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Aluminum Railings: Systems & Designs

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Aluminum Railings: Systems & Designs

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Description: Provides an overview of aluminum railing systems, their components, features and design options, as well as a review of the IBC 2006 codes related to handrails and guards.

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Learning Objectives

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

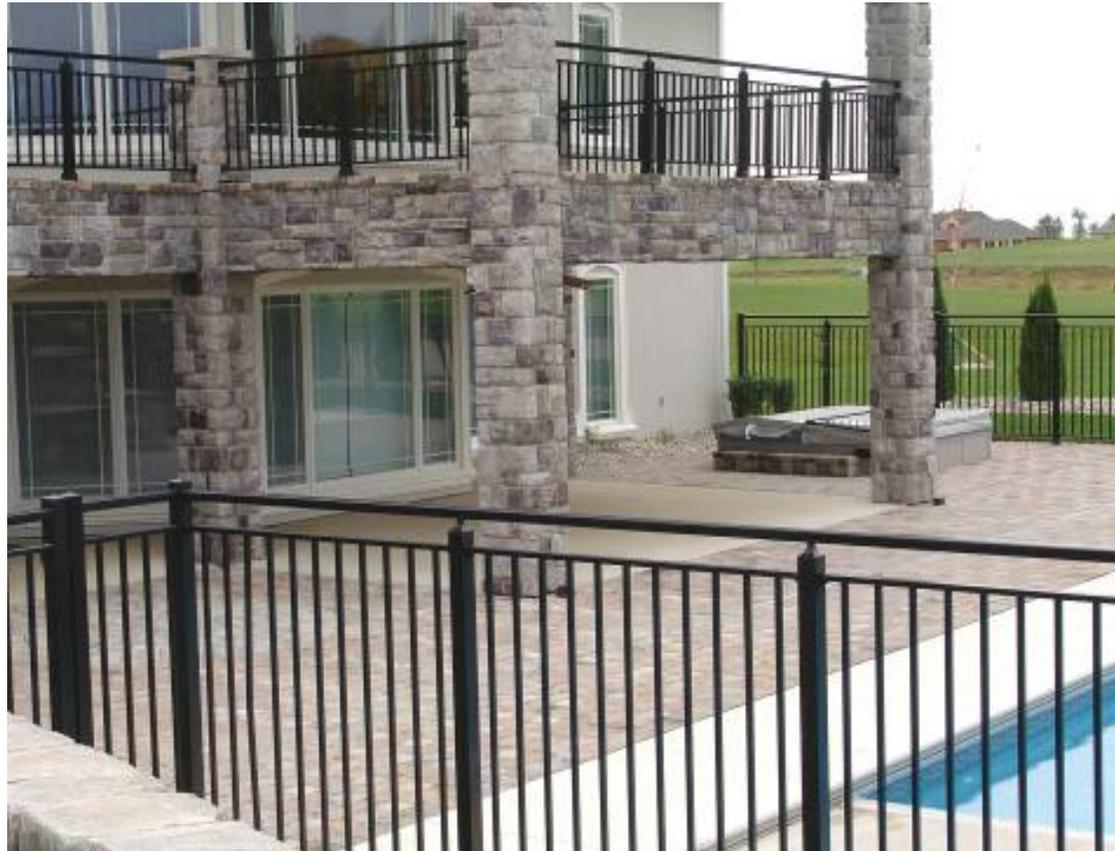
- discuss the features of aluminum railings and the assembly considerations required to facilitate a successful installation
- state the applications and design options of aluminum railing and gates
- list the features, applications and assembly of aluminum cable railing, pipe railing, and pipe picket railing, and
- discuss the IBC 2006 codes related to handrails and guards.

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Aluminum Railings

Introduction

Offering strength, durability, and maintenance-free beauty, aluminum railing provides a practical solution for the railing needs of today's building professionals.

By combining the advantages of high quality aluminum alloy extrusions with smart, contemporary designs, an aluminum railing system provides a sound investment for today's builder. Factory-assembled railings can be made to exact specifications, resulting in further site fabrication savings.

An exploration of the designs of aluminum railings is presented in this section of the course, beginning with a discussion of the characteristics of aluminum railings.



Characteristics of Aluminum Railings

Materials

Quality aluminum railing systems, including rails, posts, and pickets, are formed from 6063-T6 extruded aluminum alloys. Railing accessories may be cast from ANSI 713 alloy. All exposed fasteners used in the system are generally aluminum or stainless steel.

Durability and Strength

The aluminum construction of the railing systems provides a durable, strong product without sacrificing design.

Maintenance Free

Aluminum railing is rust and corrosion free. It will never split, warp or rot due to rain, ice, sun, or other elements, making it a great option over wood railings.

Ease of Installation

Aluminum railings are significantly lighter than other materials, and with no complicated fittings or costly custom-made fabrication, they offer ease of assembly and installation.

Design Flexibility

Quality aluminum railings offer great design flexibility and should be considered a viable railing solution to complement a range of construction designs.

Aluminum railings are available in various sizes, colors, and finishes.

Whether baked-on enamel, anodized or duranodic, the finishes are guaranteed to endure for years of continued service.

Presented in subsequent slides are descriptions of the various aluminum railings, beginning with the top rail system.



2" Top Rail

The 2" aluminum top rail system was developed to meet ADA regulations, requiring a 2" wide maximum width for the top handrail. The narrowed maximum top rail allows for a normal grip on ramps, stairs, or horizontal railing.

The standards for this rail are a 2" or 2-1/2" square post and 3/4" square pickets.

If the railing is being used in a balcony application where it needs to meet code, a 2- 1/2" square heavy duty post or 4" square post is recommended over the standard 2" square.



2" Top Rail: Applications

The 2" top rail is used on:

- office buildings
- commercial applications
- hospitals
- industrial and educational environments, and
- apartments and homes.



2-½" Top Rail

This system features a 2-½" square post or 4" square post. The ¾" square pickets are the standard, but you can also use ¾" x 1-½".

Note that all the railing systems described in this section of the course are available in standard heights of 32", 36", 42" or 48".

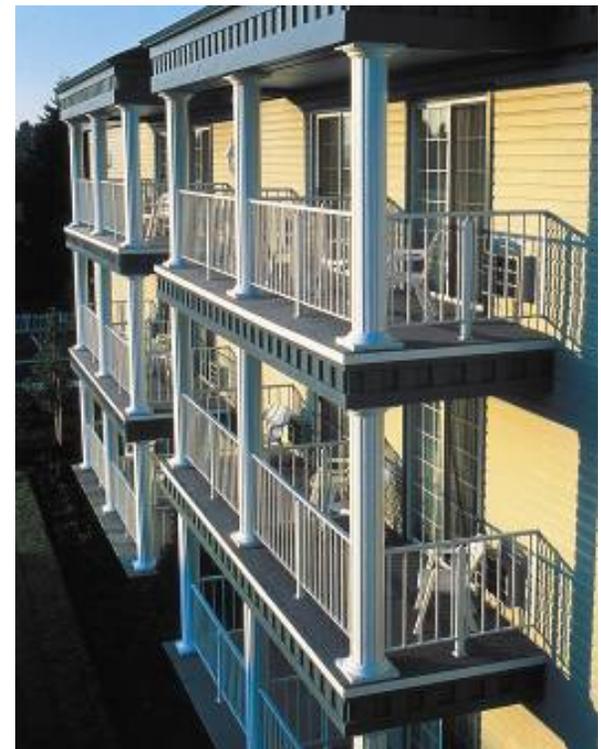
Pool railing is available in heights up to 72".



2-1/2" Top Rail

Aluminum Railings

Applications include condominiums, apartments, motels, churches, schools, and commercial and residential buildings.



Simulated Wood

Aluminum Railings

Aluminum railings have been developed that simulate the look of painted wood, but have the no-maintenance qualities of aluminum.

These railings feature 1-½" wide x ¾" pickets and 2-½" square posts.

The standard top rail is 2" wide x 4" high, but 2" or 2-½" wide x 1-5/8" high top rails are available.

Other options include ¾" square pickets and 4" square posts.



Simulated Wood: Applications

Aluminum railing that simulates the look of wood offers curb appeal combined with low maintenance and durability.



