ULTRA-TEC®
CABLE RAILING

DESIGNING A METAL CABLE RAILING

ULTRA-TEC®
CABLE RAILING

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CHOOSING THE RIGHT CABLE

Cable Construction

The Cable Connection offers cable in five different diameters for Ultra-tec® Cable Railing System: 1/8", 3/16", 1/4", 5/16", and 3/8".

For cable railings, you want to use a cable that is as rigid as possible and does not stretch. That is why we recommend 1x19 construction, type 316 stainless steel strand (cable). Other constructions such as 7x7 or 7x19 are less rigid than 1x19 and have elevated levels of stretch. The breaking strengths for 1x19 construction are also higher than 7x7 and 7x19 (see **Cable Minimum Breaking Strengths** chart below).

Cable Applications

Cable Dia.	Typical Applications
1/8"	Now the most popular diameter for residential railing because it is the least expensive, most visually unobtrusive cable size. It is also the cable used for vertical railings. Since it is so thin, 1/8" diameter cable is also more susceptible to failure under shock loads than larger diameter cables.
3/16"	3/16" and 1/4" diameters are the most commonly used cable sizes for commercial railings. 3/16", formerly the most popular size for residential railings, is still very popular with more safety-conscious homeowners.
1/4"	
5/16"	5/16" and 3/8" diameter cables are truly the best choice when a visually robust appearance is desired.
3/8"	

Cable Minimum Breaking Strengths

Cable Dia.	Minimum Breaking Strength (Lbs.) For Following Cable Constructions in Type 316 Stainless Steel		
	1x19	7x7	7x19
1/8"	1,780	1,360	1,300
3/16"	4,000	3,300	2,900
1/4"	6,900	5,500	4,900
5/16"	10,600	7,600	7,600
3/8"	14,800	11,700	11,000

NOTE: Ultra-tec® hardware is designed for us in pedestrian guardrailings. For other applications, consult the factory for suitability.

DESIGN PARAMETERS AND CONSTRAINTS

We will first address the issues encountered while designing a **horizontal run cable railing system.**

Cable is very strong in tensile strength and is a suitable in-fill material for a railing. There are many different types of constructions of cable. Most cable is designed to be flexible for going over pulleys or for lifting/moving heavy loads. Other constructions of cable are designed to hold something in tension, such as guy wire or a sailboat stay, and are less flexible. For any particular diameter of cable, the tradeoff for flexibility is strength. The opposite is also true. You compromise strength when you require a construction of cable that is capable of a higher degree of flexibility.

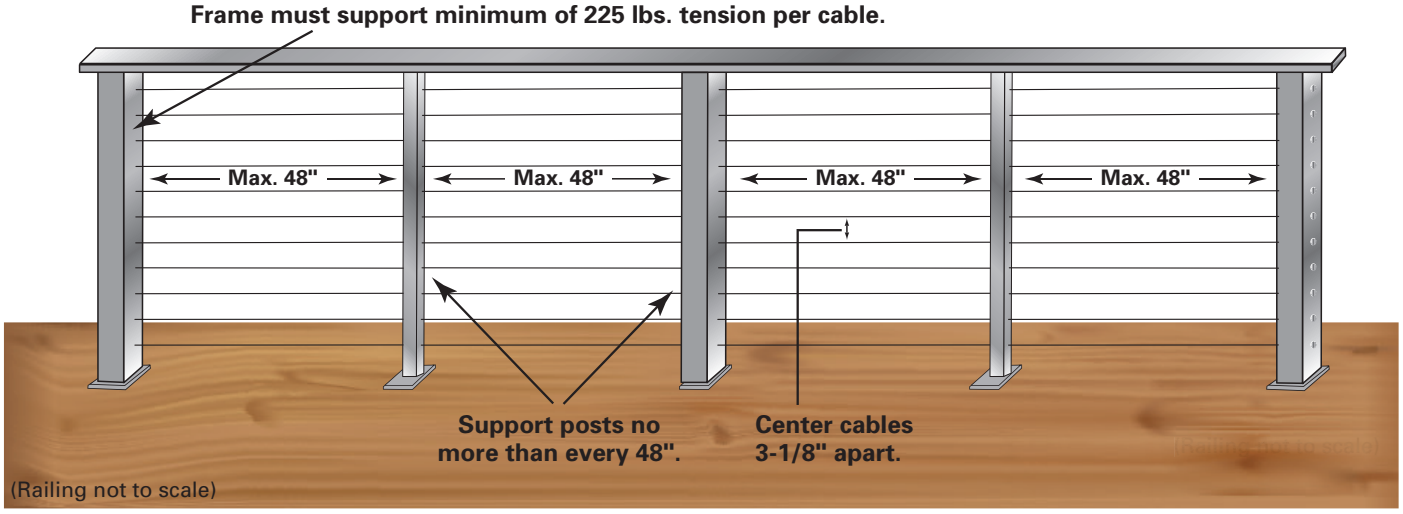
Cable flexibility is an important consideration in designing a cable railing. The IRC and IBC require that a 4" sphere shall not pass through any portion of railing. Having the rigidity to prevent deflection of a horizontally run cable that is subjected to a vertical load is partly mitigated by the cable's lack of flexibility. Therefore, it is our preference to use the most rigid of cable constructions possible when designing a railing using cable. The other factors are the tension of the cable, the span between supporting intermediate members, the diameter of the cable, and the vertical spacing of the cables on center.

