Selecting & Specifying a Railing System for Your Building Project

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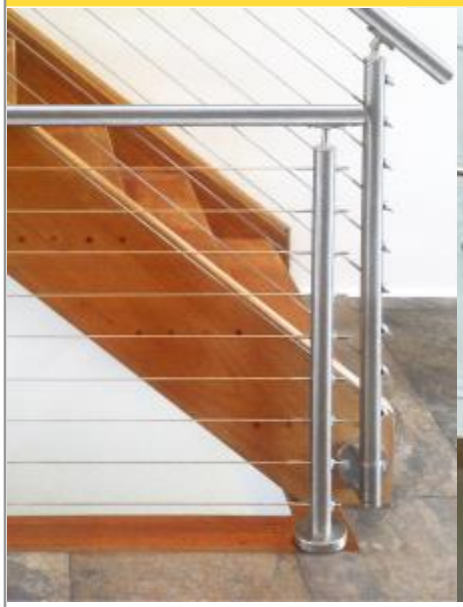

Selecting & Specifying a Railing System for Your Building Project

Presented by: Lavi Industries
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Description: Provides an overview of the important factors that need to be considered when selecting and specifying a railing system for a commercial or residential building project.

Purpose and Learning Objectives

Purpose: Provides an overview of the important factors that need to be considered when selecting and specifying a railing system for a commercial or residential building project.

Learning Objectives:

At the end of this program, participants will be able to:

- identify common railing materials and finishes, compare their performance features, and detail how to choose a railing system material to suit the safety and structural requirements of the project and its environment
- discuss the benefits of designing with stainless steel with respect to durability and sustainability
- compare railing system fabrication methods and discuss necessary assembly and installation considerations to ensure a safe and secure railing system that meets the needs of all building occupants, and
- identify and discuss relevant building codes and standards related to the structural design, safety and accessibility of a railing system project.

Introduction to Railing

What Defines a Modern-Day Railing System?

A railing system can be described as a combination of any number of horizontal, vertical or inclined members or panels that together create a framework that is located at the edge of a floor opening, stair flight, ramp or platform etc. A handrail may be part of a railing system but may not necessarily be the top member. It may be horizontal or sloping, mounted to a wall or other structural element, and grasped by the hand for support or guidance when users transition from one space to another.

Today's architectural railing systems offer durability, strength and design flexibility and are suitable for indoor and outdoor use in a variety of commercial, industrial and residential applications.

Railing Terms

- **Baluster**: "..also called spindle or stair stick—is a moulded shaft, square or of lathe-turned form, a form cut from a rectangular or square plank, one of various forms of spindle in woodwork, made of stone or wood and sometimes of metal, standing on a unifying footing, and supporting the coping of a parapet or the handrail of a staircase balustrade."[1]

- **Cap rail**: top member of a rail system.

- **Guardrail**: a rail or barrier usually located for protection of building occupants at or near outer edge of landing, platform, balcony etc. to guard against accidental falls or injury. *Note: Although the terms guardrail and handrail are sometimes used interchangeably, building codes make clear the difference.

[1]Wikipedia contributors. "Baluster." *Wikipedia, The Free Encyclopedia*. Wikipedia, The Free Encyclopedia, 26 Sep. 2014. http://en.wikipedia.org/wiki/Baluster (accessed January 2015)

Railing Terms

- **Infill panel**: a non-structural glass, picket or cable panel that is supported within a railing system. Infill panels are fabricated to meet certain codes—see also baluster.

- **Post**: a structural, vertical member of a railing system.

- **Stair railing system**: a railing system located along the open sides of a stair (a flight or series of connecting flights) and landing (the horizontal surface located in between stair flights or at the end).

- **Traffic rail system**: a railing system designed for the control of movement of people which requires the consideration of queue management strategies.

A Well-Designed Railing System Is Important

From a functional point of view, a railing system determines how safe and accessible a building's exterior and interior environments will be. The health, safety and well-being of the building users is directly affected.

A well-designed railing system not only offers support, guidance and safety, it enhances the aesthetics and visual appeal of a building environment and affects how users interact with their surroundings.

Railing Selection

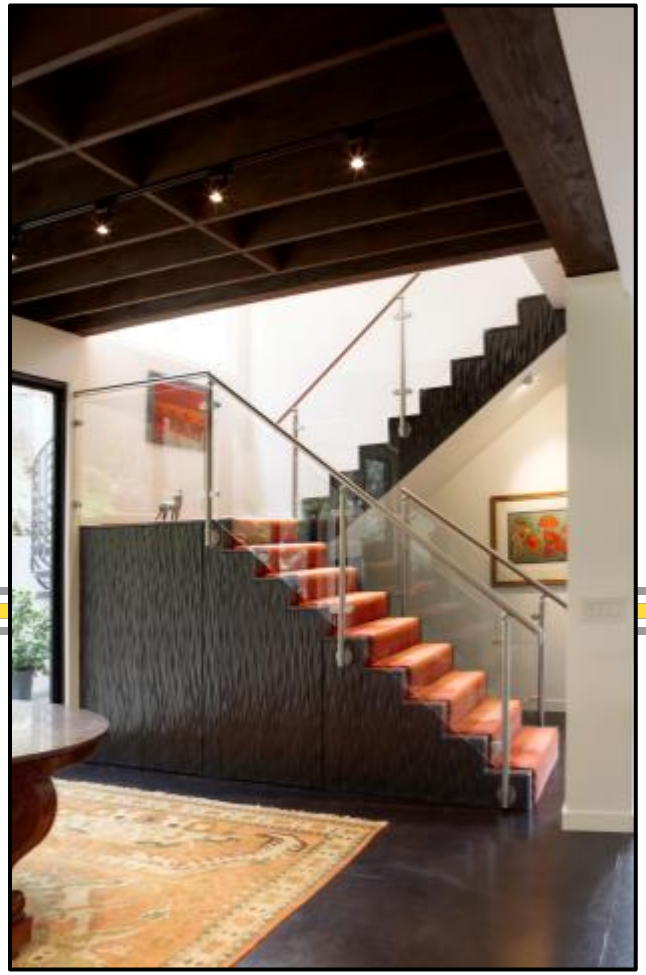
Not all railing systems are suitable for every building project. Many factors must be considered before selecting a railing design for a specific location and application.