Component Parts: Examples of Cast Fittings



Post Bracket



Top Rail Wall Bracket



Top Rail Swivel Bracket



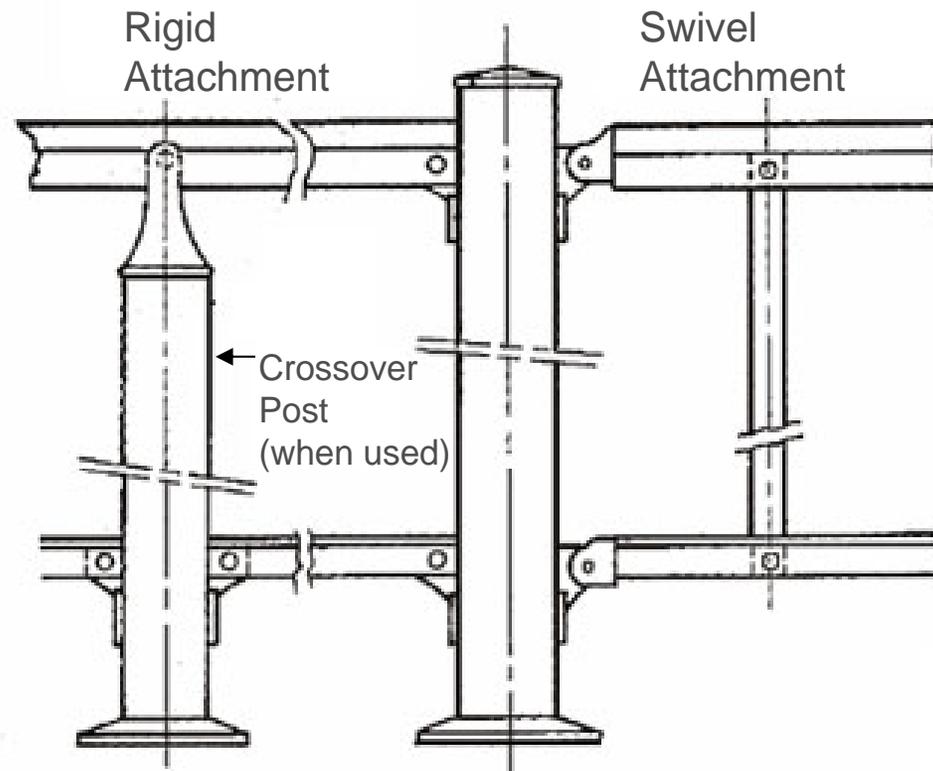
Post Cap



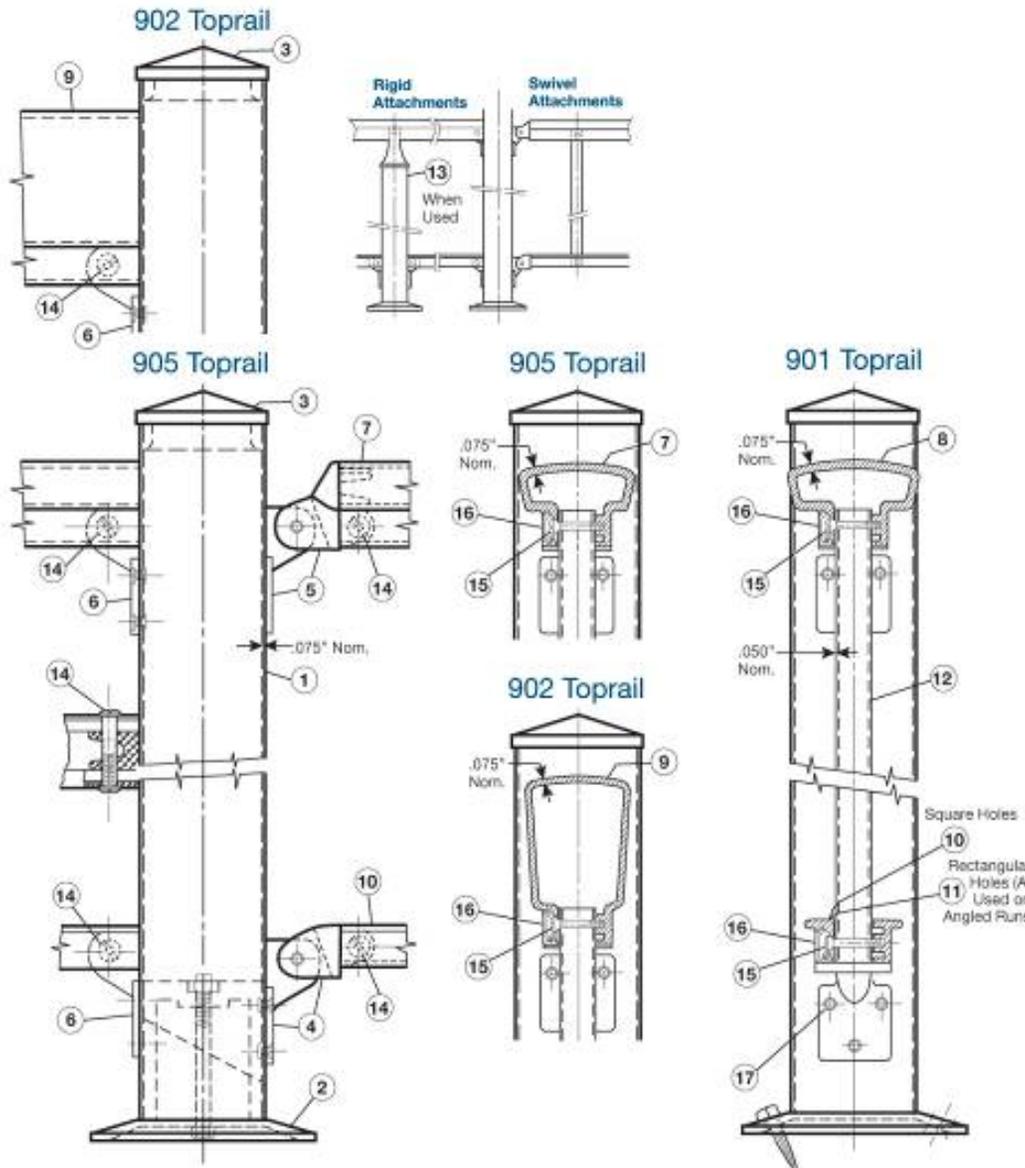
Bottom Rail Swivel Bracket

Assembly: Rigid and Swivel Attachment

Illustrated below are images of rigid attachment and swivel attachment.



Assembly: Top Rail, 2" W. or 2-1/2" W. x 1-5/8" H.

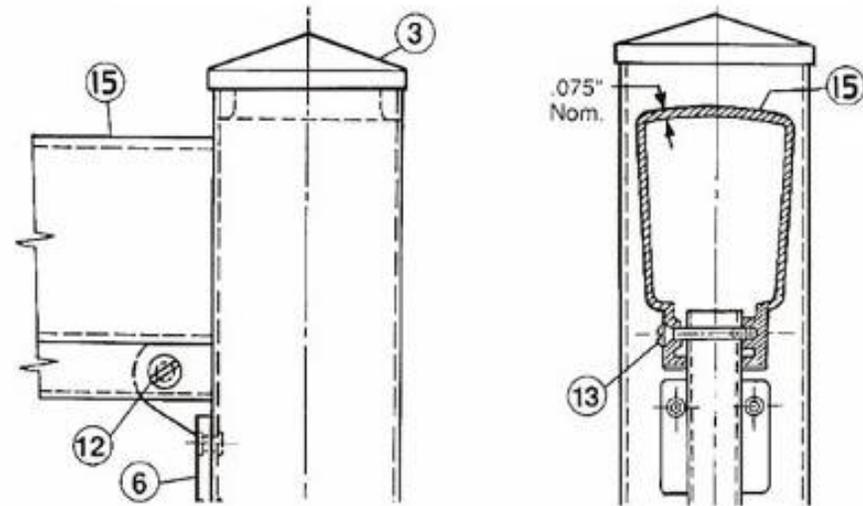


1. 990 2-1/2" Tube .075" Wall
2. 957 Base Assembly
3. 950 Cap
4. 956 Bottom Rail Swivel Assembly
5. 955 Top Rail Swivel Assembly
6. 940 Top & Bottom Rigid Attachment
7. 905 Top Rail 2" W. x 1-5/8" H.
8. 901 Top Rail 2-1/2" W. x 1-5/8" H.
9. 902 Top Rail 2" W. x 4" H.
10. 903 Bottom Rail
11. 904 Bottom Rail (A)
12. 3/4" Square Picket
13. Crossover Post
14. 912 8-32 Binder Bolt
15. 910 Picket Screws
16. Screw Cover
17. 915 5/32" Dia. Rivets

Assembly: Top Rail, 2" W. x 4" H.

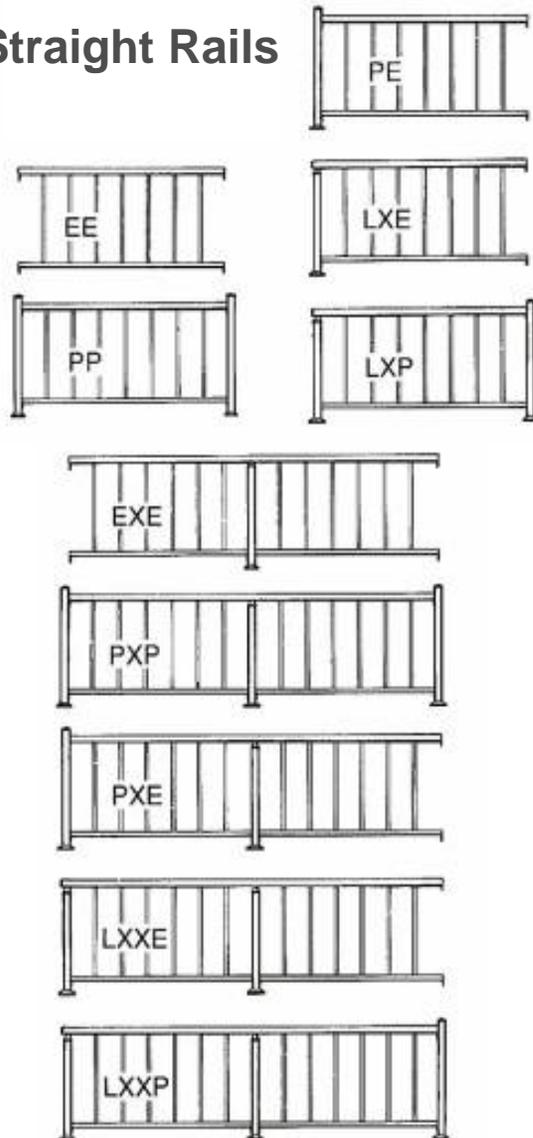
- 3. Cap
- 6. Top & Bottom Rigid Attachment
- 12. Rail Bracket Binder Bolt
- 13. Picket Screws
- 15. Top Rail 2" W. x 4" H.

Top Rail: 2" W. x 4" H.

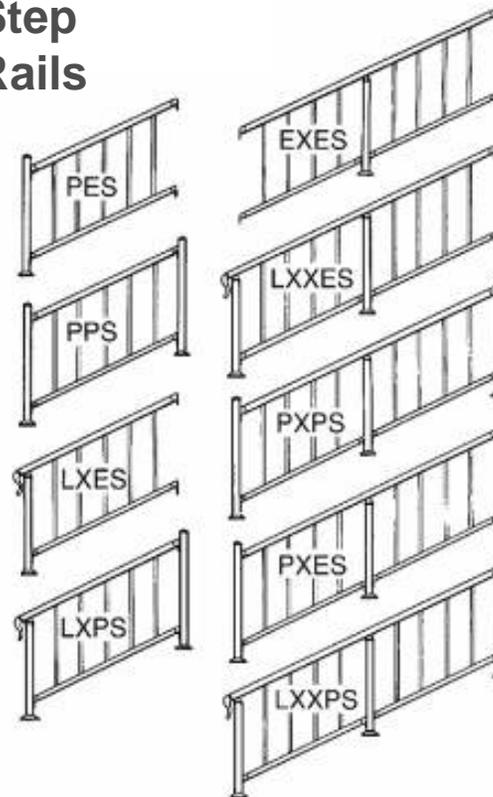


Design Selections

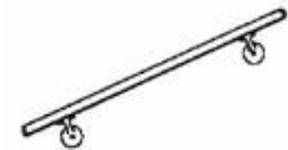
Straight Rails



Step Rails



Handrail System



LEGEND

- E = End With No Post
- P = Post
- X = Crossover Post
- L = Lamb's Tongue
- S = Step Rail

Railing Style Systems



Installation

Railing Systems, 2" or 2-1/2" Wide Top Rail:

- Railing system consists of 2", 2-1/2", or 4" square posts that can be either base mounted, side mounted, or embedded into concrete
- Pickets should be 3/4" square on 4-1/2" centers and shall run between the top and bottom rail; 3/4"x 1-1/2" pickets are also an option
- Top rail should be continuous in lengths up to 18'
- The railing systems will adapt to step railing requirements by specifying a rectangular hole in bottom rail

Simulated Wood Systems, 2" x 4" Top Rail:

- Railing system consists of 2", 2-1/2", or 4" square posts that can be either base mounted, side mounted, or embedded into concrete
- Options are available for top rail of 2" or 2-1/2" wide x 1-5/8" high
- Pickets should be 1-1/2" x 3/4" on 5-1/4" centers and shall run between the top and bottom rail
- Top rail should be continuous in lengths up to 18'
- The railing systems can meet step railing requirements by specifying the riser and tread dimensions of the steps and a rectangular hole in bottom rail



Picket Railing With Machined Posts

Introduction

This section of the course provides an overview of railing with machined posts.