Let's start with the spacing of your intermediate posts and/or braces, which will support the cable as it passes through the posts of the railing frame. (An intermediate structural post runs from the top rail to the mounting surface. A brace is a lighter weight material placed between posts; it's primary purpose being to support the cable.) Cable can be run long distances between terminating ends (60 ft. or more, depending upon railing configuration), but it needs to be supported at intervals between end posts to avoid cable deflection in excess of that permitted by building codes. When a rigid cable construction is used, such as 1x19, the spacing between posts and/or braces should not exceed 48".

The next variable is the diameter of the cable. While 1/8" is the cable diameter most often used for residential applications, we recommend 3/16" diameter cable for commercial projects or anywhere there is heavy pedestrian traffic. Using a larger diameter cable may be preferred from an aesthetics standpoint. We offer 1/4", 5/16" and 3/8" diameter cable.

Spacing of the cables vertically is critical to minimize deflection of the cables under a vertical load. Our specifications provide recommended vertical spacing not to exceed 3" between cables when they are installed.

The next variable is the tension of the cables and the construction of posts to which mounting and tensioning hardware is attached. Deflection of the end posts must be minimized, and this is where we have found the most mistakes made in the design of the railing framework. An incredible amount of force is placed on an end post when you have ten or more



lines, each tensioned to a minimum of 225 lbs. over a height of 36" to 42". The posts to which hardware is mounted must be constructed so that they will not deflect perceptively as the cables are tensioned to loads of 225 lbs. or more. All of these variables work together to minimize the deflection of the cable so as to not allow a 4" sphere to pass between the cables when they are properly tensioned in a well-designed frame.

The last variable is the Top Rail. A sturdy top rail is necessary to support the tensioning end posts and prevent them from bending under the strain of the tensioned cables.

RECOMMENDED METAL FRAME VARIATIONS

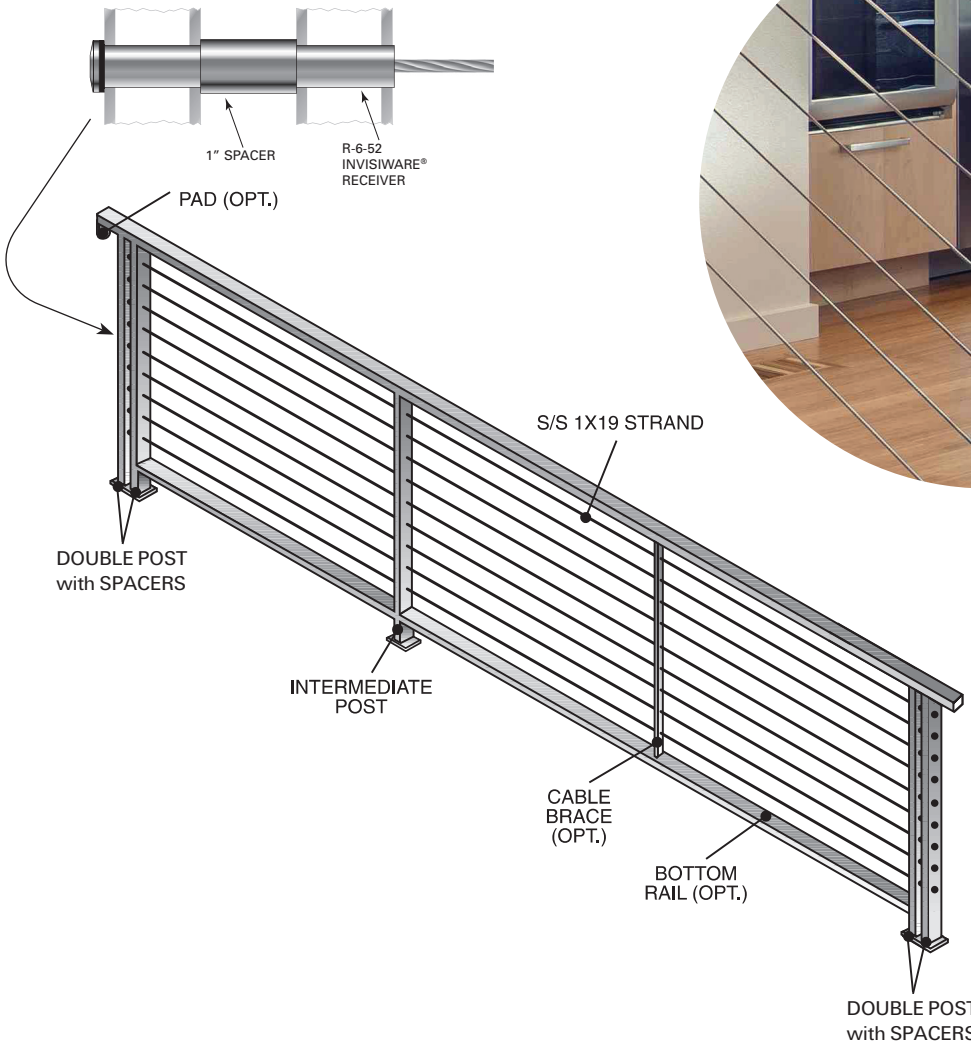
Recommended frame components can be carbon steel or stainless steel. The frames recommended below have been found to perform satisfactorily when subjected to the tension encountered when multiple load points (cables) are attached and tensioned properly to your end posts (225 lbs. per line). Detailed downloadable drawings (see page 12) show proper spacing of the cables vertically on the end posts that allow for cable flex within allowable limits to meet code requirements that a 4" sphere shall not pass through at any point.

