BALCONY AND ROOF RAILINGS AND THE CODE: MAINTAIN, REPAIR, OR REPLACE?

As building codes change, existing railings may need to be updated or replaced.

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While state and local building, fire, and occupational safety codes have the effect of making roofs, balconies, and terraces more secure for users, the tangled web of requirements can wreak havoc with a building owner's exterior envelope project. Where existing railings—also known as guards—need replacement to meet stringent code requirements, the expense of thousands of linear feet of new railings can be an unexpected blow to a project budget.

Lacking familiarity with current requirements, some owners or managers complete a roof or balcony rehabilitation, only to learn after the fact that they need to tear noncompliant railings out of their new roof or terrace and install new ones. The best strategy is to learn how railing regulations could impact the scope, logistics, and schedule of a building envelope project—and its cost. New railings, depending on complexity and materials, typically cost between $150 and $1,000 per linear foot. A 20x20-foot roof terrace, or five small residential balconies, could easily cost $40,000 to replace or install railings.

Roof and balcony railings have been subject to changing regulations with successive iterations of the codes. Unless a building owner plans for a change in occupancy, such as converting a roof area to a pedestrian terrace, or modifications, such as a roof replacement or balcony upgrades, existing railings may be permitted to remain, provided they are not designated "hazardous" and meet the building codes that were in place at the time of construction.

LEARNING OBJECTIVES

After reading this article, you should be able to:

- **DISTINGUISH among various code requirements for railings to determine applicable standards.**
- **APPLY the Secretary of the Interior's Standards for the Treatment of Historic Properties.**
- **EVALUATE existing balcony and roof railings for signs of distress and failure, and diagnose the probable cause of deficiencies.**
- **IMPLEMENT appropriate strategies for railing repair, alteration, or replacement to meet building code requirements.**

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Such “grandfathered” railing exemptions are typically granted on a case-by-case basis, and it is best not to assume that railings may remain unmodified. Researching the code requirements and the interpretation of those requirements in the local jurisdiction should be completed early in project planning to anticipate any railing upgrades or replacements that may be necessary.

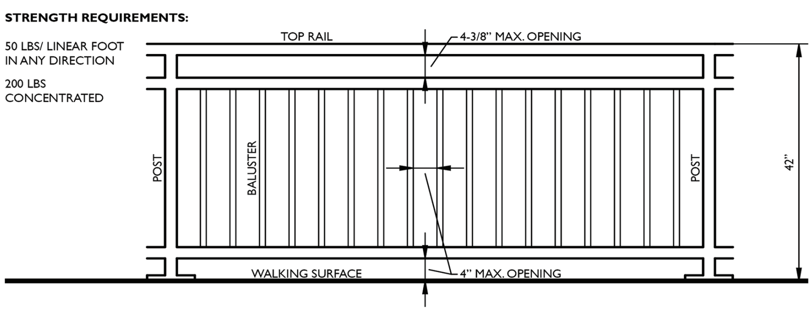
THE INTERNATIONAL BUILDING CODE

The predominant model code that dictates railing assembly height, configuration, and anchorage is the International Code Council International Building Code (IBC), which is in use or adopted in all 50 states and the District of Columbia. The latest version was published in 2015, but many states have yet to adopt the newer code, with some still using versions from as early as 2003. This variation in adoption can mean that regulations for railings can differ between states, with some holding buildings to more rigorous standards than others.