This course takes a closer look at these factors, but what's important to remember is that the selection criteria must be considered and evaluated together in order to best determine what type of railing should be specified.

Railing Selection

Railing system selection criteria include, but are not limited to the:

- Environment/Geographic Location
- Application
    - Commercial, industrial etc.
    - Scale/size
    - Building use (healthcare, school etc.)
- Materials (performance, maintenance, aesthetics)
- Assembly and Fabrication Methods
    - System design flexibility
    - Mounting conditions
- Safety, Building Code and Structural Requirements



Railing Environment, Location & Application

Environment/Geographic Location

The environment and geographic location of a railing project may dictate structural design requirements and what materials can be used, including the final finish or coating.

- Is the climate humid or dry?
  - When the overall climate is relatively humid, a more corrosion resistant material for outdoor applications is required
- Is the railing going to be near salt water or in a marine environment?
  - If the railing is to be installed near the ocean, a more corrosion resistant material should be used both indoors and outdoors
- Is the railing in a wind-prone area?
  - Specific design criteria for buildings in high-wind regions must be considered
- Rail maintenance requirements may depend on seasonal weather variations (extreme hot or cold, high rainfall etc.) or due to the landscape (termites, wet areas etc.)

Application

The application can affect the railing design selected in a number of ways. Is the railing to be installed in a commercial, residential or industrial setting?

- In ***commercial rail installations***, structural code requirements are of critical importance (see section about building codes). The railing design is usually dictated by the commercial entity that is to own/occupy the building, making color combinations and design themes important in these cases.

- A ***residential rail installation*** is normally not subject to the same strict code interpretation as commercial installations, but the design will be important and will need to meet the taste of the property owner. Residential and high-end commercial installations normally dictate the use of an architectural design style, pleasing to the eye. These applications will require special attention to the design style and the finish of the installed railing. Typical architectural design styles are:
  - glass rail
  - structural glass rail
  - cable rail
  - crossbar rail and
  - mesh or perforated metal rail.

Application

- Depending on the application, an ***industrial rail installation*** may not be subject to the same strict code interpretation as commercial installations. Railing design is often a secondary consideration that is preceded by practicality. Industrial installations normally dictate functional railing installations with less of an architectural design style. Finish requirements usually tend to require specific colors for easy identification (for example, yellow or red for safety).
- Some buildings require the use of building materials that aim to reduce the risk of disease and promote a clean and healthy environment. Railings made of an antimicrobial material or finished with an antimicrobial coating may be required in healthcare facilities, food processing plants, hospitality buildings and transportation service locations.
- Outdoor vs. indoor applications dictate which material/s are to be used. Outdoor railing installations dictate that harder and more corrosion resistant materials be used. Indoor applications will require less corrosion resistant materials. For example, good outdoor materials are metal (stainless steel or aluminum) or wood-plastic composites which will endure the weather with more ease.

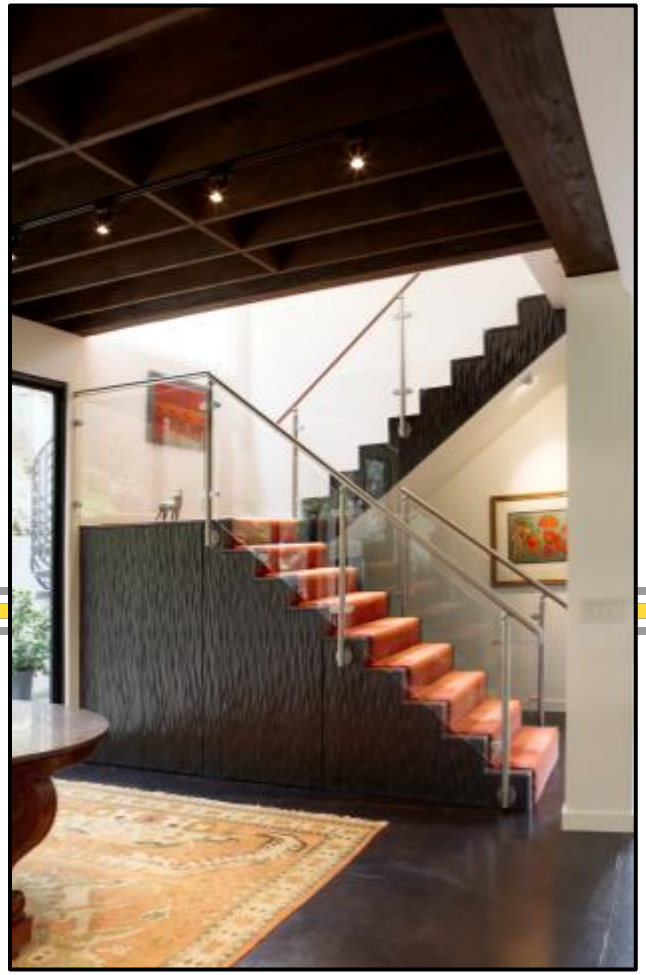
Application

What is the size/scale of the rail project?

- Small handrail or foot rail projects can often be designed and fabricated from stock components. Depending on the manufacturer, some may be sold as kits that include all the necessary components and installation instructions.
- Large rail projects may benefit from the installation of a pre-engineered, prefabricated railing system.

What is the function of the railing?

- Is the railing purely ornamental, or is it meant to enhance a space, be an architectural centerpiece, while meeting all of the required structural and safety needs of the application?
- Perhaps the railing needs to offer an unobstructed view while still providing a safety guard around a balcony, deck or staircase.
- Rails in high-use public facilities (e.g., schools, airports) may require more regular maintenance routines.



Railing Materials

Materials

Railings are built using a variety of different materials. Different materials offer their own aesthetics and advantages. The most common materials used for railing are:

- Wood
- Plastic and wood-plastic composites
- Stone
- Concrete
- Granite
- Marble
- Metals

Materials: Wood

Wood is known for its beauty and its flexibility in meeting the aesthetic requirements of a railing design because it can be stained or painted without adding excessive cost to a project. Wood can be hand-crafted for a rustic look, carved for a more traditional look, or sanded and finished for a more modern look. Interior wood railing systems can be cleaned and maintained fairly easily, but outdoor wood railing systems require regular maintenance since they may be subject to splitting, shrinking or warping. To ensure it stays structurally sound, an exterior wood railing system must be protected against weather conditions (rain, UV rays, heat, snow) to prevent deterioration or rot.