Double End Post Construction

Using 2"x1"x.120" or 3"x1"x.120" Structural Steel Posts with Stainless Steel Spacers

Using 2"x1" or 3"x1" Top and Bottom Rail and Intermediate Posts (if applicable)

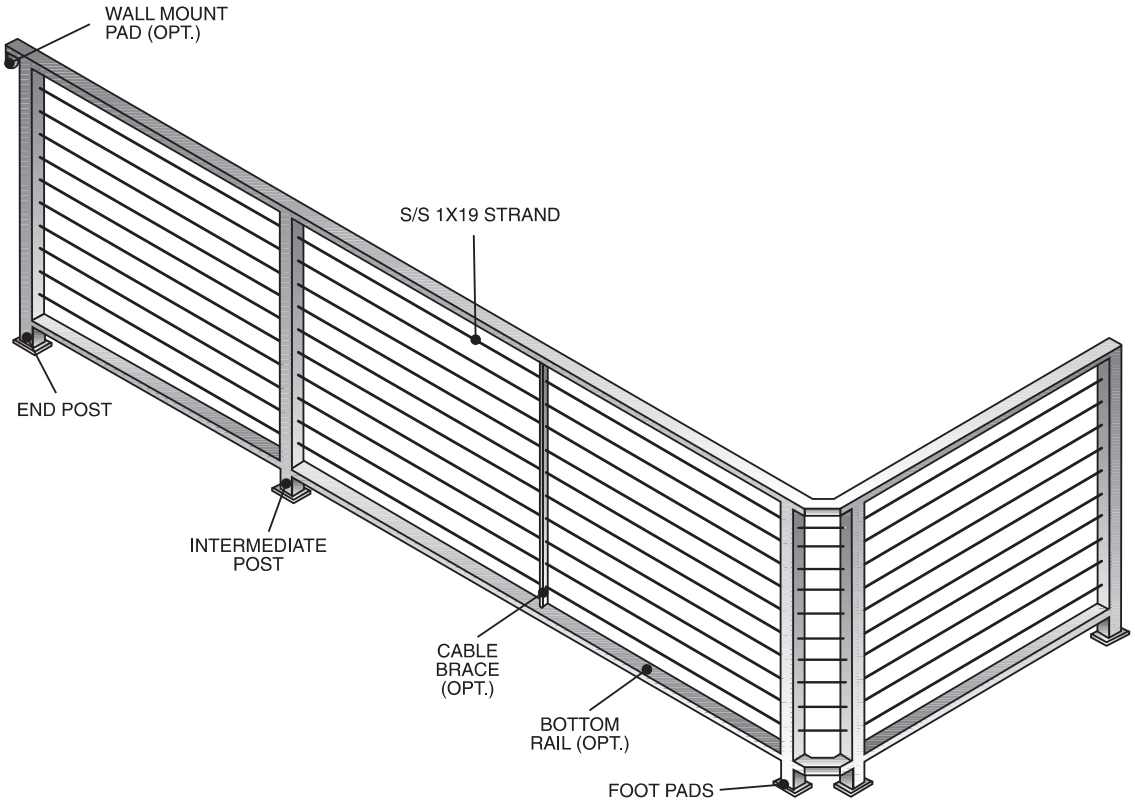
This railing style uses an end post with two vertical members separated by stainless steel spacers. Intermediate posts are only 1" thick. This construction is strong yet its elements are relatively thin, so there is little visual obstruction created by the frame.



2" x 2" x 1/4" Wall Structural Steel End Post Construction

Using 2"x1" Top Rail and Bottom Rail (if applicable)

Even though the end posts are 2"x2"x.250", intermediate posts can be 2"x1"x.120" to minimize the bulkiness of the frame.

