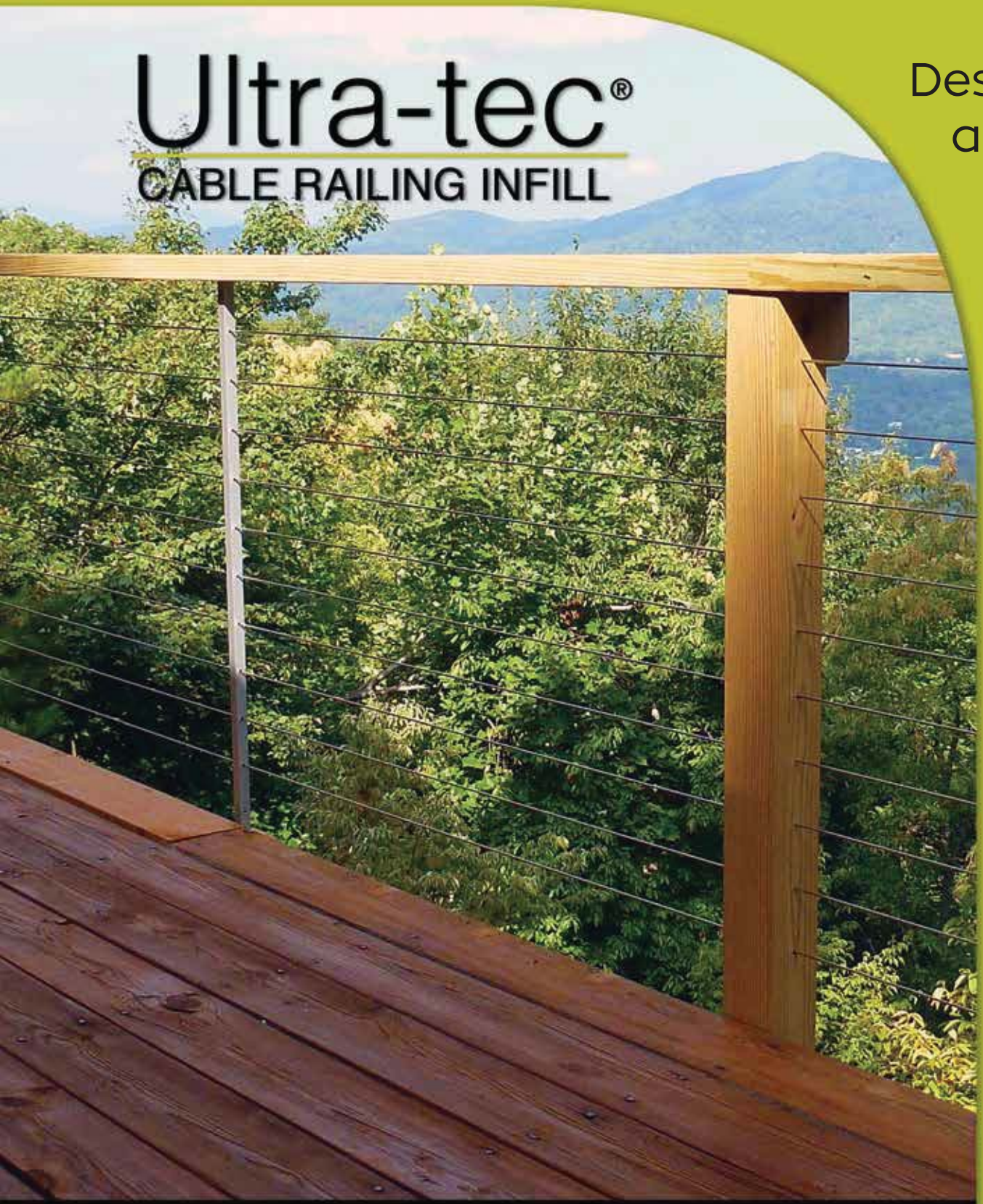
Ultra-tec®
CABLE RAILING INFILL

Designing a Wood Railing



Inside:

- Construction, location of end posts
- Configuration of corners
- Location of intermediate posts
- Choosing the right cable diameter
- Spacing of cables
- Cutting cables in field versus factory-cut
- Hardware options

U.S.A. Manufacturer

ISO 9001
QMI-SAI Global

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Ultra-tec® products contain at least 65% recycled content, helping you qualify for LEED® credits.

Designing A Wood Railing With Cable As An Infill

Overview

There are eight considerations in designing a railing with cable infill:

1. Construction and location of your end posts
2. Configuration of any corners in your design
3. Location of intermediate posts
4. Location of additional cable supports
5. Cable diameter to use
6. Spacing of cables on your end post
7. Whether to cut cables and install fittings in the field, use factory-cut and swaged cables, or use retail kits
8. Hardware options

We will address these considerations in order.

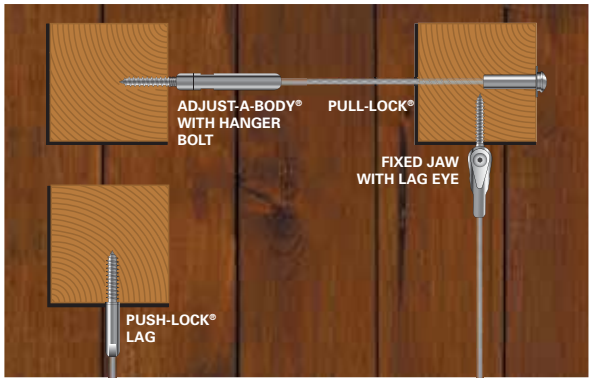
1. Construction and location of your end (terminating) posts.

An end post is a post to which terminating cable ends are attached with tensioning or non-tensioning hardware. Considerable tension is applied to the end posts, when the cable is properly tensioned. A substantial end post is necessary to prevent the end post from bending which will cause the cables to sag. In wood, a minimum 4x4 end post is required. End posts must be securely fastened to the top rail and deck or other surface to prevent the post from coming loose with the forces applied through the tensioned cables.

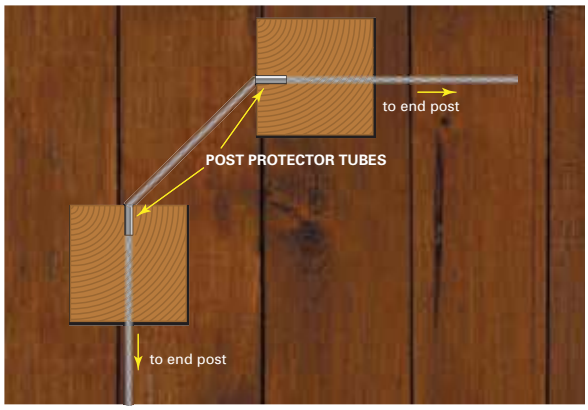
Support members between end posts are also necessary. In wood, we recommend support members running between posts, such as a 2x4 secured to the inside of each post, so you are not relying on the shear strength of the nails or screws to support the tension applied to the end post.