Materials: Plastic & Wood-Plastic Composites

Vinyl railing systems are considered low-maintenance because they are easy to clean with common household solutions and do not require painting. Vinyl does not rot like wood and does not corrode like some metals. However, in some geographic locations, the stability of vinyl can be affected by extreme hot or cold temperatures. The structural posts and top and bottom rails are commonly reinforced with aluminum or steel, and with today's metal-to-metal connections and hidden fasteners, the aesthetics of the railing systems remain intact.

Wood-plastic composites offer the look of natural wood grain patterns in a variety of colors but, unlike wood, they do not need to be stained or painted. They also have a much lesser tendency to rot, warp or splinter.

Materials: Stone, Concrete, Marble & Granite

Railing installations that utilize materials such as natural stone, concrete, granite or marble in their design are heavy and may require custom fasteners. The cost of these materials depends on the source of the material, material quality and size of the project. These materials may be susceptible to cracking or breaking if not properly handled upon installation.

Materials: Metals

Metal railings are commonplace for a number of reasons. They can provide a cost-effective solution. Metal is relatively hard and sturdy and allows for railings that have a leaner aesthetic as compared to wood or stone railings. Metal railings also offer a broad variety of aesthetic and durability options. Commonly used metals in railing installations are:

- Aluminum
- Brass
- Iron
- Steel
- Stainless Steel

Materials: Aluminum

Aluminum is a non-ferrous metal that is lightweight, strong and known for its resistance to corrosion.

Aluminum railings can be powder coated or anodized to meet the aesthetic requirements of a project and over the long term require relatively little maintenance. As a railing material, aluminum offers ease of fabrication and versatility in design, and as such, is used for structural components and decorative panels.

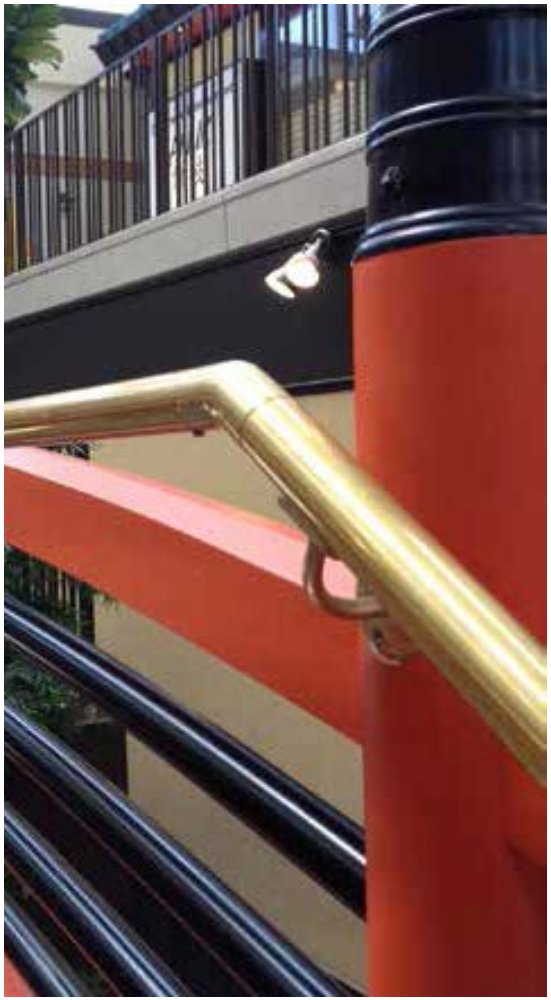
Although commonly used in areas that require greater resistance to corrosion, aluminum is one of the softer metals in use.

Aluminum tube is available in a large variety of shapes through the process of extrusion. It can be cut, deburred and welded. Fasteners and fittings are readily available and, used in conjunction with tube, adhesive and/or welding, make for an effective way to build railings.

Materials: Brass

Brass has been a favored decorative element for centuries, and it continues to be the material chosen for installations that display a classic or traditional design style. Today, brass bar railing is a classic element of pub décor and continues to be used in hospitality locations worldwide. Decorative railing such as short-height “pony rail” and structural railing including wall mounted handrail and stair rail are still in demand. Brass rail combines effectively with wood décor.

Although brass has lost some popularity over the years compared to other metals, it remains a solid product with unique corrosion resistant properties. The oxidation that occurs on brass actually protects its surface from further corrosion, thus the continued use of brass in select outdoor installations. Furthermore, certain brass alloys qualify as antimicrobial as confirmed by the Copper Development Association and the U.S. Environmental Protection Agency (EPA).



Materials: Iron

Traditional wrought iron railings are uniquely decorative and ornate, and their open work provides a much sought after antique look. Commonly coated with a black paint, wrought iron railings are heavy, which may make installation and repairs cumbersome. Additionally, repairs require welding, and replacing the curved shapes, scrolls or twisted spires may be difficult.

Wrought iron railings are often combined with brass handrail and fittings.

Materials: Steel

Steel is an ideal material for railings because it is stronger and more durable than other metals and, because of its relative strength, allows for leaner designs to be employed in railings. In terms of finishes, steel can be polished (brushed), cleaned, powder coated and plated easily.

Steel tube, the basic building block for railings, can be found easily in round, square, rectangular and oval shapes. Steel tube can be cut, de-burred and welded. Additionally, fasteners and fittings for steel tube are readily available. Fasteners and fittings, used in conjunction with tube, adhesive and/or welding, make for an effective way to build railings.

Materials: Stainless Steel

Stainless steel (like steel) is stronger and more durable than other metals and therefore allows for leaner designs to be employed in railings. The major advantage of stainless steel over steel is that it is more resistant to corrosion.

In terms of finishes, stainless steel can be polished, cleaned, powder coated and plated easily. It also has the capability to maintain its luster for a long time, and maintenance requirements are low.

Again, like steel, stainless steel tube can be found easily in round, square, rectangular and oval shapes. It can be cut, de-burred and welded. Additionally, fasteners and fittings for stainless steel tube are readily available.

Materials: Stainless Steel Grades

There are different types, grades and categories of stainless steel, each with its own performance properties, surface finish, corrosion resistance and maintenance requirements.

Railing systems often use 304 and 316 grade stainless steel. What's the difference?