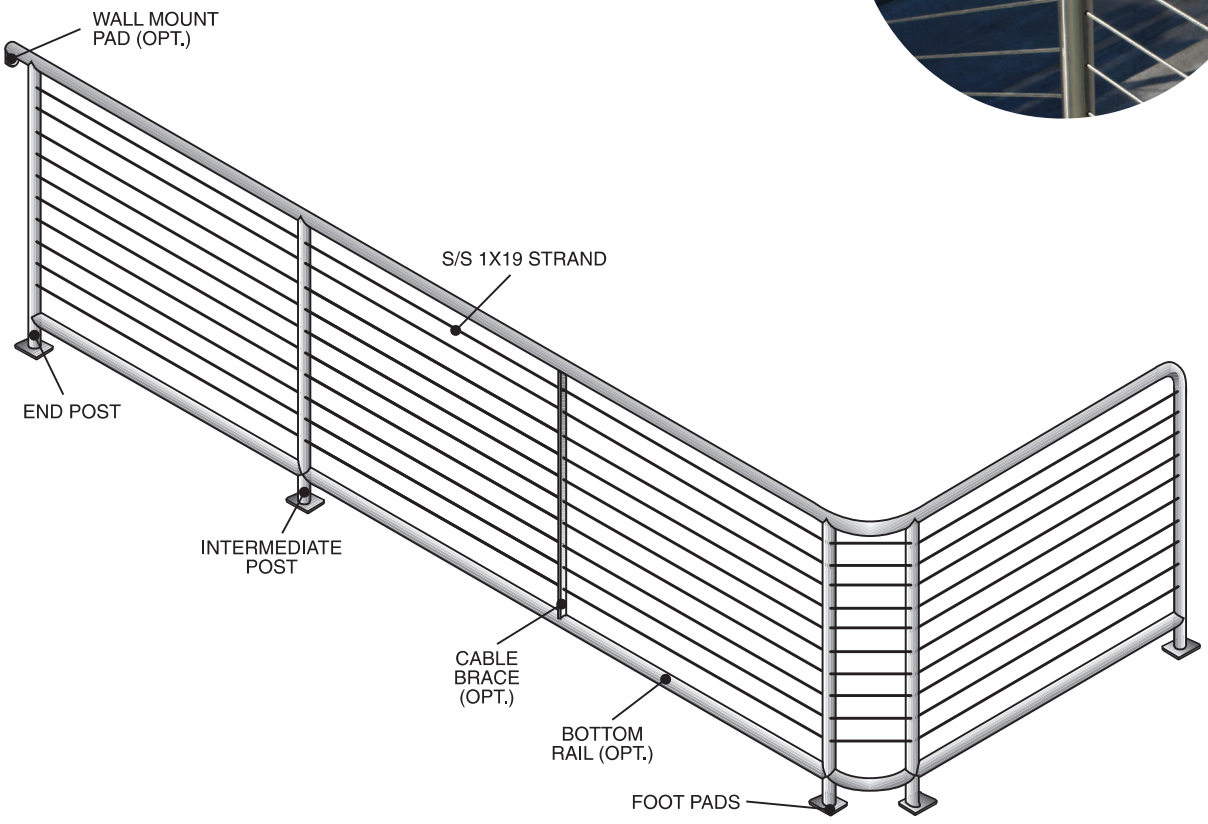


Pipe and Round Steel Tube Posts

Using 1-1/4", 1-1/2", or 2" Standard Pipe

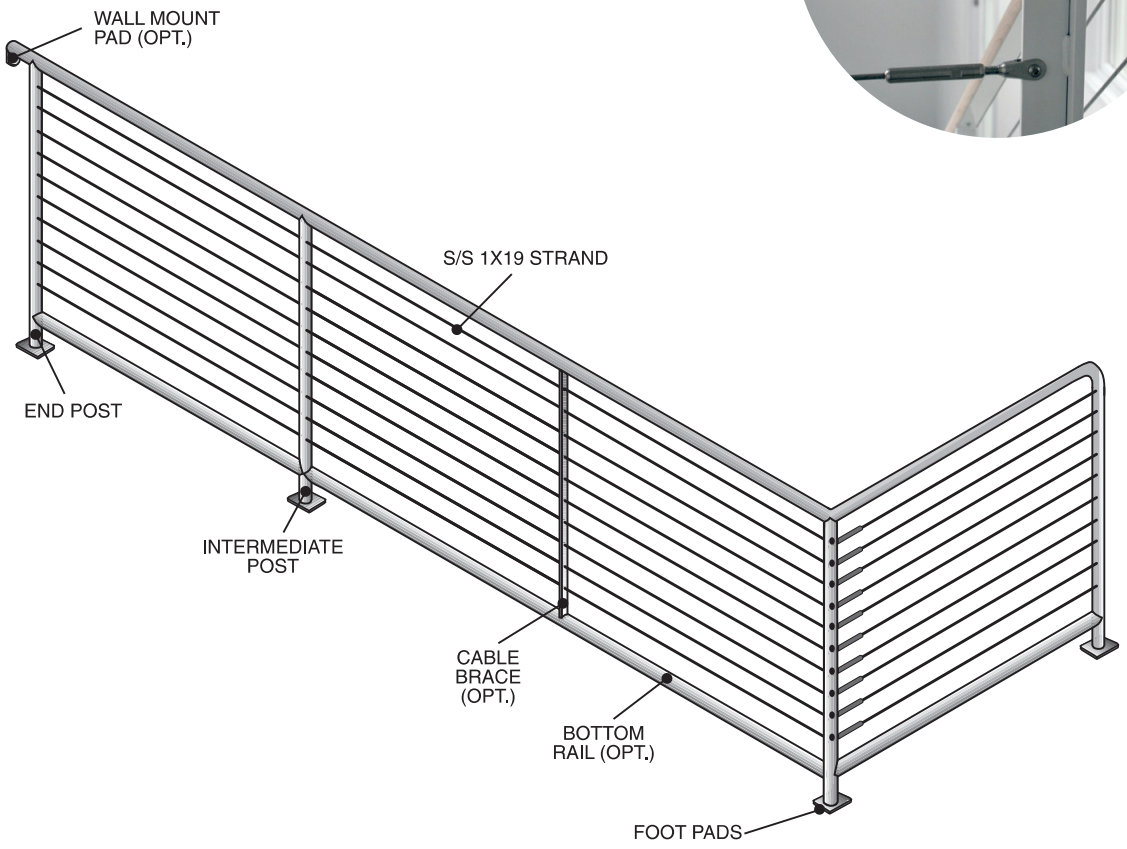
Detailed downloadable drawings for 1-1/4", 1-1/2" and 2" standard pipe are available (see page 12). Minimum schedule 80 pipe is required for your end posts.

Round tube can be used with a wall thickness at least comparable to schedule 80 pipe. **If you are using round tube, the downloadable drawings must be modified to allow for the different diameters of tube versus pipe.**



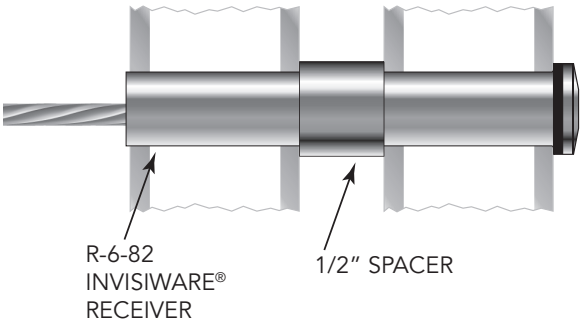
Other Metal Frame Materials

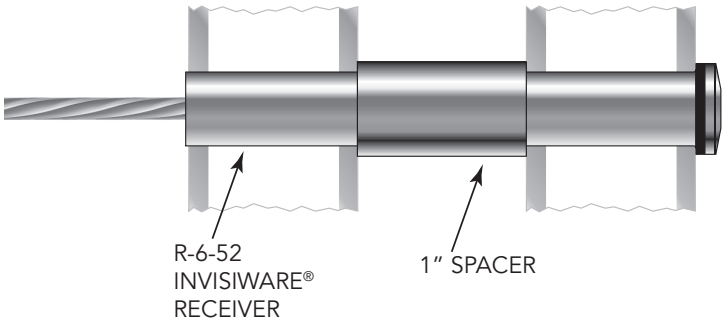
Frame components other than those shown in this guide can be made using carbon steel, stainless steel or aluminum. Custom frame styles should be engineered to perform satisfactorily when subjected to the tension encountered when multiple load points (cables) are attached and tensioned properly