Posts with machined openings were developed to specifically:

- provide better aesthetics
- provide more strength
- lower material and installation costs, and
- require less maintenance.



Posts

All posts (end posts, section posts, corner posts) in an assembled picket railing system are machined to receive the top and bottom rails.



The end posts are machined on one side only.



Section posts are machined on opposite sides.



Corner posts are machined with openings at 90°.

Assembly

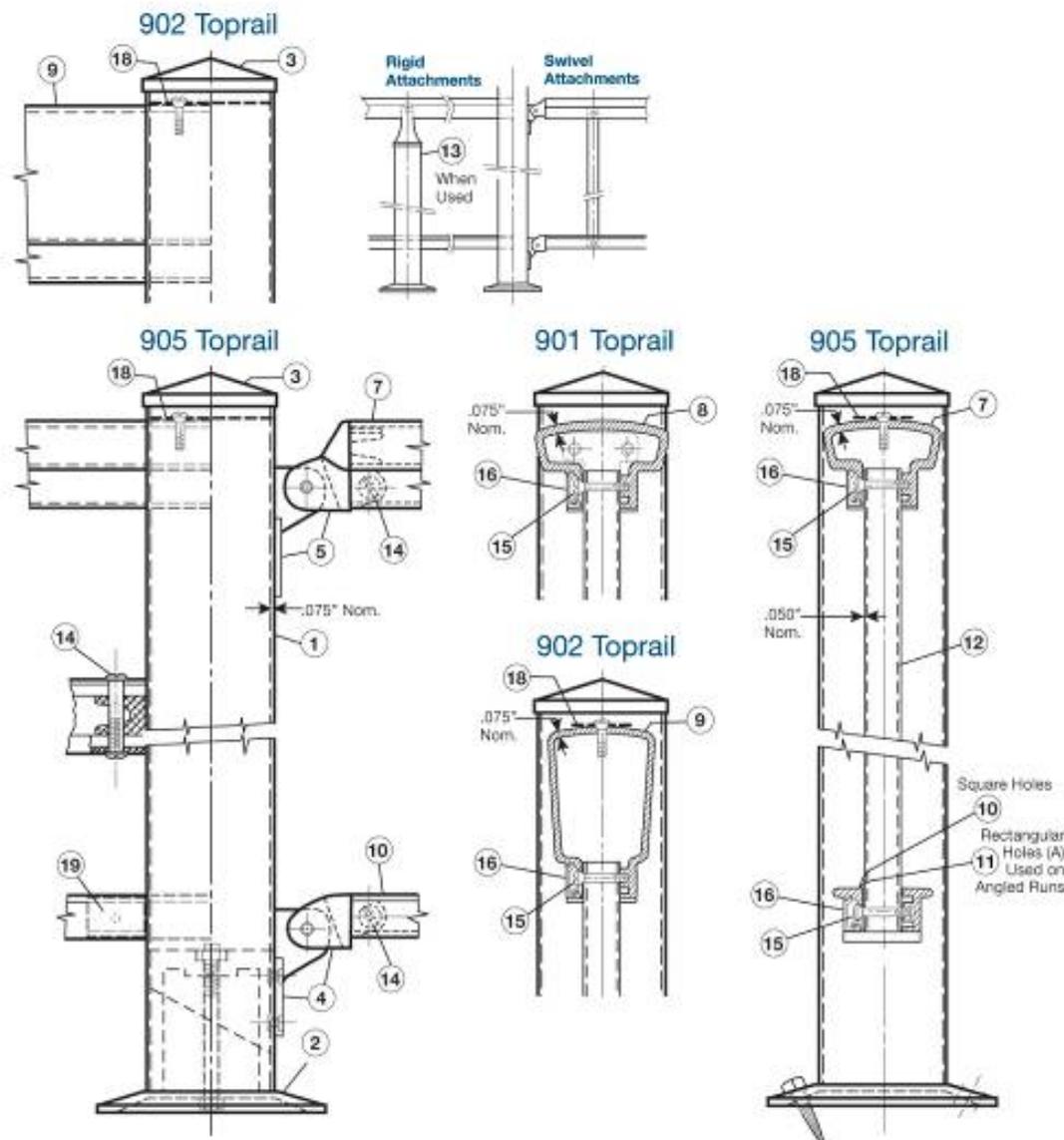
These images indicate how the top and bottom rails of an assembled aluminum picket railing are positioned into the matching machined post openings, resulting in a clean, rigid design.



Screw
Cover



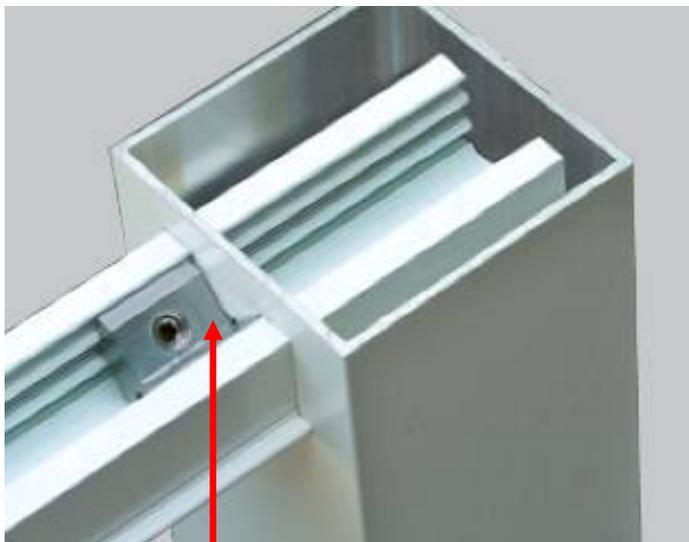
Assembly: Top Rail, 2" W. or 2-1/2" W. x 1-5/8" H.



1. 990 2-1/2" Tube .075" Wall
2. 957 Base Assembly
3. 950 Cap
4. 956 Bottom Rail Swivel Assembly
5. 955 Top Rail Swivel Assembly
6. 940 Top & Bottom Rigid Attachment
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13. Crossover Post
14. 912 8-32 Binder Bolt
15. 910 Picket Screws
16. Screw Cover
17. 915 5/32" Dia. Rivets
18. Rail Tab
19. Rail Wedge

Rail Wedges

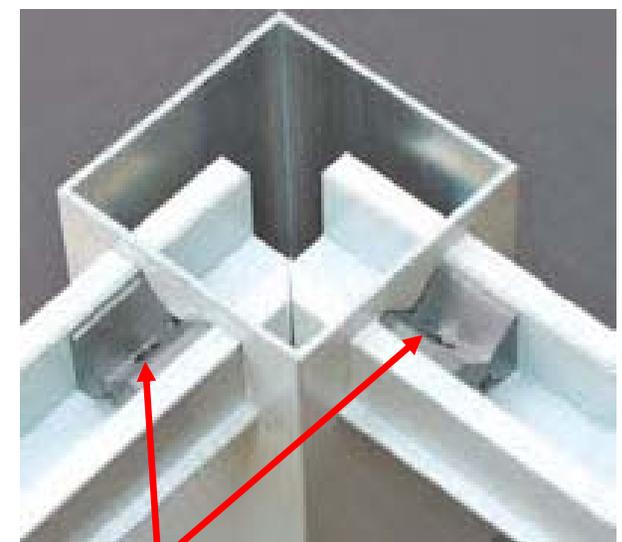
Rail wedges, located in bottom rails, assure proper rail insertion of 1-¼” beyond the post machined opening inside the post. Views of the underside of the bottom rail indicate the location of rail wedges in an end post, section post, and corner post.



Rail Wedge: End Post



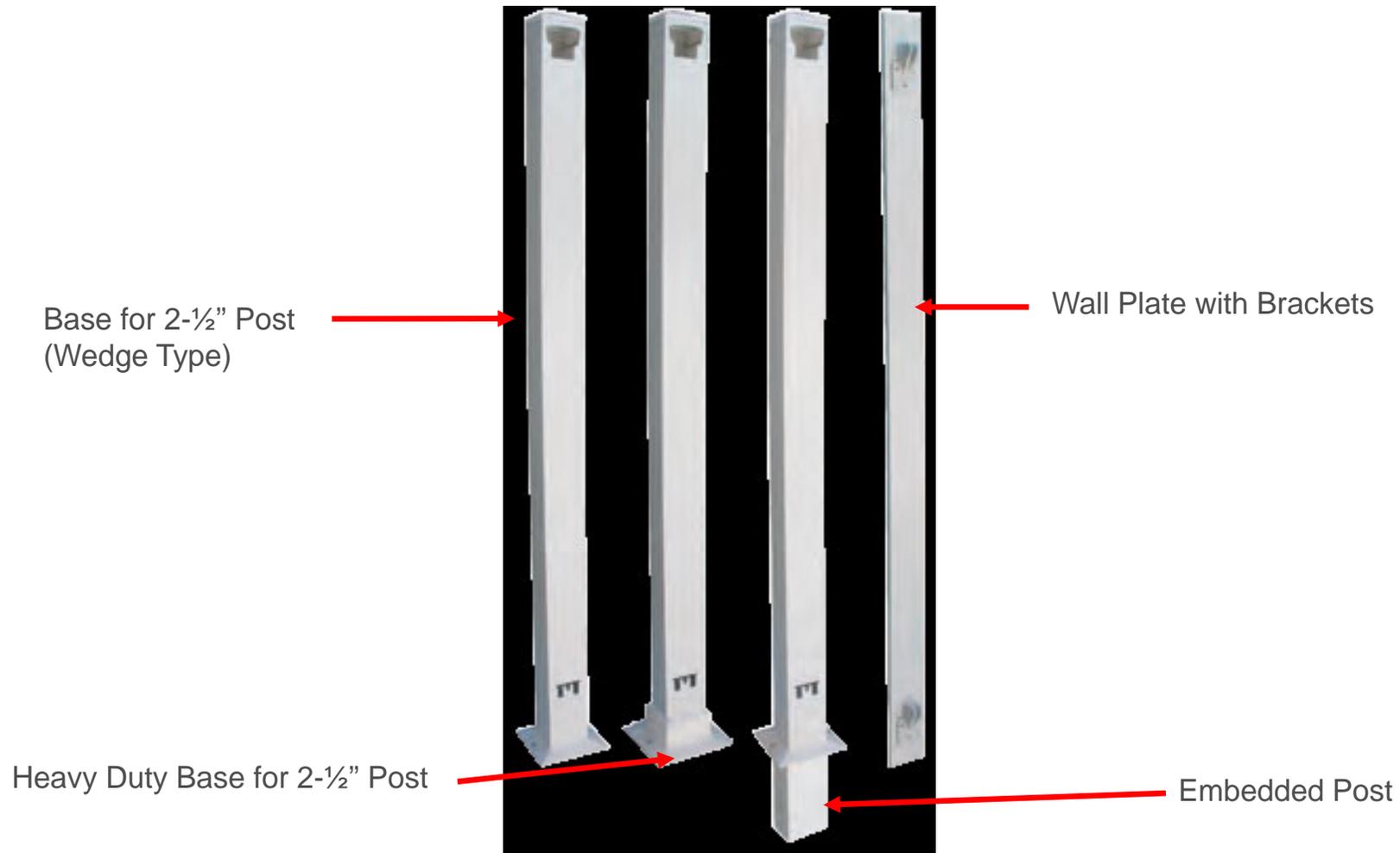
Rail Wedge: Section Post



Rail Wedge: Corner Post

Post Styles

Manufacturers offer a variety of post styles, wall plates, horizontal or vertical swivels and/or gates to suit any railing application. Several post styles are pictured below.



