



## STAIRS: FROM THE BOTTOM UP

By Steve Taylor, CSI

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■ ■ ■



*An example of stringer brackets.*

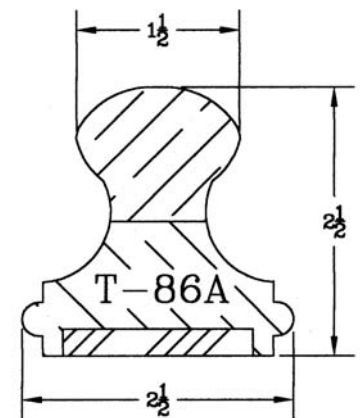
Whether the project is a public building, a tenant improvement, or a residence, a well-designed stairway can be an architectural feature that establishes the style of the whole project. The steps at the U.S. Supreme Court and the New York Public Library are examples of exterior stairs that are important to the effect of the entire building and have become icons of the institutions. The magnificent double stairs at the California State Capitol establish and unify the style of the interior design.

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*Large photo at right: This stair illustrates a side-mounted handrail attached to a traditional guardrail. It also shows a closed stair with a curb.*

*Small photo: A well-executed rake-to-rake bend.*





An example of an ADA - compliant rail.

The volutes at the start of this stair fulfill the ADA handrail requirements by extending in front of the starting step.

Whatever other functions a stair fulfills, it's a life-safety element first. All aspects of stair design which are regulated by building codes and the Americans with Disabilities Act (ADA) relate to safety issues. Stairs must be safe both for normal use and as emergency exits. Code changes in recent years have had an impact on the appearance of modern stairs. The reduction of the maximum baluster gap from 6 inches to 4 inches has meant an increase from two balusters on each tread to three in most traditional designs. The 1-1/2 inches maximum handgrip size coupled with the requirements for handrail extensions beyond the top and bottom risers in ADA-regulated construction have caused major changes in balustrades.

While structural issues are outside the scope of this article, it's important to note that the loads which stairs, guardrails, and handrails are required to resist are not trivial. Any unconventional design should be reviewed by a civil engineer and a fabricator early in the design process. Even conventional designs may require larger and more frequent structural members than in the past.

### Rise and Run

Restrictions on rise and run affect other aspects of stair design. In non-residential applications, the maximum rise is 7 inches and the minimum is 4 inches. Risers of less than 6 inches, while legal, should be avoided as they make an uncomfortable stair. Residential stairs are allowed to have risers up to 8 inches. I believe that risers greater



This awkward situation is caused by the upper floor overlapping the stair. The opening in the upper floor should be big enough to allow the rail to pass through.

than 7-1/2 inches should be avoided except for stairs to unoccupied attics or basements. If the distance between floors is greater than 12 feet, an intermediate landing is required.

One of the major causes of accidents on stairs is irregular rise or run. All the rises in a flight of stairs should be equal (within 1/4 inch). It's acceptable to make the rises above a landing differ from those below as long as they are equal within each flight. All finish floor elevations should be determined before stair construction begins. It may be impossible for the stair fabricator to maintain even rises if finish floor thicknesses are changed after work begins.

The run (the distance from nose to nose) of each tread in a flight also must be equal (within 3/8 inch). In commercial and public applications, runs may not be less than 11 inches. The run on a curved stair will vary across the width of the tread. For residential stairs, the

small end of winders may be as small as 6 inches if a minimum 9 inch run is maintained 12 inches from the small end. Non-residential stairs must have a 10 inch run at the small end. All the treads in a curved stair should be the same, so that the runs are equal at any point across the width of the stair. This makes the design of elliptical stairs, or stairs which transition from curved to straight, more difficult. In residential work, it's acceptable to assume the user will walk approximately 12 inches from the handrail, and to make the runs equal at that point. This makes "J" shaped stairs and other variations possible. In commercial work where it's reasonable to assume use of the whole width of the stair, changes of tread pattern should take place only at landings.