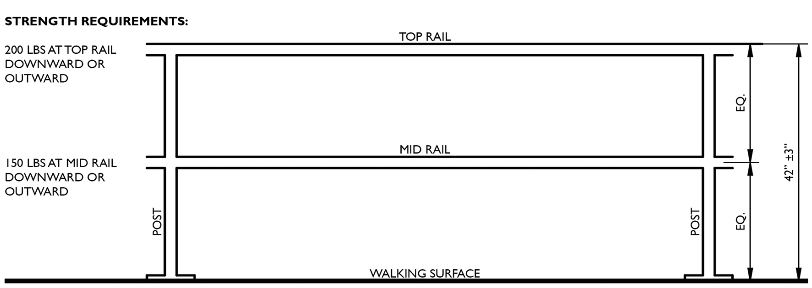
The diagram shown here illustrates the dimensional and structural requirements of the 2015 IBC, which demands higher performance than previous iterations. The 2015 IBC mandates that glass used in railing systems generally be laminated tempered glass, whereas the 2012 IBC accepted single tempered glass. Additional changes pile up when looking back just a few code cycles. For example, the 2015 IBC limits openings near the top of the railings to a maximum diameter of $4^3/_8$ inches. As recently as the 2006 edition, the IBC allowed top rail openings up to eight inches in diameter. As codes become more demanding, it is easy to see how older buildings could have railings which fall well short of meeting current regulations.

Typical Examples of Compliant Railing Configurations

2015 International Building Code (IBC)



Occupational Safety and Health Administration (OSHA), 1910.29



OSHA FALL PROTECTION REGULATIONS

With the passage of the Occupational Safety and Health Act (OSHA) of 1970, fall protection not only for building occupants, but also for workers became protected by code. Even spaces not accessed by the public require fall protection.

OSHA provides requirements for fall protection both at construction sites (Occupational Safety and Health Standards Part 1926 M) and for buildings in use by workers (Part 1910 D). Note that updated regulations went into effect January 17; these include options for fall protection.

Some areas, such as rooftop equipment spaces and maintenance terraces, may be subject to both IBC and OSHA regulations. Often the stipulations overlap, but where one is more stringent than the other, it should be followed as a matter of course.

The International Existing Building Code must also be considered in railing projects. Adopted by 39 states and the District of Columbia, the IEBC is intended to achieve safety standards in existing buildings, with sensitivity to the challenges of achieving full compliance with new construction requirements in older buildings.

The IEBC stipulates that building elements cannot be altered such that they become less safe than their original condition. Repairs may be performed without changing the entire system. However, where there are no guard railings or existing railings need replacement, the IEBC requires that these new elements be constructed in accordance with the current IBC.

Some jurisdictions, notably New York City, do not recognize the IEBC and may subject existing buildings to code requirements for new construction.

DON'T FORGET LOCAL BUILDING CODES

Even if the railing design passes muster with IBC and OSHA, there are still municipal codes to consider. Most adopt a version of the IBC, but some jurisdictions, New York City among them, have their own code or modifications.

The 2014 New York City Building Code (NYC BC) requires that all buildings greater than 22 feet in height with low-slope roofs and terraces have a 42-inch-tall parapet, railing, or fence. On the surface, this seems to line up with IBC and OSHA regulations, but there is one crucial difference: the NYC building code does not limit this requirement to accessible roof areas.

This means that even roofs and terraces with no entry point from the building interior must still have a safety railing. In an emergency, firefighters who need to climb onto the roof via ladder or lift bucket risk falling from an unprotected roof edge, especially with smoke reducing visibility. New York enacted this regulation to safeguard first responders.

These modifications may be enacted at the state or county level, as well. For example, North Carolina adopted a provision that requires a curb or toe rail at the base of all railings to prevent small objects (two inches in diameter) from falling to adjacent surfaces.

Unless the design team is familiar with code requirements at all applicable jurisdictional levels, such local regulations could go unnoticed, leading to violations and potential safety risks.

WHAT ABOUT HISTORIC RAILINGS?

Depending on the jurisdiction, historic and landmark structures may be subject to additional regulations regarding the railing design, beyond those imposed by general building codes. Landmarks review boards and historic preservation offices typically refer to the Secretary of the Interior's Standards for the Treatment of Historic Properties from the National Park Service (NPS). Tax credits for qualifying rehabilitation projects are reviewed by the State Historic Preservation Office or NPS staff for compliance with the Secretary's Standards. "Railings are important character-defining features of a historic building," notes NPS in an Interpreting the Standards bulletin. "Any modifications must be completed as sensitively as possible."