Range of Styles

Made in a wide range of heights, assembled picket railing is available in 6' lengths and custom lengths in 2-line or 3-line styles.

Standard posts are 2-½" square and pickets are ¾" square, with standard picket spacing on 4-½" centers.

The top rail has a code approved 2" wide gripping surface for ramps, stairs, or on horizontal railing.



2-½" Square Posts, ¾" Square Pickets

Range of Styles

Picket Railing With Machined Posts



Assembled picket railings are also available with a 2" wide x 4" high top rail and 3/4" square pickets.



The image shows a 3-line style (level rail only) featuring a 1-1/2" Schedule 40 round top rail with an outside diameter of 1.90".

Step Railing

Picket Railing With Machined Posts

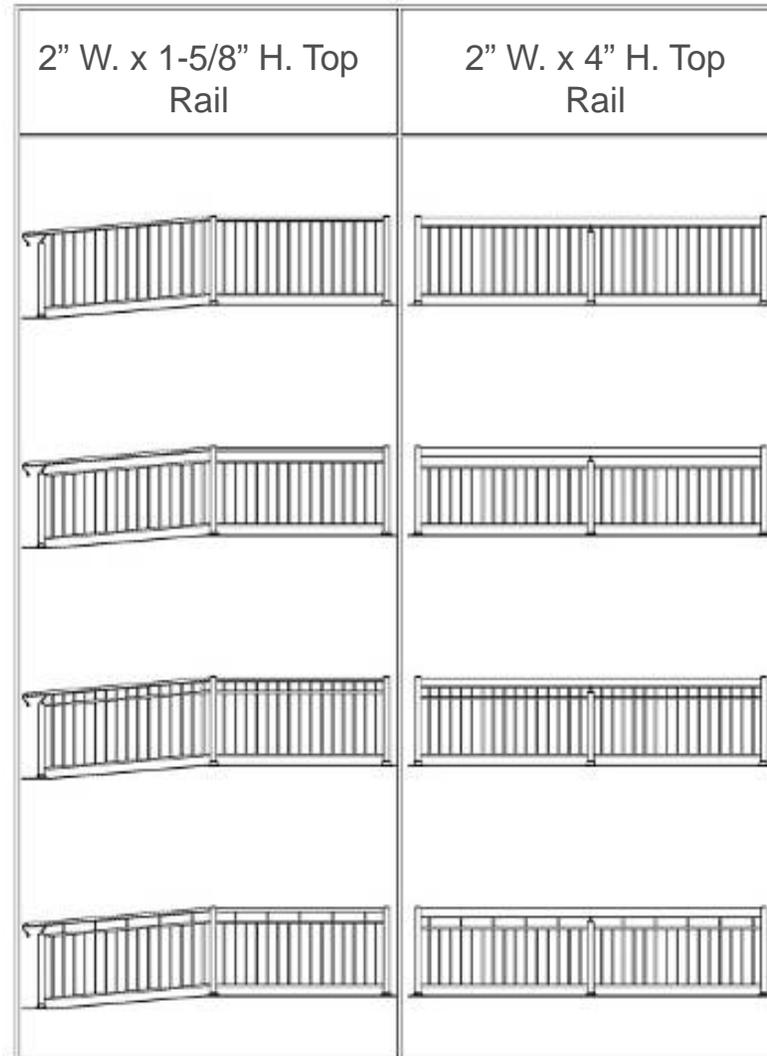
Note that the railing can meet step railing requirements by specifying the riser and tread dimensions of the steps. For this type of application, swivel brackets are required.

Note that if railing is angled horizontally, the angle needs to be specified so the proper openings can be machined in the post for top and bottom rail insertions.



Design Selections

Picket Railing With Machined Posts



Design Selections: 3/4" Square Pickets



Aluminum Picket Fence

Introduction

Aluminum picket fence is utilized for perimeter fencing, pool railings, and dividers for residential, commercial, institutional, multi-housing, and municipal installations.

Using horizontal or vertical swivel brackets, aluminum picket fence can be adjusted for uneven terrain.

It is available in heights from 36" to 72".

Posts are 2-1/2" or 4" square and pickets 3/4" square.

Picket spacing is 4-1/2" with formed spear, cast spear or flat top design.



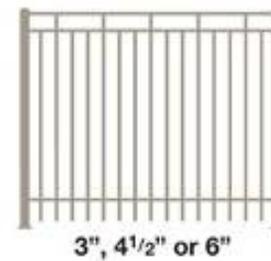
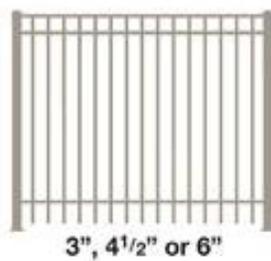
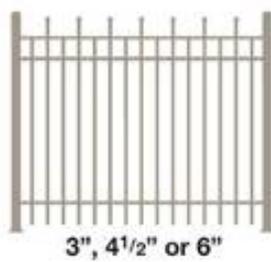
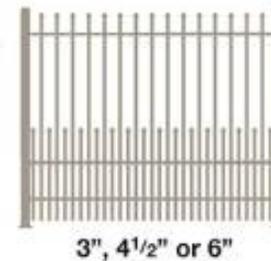
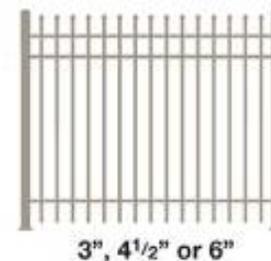
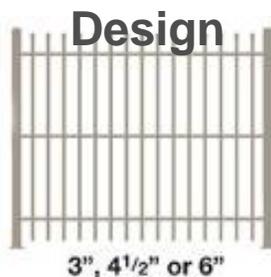
Ornaments

Ornaments are available to mount on top of posts and to add to the pickets for a custom decorative appearance.



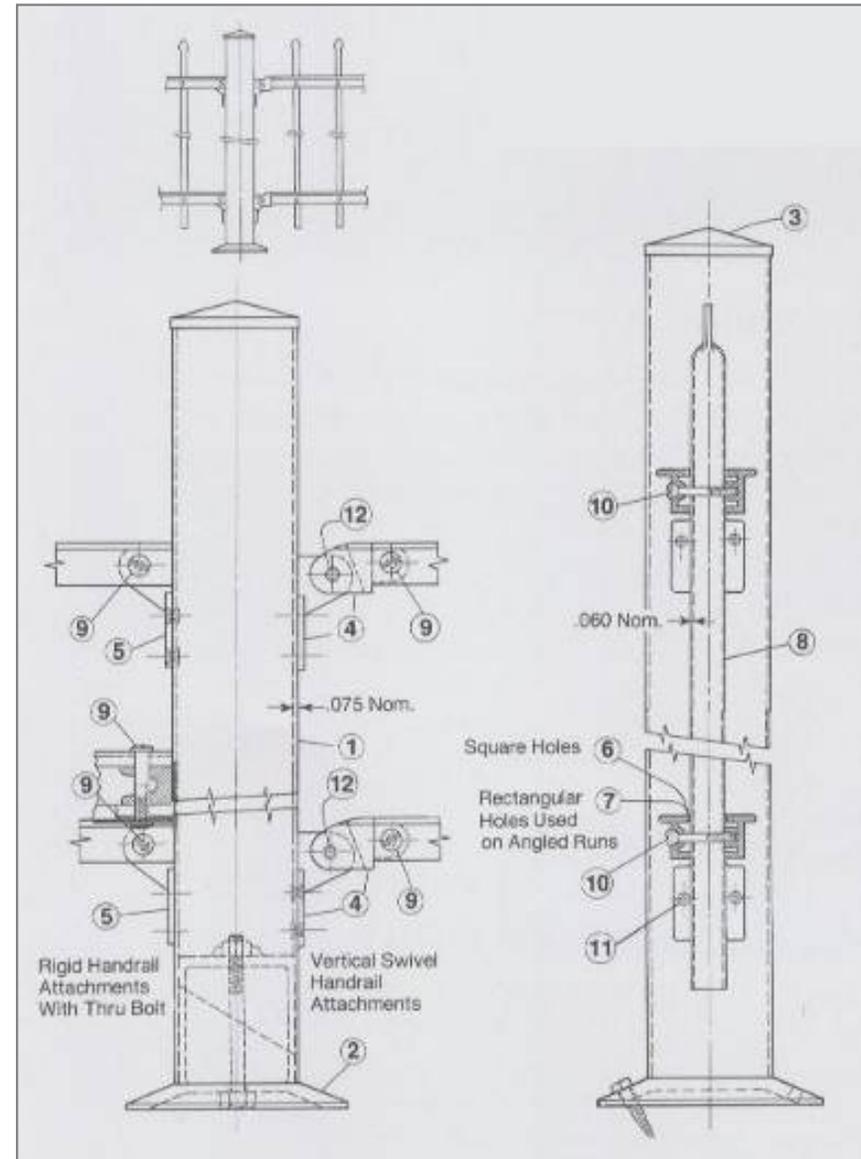
Picket Fence Design Selections

Examples of Aluminum Picket Fence Design



Picket Fence Assembly

1. 2-½" Tube .075 Wall
2. Base Assembly
3. Post Cap
4. Swivel Bracket Assembly
5. End Bracket – Rigid
6. Rail – Square Hole
7. Rail – Rectangular Hole
8. ¾" Square Picket
9. ¼" Rail Binding Bolt
10. 10-24 Oval Hd. Screw
11. 5/32" Diameter Rivets
12. 3/16" Diameter Rollpin



Aluminum Picket Fence With Machined Posts

Some manufacturers offer assembled aluminum picket fence systems.

They are available in 6' lengths and custom lengths in 2-line or 3-line styles. Typically, the 2-line style is available in heights up to 60" and the 3-line style is available up to 72" high.

Posts are 2-½" square and pickets ¾" square. Picket spacing is on 4-½" centers with formed spear, cast spear or flat top design.

If the fence is sloped (due to uneven terrain) or angled horizontally, it is important to specify the angle so the proper openings can be machined in the post for top and bottom rail insertions.



Custom Aluminum Gates

Where access is a requirement, durable, all-welded aluminum gates can be specified for any design and size configuration.