2. Configuration of any corners in your design.

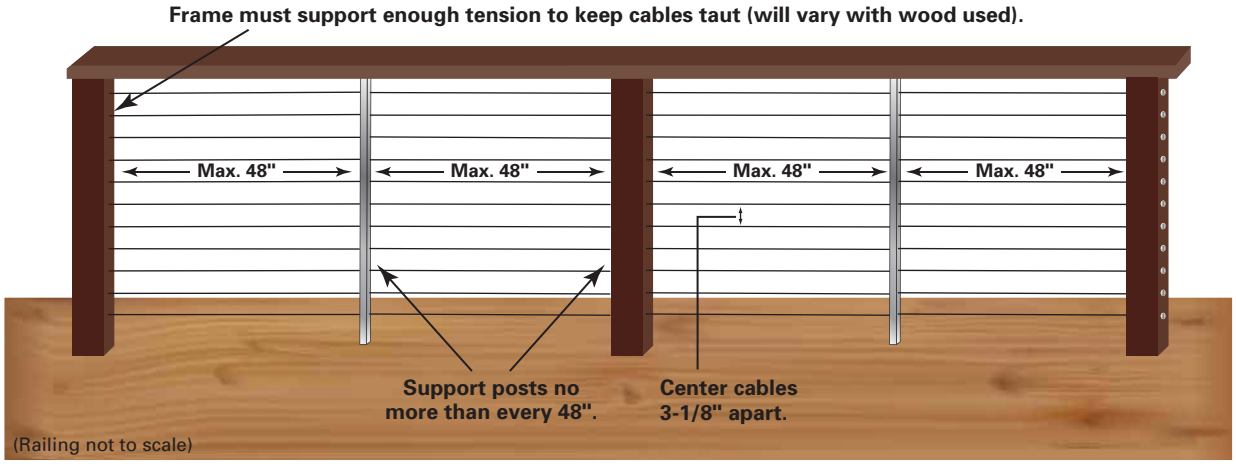
At corners or turns of more than approximately 45 degrees, it is best to terminate your runs in each direction with an end post (minimum of a nominal 4x4). The following illustrations demonstrate how this is done.



A corner may be designed using two posts on the corner and running the cables between the posts as illustrated below.



When going around a corner, the cable will often enter or exit the post at an angle. To prevent



the cable from biting into the wood when it is tensioned, the wood in the post must be protected. Post protector tubes are available from the factory (see the *Accessories* section of this publication for order information).

The post protector tube is a flared length (3/4") of tube that is pushed into the hole for the cable, so the cable rests against it as opposed to the wood itself. The inside diameter of the tube is just large enough for the cable to pass through, so its use requires either swageless fittings or on-site swaging; no pre-swaged fittings will pass through the post protector tube.

On a turn of less than approximately 45 degrees, you can run your cables through a single post, but you will still need to protect the post where the cable enters or exits the post at an angle to prevent the cable from biting into the wood when it is tensioned.

See **No. 8** for other hardware combinations that can be used on corner posts.

3. Location of intermediate posts.

Intermediate posts (or mid-posts) are placed between end posts. An intermediate post runs from the top rail to the lower mounting surface and is a structural element. Intermediate posts should be placed at intervals between end or corner posts as frequently as necessary to meet building code requirements. An engineer or design professional should be engaged, if you are unable to otherwise determine intermediate post spacing.

Cable is strung through holes drilled in the intermediate posts, so intermediate posts also become supports for the cable between end posts.

With cable spaced vertically on centers as recommended below (see **No. 6**), we recommend that the cable be supported in some manner no more than every 48" along its run. The support can be provided by an intermediate post or it can be something thinner such as a 2x4 or a thin steel or aluminum cable brace (see **No. 4** below).

4. Location of additional cable supports.

Regardless of the amount of tension you apply to the cables, there will be some flex in the cable when it is installed. When the cables are spaced vertically on your end post as recommended in **No. 6**, we recommend that the cable be supported in some manner no more than every 48" along its run, to meet code requirements that a 4" sphere cannot pass through the cables.

As indicated, this support can be provided with intermediate posts or a lighter material acting as a cable brace. As with an intermediate post, a cable brace also runs between the top rail and the lower mounting surface, but its purpose is only to support the cable. It is not intended to be an element providing structural support to the railing.

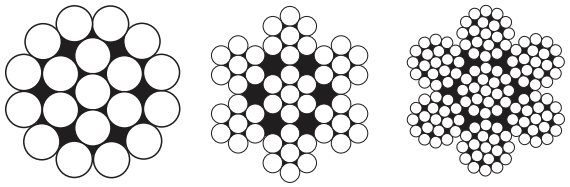
Cable braces can be much thinner and, therefore, less obtrusive than posts, as their primary purpose is only to support the cable.

A 1/4"x1" steel flat bar (stainless steel recommended) or 3/4"x3/4" aluminum tube, with holes drilled for the cables to pass through, makes an excellent cable brace. Both types of cable braces are available from the factory (see the *Accessories* section of this publication for order information).

5. Cable diameter to use.

It is important to use 1x19 construction cable as a railing infill, because it is attractive, smooth to the touch, and designed to support loads in tension with minimal stretch.

The individual wires in 1x19 construction cable are much larger than those used in more flexible constructions. This makes the cable less prone to damage from abuse, and it is also the reason why strand does not stretch as much as other constructions.



1 x 19
Non-Flexible

7 x 7
Flexible

7 x 19
Very Flexible

You will want to specify type 316 stainless steel, because it is the most corrosion resistant commercially available alloy used in manufacturing cable. Ultra-tec® hardware is made from type 316 stainless steel, so no material compatibility issues will arise when you use type 316 stainless steel cable with Ultra-tec® hardware.

For commercial railing, it is important to use at least a 3/16" diameter cable. Problems have been experienced with damage from abuse when 1/8" diameter cable has been used. Following are minimum breaking strengths for type 316 stainless steel cable.

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 use in pedestrian guardrailings. For other applications, consult the factory for suitability.

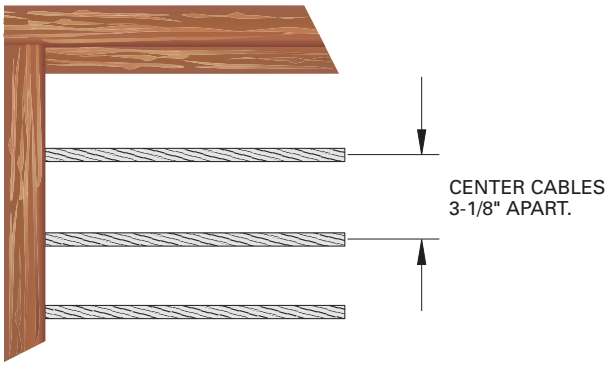
As the chart above illustrates, for a small increase in size (and cost) you can more than double the strength of your infill and ensure that damage from abuse is not an issue with your railing.

6. Spacing of cables on your end post.

Even though you use 1x19 construction cable and the cables are properly tensioned on a strong end post, there will be some flex in the cable when a load is applied.

The spacing of the cable on the end posts works together with the distance between points where the cable is supported, to minimize cable flex. The closer together the cables are spaced on the end posts, the longer the distance can be between cable support points. The reverse is also true.

Weighing the desire to use as few cables as necessary with the need to minimize cable flex, we recommend maximum vertical spacing of the cables on your end posts be 3-1/8” on center.



7. Whether to cut cables and install fittings in the field or use factory-cut cables.

There are three choices to consider for attaching fittings to the cables. Cables can be: 1) cut at the job site and the fittings attached using swageless fittings; 2) cut at the job site and swaged on the cables using equipment and tools rented or purchased from the factory or a distributor; or 3) supplied by the factory or a distributor cut to length with the fittings attached to the cable. Complete instructions are included with orders.

Swageless Fittings

Swageless fittings are installed by hand in the field. No special equipment is needed, except cable cutters. (As with any method of installing, we also recommend that you use special cable gripping pliers to keep the cable from turning when you tighten the fittings to tension the cable. Cable cutters and cable gripping pliers can be ordered from the factory and some distributors).

The first advantage is that the holes the cables pass through in your intermediate posts do not have to be any larger than is necessary for just the bare cable to pass through. If you have fittings already attached to both ends of the cable, your intermediate post holes must be at least as large as the diameter of the smallest fitting attached to the cable. The difference between the hole and cable diameters will be 1/16” or more, which will cause more cable deflection than the tighter fit obtained if the fittings are swaged on site.

The second advantage is that there is no need to provide accurate measurements to a second party who is doing the cutting and swaging of the cables. This eliminates the possibility for misinterpreting your dimensions. In the field, the cables are cut slightly longer than necessary and one end fitting is attached to the cable. This allows you to measure and cut the cable to exact length before attaching the Push-Lock® or Pull-Lock® fitting. One end of your cable will be a swaged-on tensioning device, which you will use to tension your cables once installed. You do not have to wait for someone else to make the cables and ship them to you and take the chance that some of them may not be cut correctly. Most importantly, you are in control of when the cables are made.