Often, historical railings are too low to meet applicable modern building codes. In New York City, the Landmarks Preservation Commission (LPC) requires that extensions to increase railing height must be "in keeping with the age and style of the building" and that replacement railings should "match the design, dimensions, and details" of the original.

However, the Standards suggest instead that railing additions "will be differentiated from the old," and yet be "compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property." In other words, code-compliant railing extensions should complement existing railings but remain visually distinct. This approach differs markedly from that in New York City, where the LPC rules require new railing components to blend in with the existing railing system.

These differences in ideology underscore the importance of determining local requirements before proceeding with a railing modification or replacement, particularly at a historic or landmark structure.

ADDRESSING COMMON RAILING PROBLEMS

Even if a railing system meets code requirements, it may still fall prey to the ravages of time, weather, poor design, or faulty construction. Problems most often develop where different materials intersect, or where gaps or crevices concentrate water and corrosive solutes, accelerating deterioration. For example, galvanic corrosion resulting from the contact of dissimilar metals can commonly result in fastener failure.

Material properties. A basic understanding of typical railing material properties helps not only in evaluating conditions at existing systems, but also in designing new or replacement railings.

Carbon steel, a metal alloy principally composed of iron, quickly corrodes (or "rusts") in the simultaneous presence of air and moisture. To prevent this reaction, protective coatings may be applied, but corrosion can occur at areas with failed or missing coatings, or from the uncoated interior of a hollow pipe or rail section. As corrosion progresses through a steel element, the metal delaminates and expands to many times its original volume, creating substantial outward forces that can damage adjacent materials. Significantly corroded posts or rails may have greatly compromised abilities to resist structural loads.

Stainless steel provides increased corrosion resistance compared to carbon steel due to the addition of chromium to the alloy, but problems can still develop. At gaps, dents, or scratches, or where the steel is in contact with other materials, chloride-containing pollutants may lead to pitting and crevice corrosion. At some welds, intergranular corrosion may reduce the chromium available to protect the steel, resulting in rust staining. Although unsightly, minor corrosion of stainless steel at welds and crevices is unlikely to result in structural deterioration.

Aluminum is a low-density, lightweight metal that develops a protective layer of aluminum oxide at its surface that shields the rest of the section from corrosive elements. When in contact with alkaline concrete, the protective film can break down, leading to corrosion. Chlorides, a common component of deicing salts, can cause pitting.

Glass railing systems are composed of safety glass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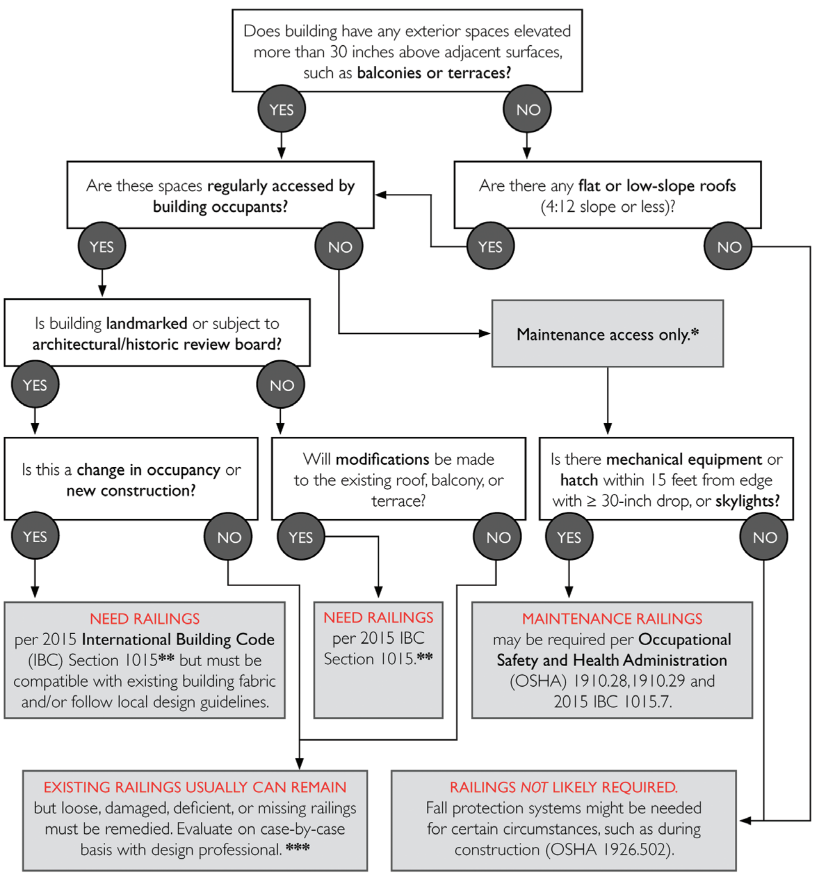
Railing corrosion causing cracks and spalls at post-slab interfaces.