### Guardrails

Because of the requirements of the ADA, it's useful to distinguish between guardrails and handrails even though

they may be combined. The principal change in guardrail requirements in recent years is the decrease in the allowable opening from 6 inches to 4 inches. Whether the balustrade is metal or wood, this change makes for a much denser appearance. If the balusters are to stand on the treads, the actual spacing may be much closer than the code requires, as it will usually be necessary to use at least three balusters on each tread if the run is greater than 10 inches. A stair with 11 inch runs may need balusters spaced at 3-5/8 inches o.c. It may be possible to avoid this by the use of bigger balusters or balusters with less detail. Careful design is required.

In most conventional designs, the balusters and guardrail are supported at intervals by newel posts, which are the principle load-bearing members. The method of connection of these newels will impact other aspects of the design.

### Handrails

Two requirements of the ADA have revolutionized the design of handrails in commercial and public construction:

- 1) The maximum handgrip size.
- 2) The rail extension onto the floor at the top and bottom of each flight.

In the past, it's been customary for the handrail to be the guardrail. This is still possible but conflicts between guardrail and handrail requirements make it desirable to provide separate members in many cases. Guardrails at balconies and landings are required to be 42 inches minimum above the finish floor. Handrails are required at top and bottom to level off 34 inches to 38 inches above the floor or landing and extend 12 inches at that height. It isn't practical in this article to describe all the designs that have been used to overcome the conflict between the handrail and guardrail requirements, but the most successful system has been to attach a separate handrail to the side of the guardrail balustrade. Typically a 1-1/2 inch round rail is used for this purpose. If a wood rail is desired, it may be necessary to reinforce it with metal in sections with complex bends.

### Appearance

The style of a stair is established by the details of its various components. Whatever effect is desired, each component of the stair must contribute. For example, a Victorian design would have a traditional bulbous and scotia detail on the tread. If it is an open stair, a carved or sawn bracket should decorate the skirt board at each tread. If a closed design is preferred, a paneled or carved fascia would enhance the curb. Balusters would be elaborately turned or carved and relatively massive. The starting treatment could be a large volute or a



*This starting treatment required a 1/2 x 3/4-inch steel bar inside the wood rail from the floor to the first handrail bracket.*

large elaborate newel post. By contrast, a contemporary stair would have a minimal tread edge detail with no scotia, an open side with a plain skirt and no moulding or a curb with little or no trim. A glass balustrade or a simple metal or wood pattern with a round or oval rail would complement the look.

The balusters are usually the most prominent feature of a stair. They do more to establish the style than any other element. Traditional turned balusters may evoke Victorian, Georgian, or colonial traditions. Plain square or tapered balusters suggest the Shaker style. Square or chamfered balusters may be used in a Craftsman or Tudor context. The use of glass panels instead of balusters establishes a modern or minimalist look, and a number of materials and methods have been used in attempts at a post-modern balustrade.

Curved stairs establish a tone of grace and sophistication, however they

require space and a substantial budget. The requirement of an even run precludes stairs with uneven curvature unless the sections are separated by a landing (residential codes may be more lenient.) Changes in curvature or direction may also cause awkward transitions in handrails. Generally the most attractive curved stairs have the least variation from a true radius.

In a perfect world with no space limitations or structural limitations, we would design stairs from the handrail down. Having decided the style of the balustrade and the types of transitions desired, the location of each flight of stairs would be adjusted to optimize the appearance of the balustrade. In the real world, it's worthwhile to look at the implications for handrail design before finalizing a plan.

*Continued on page 24*



## STAIRS

Continued from page 23

Volutes remain a graceful option for starting a balustrade. In non-residential work, the ADA requires that the volute be placed on the floor in front of the starting tread in order to provide the required rail extension. It may be desirable to provide a pediment for the volute to stand on or to differentiate that part of the floor in order to achieve the desired effect. In residential construction, a volute which stands on the starting tread should have a descending arm so that the newel will be as short as possible.