Field Swaging

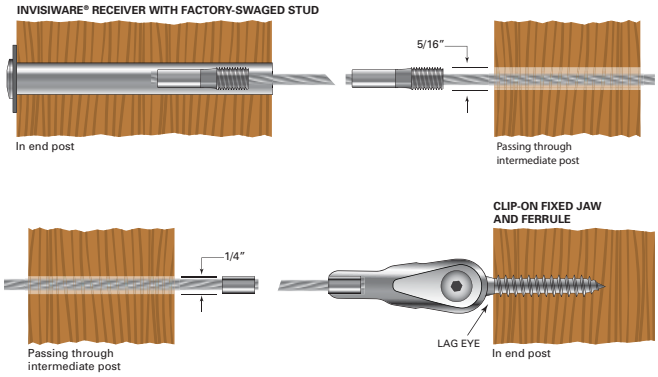
Field swaging offers the advantage that you do not have in using swageless fittings, in that your choice of fittings is unlimited when you field swage. Field swaging requires the use of a swaging kit and an air

compressor (see our catalog or installation guide for compressor specifications) to attach the fittings to the cables. All of the equipment necessary is available for purchase or rental from the factory and through some distributors.

Factory Swaging

If the cables are cut and the fittings swaged by us, you do not need to use special equipment. There is a charge for factory cutting and swaging, but for smaller jobs the cost will be less than renting the equipment required to field swage the cables.

Some Ultra-tec® hardware is designed to pass through holes in your intermediate posts that are drilled as little as 1/16" larger than the diameter of the cable, when both ends are swaged by us.



Where the cable will not pass through any intermediate posts, you can order factory-cut and -swaged cables using any hardware. You are not limited as to the fittings you can use.

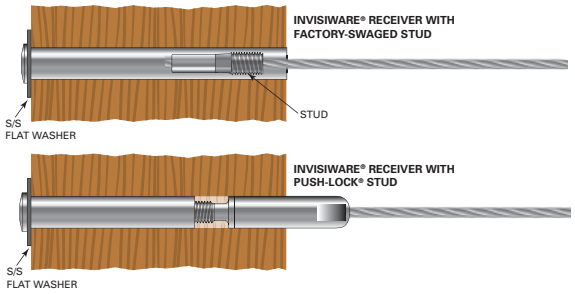
If you can use our Push-Lock® or Pull-Lock® fitting on one end of your cable, we can supply your cable with one of our tensioning devices (see **8-A**) on one end and only bare cable on the other end to which the Push-Lock® or Pull-Lock® fitting will be attached by hand. The advantage is that you can drill your intermediate post holes just large enough for the cable to pass through.

8. Hardware options.

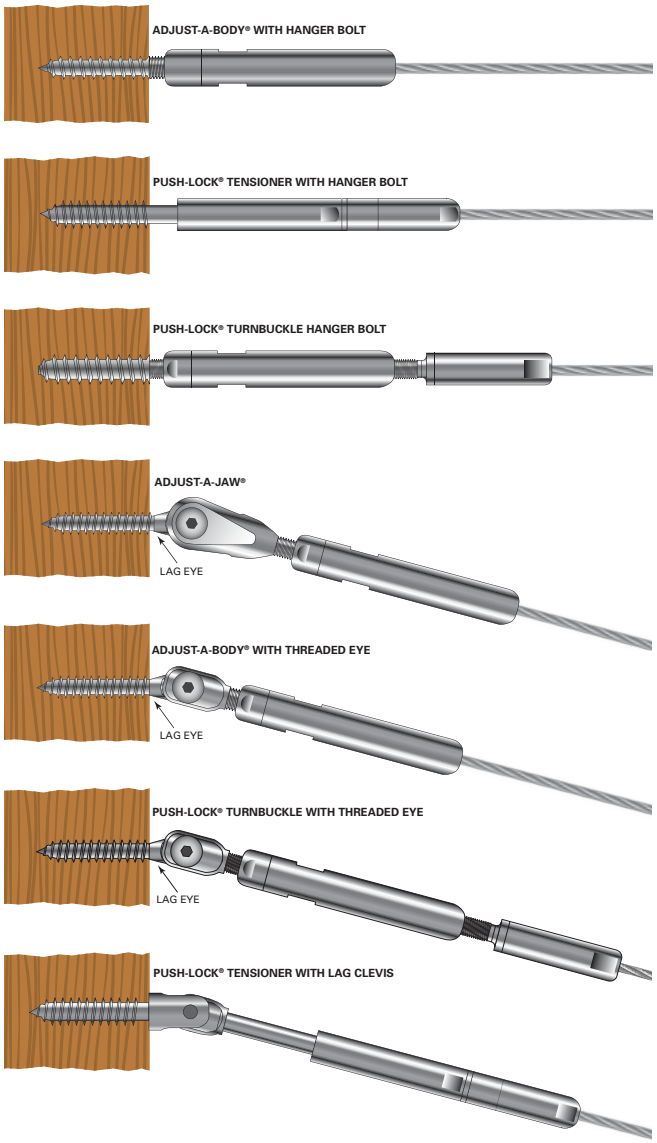
If your cables will be cut and the fittings swaged on at the factory, you will need to provide the factory with measurements for your cable runs after the posts have been installed. The factory will incorporate those measurements into a layout sheet for you to approve so the cable is cut to the correct length.

A. Mounting hardware on your end posts. If you are mounting hardware on two sides of your corner posts, then your corner posts are considered end posts for this discussion.

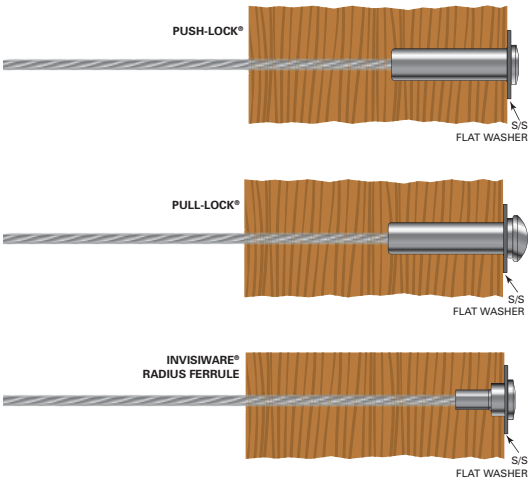
You will need to put tensioners on at least one end of each cable run. Following are ***tensioning devices.***



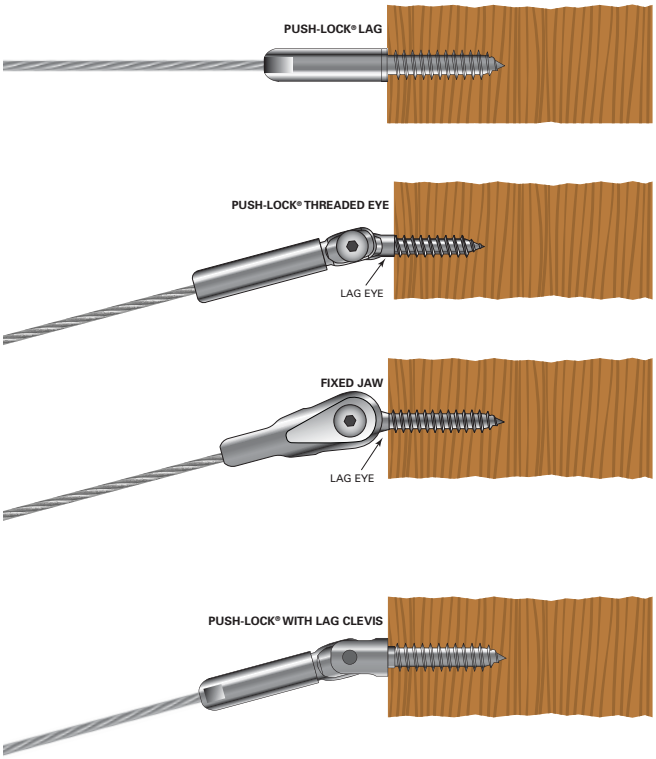
Note: With the Invisiware® Receiver or Receiver with Push-Lock® stud tensioner, you will need up to 3-3/4" of space between the back of your end post and any structure in order to insert the fitting into the end post from the back side.