to your end posts (225 lbs. per line). Center-to-center spacing of the cables vertically on the end posts should not exceed 3" spacing between the cables to allow for cable flex within the allowable limits to meet code requirements that a 4" sphere shall not pass through at any point.



Railing Frame Components Material Specifications for Railings with Horizontally Run Cables

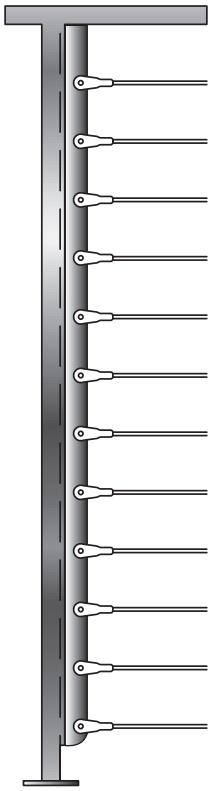
NOTE: Stainless steel strongly recommended for exterior applications





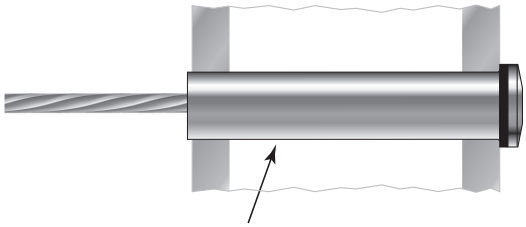
Carbon or Stainless Steel Structural Tubes	Minimum Wall Thickness	
Size and Shape	**End Posts**	**Top and Bottom Rails and Intermediate Posts**
2" x 1" Rectangular	.120" *See Note	.120"
3" x 1" Rectangular		

*Note: Minimum wall thickness shown is for double end post construction using two rectangular posts separated by stainless steel spacers. We do not recommend .120" wall for a stand-alone end post.