They are available in a variety of powder coated or anodized finishes and can be equipped with standard or custom security locks.

Decorative scrolls and cast aluminum inserts are available to mount on pickets to complement the overall aesthetics.



Custom Aluminum Gates: Designs

Examples of available designs of aluminum gates are illustrated below.



Single Door Gate

Single Door Arched Gate



Double Door Arched Gate with Cast Spears



Double Door Arched Gate



Aluminum Cable Railing / Pipe Railing / Pipe Picket Railing

Cable Railing

Available in a variety of decorative permanent finishes is aluminum cable railing with 2-½” square posts, 2” wide top rail and 3/16” diameter steel cables. Strong, durable, maintenance-free cable railing provides an almost unobstructed view.



Cable Railing

Aluminum Cable Railing / Pipe Railing / Pipe Picket Railing



Pipe Railing / Pipe Picket Railing

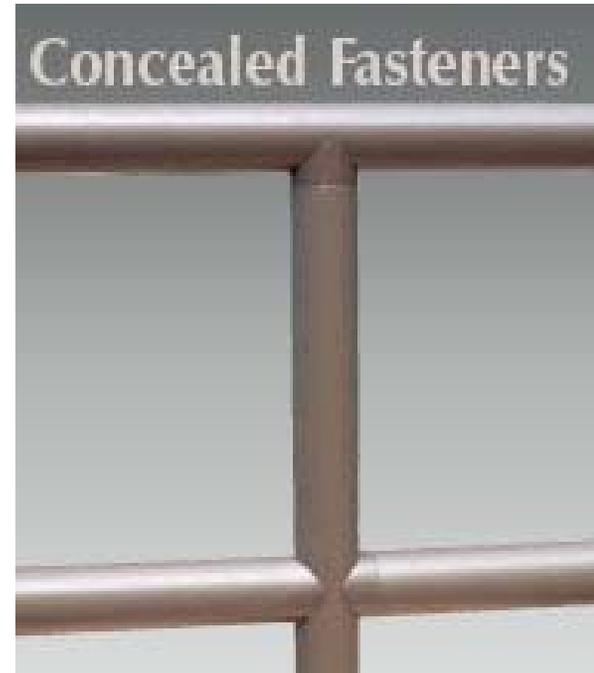
Aluminum Cable Railing / Pipe Railing / Pipe Picket Railing

Quality non-welded aluminum pipe railing and pipe picket railing feature high-quality aluminum extrusions and castings with concealed fasteners.

Aluminum pipe railing and pipe picket railing can be factory assembled to exact specifications. Special curves or pipe radius can easily be fabricated to meet specific project requirements.

Factory-assembled pickets have a tight drive-in fit to the top and bottom rails to assure squareness and rigidity.

Sections up to 24' can be shipped factory-assembled or knocked down for reassembly.



Variety of Applications

Aluminum Cable Railing / Pipe Railing / Pipe Picket Railing

Applications of pipe railing/pipe picket railing include the following:

- handicap ramps
- condominiums
- industrial buildings/factories
- stores
- waste water treatment plants
- nursing homes
- municipal buildings
- schools
- office buildings
- motels
- churches
- hospitals
- swimming pools
- amusement parks
- restaurants/cafeterias



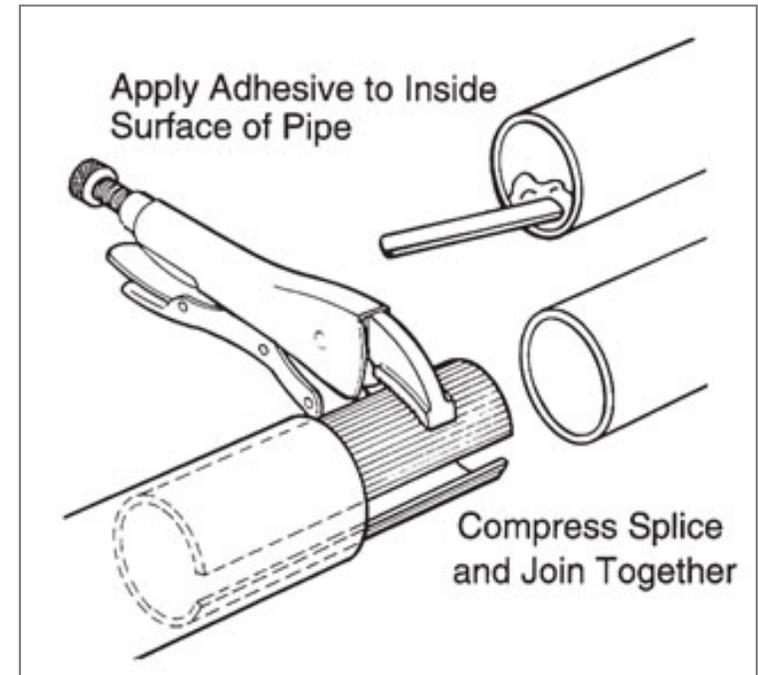
Assembly

Aluminum Cable Railing / Pipe Railing / Pipe Picket Railing

Components of aluminum pipe railing and pipe picket railing are easily assembled by using mechanical fasteners at intersections and epoxy structural adhesive at splice joints.

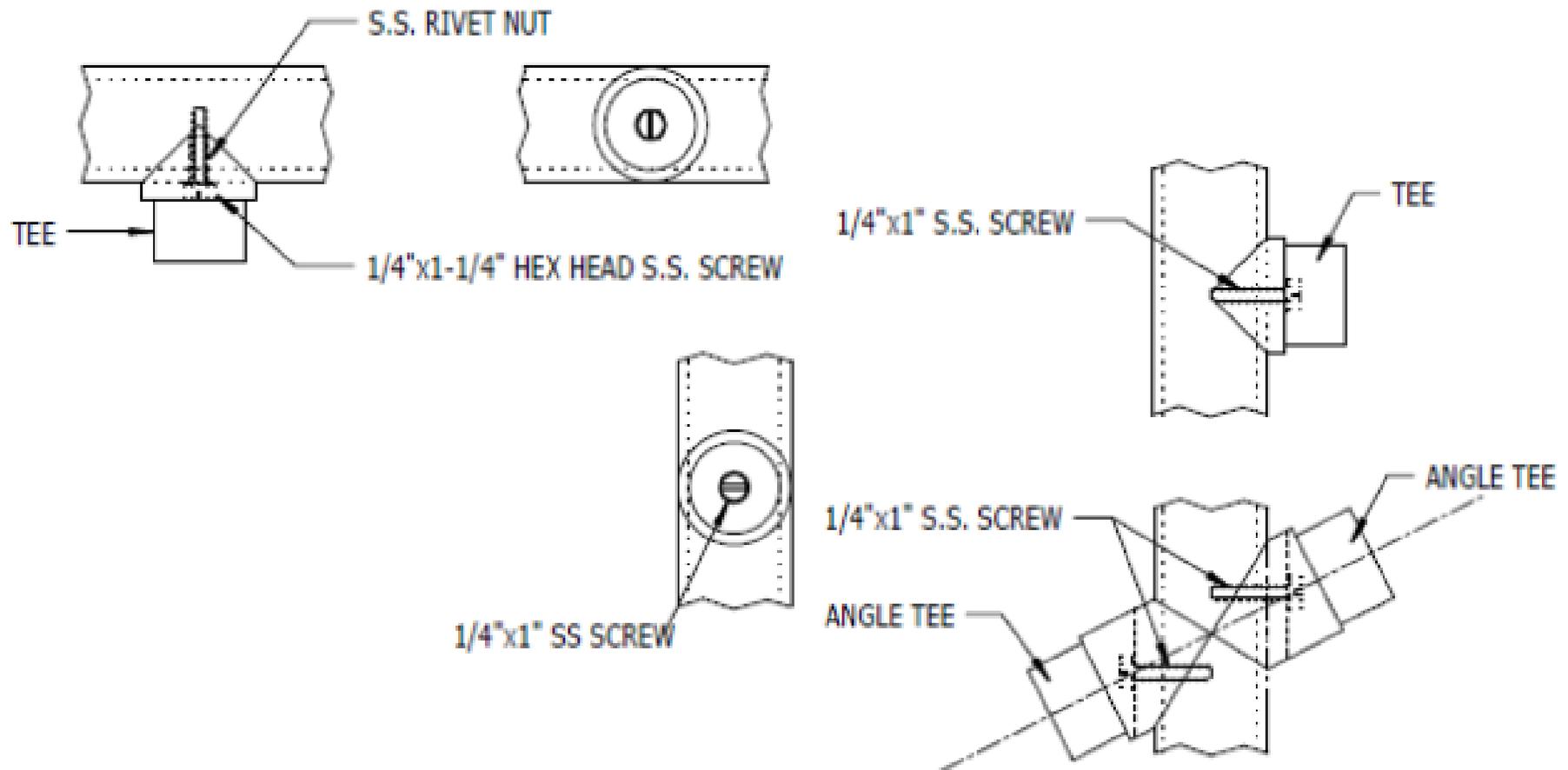
Railing splices are designed for a tight press fit and must be compressed with pliers to permit them to slip into the pipe.

Posts and top rails are assembled to run in continuous lengths, resulting in a system that is stronger than one with a cast tee and cross connections.



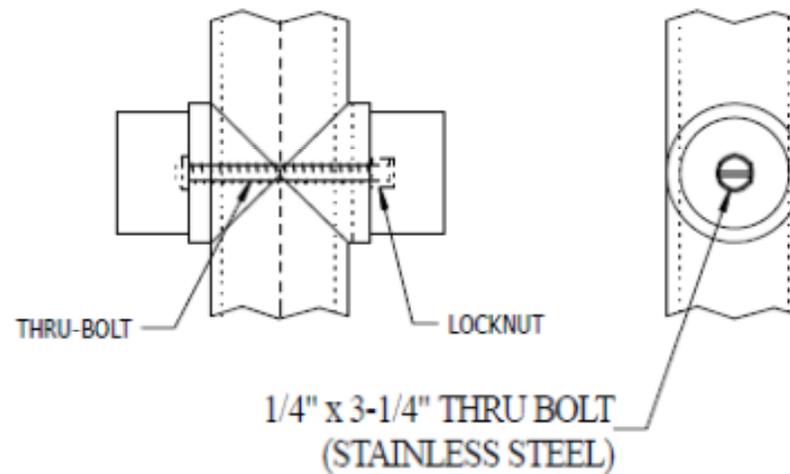
Tee Fittings

To attach a tee fitting to the post, a self-tapping, stainless steel, hexagon head screw with lockwasher is positioned through the fitting and threaded into the 7/32" hole in the tubular post.



Tee Fittings

When two 90° tees are located directly opposite each other to form a cross, a stainless steel through bolt, lockwasher, and nut are used.



Expansion Joints

For continuous spans exceeding 40', expansion joints should be provided.

To make an expansion joint, one end of the spliced joint should not have structural adhesive applied so that it is free to move in or out of the pipe.

