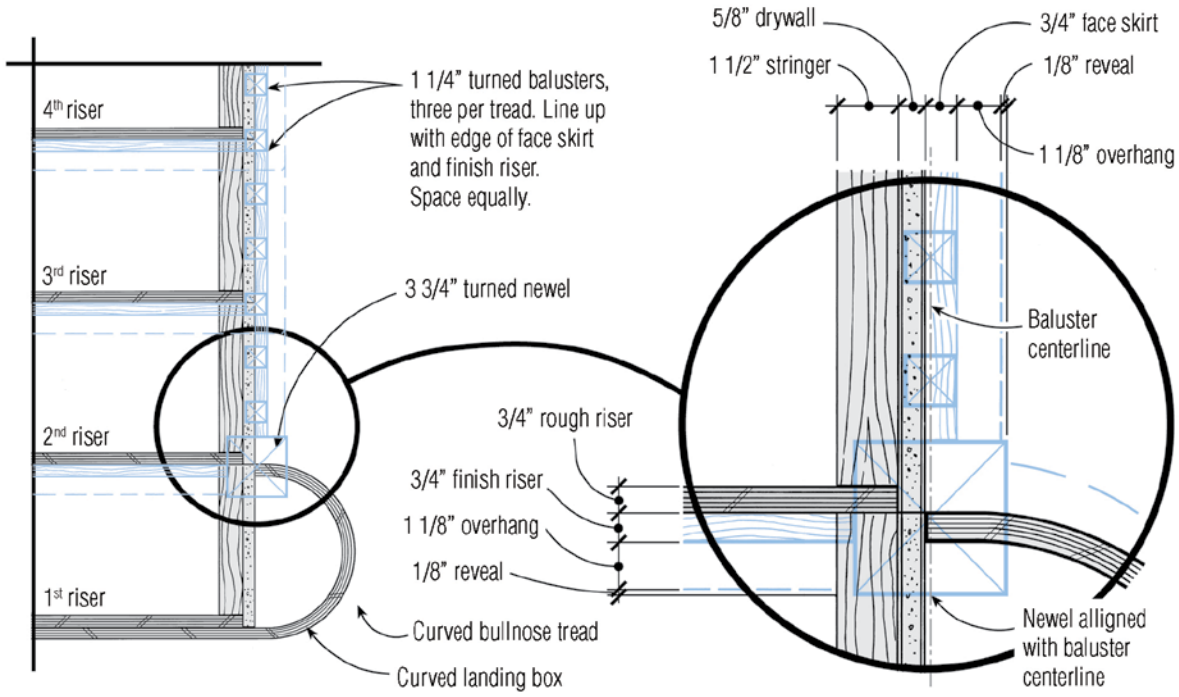


Codes often let a building inspector make exceptions for railings that are wider than the minimum but may still be easily grasped to prevent a fall. In a jurisdiction with a 2 5/8 in. maximum rail cross section, railings A and B would both pass without an exception, while C and D would be acceptable only if the inspector deemed them to have equivalent grasping surfaces.

Installing Handrails

Newel placement. The bottom newel works best on the second step, rather than the first. Place it where it will catch the front overhang of the second tread, plus a slight reveal, as shown in **Figure I**. To find the side-to-side location, work off the centerline of the handrail.