The other end of each cable run can be either a tensioner or a non-tensioning device. Following are ***non-tensioning devices.***

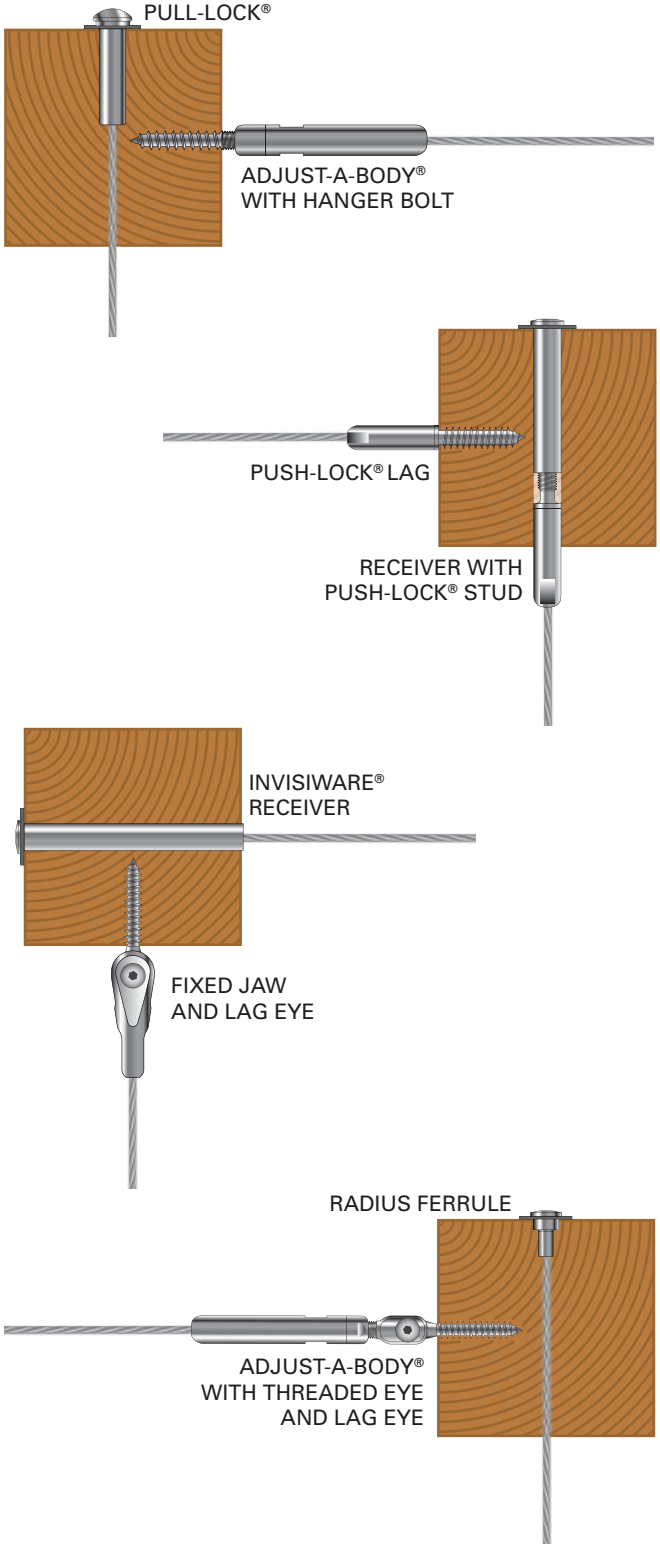


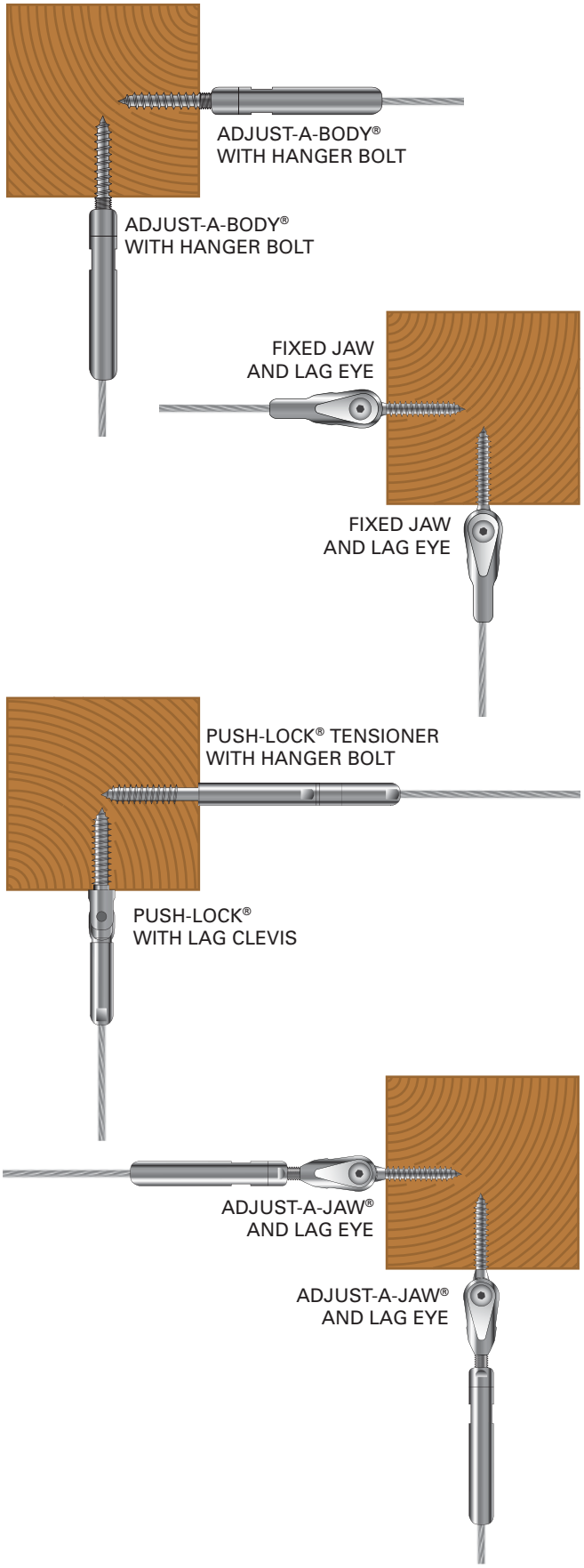
Note: With the Push-Lock®, Pull-Lock®, or Radius Ferrule fittings, you will need approximately 2-1/2" of space between the back of your end post and any structure to insert the fitting into the end post from the back side.



B) How you wish to configure your corners (if applicable). See **No. 2.** *Configuration of any corners in your design* for ways to treat your corners.

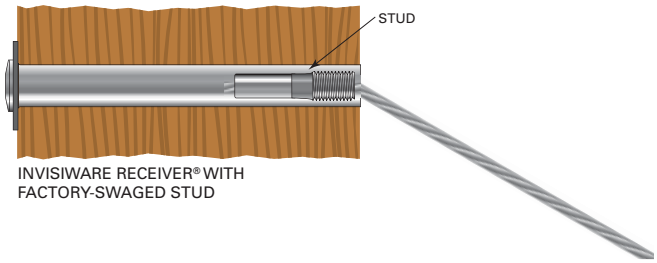
The following illustrations demonstrate how the hardware can be used on a single corner post. Not all combinations are shown here. If the hardware and cable run all the way through the post in one direction, you will need to use a hanger bolt end or hardware that is mounted to a lag eye for the perpendicular direction, as shown in the first four illustrations that follow.