Rake-to-rake bends may provide an elegant transition between two flights of stairs. In designing for a rake-to-rake bend, it's necessary to provide for the rail to travel over the landing a distance which is equal to the run on the stairs. This prevents awkward changes in pitch which can spoil the desired effect.

### Common pitfalls

Almost all the common stair problems are the result of lack of space. Because of requirements for finger clearance, the opening in the floor which a stair passes through must be wider than the stair. A section through the stair at the point that the handrail passes the balcony trim is essential if space is tight. The same precaution is called for in a switchback stair if one of the flights has an open side.

The 80 inches of headroom required by the codes is not generous. More headroom should be provided if possible. Headroom both above and under the stair should be checked carefully if there is any possibility of obstruction. It's wise to allow some extra headroom, as all those adjustments which take place in the course of construction seem to decrease headroom.

Over the years we have been confronted by many stairs with 45° or 30° bends. None of them has turned out satisfactorily. If it's necessary to put a stair in an octagonal space, make the open side of the stair curved, not segmented.

### Conclusion

While code restrictions may place limits on stair design, their intent is to govern the building of good stairs. In 30 years as a stair professional, working with designs in every recognized style and some not yet catalogued, I have been astonished at the possibilities. While I'm no longer actively engaged in stair construction, I anxiously await new developments in the trade.

*Steve Taylor was a stair builder for 30 years and became a Woodwork Institute Director of Architectural Services in 2003. He enjoys opportunities to work with design professionals in the execution of stairs in a wide variety of styles and materials.*

# STAIR GLOSSARY

<b>ADA</b>	Americans with Disabilities Act. The handicapped access codes.
<b>Balustrade</b>	A structure that includes newels, balusters, and rails which guard the edge of a balcony or stair against falls.
<b>Baluster</b>	Vertical members spanning the space between the floor and the guardrail to provide a barrier.
<b>Curb</b>	A low wall (typically less than 8") along the edge side of a stair or balcony. Used as the bottom member of the balustrade.
<b>Fascia</b>	A horizontal or rake trim piece along the outboard side of a curb.
<b>Flight</b>	A set of stairs between landings or floors.
<b>Guardrail</b>	A railing which blocks the edge of a balcony or stair against falls, the top member of a balustrade. Guardrails may also be handrails if they meet all handrail requirements.
<b>Handrail</b>	A railing which provides a continuous hand hold for use while ascending or descending stairs. Handrails must provide a usable hand grip.
<b>Newel</b>	The structural post unit that supports the guardrail.
<b>Nosing</b>	The member which lies along the edge of a landing or upper floor. At the top riser the nosing acts as a tread, making the transition to the finish floor. Along the edge of a balcony, the nosing provides a platform for the balusters and a cap for the apron and trim.
<b>Nose</b>	The front edge of a tread; usually but not necessarily rounded.
<b>Rise</b>	The vertical distance from one tread to the next.
<b>Riser</b>	The vertical member at the back of a tread which extends to the bottom of the next tread.
<b>Run</b>	The horizontal distance in the direction of travel from the front edge of one tread to the front edge of the next.
<b>Scotia</b>	The moulding at the top of the riser, abutting the bottom of the tread. Typically a cove detail.
<b>Skirt</b>	The member which lies flat against the wall below the ends of the treads on the open side of a stair or on top of the treads at the wall side. An open stringer is typically mitered to the ends of the risers and notched under the treads. A wall stringer may be notched over the treads and risers, or morticed to receive them.
<b>Stringer Brackets</b>	Individual panels, usually band sawn or carved, planted on the skirt board below each tread.
<b>Total Rise</b>	The vertical distance from lower finish floor to upper finish floor.
<b>Total Run</b>	The level distance from the front of the first tread to the front of the top nosing.
<b>Tread</b>	A step.
<b>UBC</b>	Uniform Building Code, the most common code in the western United States.
<b>Volute</b>	A spiraling section of handrail. Usually used at the start of a stair.