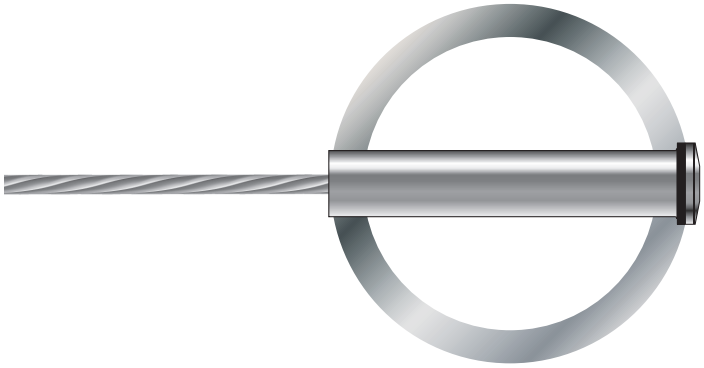
End Posts using Structural Tees

Frame Material	Structural Tee
2"x 1" Rectangular	2" x 2" x 1/4"
3"x 1" Rectangular	2-1/2" x 2-1/2" x 1/4"
2"x 2" Square	2" x 2" x 1/4"



R-6-32 INVISIWARE® RECEIVER

Carbon or Stainless Steel Structural Tubes	Minimum Wall Thickness	
Size and Shape	**End Posts**	**Top and Bottom Rails and Intermediate Posts**
2" x 2" Square	.250"	.120"



Round Tube or Stainless Steel Pipe **See note		Minimum Wall Thickness	
Size	**Outside Diameter**	**End Posts** Use Minimum Schedule 80	**Top and Bottom Rails and Intermediate Posts** Use Minimum Schedule 40
1-1/4" Pipe	1.660"	.191"	.140"
1-1/2" Pipe	1.900"	.200"	.145"
2" Pipe	2.375"	.218"	.154"

**Note: For tube, use wall thickness approximating wall thickness of pipe schedule shown.

See page 12 for a list of CAD drawings that can be downloaded for engineered tubular steel and pipe railings together with material specifications for each railing. The material specifications above are intended as general guidelines for use in designing a railing for which drawings are not available on the website. The design professional is responsible for engineering the railing to meet building code requirements.

DOWNLOADABLE DRAWINGS / HORIZONTAL

Detailed downloadable drawings and material specifications are available for the following frame constructions on the Ultra-tec® cable railing system web site.

Horizontal Cable Railings Downloadable Drawings

Drawing No.	Description
Double End Post constructions with stainless steel spacers between vertical elements:	
D1	3"x1" or 2"x1" x 36-1/2" high rectangular tubing with bottom rail
D2	3"x1" or 2"x1" x 36-1/2" high rectangular tubing without bottom rail
D3	3"x1" or 2"x1" x 42-1/2" high rectangular tubing with bottom rail
D4	3"x1" or 2"x1" x 42-1/2" high rectangular tubing without bottom rail
2" Square Structural Tubing construction (may also be used for other sizes of square tubing):	
D5	2" square tube x 36-1/2" high with bottom rail
D6	2" square tube x 36-1/2" high without bottom rail
D7	2" square tube x 42-1/2" high with bottom rail
D8	2" square tube x 42-1/2" high without bottom rail
Round Pipe (same drawings can be used for round steel tubing of the same approximate outside dimensions as pipe):	
D25	1-1/4" pipe x 36-1/2" high with bottom rail
D26	1-1/4" pipe x 36-1/2" high without bottom rail
D27	1-1/4" pipe x 42-1/2" high with bottom rail
D28	1-1/4" pipe x 42-1/2" high without bottom rail
D21	1-1/2" pipe x 36-1/2" high with bottom rail
D22	1-1/2" pipe x 36-1/2" high without bottom rail
D23	1-1/2" pipe x 42-1/2" high with bottom rail
D24	1-1/2" pipe x 42-1/2" high without bottom rail
D17	2" pipe x 36-1/2" high with bottom rail
D18	2" pipe x 36-1/2" high without bottom rail
D19	2" pipe x 42-1/2" high with bottom rail
D20	2" pipe x 42-1/2" high without bottom rail