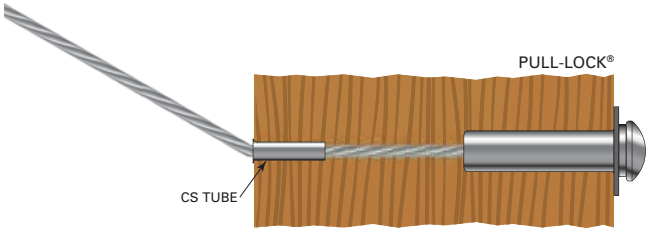


C) Hardware used for stairs or angled runs.
You can use any of the articulating fittings in conjunction with a lag eye to accommodate stairs and runs that angle out of the end post. These fittings are Adjust-A-Jaw®, Adjust-A-Body® with Threaded Eye, Push-Lock® Tensioner with Lag Clevis, and Push-Lock® Turnbuckle with Threaded Eye tensioners. Non-tensioners for use in these applications include the Fixed Jaw, Push-Lock® with Threaded Eye, and Push-Lock® with Lag Clevis.

You can also use R-6-62 Invisiware® Receivers and Pull-Locks® on your 4x4 (3.5" square) end posts *without having to drill your holes at an angle.*



Invisiware® Receivers are less expensive than articulating fittings and do not require lag eyes and screws to mount them. When installed, they are hidden inside the end post to help preserve that special view. The R-6-62 Invisiware® Receivers are especially designed for 4x4 wood posts and can be an excellent choice for stairs and angled runs as well as straight runs.



Pull-Lock non-tensioners work well opposite the Receiver in stair and angled runs from wood posts. When coupled with a post-protector tube, they complement the Receiver while allowing the cable to be trimmed on site.

Conclusion

Cable as a railing infill is attractive, easy to install and virtually maintenance free. Understanding the above considerations when designing your cable railing will go a long way toward ensuring that code requirements are met with a railing that you and your customer will be proud of.

Accessories, Railing Components

Drill Guide

Drill straight holes through your wood posts with a steel drill guide. Use the drill guide to drill your pilot holes. Subsequent drills will follow pilot holes. Clamp the guide to post and drill. It is best to drill one side, then the other. When ordering, allow space for clamps. A 6"-overall-length drill bit is included that can also be used to drill your cable through holes.

Contact factory for **DRILL GUIDE ORDER FORM**

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

Stainless Steel Cable Brace for Stair

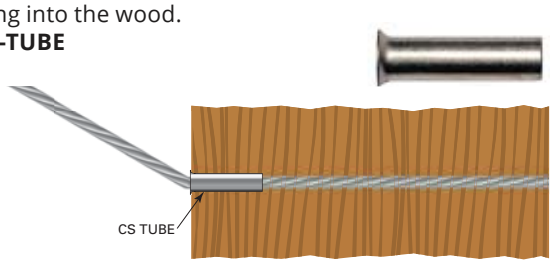
1/4" x 1" in 2 lengths, for 36" and 42" high rails. Slots pre-drilled at 3-1/8" on center, 10 slots in short length, 12 in long. For use between structural posts to keep cables code compliant on stair runs. Weld to metal frames; use cable brace floor plates for attaching to wood. Must be field-chamfered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

Stainless Steel Post Protector Tube

The post protector tube is inserted into a wood post where the cable enters/exits the post at an angle to keep the cable from biting into the wood.
Order **CS-TUBE**



Cut-off Tool

Used to cut cable flush with the end of Pull-Lock fittings, and to cut excess threads off stud-type tensioners. Includes mandrel and two cut-off wheels.
Order **CUT-OFF KIT**

Anodized Aluminum Cable Brace

3/4" x 3/4" tube, 42" long for cutting down to any size rail height. Holes pre-drilled at 3-1/8" on center, 13 holes total. For use between structural posts to keep cables code compliant on level runs. Use cable brace plugs to attach to top and bottom rail or deck.
Order **CB-42-AN-AL-13-P**

Black Aluminum Cable Brace

Order **CB-42-BL-AL-13-P**

Anodized Aluminum Cable Brace for Stairs

3/4" x 3/4" tube, 42" long for cutting down to any size rail height. Comes undrilled so slots can be field-drilled to match cable array.
Order **CB-42-AN-AL-P**

Black Aluminum Cable Brace for Stairs

Order **CB-42-BL-AL-P**

Ultra-tec®

CABLE RAILING INFILL

Designing a Metal Railing

U.S.A. Manufacturer

ISO 9001
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green
Ultra-tec® products contain at least 65% recycled content, helping you qualify for LEED® credits.

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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).

Coated Cable

Any of our standard sizes of cable can be special ordered with a PVC coating to any standard color. However, using coated cable requires special hardware and hole specifications for frame components that differ from those shown in our design guides, boring diagrams, and other publications. PVC coatings have UV inhibitors, but they will deteriorate (fade, crack, peel) over time if exposed to sunlight. They also have a tendency to attract dust and dirt which may present a cleaning problem.

The 1x19 construction stainless steel strand (cable) is smooth to the touch and does not fray as easily as some other constructions, so there is no need to coat it for the purpose of creating a smooth, protective surface on the cable.

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 use 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 **horizontally run cable railing system.**

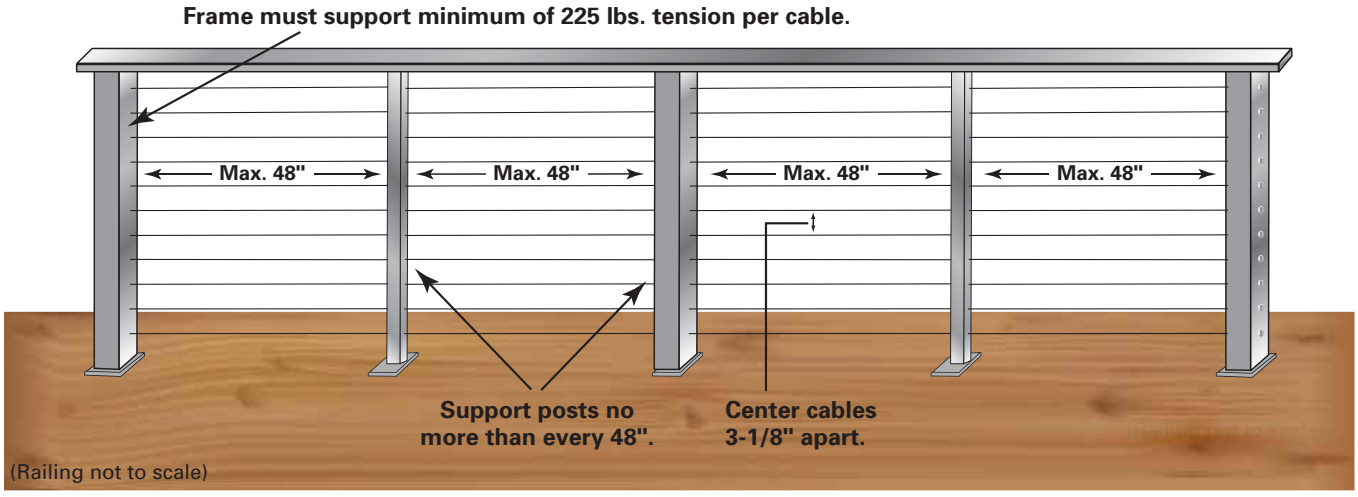
A horizontally run series of cables used as in-fill in a railing is legal in most jurisdictions. A few places, however, do not allow the “ladder effect" of horizontal in-fill elements. Therefore, the first step to be taken is to determine if the jurisdiction of the site will allow a “ladder effect" type of railing. If you are unable to use a horizontal railing, we offer a vertical cable railing system, which is described later on in this section.