FIGURE I: LAYING OUT THE BOTTOM NEWEL

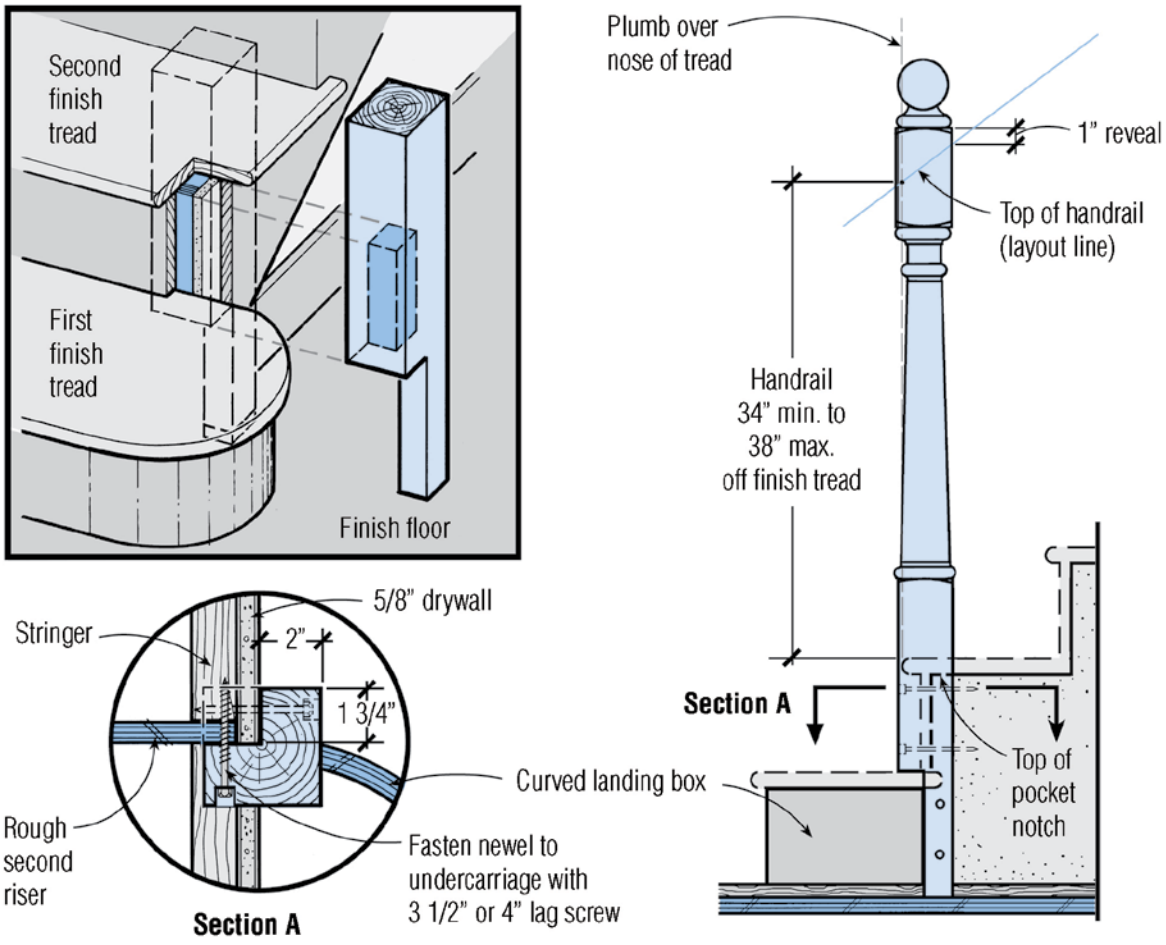


Treads are typically cut to overhang 1 1/8 in. If the baluster edges line up with the face skirt edge, the centerline of a handrail is going to be half of one baluster in from the face of a face skirt.

Newel width. Traditionally, the tread nosing dies into the newel posts. For this to work out, the newel posts must be wide enough to catch the nosing. However, many readily available newel posts are not wide enough to notch solidly into position. Consider using a wider newel post style. The minimum width of newels should equal half of the baluster width plus the tread overhang plus an optional reveal — times two.

Newel length. To determine the length of a bottom newel, carry the line of the top of the handrail across to the front side of the newel to a point exactly over the nose of the second tread (**Figure J**). This should be slightly in from the newel edge to allow the nosing to die into the newel with a slight reveal.