- Type 304 stainless steel contains 18–20% chromium and 8–10.5% nickel.
- Type 316 stainless steel contains 16–18% chromium, 10–14% nickel and 2% molybdenum.

Why molybdenum? It helps to resist pitting and corrosion by most chemicals and is very resistant to salt water corrosion, making Type 316 an ideal material for railings in coastal areas, marine environments and heavy industrial applications. A Type 304 railing in a coastal area would require regular maintenance/cleaning to remove corrosion, staining and salt.

Finishes: Stainless Steel

Common terms used to describe the finishes available for stainless steel are mill, polished and special.

- Mill finishes are produced by passing the stainless steel through a roll or die. They are often the least expensive option and range from dull to mirror-like.
- Polished finishes are produced by mechanically abrading the surface of the stainless steel with a series of abrasives. The grit size used depends on how rough the initial surface finish of the stainless steel being polished is. This process creates surface finishes that range from dull, to satin, to highly polished.
- Special finishes are specified when specific aesthetics (swirls, patterns etc.) are required.

Source: Specialty Steel Industry of North America (SSINA). “Finishes: Standard Finishes: Introduction.” *Stainless Steel Information Center*, n.d. www.ssina.com/finishes/intro.html (accessed January 2015)

Finishes: Stainless Steel

The most common terms used in railing for stainless steel finishes are brushed, satin, polished and mirror. These four terms are not exclusive of each other, and there is often confusion over the differences between brushed and satin and polished and mirror. Much of the confusion can be eliminated by defining finishes in technical terms.

180-grit polish is the most common polished finish. Rougher grits (80- and 120-grit) are also available. Polishing can be specified on the inside or outside diameter or on both. Seamless, welded or cold drawn products can be polished. Polishing is available on round, square and rectangular tubing. On round products, it is typically circumferential, but some polishers can longitudinally polish. Other shapes are longitudinally polished.

- Applications: brewery, food and dairy processing, furniture, grab bars, handrails, medical equipment tubing, oven and refrigerator door handles, pharmaceutical, pumpshell tubing, restaurant equipment and structural applications.

Source: Specialty Steel Industry of North America (SSINA). “Finishes: Standard Finishes: Introduction.” *Stainless Steel Information Center*, n.d. www.ssina.com/finishes/tubepipesamples.html (accessed January 2015)

Finishes: Stainless Steel

Finer polished finishes (240-, 280- and 320-grit) are produced for applications where a smoother finish is desired for aesthetic applications and where improved corrosion resistance or cleanability is needed. Higher grit numbers produce smoother, finer and more reflective finishes.

- Applications: brewery, boat railings, food and dairy processing, furniture, grab bars, handrails, medical equipment, oven and refrigerator door handles, pharmaceutical, restaurant equipment, structural applications and soot blowers for cleaning boilers.

Buffed finishes are achieved by mechanical polishing (typically to 320-grit) and then buffing. Like the No. 7 and No. 8 sheet finishes, different levels of buffing are available, and the visibility of residual polishing lines can vary. Buffed finishes are used for aesthetic applications and where a higher level of corrosion resistance or cleanability is desired. A visual standard is suggested if the application is aesthetic, and a maximum surface roughness should be specified if the goal is improved corrosion resistance or cleanability.

- Applications: furniture, handrails, boat rails, ladders, luggage racks, automotive, exercise equipment, swimming pool ladders and structural applications.

Source: Specialty Steel Industry of North America (SSINA). “Finishes: Standard Finishes: Introduction.” *Stainless Steel Information Center*, n.d. www.ssina.com/finishes/tubepipesamples.html (accessed January 2015)

Stainless Steel Performance

The Specialty Steel Industry of North America (SSINA) identifies the following benefits of stainless steel:

Corrosion resistance

- The self-repairing quality of its chromium rich protective film means stainless steel can restore its surface after being scratched or damaged, ensuring high corrosion resistance.

Fire and heat resistance

- High grades resist scaling and retain strength at high temperatures.

Hygiene

- Its easy cleanability makes it ideal for applications where hygiene is a requirement, such as healthcare facilities and food processing plants.

Aesthetics

- It has a bright, contemporary appearance that is easy to maintain.

Source: Specialty Steel Industry of North America (SSINA). "Stainless Steel Overview: Features & Benefits." *Stainless Steel Information Center*, n.d. www.ssina.com/overview/features.html (accessed January 2015)

Stainless Steel Performance

Strength-to-weight advantage
- Its strength allows for the use of less material (reduced material thickness means slimmer profiles etc.).

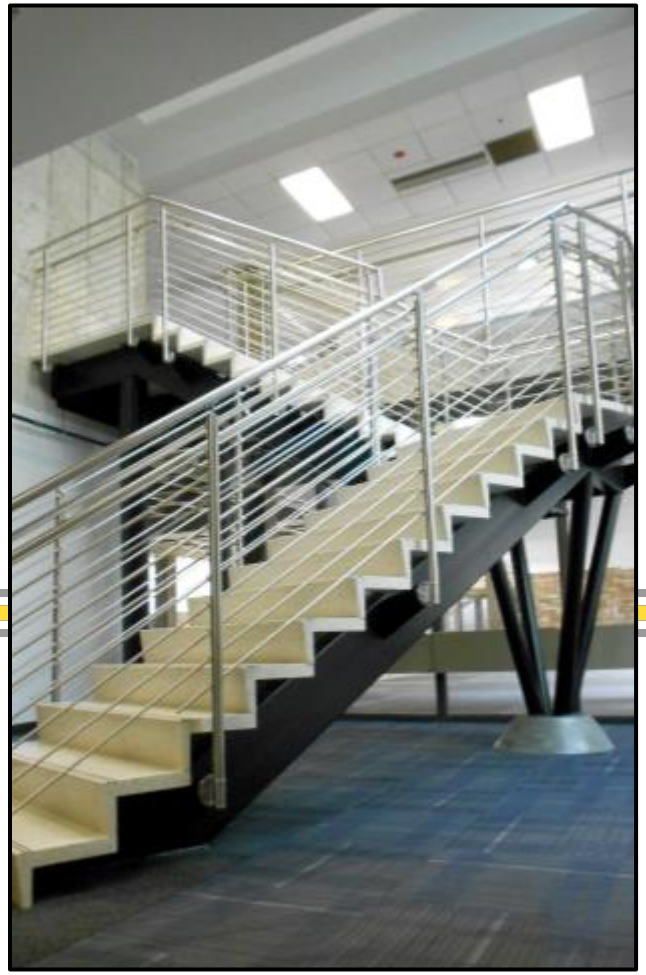
Ease of fabrication
- It can be cut, welded and fabricated into standard metal forms or custom shapes.