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 (also referred to as wire rope). 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 trade-off 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/stair rail. 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 members, which are posts and/or braces, which will support the cable as it passes through the walls of the railing frame. (An intermediate post runs from the top rail to the mounting surface. A brace is a lighter weight material placed between posts, its primary purpose being to support the cable.) Cable can be run quite 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 it be used only in an area that is unlikely to experience heavy pedestrian traffic. For most applications, we suggest 3/16" diameter cable. When the scale of the project is large, a larger diameter cable may be preferred from an aesthetics standpoint. We offer systems using up to 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 of 3-1/8" on center for cables when they are installed.

The last 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". Often, designers and fabricators inexperienced in cable railings will not recognize the amount of the tension applied to the posts. The end result all too often is end posts which will bend considerably as the cables are being tensioned...or with a railing where the cables cannot be properly tensioned without an unacceptable amount of post deflection. 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.

Now, we will discuss issues encountered in designing a railing using **vertically run cables** as in-fill.

Top and bottom rails are necessary in a vertical railing using cable, because mounting and tensioning hardware is attached to top and bottom rails instead of end posts. We recommend schedule 80 pipe or 2"x2"x1/4" square tubing for both the top and bottom rail, because of the forces applied when the cables are properly tensioned. However, the tension applied to a vertical cable is less than must be applied to a horizontally run cable. The result is less force being applied to the mounting and tensioning fittings. Therefore, you may consider using 1/8" diameter cable with a vertical system, where you may not want to use it in a horizontal system.

Recommended Metal Frame Variations

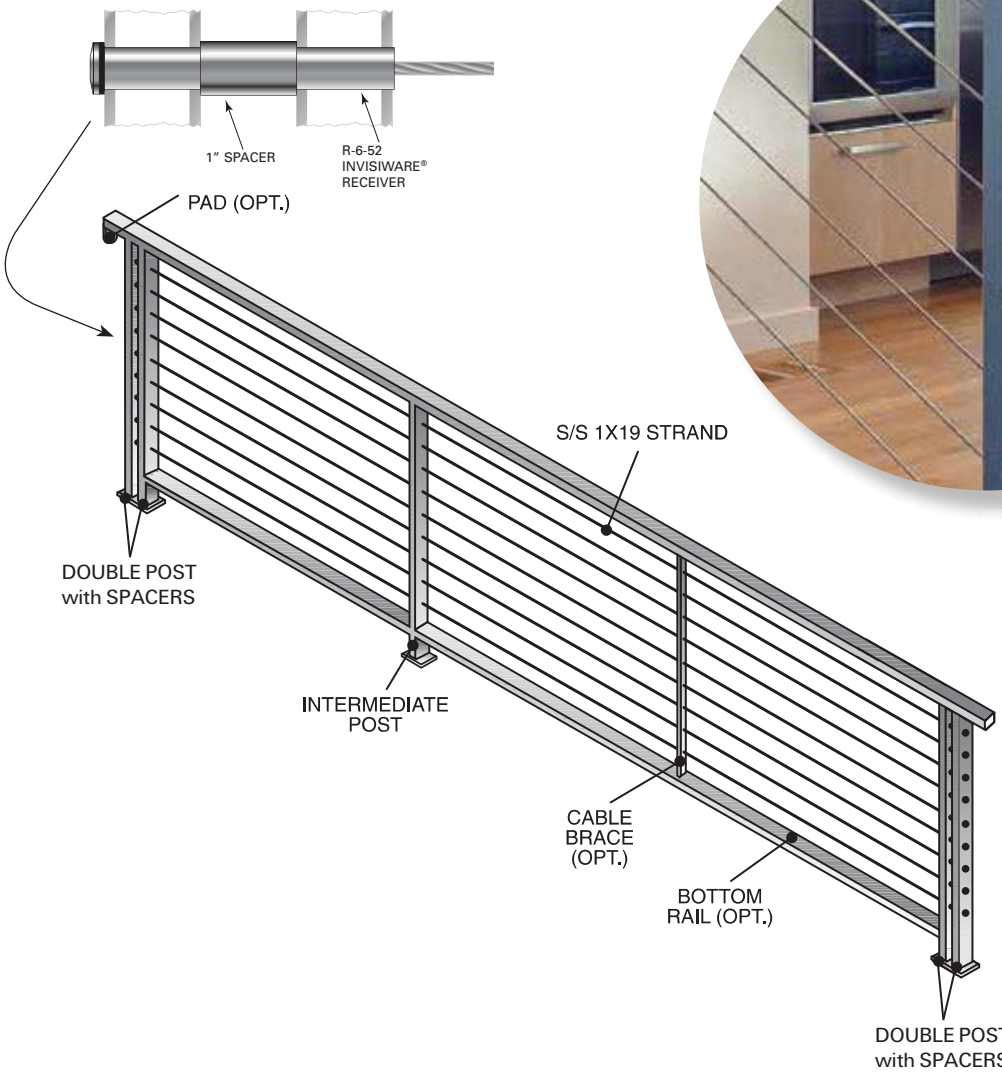
Recommended frame components can be carbon steel or stainless steel. While aluminum posts are also very popular, because aluminum is weaker, the posts must have thicker walls for cable railing usage. We have not tested cable railing with aluminum posts or frames, so we are unable make any recommendations. 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 spacings 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)

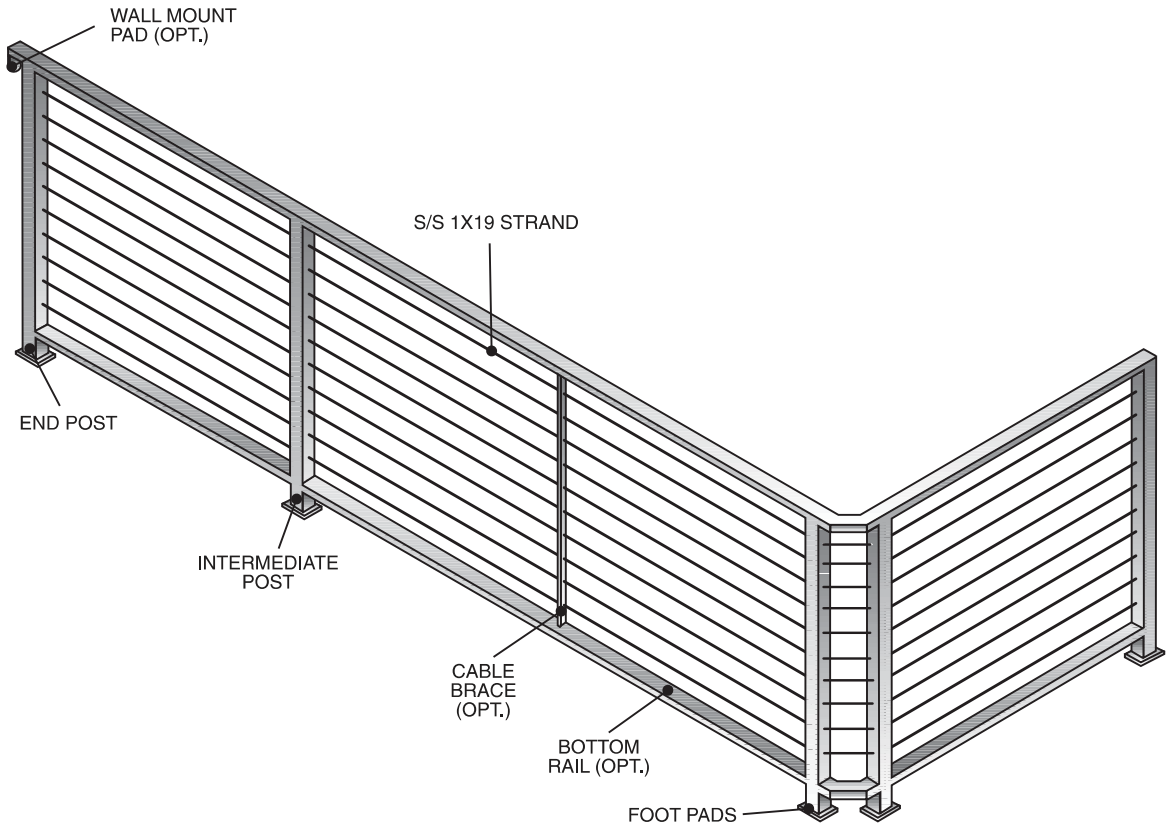
This railing style uses an end post with two vertical members separated by stainless steel spacers. Intermediate posts are only 1" thick. This construction is strong yet its elements are relatively thin, so there is little visual obstruction created by the frame.