Do My Roofs, Balconies, or Terraces Need New or Updated Railings?



NOTES

* In New York City, roofs, balconies, or terraces with slope of 2.4:12 or less and height of 22 feet or greater require railings per 2014 NYC Building Code, Section 1509.8. Often, older buildings may comply with the code under which they were constructed.

** In NYC, railings must comply with 2014 NYC Building Code, Section 1013 and 1607. Often, older buildings may comply with earlier codes.

*** The International Existing Building Code (IEBC) may also be applicable, depending upon building location.

sheets, often supported by aluminum or stainless steel channels or "shoes" with flexible gaskets. Some glass is supported by through-glass fasteners connected to metal railing posts. Since the thermal expansion of stainless steel is about twice that of glass, and that of aluminum is even greater, composite-railing designs must provide for differential movement.

Post-slab interface. At reinforced concrete balconies, railing posts are commonly set into metal sleeves embedded into the concrete slab. To avoid premature deterioration, embedded post sleeves must be coordinated with the balcony reinforcement design, such that sleeve positioning and concrete coverage over reinforcement are carefully arranged prior to pouring concrete.

If not coordinated at the design or shop drawing phase, core-drilled holes to set railing posts can sever concrete reinforcement at the critical slab edge, compromising structural integrity of the balcony. Poorly positioned post sleeves, particularly those without protective coatings, can undergo galvanic corrosion from contact with concrete reinforcement, and resultant expansion forces can crack or spall the concrete.

Gaps at the post-sleeve-slab interface, if not properly finished, can allow water to penetrate the concrete, bringing deleterious chlorides, crevice corrosion, and harbored water subject to freezing and thawing stresses. Around post sleeves, gypsum-containing setting grout may absorb water and swell, causing the concrete to crack.

Returns at exterior walls. Where railings terminate at masonry walls, railing ends usually include embedded brackets for bracing. If termination brackets or fasteners contain ferrous metals, corrosion and expansion may lead to rust stains and masonry cracks. As deterioration advances, reduced structural integrity of the railing system and spalled masonry units may present safety hazards.

Dimensional deficiencies. As building codes evolve, regulatory requirements for railing dimensions have changed, stipulating railings that are taller and with opening limitations. For example, a NYC building constructed in 1910 may have had railings that were only 36 inches high, whereas a 1982 building should have 42-inch-high railings. However, even "modern" railings may be installed or fabricated incorrectly (e.g., too short, too weak), necessitating remediation before the end of their service life.

Energy codes have indirectly impacted railing height by requiring increased insulation thickness for replacement roofs, resulting in an elevated roof surface relative to the top rail. With added insulation, railings that once were code-compliant may now be too low.

Unrelieved expansion/contraction. Railings that do not include the facility to expand and contract under thermal stress can self-destruct under restraint. For each specified material, rates of expansion should be considered and properly sized expansion joints provided to accommodate movement at strategic locations, while maintaining structural continuity along the entire railing system.