Impact resistance
- The 300 series provides high toughness in elevated temperatures and those below freezing level.

Long-term value
- When total life cycle costs are taken into consideration, stainless steel is a very economical choice.

Life cycle
- Stainless steel products are 100% recyclable, and it is estimated that over 50% of new stainless steel comes from old, re-melted stainless steel scrap.

Source: Specialty Steel Industry of North America (SSINA). “Stainless Steel Overview: Features & Benefits.” *Stainless Steel Information Center*, n.d. www.ssina.com/overview/features.html (accessed January 2015)



Railing Fabrication

Railing Fabrication: Building Blocks

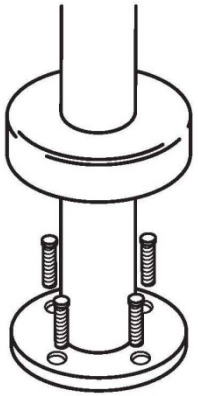
In order to understand railing fabrication, one needs to first be knowledgeable of the five fundamental building blocks of a railing system. These building blocks are:

1. Mounting conditions
2. Vertical supports
3. Infills
4. Handrails
5. Mounting hardware

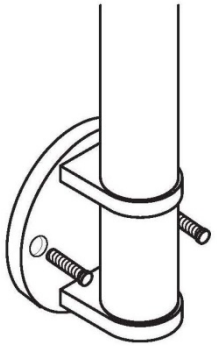
Mounting Conditions

Mounting conditions can be grouped into one of four types: floor mount, fascia (side) mount, core drilled and angle mount.

Floor mounts are made of a flange that is connected to a vertical post by either threading or welding. They can come with or without a decorative canopy and typically have two to four through holes for mounting hardware. The type of hardware to be used will be determined by the surface on which the flange is mounted.

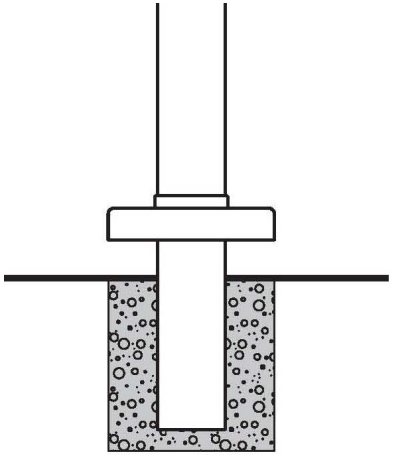


Fascia mounts are made of a flange that is vertically oriented and has a bracket or two that hold a vertical post in place. They typically have two to four through holes for mounting hardware. The type of hardware to be used will be determined by the surface on which the flange is mounted.

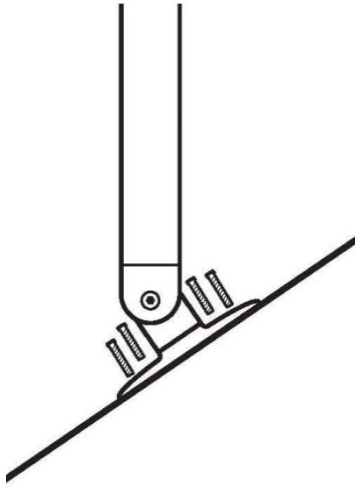


Mounting Conditions

Core drill mounts are usually extended lengths of a vertical post that are embedded in concrete. They can come with or without a decorative canopy or flange. This mounting method does not use hardware. Comparatively, it is a more stable mounting condition because the post is set in concrete. It does require the ability and resources needed to drill into concrete and set a post vertically into concrete**.**



Angle mounts are flanges that have a neck that can be adjusted so that a post can be installed vertically on an angled surface. The post connects to the neck by welding. They can come with or without a decorative canopy and typically have two to four through holes for mounting hardware. The type of hardware to be used will be determined by the surface on which the flange is mounted.



Vertical Supports

Vertical supports, also known as posts, stanchions or prefabricated posts, are the component in railing systems that brings the infill and the handrail together. They also provide a great deal of the structural support in a railing system. Vertical supports often have connectors on them, designed to hold infills and handrails in place.

There exists a large variety of materials and shapes that can make up a vertical support. Designers have, over the years, come up with dozens of ways of making a railing look different. The most commonly employed ones are glass and cable infills.

Infills

A railing system infill fills the space between the vertical supports, handrail and mounting condition. It can be made of any of a variety of materials, and it can be fabricated into any number of shapes giving it, in turn, a specific look.

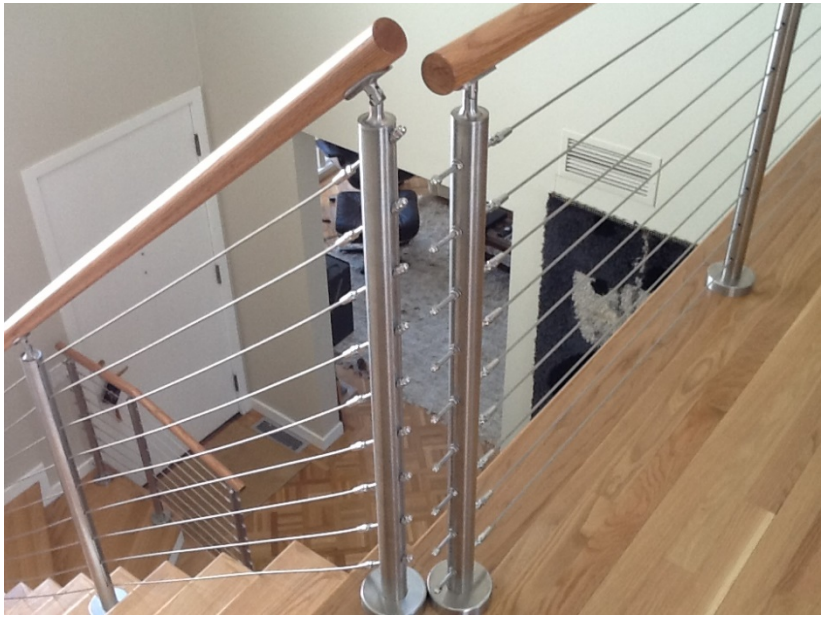
Infill types include:

- glass
- horizontal or vertical cable
- horizontal or vertical rod
- cable mesh, and
- perforated metal.