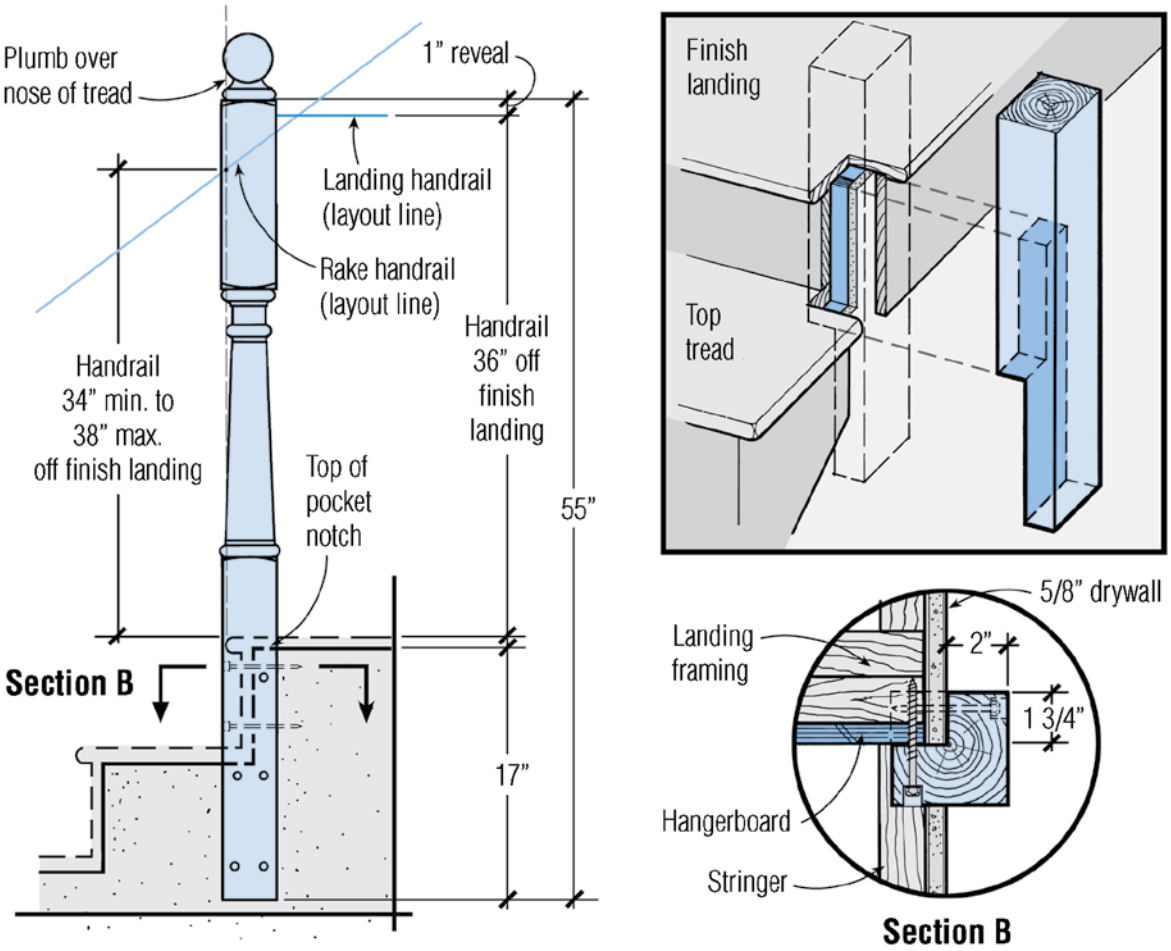
FIGURE J: BOTTOM NEWEL



Carry the line of the top of the handrail across to the front side of the newel to a point exactly over the nose of the second tread. This should be slightly in from the newel edge to allow the nosing to die into the newel with a slight reveal.

A landing newel is a little bit different — it has a longer top block that allows it to pick up both the landing rail (at a height of 36 in.) and the rake rail (at 32 in.). See **Figure K**.