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.

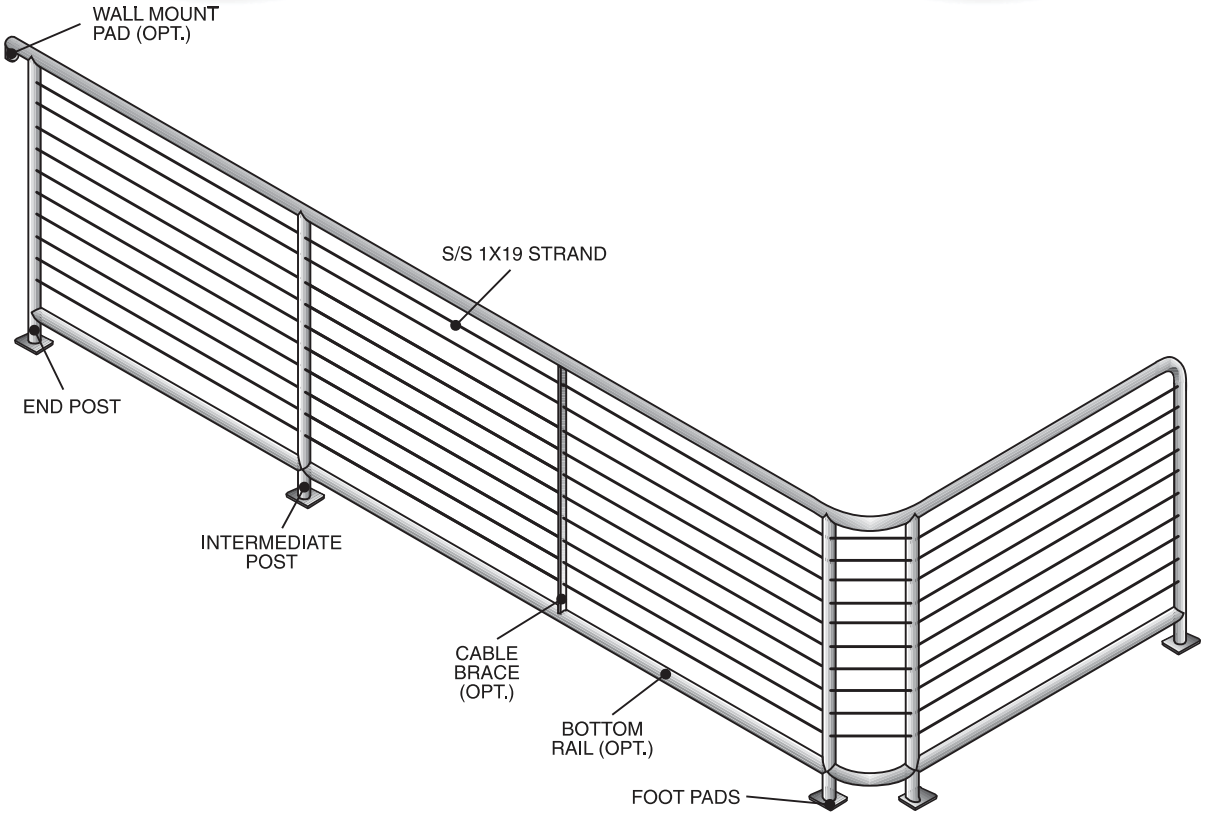


Pipe and Round Steel Tube Posts

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.

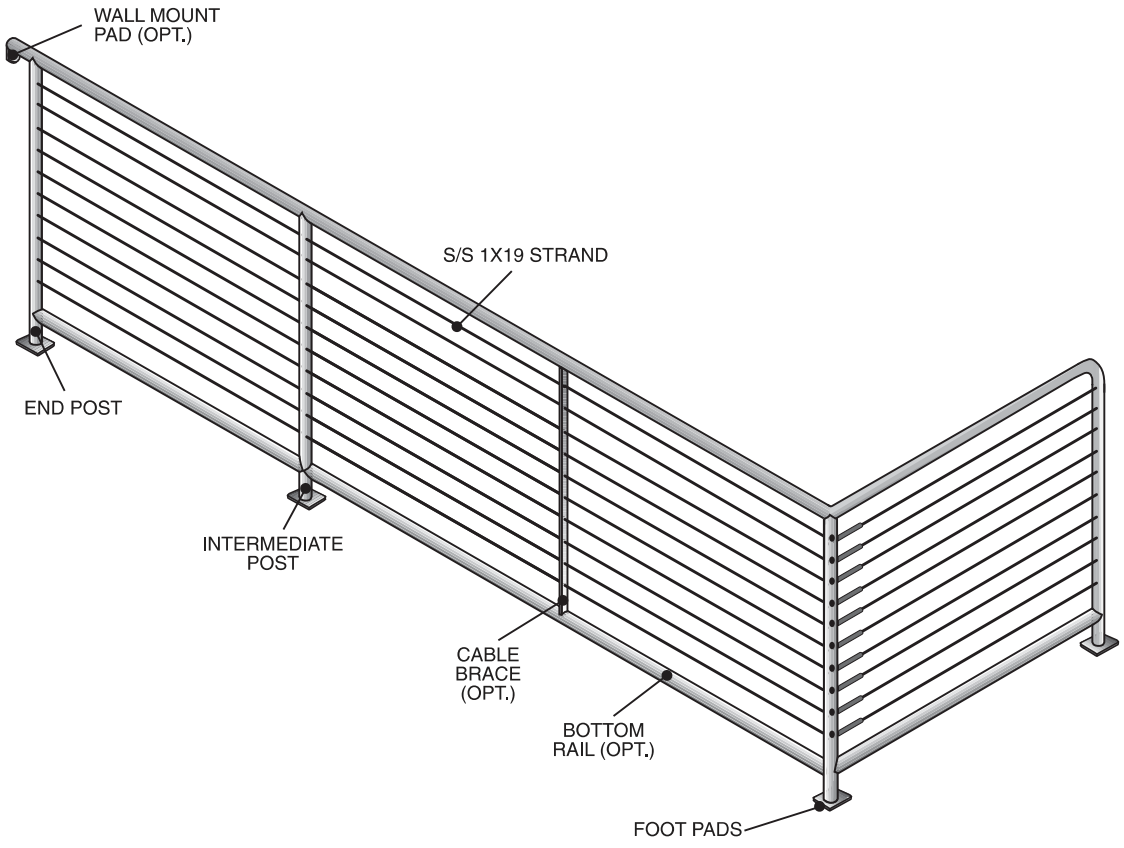
Round tube can be used with a wall thickness at least comparable to schedule 80 pipe. ***If you are using round tube, the downloadable drawings must be modified to allow for the different diameters of tube versus pipe.***



Other Metal Frame Materials

Frame components other than those shown in this guide can be made using carbon steel or stainless steel. Other 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 spacings of the cables vertically on the end posts should be 3-1/8", to allow for cable flex within allowable limits to meet code requirements that a 4" sphere shall not pass through at any point.