If a joint is provided every 30', the width of the gap should allow 1/8" expansion for each 40°F of expected temperature rise.

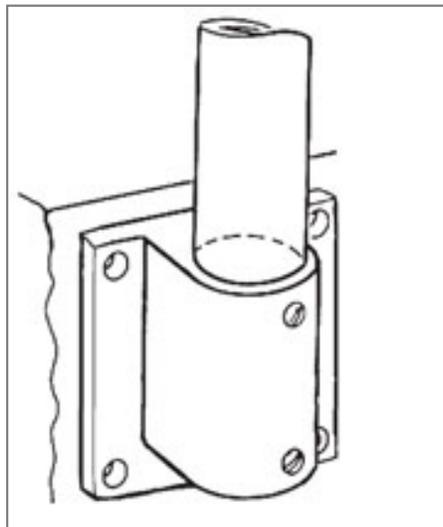
All pipe railing splices should be made 12" or less from the nearest post.

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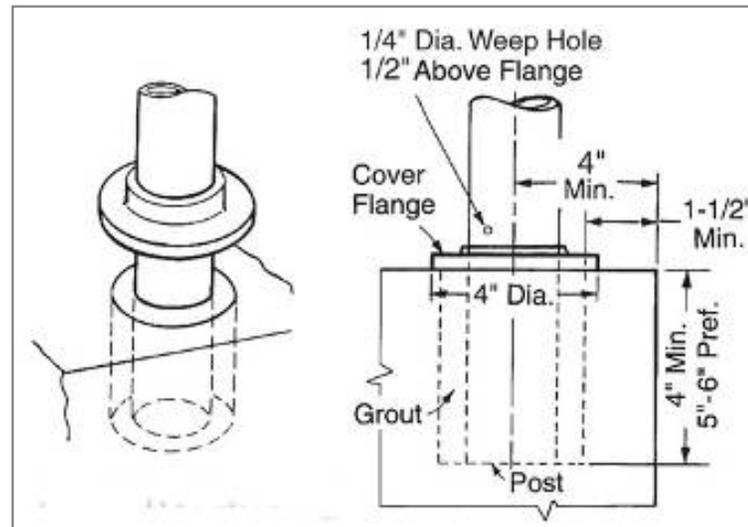
Mounting Options

Aluminum pipe or picket railing may be embedded in concrete and grouted. All posts grouted in concrete must have one 1/4" diameter weep hole, 1/2" above post collar, in the plane of the rail.

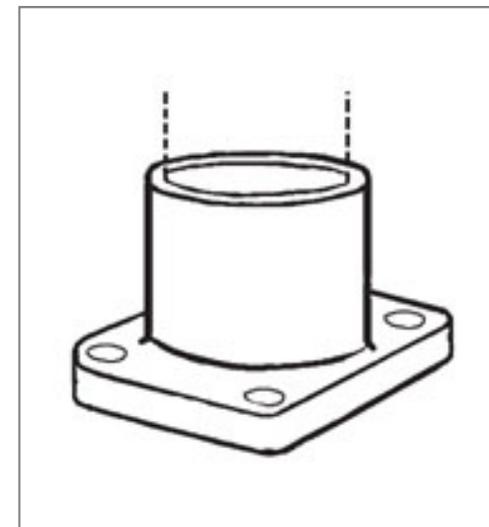
They can also be side mounted on fascia or stringer by means of fascia flanges (left image). Alternatively, they may be mounted on decks and platforms using base flanges.



Side Mount Flange



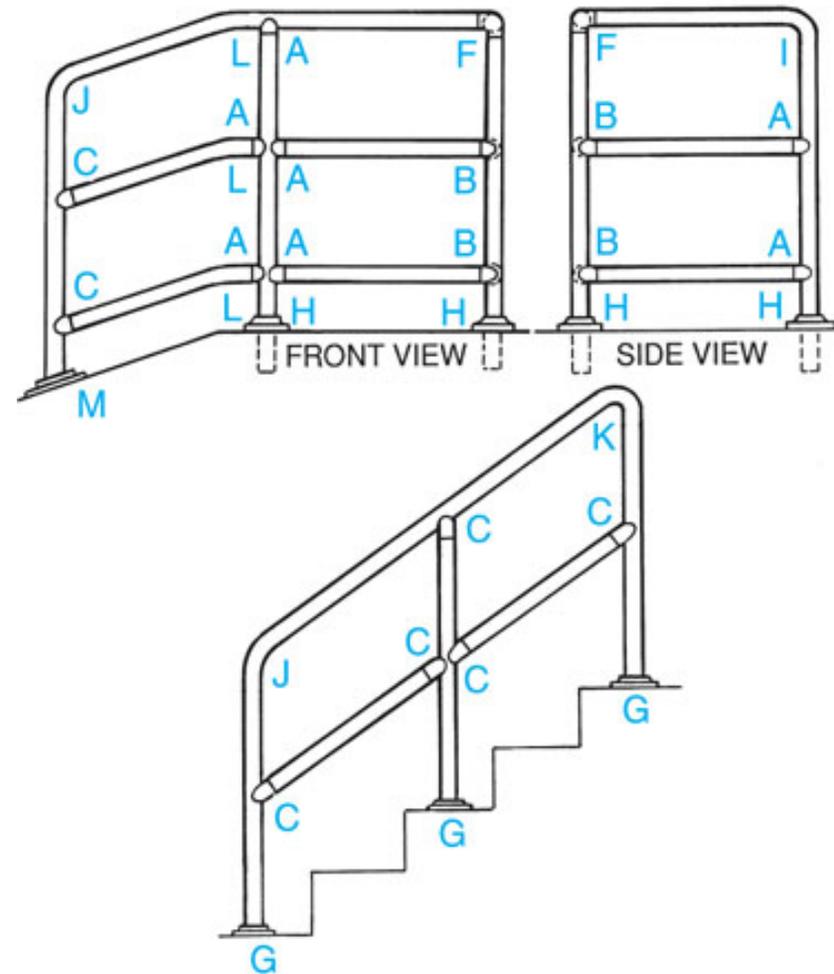
Base Mounting



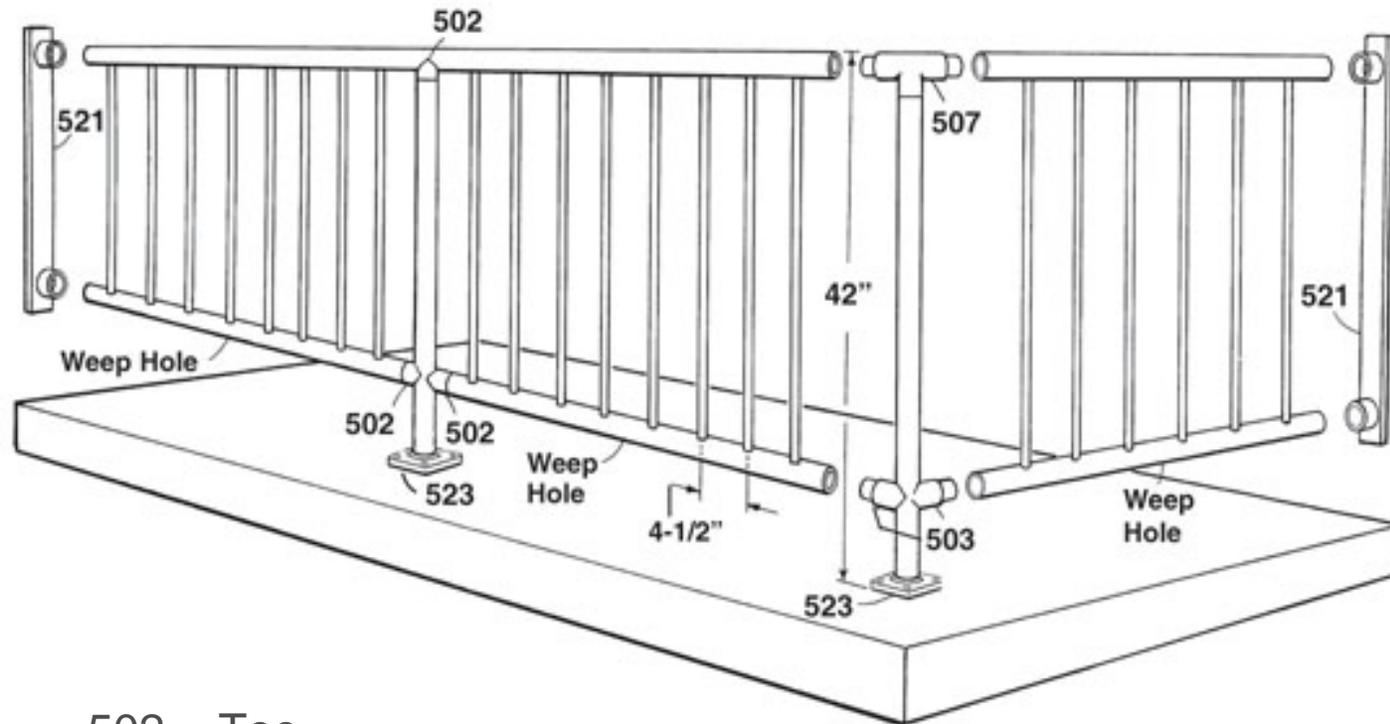
Welded Heavy Duty Base with Post

Part Applications: Pipe Railing

- A. Tee
- B. Corner Tee
- C. Angle Tee
- F. 90°3-Way Elbow
- G. Floor Flange
- H. Cover Flange
- I. 90° Radius Elbow
- J. Bottom Step Post Elbow
- K. Top Step Post Elbow
- L. Rail Elbow
- M. Angle Flange with Post