FIGURE K: LANDING NEWEL



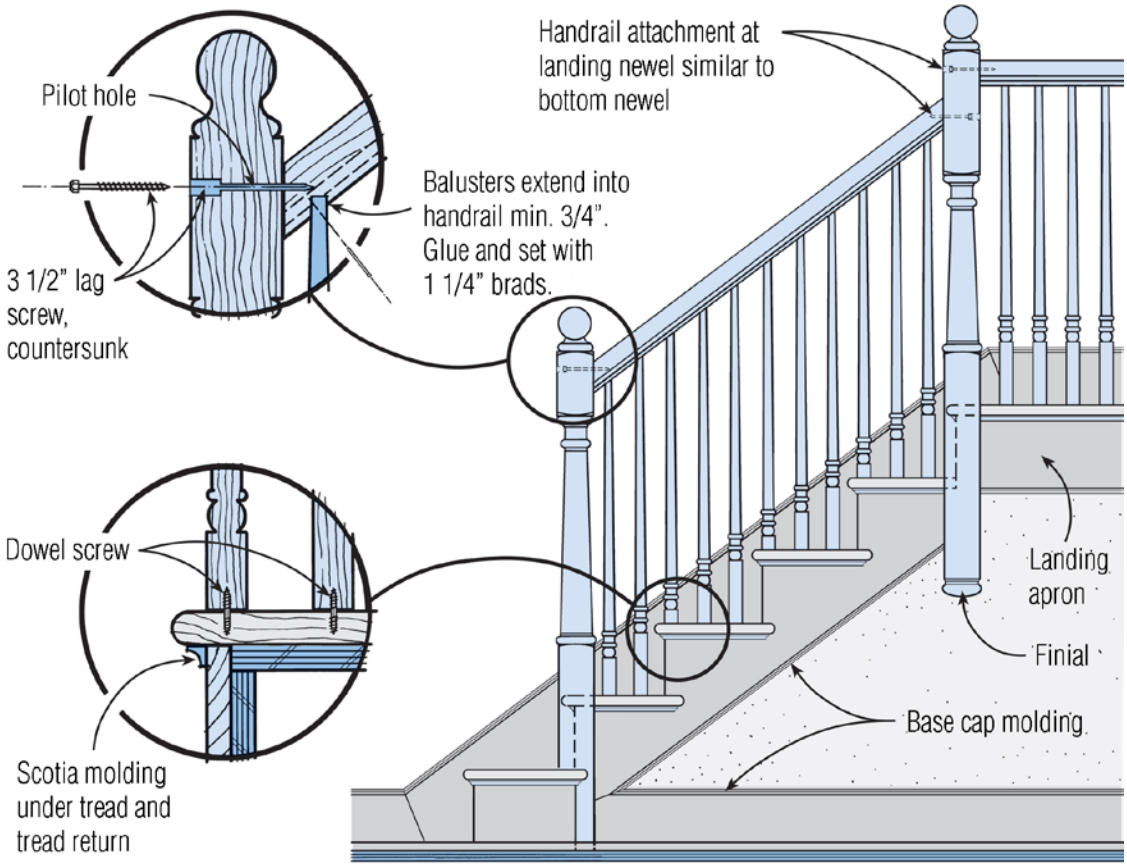
Leaving a 1-in. reveal above the landing rail, the top edge of the newel block has to be 37 in. over the finish floor. The bottom end of the landing newel should extend below the face skirt board.

Newel attachment. For maximum strength, notch newel posts into the stair carriage, as shown in **Figure I** and **J** before securing with lag bolts.

Lags hold better in hardwood than in softwood, so always lag through the framing into the hardwood newel rather than vice-versa. Large washers or hardwood blocks prevent the lag head from crushing the wood fibers in the joist and loosening the newel.

Handrail and baluster attachment. For attaching balusters to the treads, all of the manufacturers of stair parts provide some type of dowel screw — a screw that has a lag-type thread on both ends (**Figure L**). With these, it's usually necessary to predrill holes in both the treads and balusters. Some manufacturers predrill the balusters.

FIGURE L: FASTENING BALUSTERS AND RAILING

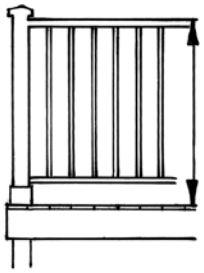
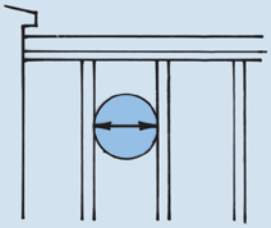
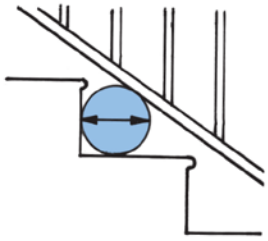


After the baluster bottoms are tightened into place using dowel screws, the handrail can be installed over the pin-tops on each baluster. Secure the handrail with lag screws through the newels.

GUARDRAILS

In general, guardrails must protect the edge of any raised floor level over 30 in. high or any open stairway with a rise of more than 30 in. Most codes require residential guardrails to be a minimum of 36 in. tall (**Figure M**).