Handrails

Handrails are most commonly on the top of the railing system and are at times also placed at the side. They serve as a guide for the hands, and their size and positioning are often specific by building code.

Handrails can be made of wood, metal and plastic.



Mounting Hardware

Mounting hardware on railings can be used at the bottom of the rail to connect to the floor, at the top of the rail to connect vertical posts to the handrail, and on the vertical posts to connect fittings to the posts.

Floor mount hardware
- Mounting on to a wood surface will require the use of lag bolts.
- Mounting on to a concrete surface will require the use of anchor bolts.
- Mounting on to a steel surface will require the use of machine screws and mating nuts, washers/lock washers.

Vertical post to handrail hardware
- Use wood screws to mount wood handrail to posts.
- Use self-drilling screws to mount thin wall metal tube (0.05" or thinner) to posts.
- Use machine screws to mount thicker wall metal tube to posts.

Fittings to posts
- Use wood screws or machine screws for wood and metal respectively.

Exact hardware, including code compliance specifications, is available from hardware distributors nationwide.

Railing Fabrication Methods

There are three main methods of building a railing installation:

1. Fabrication from scratch.
2. Assembly using a modular system.
3. Assembly using prefabricated posts and accessories: tube and fittings designed to mate with the handrail.

To fabricate from scratch, one cuts, grinds, welds and refinishes the desired material and mates it with specially machined or hand-fabricated fittings. This allows for control over on-site fitment of the installation and also allows for a relatively artistic/rustic look to the installation. This is a time-consuming method.

Assembly using a modular system involves mating tube or cap rail or rod with fittings specially designed to mate with the tube, cap rail etc. Parts can be connected by welding or using the appropriate adhesive. It requires less time than the first method.

Assembly using prefabricated posts simplifies the installation further. Predesigned vertical posts are produced off-site, and installation is performed at the designated location with specially designed fittings and handrails. Parts can be connected by welding or using the appropriate adhesive. This method normally requires the least amount of time to install.

Railing Fabrication Methods

Railing infills, where required, can be installed using all of the fabrication methods.

Why select one of the methods over another? All three methods can produce the same results in terms of design aesthetic and functionality.

The real consideration when selecting one of these methods is ease of installation or, as viewed in many cases, cost. Methods 2 (modular) and 3 (prefabricated) as described offer a cost opportunity that method 1 (from scratch) does not.

Railing Fabrication Methods

While this section of the course highlighted stainless steel and brass railing systems, railing fabrication is available in today's marketplace in a variety of materials. Consult individual railing manufacturers for details about their products.

Specification & Installation

Prefabricated Railing Assemblies

Design considerations for a prefabricated railing assembly include:

Post options
- height (standard 36", guardrail 42")
- position/connection (end, center, stair center, corner)

Handrail connections
- ball saddle, short saddle, adjustable short saddle or flush fittings

Mounting conditions and options
- floor mount or fascia mount
- concrete, wood or metal
- interior or exterior

Infill options
- cable, crossbar railing or glass

Railing Specification

Specifying a railing installation involves taking the following aspects into consideration:

1. Tube diameter/wall thickness
2. Railing height
3. Mounting condition
4. Infill type
5. Identifying slope: will the rail be mounted on a stair or ramp?

Tube Diameter/Wall Thickness

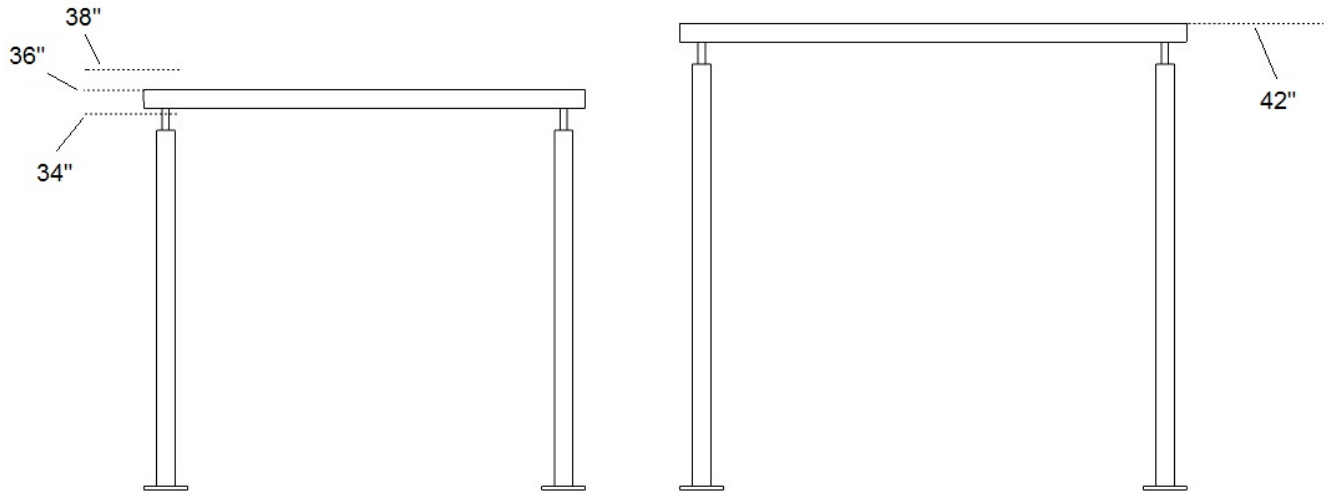
Common tube diameters for railing are 1½", 1.67" and 2". Wall thickness requirements vary based on building code requirements. Generally, the thicker the wall of the tube, the greater the load bearing capacity and the lesser the deflection of the tube.

Railing Height

There are two commonly used rail heights.

Handrail is specified as having a height AFF (above finished floor) of 34"–38". Most handrail is built at the average height of 36".

Guardrail is specified as having a height AFF of 42" or greater. Guardrail is required where rail is designed to protect from a fall of 30" or greater.