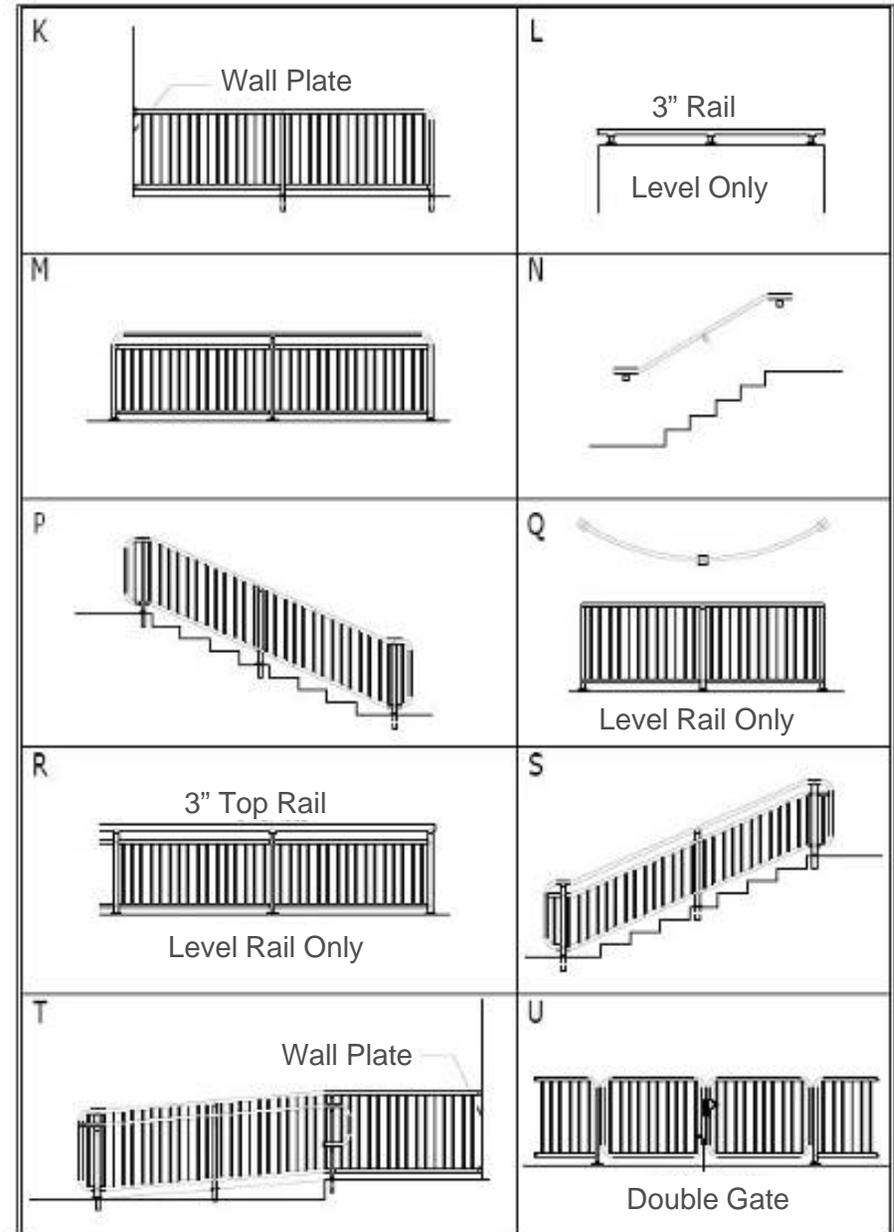
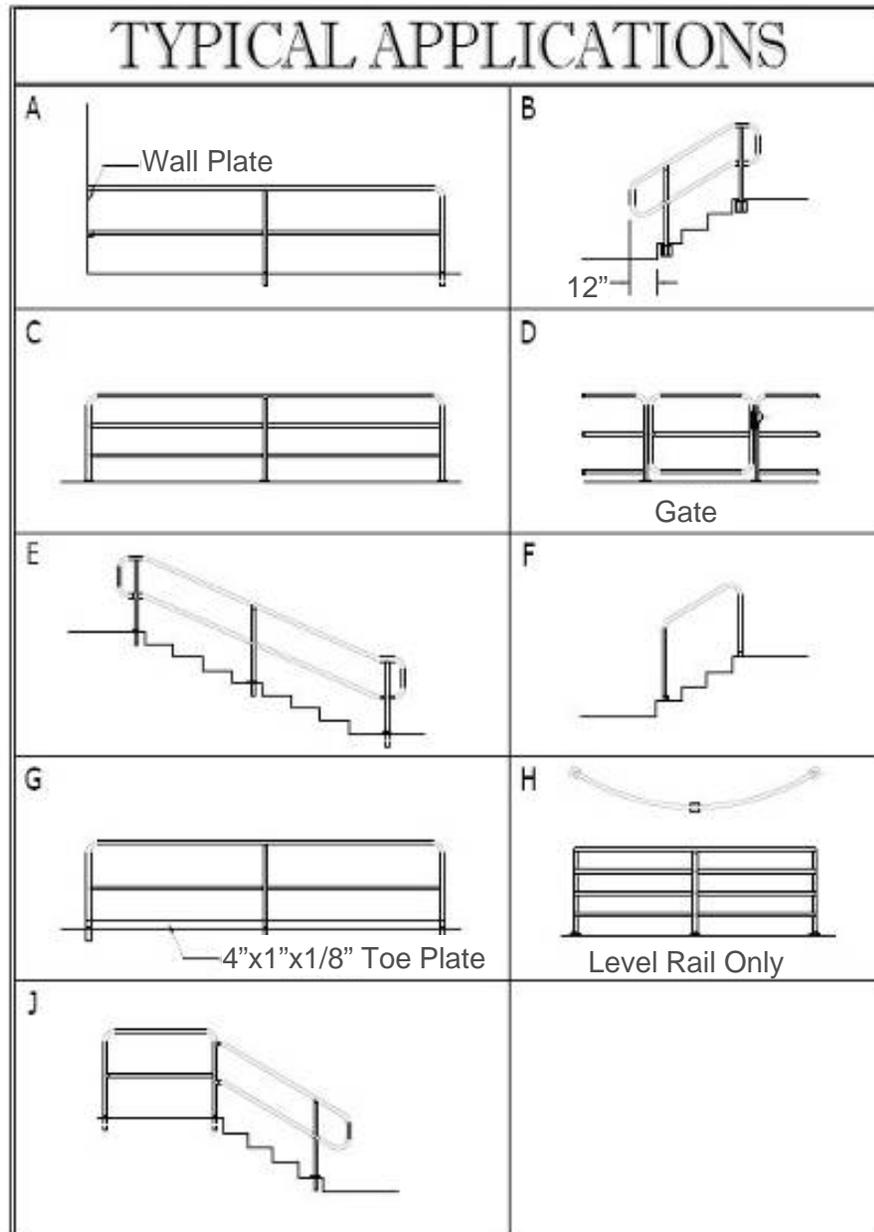


Part Applications: Pipe Picket Railing



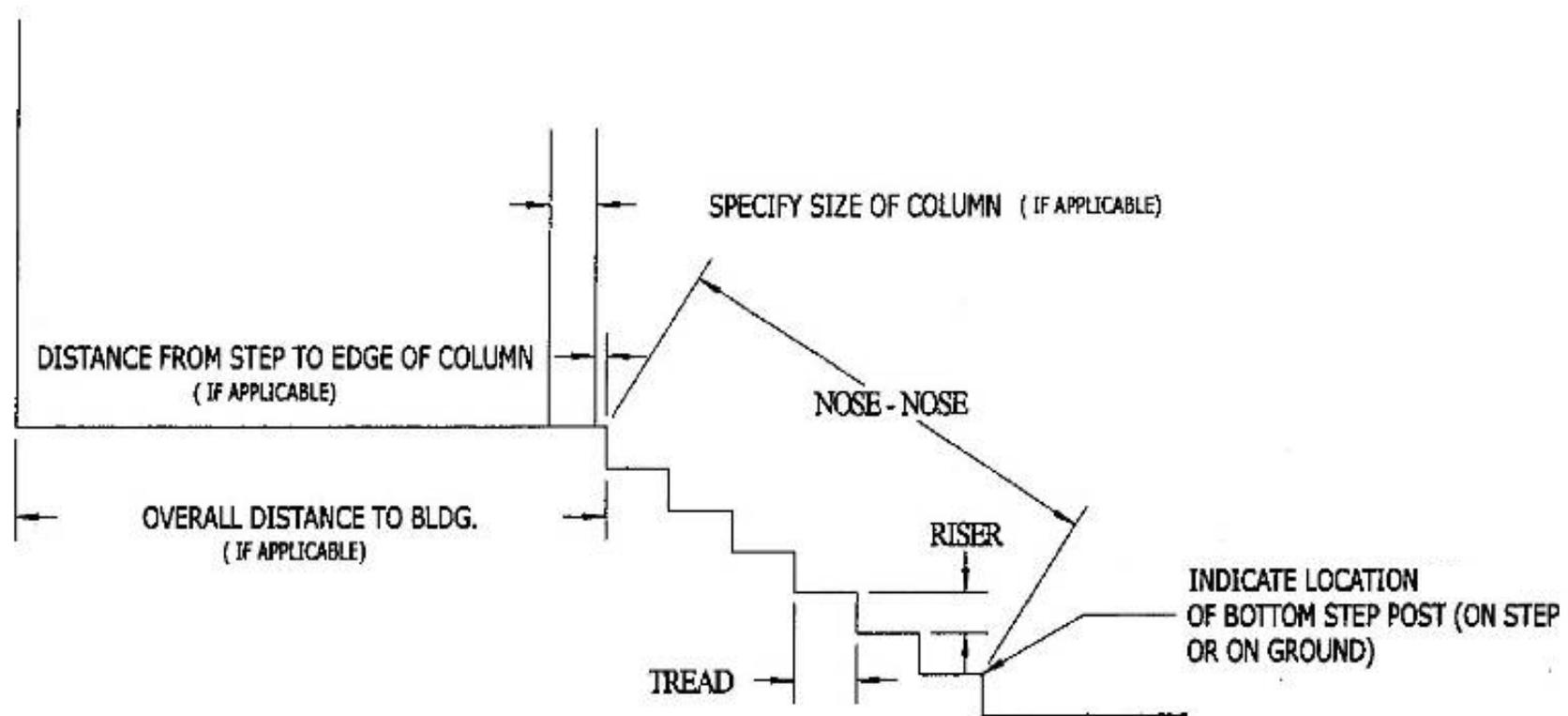
- 502. Tee
- 503. Corner Tee
- 507. 90° 3-Way Elbow
- 523. Heavy Duty Base with Post
- 521. Wall Plate with Adj. Brackets

Typical Applications



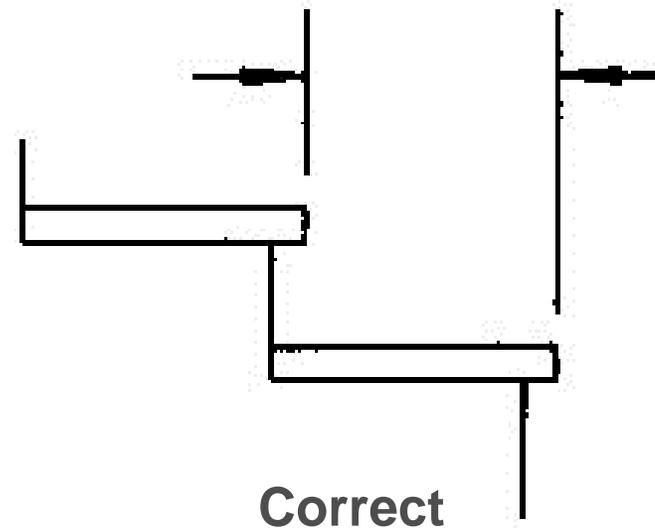
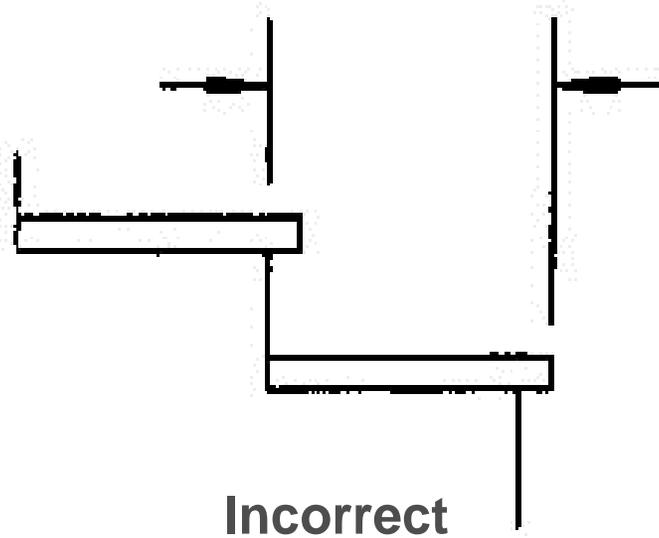
Stair Measurement

To ensure accuracy when specifying, make a complete sketch of the stairs indicating the correct number of treads and risers. Measure the nose-to-nose dimension of the steps, as well as the tread.