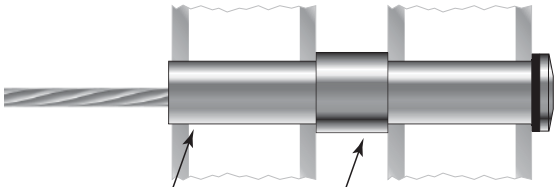


Railing Frame Components Material Specifications for Railings with Horizontally Run Cables

NOTE: We strongly recommend stainless steel for exterior applications.

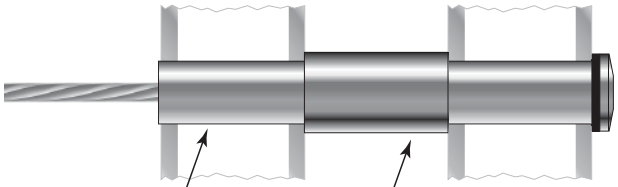
Carbon or Stainless Steel Structural Tubes	Minimum Wall Thickness	
Size and Shape	End Posts	Top and Bottom Rails and Intermediate Posts
2" x 1" Rectangular 3" x 1" Rectangular	.120" *See Note	.120"

*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.



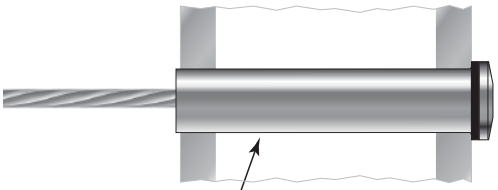
R-6-82 INVISIWARE® RECEIVER

1/2″ SPACER



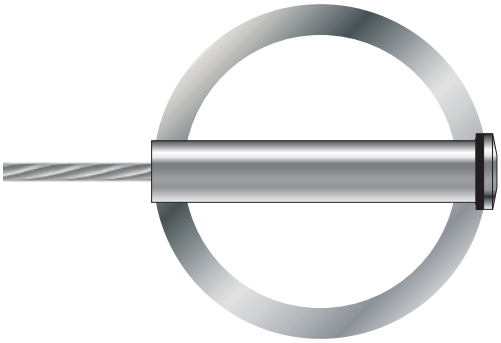
R-6-52 INVISIWARE® RECEIVER

1″ SPACER



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"

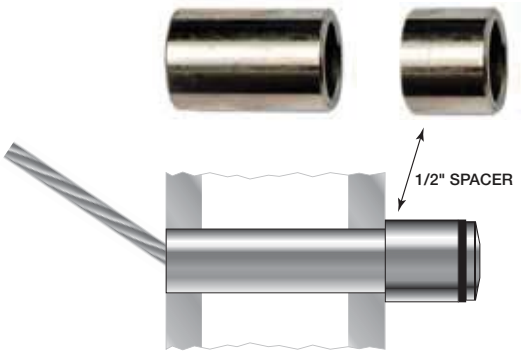


Round Tube or Stainless Steel Pipe **See note		Minimum Wall Thickness	
Size	Outside Diameter	End Posts Use Minimum Schedule 80	Top and Bottom Rails and Intermediate Posts Use Minimum Schedule 40
1-1/4" Pipe	1.660"	.191"	.140"
1-1/2" Pipe	1.900"	.200"	.145"
2" Pipe	2.375"	.218"	.154"

**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.

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



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

Stainless Steel Spacers
for double end post railing construction
and post “extensions” for stairs

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

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. The website is accessible through the Ultra-tec® cable railing system CD included in our product binders or available separately.

Access drawings and material specifications on the website by going to *Metal Railing Styles with Downloadable Drawings* under *Architects and Other Design Professionals*. (Note drawings are scaled for railings 1/2" higher than 36" and 42" to allow for carpeting. Overall height dimensions on drawings can be reduced by 1/2" for applications without carpeting.)

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

Vertical Railings

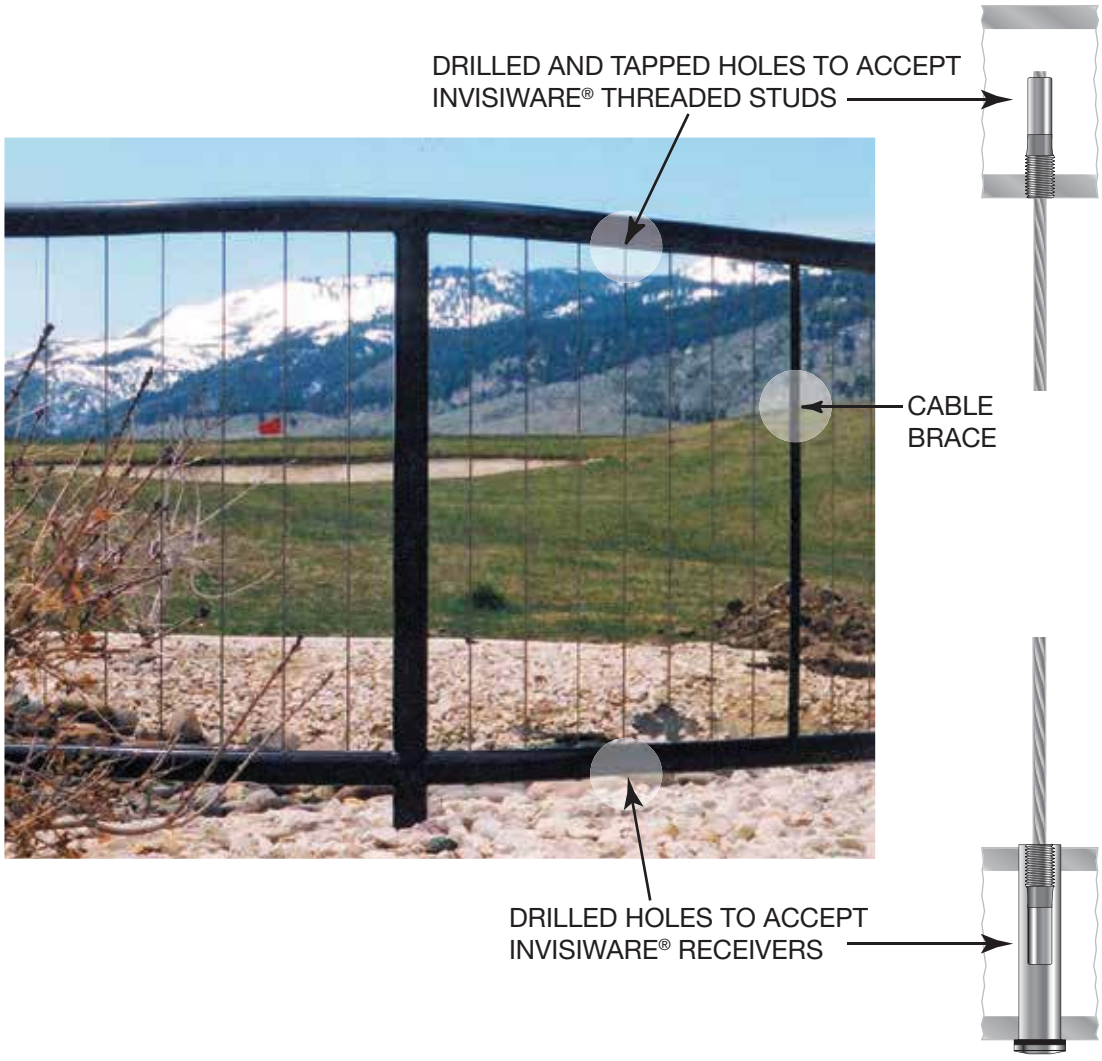
This railing frame style facilitates the use of cables in the vertical position, running from the top rail to the bottom rail.

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® cable railing system web site.

(Note drawings are scaled for railings 1/2" higher than 36" and 42" to allow for carpeting. Overall height dimensions on drawings can be reduced by 1/2" for applications without carpeting.)

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

Photo courtesy McClean Iron Works

Ultra-tec®

CABLE RAILING INFILL