Drawing No.	Description
Stair Rail End Posts	
D34	Square or rectangular tube rail end options
D35	Pipe rail end options
Mounting Options	
D103	Floor plate
D112	Square tubing, end or intermediate post – concrete embedding
D113	Pipe or round tubing, end or intermediate post – concrete embedding
D110	3"x1" or 2"x1" double end post – concrete embedding
D111	Intermediate post – concrete embedding
D114	Steel post – fascia mounting
D115	Wood 1-1/2" post – fascia mounting

RAILING COMPONENTS

Stainless Steel Cable Brace

1/4" x 1" in 2 lengths, for 36" and 42" high rails. Holes pre-drilled at 3-1/8" on center, 10 holes in short length, 12 holes in long. For use between structural posts to keep cables code compliant on level runs. Weld to metal frames; use cable brace floor plates for attaching to wood. Type 316 Stainless Steel

Order **CB-34.5-SS-10** or **CB-40.5-SS-12**

Stainless Steel Cable Brace for Stairs

1/4" x 1" in 2 lengths, for 36" and 42" high rails. Slots pre-drilled at 3-1/8" on center, 10 slots in short length, 12 holes in long. For use between structural posts to keep cables code-compliant on stair runs. Weld to metal frames; use cable brace floor plates for attaching to wood. Must be field-chamfered to match stair angle. Type 316 Stainless Steel

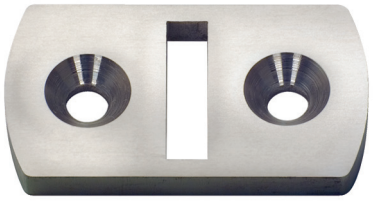
Order **CBS-34.5-SS-10** or **CBS-40.5-SS-12**

Stainless Steel Cable Brace Floor Plates

For mounting cable braces to top or bottom rail or deck.
2-1/4" x 1-1/4" x 1/4"
Type 316 Stainless Steel

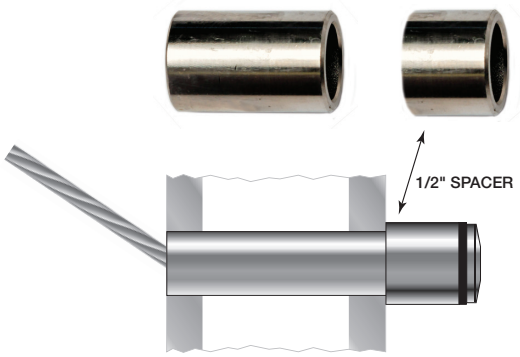
Order **FLP-CBS**

Install with 1/4" flathead screw, purchased separately.



Stainless Steel Spacers

Used to support thin-walled double end post design or allow for Receiver extension in a stair system.



Post "extension" for stairs.
Example: 1-1/2" post

For Cable Diameter	Length	Outside Diameter	Wall Thickness	Part Number
1/8", 3/16"	.500"	5/8"	.083"	SPC-R6-.500
1/8", 3/16"	.970"			SPC-R6
1/4"	.970"	3/4"	.095"	SPC-R8