Missing or unstable railings. Depending on the jurisdiction, exterior elevated surfaces may require perimeter protection by law. Railings that are discontinuous or absent can risk a violation or, worse, an accident. If rails, posts, or panels move by gentle pushing and pulling by hand, field structural testing may be recommended to quantify the location and extent of structural inadequacies.

Railing maintenance. Railings should be checked regularly for deterioration, gaps at penetrations, and overall structural stability. Building owners should limit

+EDITOR'S NOTE

To earn 1.0 AIA CES HSW learning units, study the article and take the exam posted at **www.BDCnetwork.com/BalconyRailings** use of deicing compounds with corrosive chlorides near railing posts.

Often prominent architectural features, railings require periodic cleaning. Based on the substrate condition and type of soiling, cleaning may involve water, chemicals, or abrasive techniques. To determine the most efficient and cost-effective approach, mockups should be conducted. Considerations include damage to existing materials, runoff containment, and worker safety.

To mitigate water penetration at railing post ends or returns, application of suitable sealant at openings may be appropriate, provided the concrete or masonry is undamaged. Manufacturers offer various sealants with proprietary chemical configurations, so products vary in performance. Prior to any sealant installation program, careful product selection and field adhesion testing of sealant mockups are recommended.

New or replacement coatings, whether to improve aesthetics or mitigate corrosion, demand consideration of both the substrate and the desired finished appearance, as well as constraints of budget. Mockups should be used to verify appearance and performance. Careful cleaning and substrate preparation is critical to proper bonding of primers and subsequent performance of the finished coating system. Various formulations are available, from brush-applied acrylics to solvent-based alkyds to field- or shop-applied fluoropolymers. Access, protection of adjacent surfaces, odors, and volatile organic compounds can impact a coating plan.

DECISION TIME: REPAIR OR REPLACE?

Simple repairs, such as fastener replacement or sectional rail replacement, may address limited deterioration or deficiencies. Materials should be corrosion-resistant or protected from corrosion, close on the galvanic scale to the material to which they are attached, and of a similar strength to surrounding materials.

Railing repairs can be performed in the field, or railings can be dismantled and taken to a shop, which usually results in a finished product that will perform better over time. Mobilization, cost, and schedule are key considerations. Until such work is completed, restricted use is important for safety reasons.

If a railing is too low, too “open,” structurally inadequate, or has caused damage to the substrate into which it is anchored, replacement of the railing may be the best option. After substrates are repaired, a new robust and dimensionally compliant railing can be installed and anchored. Due to the ever-evolving landscape of regulations and stylistic preferences, anchorage details can be specified that allow for simplified removal/replacement of railings, with minimal disturbance to structural or waterproofing elements at the mounting points.

If railing damage is limited to concrete deterioration and corrosion at the post sleeve or inadequate anchorage strength, replacement of the entire system may not be necessary. Instead, new post anchorage can be designed for the existing assembly. After the concrete is repaired, a new post bracket can be anchored to the slab with stainless steel fasteners, a configuration that greatly reduces potential for water penetration.

Where increased roof insulation thickness required by energy regulations renders existing perimeter protection inadequate, an extension to the original railing may be feasible, but may not be cost-effective when compared to replacing the railing, especially if the railing is a simple, economical design.

For railings deemed historic or architecturally significant, minimal and reversible interventions are preferred. One possible solution is to introduce a visually unobtrusive second railing in-board of the original, relieving the historically significant railing of duty as a safety component but leaving the aesthetics generally intact. Work closely with local architectural review boards and state historic preservation offices to determine options.

Sometimes, a building owner discovers that an unprotected area should have railings, or that a roof replacement or other alteration has rendered an existing system inadequate. Should older railings be found deficient, a design professional should review codes in effect at the time of construction, as well as capacity and condition of existing materials, to determine whether original railings may be retained. Generally, it is recommended to evaluate design and performance requirements for existing and new railings in light of current codes.+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