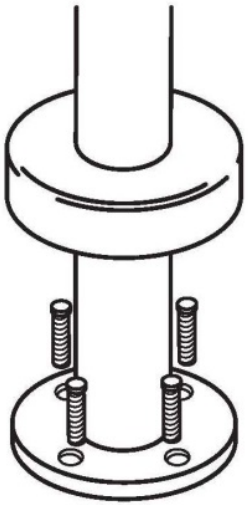


Handrail Guardrail

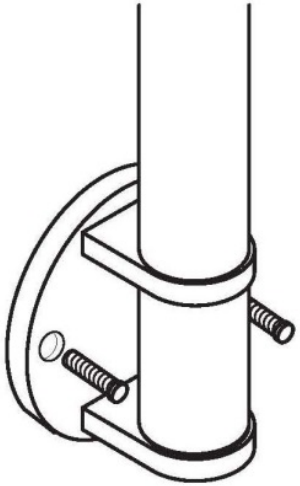
Mounting Conditions

There are four basic ways to mount a railing:

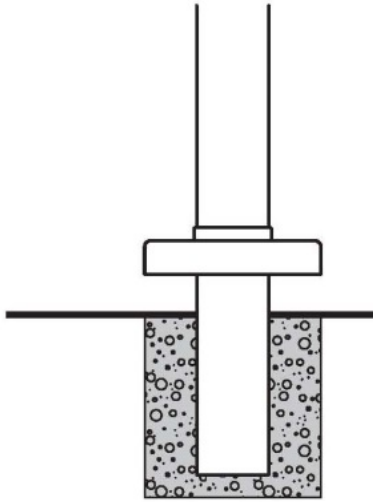
- floor mount
- fascia mount
- core drill, and
- angle mount.



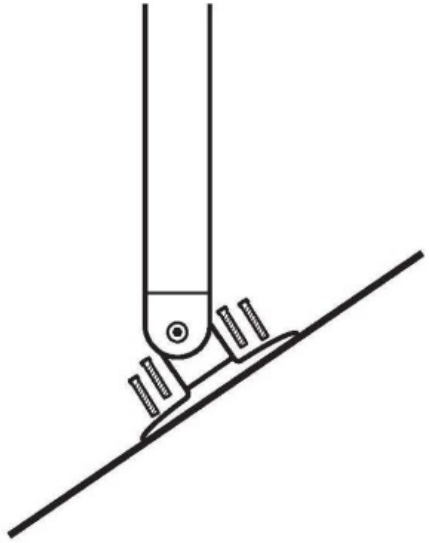
Floor mount



Fascia mount



Core drill



Angle mount

Infill Type

Infill type is to be selected based on the aesthetic and cost level desired. Some infills are less obtrusive than others as is the case with glass or cable infills. These infills provide for an unencumbered view and allow for light or air to pass through. Other infills can offer a more intricate look as well as a variety of architectural styles.

Cable infill

Crossbar infill

Glass infill

Stairs/Ramps

Railing can be placed on stairs and on ramps to serve as a handrail guide and to protect from falls of 30" or greater. Depending on the type of handrail and infill used, railing posts for stairs and ramps will need to be designed differently. Post top saddles will need to be adjustable to allow for a slope, and infill holders will need to be properly placed and will sometimes need to be adjustable as well.

Railing Installation

Railing should be installed by a qualified contractor with experience installing railing. Normally, contractors that build decks, ramps, balconies and stairs have this type of experience. Furthermore, the contractor will need a thorough working knowledge of the material that the railing is made of.

One should be sure to address all the design considerations that were previously outlined (post height, handrail connections, mounting conditions, infill options).

Furthermore, building code and standards for railings must be met. See the next section.

Codes & Standards

Introduction

Before selecting and specifying a railing, it is important to become familiar with the requirements of international, state and local building codes and standards. This section of the course highlights some of the international and national codes and standards that many state and municipal authorities use as guidelines when establishing rules for their local jurisdiction.

Always consult relevant building codes and local authorities for specific details, limitations and exceptions regarding code requirements before starting a railing project.

IBC 2012: Guardrails

Chapter 10 Means of Egress, Section 1013 Guards

1013.2 Where required

- Guards shall be located along open-sided walking surfaces, including mezzanines, equipment platforms, stairs, ramps and landings that are located more than 30 inches (762 mm) measured vertically to the floor or grade below at any point within 36 inches (914 mm) horizontally to the edge of the open side.

1013.3 Height

- Required guards shall not be less than 42 inches (1067 mm) high, measured vertically as follows:
  1. From the adjacent walking surfaces;
  2. On stairs, from the line connecting the leading edges of the tread nosings; and
  3. On ramps, from the ramp surface at the guard.

IBC 2012: Guardrails

Chapter 10 Means of Egress, Section 1013 Guards

1013.4 Opening limitations

- Required guards shall not have openings which allow passage of a sphere 4 inches (102 mm) in diameter from the walking surface to the required guard height.
- Exceptions:
  1. From a height of 36 inches (914 mm) to 42 inches (1067 mm), guards shall not have openings which allow passage of a sphere 43/8 inches (111 mm) in diameter.
  2. The triangular openings at the open sides of a stair, formed by the riser, tread and bottom rail, shall not allow passage of a sphere 6 inches (152 mm) in diameter.

IBC 2012: Handrails

Chapter 10 Means of Egress, Section 1012 Handrails

1012.1 Where required

- Handrails for stairways and ramps shall be adequate in strength and attachment in accordance with Section 1607.8.
- Stairways shall have handrails on each side by Section 1009.15.
- Ramps with a rise greater than 6 inches shall have handrails on both sides by 1010.9.

1012.2 Height

- Handrail height, measured above stair tread nosings, or finish surface of ramp slope, shall be uniform, not less than 34 inches and not more than 38 inches. Handrail height of alternating tread devices and ship ladders, measured above tread nosings, shall be uniform, not less than 30 inches and not more than 34 inches.

IBC 2012: Handrails

Chapter 10 Means of Egress, Section 1012 Handrails

1012.3 Graspability

- All required handrails shall comply with Section 1012.3.1 or shall provide equivalent graspability.
  1012.3.1 Type 1
  - Handrails with a circular cross-section shall have an outside diameter between 1¼" to 2". Handrails with a non-circular cross-section shall have an outside perimeter dimension between 4" and 6¼" with a maximum cross-section dimension of 2¼".