VERTICAL RAILINGS

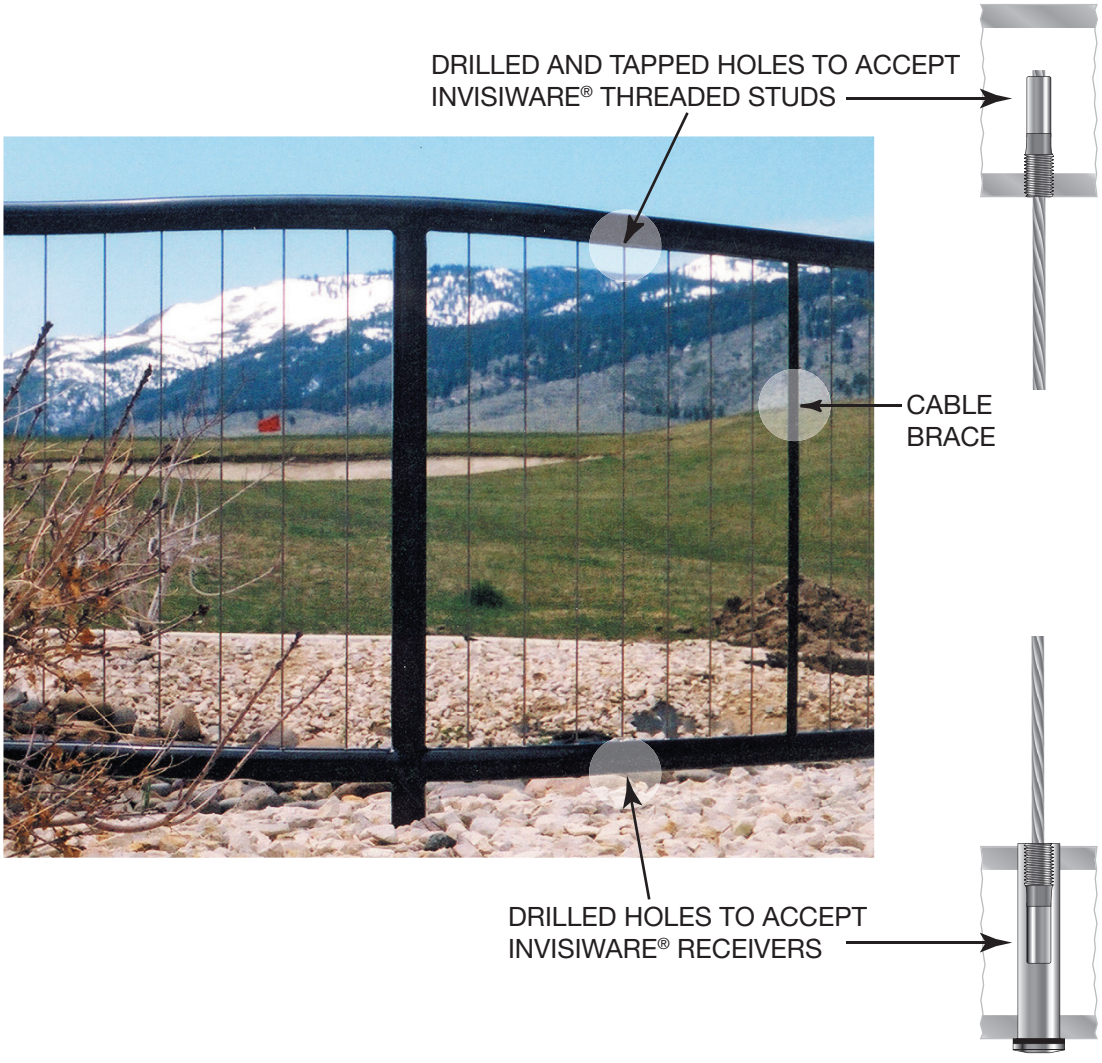
This railing frame style facilitates the use of cables in the vertical position, running from the top rail to the bottom rail.

The drawings on the following pages illustrate fabricating the railing from pipe. Square or rectangular tubing can also be used, but we recommend a minimum wall thickness of 1/4" in your frame material.

An Invisiware® Threaded Stud on one end of the cable is screwed into a drilled and tapped hole in the underside of the top rail. An Invisiware® Receiver is inserted into a hole drilled through the bottom rail. A threaded stud on the other end of the cable is inserted into the receiver, and the cable is tensioned by turning the receiver with an Allen wrench.

Because the Invisiware® receiver goes all the way through a hole in the lower rail, a stainless steel frame must be used in exterior applications to prevent rust in the frame.

This frame has been shown to perform satisfactorily when subjected to the tension encountered when multiple load points (cables) are attached and tensioned properly on the top and bottom rails. Detailed downloadable drawings (see page 15) show proper spacing of the cables on the top and bottom posts to allow for cable flex within allowable limits to meet most code requirements (that a 4" sphere shall not pass through at any point). Note that we recommend cable braces to replace every eighth cable to keep the top and bottom rails from bending when the cables are tensioned.



Railing Frame Components Material Specifications for Railings with Vertically Run Cables

NOTE: For exterior applications, specify stainless steel to prevent rust in the railing frame.

Structural Tube

Size and Shape	Minimum Wall Thickness Posts and Top and Bottom Rails
2" x 2" Square	.250"

Round Tube or Pipe *See note

Size	Outside Diameter	Minimum Wall Thickness Posts and Top and Bottom Rails Use Minimum Schedule 80
1-1/4" Pipe	1.660"	.191"
1-1/2" Pipe	1.900"	.200"
2" Pipe	2.375"	.218"

*Note: For tube, use wall thickness approximating wall thickness of pipe schedule shown.

Cable Braces

For use in place of a cable at least every eighth cable on 3-1/8" centers between structural posts to support top and bottom rails under tension.

Material	Dimensions
Stainless Steel	1/4" x 1" 304 cold-finish flat bar, #4 finish

DOWNLOADABLE DRAWINGS / VERTICAL

Detailed downloadable drawings for use with most commonly used programs are available for the following frame constructions on the Ultra-tec® web site.

Vertical Cable Railings Downloadable Drawings

Drawing No.	Description
D95	1-1/4" pipe x 36-1/2" high
D96	1-1/4" pipe x 42-1/2" high
D97	1-1/2" pipe x 36-1/2" high
D98	1-1/2" pipe x 42-1/2" high
D99	2" pipe x 36-1/2" high
D100	2" pipe x 42-1/2" high

Drawing No.	Description
D80	Corner section
D81	Corner section plan view for 1-1/4" pipe
D82	Corner section plan view for 1-1/2" pipe
D83	Corner section plan view for 2" pipe

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