FIGURE M: CODE REQUIREMENTS FOR GUARDRAILS

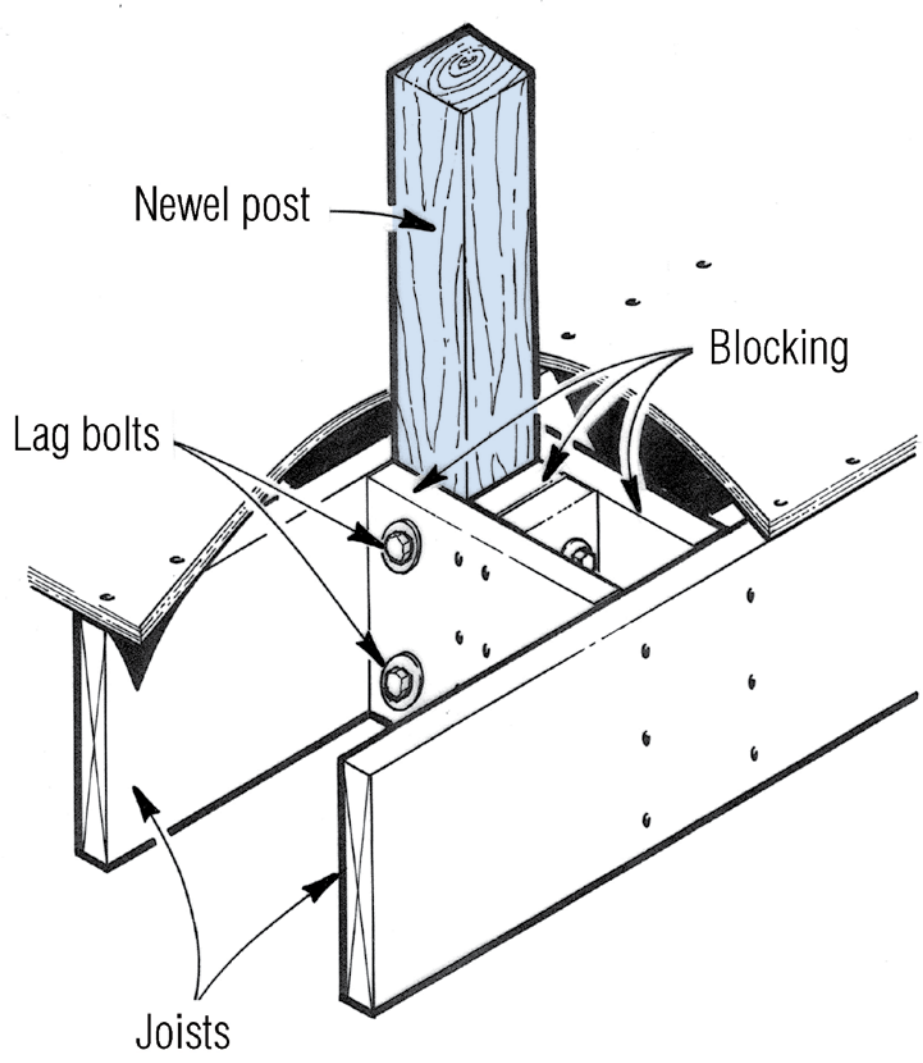
Where Required:		**On Stairs and Landings More Than 30" Above Grade**
Minimum height:		36"
Baluster spacing, opening limitations:		Guard built so that a 4" sphere cannot pass between any opening; no decorative patterns that provide a ladder effect
Maximum space below lower stair rail:		Built so a 6" sphere cannot pass through
Design strength:		200-lb. concentrated load applied at any point in any direction along top railing; 200-lb. horizontal concentrated load applied on a 1-sq.-ft. area of guard infill

As with handrails for stairs, there may be slight variations between the model codes on guardrail design and construction. Be sure to consult the code that applies in the local jurisdiction.

Baluster spacing. To keep small children from squeezing through them, balusters in guardrails should be spaced no more than 4 in. apart.

Strength. The top member of a guardrail should be able to withstand a concentrated horizontal load of 200 pounds. Balusters or gridwork must be able to withstand a horizontal force of 200 pounds applied over an area of one square foot. Achieving this requires a sturdy fastening system for railings and newels. Acceptable details for attaching guardrail newels are shown in **Figure N**.

FIGURE N: FASTENING A NEWEL



For the strongest possible newel post in a balcony or landing guardrail, arrange the floor framing so that starting newels land over a joist bay. The landing newel can then be bolted to the front of the header without needing to be notched.