1012.4 Continuity

- Handrail gripping surfaces shall be continuous, without interruption by newel posts or other obstructions.

IBC 2012: Handrails

Chapter 10 Means of Egress, Section 1012 Handrails

1012.7 Clearance

- Clear space between a handrail and a wall or other surface shall be a minimum of 1½ inches.

1012.8 Projections

- On ramps, the clear width between handrails shall be 36 inches minimum. Projections into the required width of stairways and ramps at each side shall not exceed 4½ inches at or below the handrail height.

1012.9 Intermediate handrails

- Stairways shall have intermediate handrails located in such a manner that all portions of the stairway width required for egress capacity are within 30 inches of a handrail.

IBC 2012: Structural Design Requirements

Chapter 16 Structural Design

1607.8 Loads on handrails, guards, grab bars, seats and vehicle barriers

1607.8.1 Handrails and guards

- Handrails and guards shall be designed to resist a load of 50 pounds per linear foot (plf) [applied in any direction at the top and to transfer this load through the supports to the structure]. Glass handrail assemblies and *guards* shall also comply with Section 2407 (see next slide).

1607.8.1.1 Concentrated load

- Handrails and guards shall be designed to resist a single concentrated load of 200 pounds applied in any direction at any point along the top, and to transfer this load through the supports to the structure.

1607.8.1.2 Intermediate rails

- Intermediate rails (all those except the handrail), balusters and panel fillers shall be designed to resist a concentrated load of 50 pounds.

IBC 2012: Structural Design Requirements

Chapter 24 Glass and Glazing, Section 2407 Glass in Handrails and Guards

2407.1 Materials

- Glass used as a handrail assembly or a guard section shall be constructed of either single fully tempered glass, laminated fully tempered glass or laminated heat-strengthened glass.
- Glazing in railing in-fill panels shall be of an approved safety glazing material that conforms to the provisions of Section 2406.1.1.
- For all glazing types, the minimum nominal thickness shall be 1/4 inch (6.4 mm).

2407.1.2 Support

- Each handrail or guard section shall be supported by a minimum of three glass balusters or shall be otherwise supported to remain in place should one baluster panel fail.
- Glass balusters shall not be installed without an attached handrail or guard.

Accessibility

The Americans with Disabilities Act (ADA) became a civil rights, federal law in 1990, and it prohibits discrimination against people with disabilities. It requires public entities and public accommodations to provide accessible accommodations for people with disabilities.

The ADA Accessibility Guidelines (ADAAG) are design guidelines for providing access to a range of indoor and outdoor settings by people with disabilities.

In a situation where the requirements of both a state or local building code and the 2010 ADA Standards need to be simultaneously considered, the code or Standard which results in greater accessibility takes precedence.[1]

To avoid conflict between accessibility requirements, the 2010 ADA Standards for Accessible Design reference the IBC; however, code requirements should be addressed during the railing design process to ensure all aspects of accessibility and safety are adopted.

[1]ADA National Network. “Frequently Asked Questions.” *adata.org.* U.S. Department of Education, National Institute on Disability and Rehabilitation Research (NIDRR). http://adata.org/faq-page#t110n1251 (accessed January 2015)

NFPA

The National Fire Protection Association (NFPA) publishes the NFPA 101®, Life Safety Code®, a source for strategies for occupant safety throughout the life cycle of a building. Consult the state fire marshal in your area to see if this code (and which edition) has been adopted by your local jurisdiction.

It is important to confirm which edition has been adopted in your area because older editions of this code require a wall clearance of 2¼ inches for a new handrail, whereas the 2012 edition requires new handrails to be installed to provide a clearance of not less than 1½ inches nor more than 2¼ inches between the handrail and the wall to which it is fastened.

Summary & Resources

Course Summary

- Architectural railing systems offer durability, strength, and design flexibility and are suitable for indoor and outdoor use in a variety of commercial, industrial and residential applications.

- Railing system selection criteria include, but are not limited to the: geographic location of the project, application, scale/size of the project, building use, materials, assembly and fabrication method, and safety, code and structural requirements.

- Typical architectural rail design styles are: glass rail, structural glass rail, cable rail, crossbar rail and mesh or perforated metal rail.

- Three main methods of building a railing installation are: fabrication from scratch, assembly using a modular system, and assembly using prefabricated posts and accessories: tube and fittings designed to mate with the handrail.

- Stainless steel is an ideal material for railing systems because it is stronger and more durable than many other metals. It is corrosion, fire, heat and impact resistant, can be easily fabricated, and has a bright, contemporary appearance that is easy to maintain.

Resources

- ADA National Network. “Frequently Asked Questions.” *adata.org.* U.S. Department of Education, National Institute on Disability and Rehabilitation Research (NIDRR). http://adata.org/faq-page#t110n1251 (accessed January 2015)
- Americans with Disabilities Act (ADA), U.S. Department of Justice Civil Rights Division, www.ada.gov (accessed January 2015)
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- Houska, Catherine, TMR Stainless (Consultants to IMOA). “Molybdenum Keeps Street Handrails Safe and Attractive.” *IMOA.info.* n.d. www.imoa.info/molybdenum-uses/molybdenum-grade-stainless-steels/architecture/specification-article.php (accessed January 2015)
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Resources

- International Code Council (ICC), www.iccsafe.org (accessed January 2015)
  - "Accessible Means of Egress," International Code Council, www.iccsafe.org/safety/Documents/MeansofEgressBroch.pdf (accessed January 2015)
  - "Building Codes and Accessibility Requirements," International Code Council, www.iccsafe.org/safety/Documents/BuildCode-AcessReqs.pdf (accessed January 2015)
- International Molybdenum Association (IMOA), www.imoa.info (accessed January 2015)
- Lavi Industries, www.lavi.com/railing-systems/ (accessed January 2015)
- National Fire Protection Association (NFPA), www.nfpa.org (accessed January 2015)
- *Stainless Steel Information Center*, Specialty Steel Industry of North America (SSINA).
  - "Stainless Steel Overview: Features & Benefits," www.ssina.com/overview/features.html (accessed January 2015)
  - "Standard Finishes," www.ssina.com/finishes/intro.html (accessed January 2015)
- U.S. Green Building Council (USGBC), www.usgbc.org (accessed January 2015)

Conclusion