Stair Measurement

It is important to measure each tread and riser of the steps correctly.

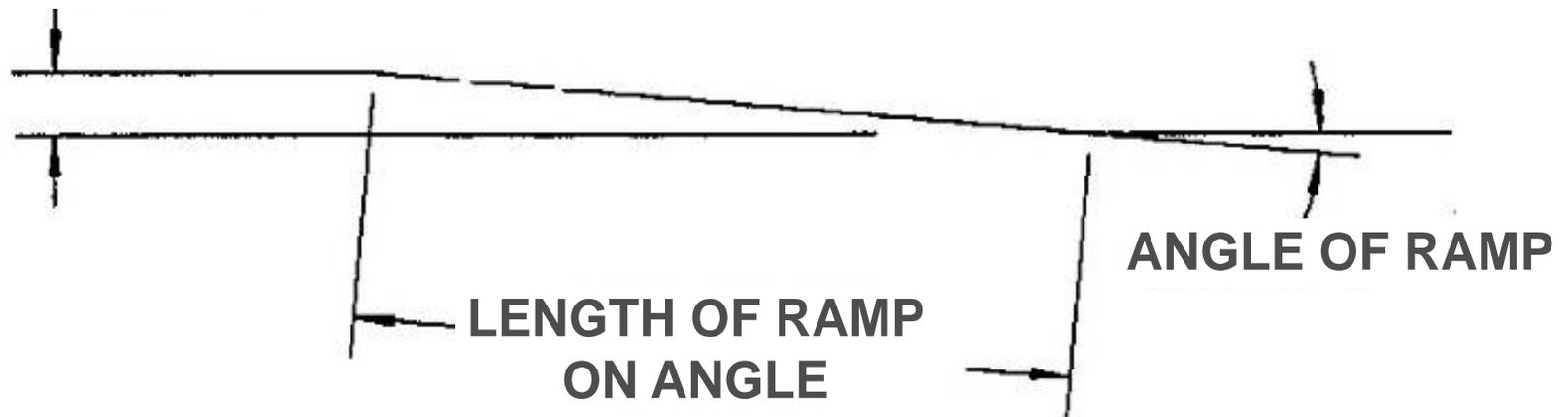


Ramp Measurement

Steps for Proper Ramp Measurement:

- Make a complete sketch of the ramp
- Measure the length of ramp on angle
- Measure total rise of ramp or the angle of the ramp

TOTAL RISE OF RAMP



Examples of Installations

Aluminum Cable Railing / Pipe Railing / Pipe Picket Railing





Codes & Standards

Introduction

In terms of safety criteria, look for aluminum railing products that meet the safety standards of:

- OSHA (Occupational Safety and Health Administration)
- ADA (Americans with Disabilities Act), and
- ICC (International Code Council).

Presented in this section of the course is a review of the ICC code requirements for railings and guards.



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SECTION 1012: HANDRAILS

1012.1 Where required. Handrails for stairways and ramps shall be adequate in strength and attachment in accordance with Section 1607.7. Handrails required for stairways by Section 1009.10 shall comply with Sections 1012.2 through 1012.8. Handrails required for ramps by Section 1010.8 shall comply with Sections 1012.2 through 1012.7.

1012.2 Height. Handrail height, measured above stair tread nosings, or finish surface of ramp slope shall be uniform, not less than 34" (864 mm) and not more than 38" (965 mm).

1012.3 Handrail graspability. Handrails with a circular cross-section shall have an outside diameter of at least 1.25" (32 mm) and not greater than 2" (51 mm) or shall provide equivalent graspability. If the handrail is not circular, it shall have a perimeter dimension of at least 4" (102 mm) and not greater than 6.26" (160 mm) with a maximum cross-section dimension of 2.25" (57 mm). Edges shall have a minimum radius of 0.01" (0.25 mm).

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1012.4 Continuity. Handrail-gripping surfaces shall be continuous, without interruption by newel posts or other obstructions.

Exceptions:

1. Handrails within dwelling units are permitted to be interrupted by a newel post at a stair or ramp landing.
2. Within a dwelling unit, the use of a volute, turnout or starting easing is allowed on the lowest tread.
3. Handrail brackets or balusters attached to the bottom surface of the handrail that do not project horizontally beyond the sides of the handrail within 1.5" (38 mm) of the bottom of the handrail shall not be considered obstructions. For each 0.5" (12.7 mm) of additional handrail perimeter dimension above 4" (102 mm), the vertical clearance dimension of 1.5" (38 mm) shall be permitted to be reduced by 0.125" (3 mm).

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1012.5 Handrail extensions. Handrails shall return to a wall, guard or the walking surface or shall be continuous to the handrail of an adjacent stair flight or ramp run. At stairways where handrails are not continuous between flights, the handrails shall extend horizontally at least 12" (305 mm) beyond the top riser and continue to slope for the depth of one tread beyond the bottom riser. At ramps where handrails are not continuous between runs, the handrails shall extend horizontally above the landing 12" (305 mm) minimum beyond the top and bottom of ramp runs.

Exceptions:

1. Handrails within a dwelling unit that is not required to be accessible need extend only from the top riser to the bottom riser.
2. Aisle handrails in Group A occupancies in accordance with Section 1025.13.

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1012.6 Clearance. Clear space between a handrail and a wall or other surface shall be a minimum of 1.5" (38 mm). A handrail and a wall or other surface adjacent to the handrail shall be free of any sharp or abrasive elements.

1012.7 Projections. On ramps, the clear width between handrails shall be 36" (914 mm) minimum. Projections into the required width of stairways and ramps at each handrail shall not exceed 4.5" (114 mm) at or below the handrail height. Projections into the required width shall not be limited above the minimum headroom height required in Section 1009.2.

1012.8 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" (762 mm) of a handrail. On monumental stairs, handrails shall be located along the most direct path of egress travel.

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SECTION 1013: GUARDS

1013.1 Where required. Guards shall be located along open-sided walking surfaces, mezzanines, industrial equipment platforms, stairways, ramps and landings that are located more than 30" (762mm) above the floor or grade below. Guards shall be adequate in strength and attachment in accordance with Section 1607.7.

Where glass is used to provide a guard or as a portion of the guard system, the guard shall also comply with Section 2407.

Guards shall also be located along glazed sides of stairways, ramps and landings that are located more than 30" (762 mm) above the floor or grade below where the glazing provided does not meet the strength and attachment requirements in Section 1607.7.

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1013.1 Cont'd...

Exceptions: Guards are not required for the following locations:

1. On the loading side of loading docks or piers.
2. On the audience side of stages and raised platforms, including steps leading up to the stage and raised platforms.
3. On raised stage and platform floor areas, such as runways, ramps and side stages used for entertainment or presentations.
4. At vertical openings in the performance area of stages and platforms.
5. At elevated walking surfaces appurtenant to stages and platforms for access to and utilization of special lighting or equipment.
6. Along vehicle service pits not accessible to the public.
7. In assembly seating where guards in accordance with Section 1025.14 are permitted and provided.

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1013.2 Height. Guards shall form a protective barrier not less than 42” (1067 mm) high, measured vertically above the leading edge of the tread, adjacent walking surface or adjacent seatboard.

Exceptions:

1. For occupancies in Group R-3, and within individual dwelling units in occupancies in Group R-2, guards whose top rail also serves as a handrail shall have a height not less than 34” (864 mm) and not more than 38” (965 mm) measured vertically from the leading edge of the stair tread nosing.
2. The height assembly seating areas shall be in accordance with Section 1025.14.

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1013.3 Opening Limitations. Open guards shall have balusters or ornamental patterns such that a 4" diameter (102 mm) sphere cannot pass through any opening up to a height of 34" (864 mm). From a height of 34" (864 mm) to 42" (1067 mm) above the adjacent walking surfaces, a sphere 8" (203 mm) in diameter shall not pass.

Exceptions:

1. The triangular openings formed by the riser, tread and bottom rail at the open side of a stairway shall be of a maximum size such that a sphere of 6" (152 mm) in diameter cannot pass through the opening.
2. At elevated walking surfaces for access to and use of electrical, mechanical or plumbing systems or equipment, guards shall have balusters or be of solid materials such that a sphere with a diameter of 21" (533 mm) cannot pass through any opening.

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1013.3 Opening Limitations.

Exceptions Cont'd:

3. In areas that are not open to the public within occupancies in Group I-3, F, H or S, balusters, horizontal intermediate rails or other construction shall not permit a sphere with a diameter of 21”(533 mm) to pass through any opening.
4. In assembly seating areas, guards at the end of aisles where they terminate at a fascia of boxes, balconies and galleries shall have balusters or ornamental patterns such that a 4” diameter (102 mm) sphere cannot pass through any opening up to a height of 25” (660 mm). From a height of 26” (660 mm) to 42” (1067 mm) above the adjacent walking surfaces, a sphere 8” (203 mm) in diameter shall not pass.
5. Within individual dwelling units and sleeping units in Group R-2 and R-3 occupancies, openings for required guards on the sides of stair treads shall not allow a sphere of 4.375” (111 mm) to pass through.

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1013.4 Screen Porches. Porches and decks which are enclosed with insect screening shall be provided with guards where the walking surface is located more than 30" (762 mm) above the floor or grade below.

1013.5 Mechanical Equipment. Guards shall be provided where appliances, equipment, fans, roof hatch openings or other components that require service are located within 10' (3048 mm) of a roof edge or open side of a walking surface and such edge or open side is located more than 30" (762 mm) above the floor, roof or grade below. The guard shall be constructed so as to prevent the passage of a 21" diameter (533 mm) sphere. The guard shall extend not less than 30" (762 mm) beyond each end of such appliance, equipment, fan or component.

1013.6 Roof Access. Guards shall be provided where the roof hatch opening is located within 10' (3048 mm) of a roof edge or open side of a walking surface and such edge or open side is located more than 30" (762 mm) above the floor, roof or grade below. The guard shall be constructed so as to prevent the passage of a 21" diameter (533 mm) sphere.

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