Ultra-tec®

CABLE RAILING SYSTEMS
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Metal framed railings

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. For most applications, we recommend 1x19 construction, type 316 stainless steel strand (cable). Other constructions can be used, such as 7x7 or 7x19, but they are rarely recommended because they 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 Diameter	Typical Applications
1/8”	*See note below. Can be used on horizontal railings where there is little or no pedestrian traffic or where railing does not need to meet code requirement (such as where there is little or no drop off). Can be used on vertical railings, which are not as susceptible to heavy shock loads as horizontal railings.
3/16”	Most commonly used diameter for pedestrian railings.
1/4” 5/16” 3/8”	Diameters larger than 3/16" can be used where a larger diameter is desirable from a visual / aesthetics standpoint. In areas subject to extreme abuse (such as school or heavily trafficked public area) 1/4" diameter or larger is recommended.

*1/8" diameter cable can be vulnerable to failure under shock loads caused by abuse, such as a heavy person applying an out of plane load on properly tensioned cable. 3/16" and larger cable diameters have significantly higher load ratings than 1/8" and are, therefore, not as susceptible to failure as 1/8".

Cable minimum breaking strengths

Cable Diameter	Min. Breaking Strengths (Lbs.) for following cable construction 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

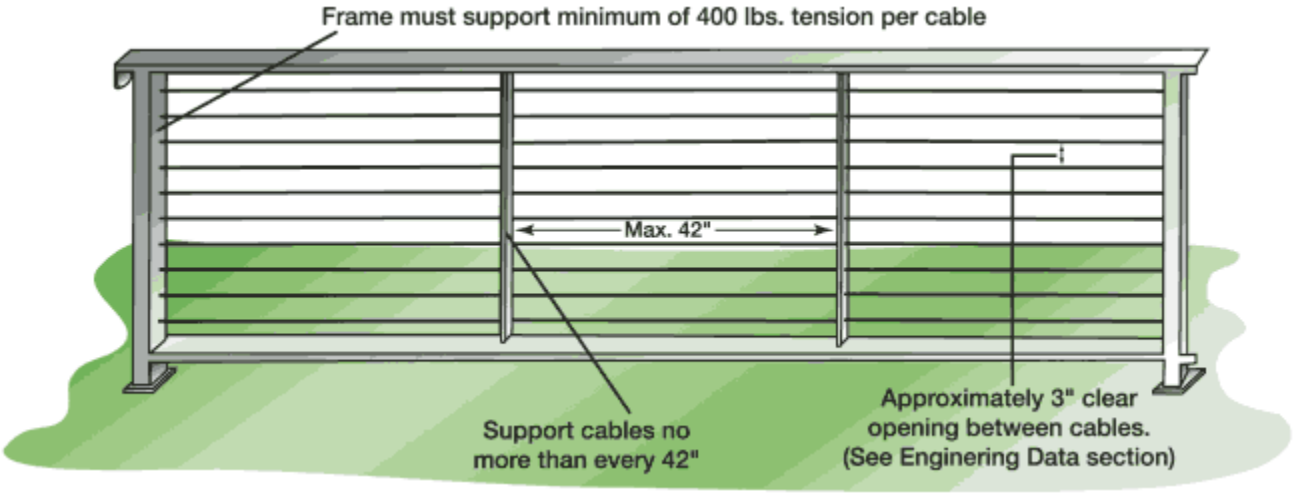
Note: Ultra-tec® hardware is designed for use in pedestrian guard railings.
For other applications, consult the factory for suitability.

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.

Spacing of your intermediate members, which are posts and/or braces: they 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 (150 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 42".



Spacing of the cables vertically is critical to minimize deflection of the cables under a vertical load. Our specifications provide recommended vertical spacing of approximately 3" free opening between cables when they are installed. (See Engineering Data) section for spacing cables using different cable diameters.

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 tension is generated on an end post when you have ten or more lines, each tensioned at 400 lbs. or more 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 400 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 amount of force that can be applied to a vertical cable is generally less than can 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.

Horizontal railings

Double end post construction

2"x 1"x .120" or 3"x 1"x .120" structural steel posts with stainless steel spacers
2"x 1" or 3"x 1" top and bottom rail and intermediate posts (if applicable)

Frame components can be carbon steel or stainless steel. This style has been designed to perform satisfactorily when subjected to the tension encountered when multiple load points (cables) are attached and tensioned properly to your end posts (400 lbs. or more per line). Detailed downloadable drawings (see bottom of this page) 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" ball shall not pass through at any point.

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.

Note the tubed corner sections that are illustrated. They replace corner posts with hardware mounted on two sides or two posts with cable pulled between them. The cable runs through tubes welded to two posts. It makes a nice looking corner with uniform curves going around the corner. See Tubed Corner Sections on page 10 for detailed drawings.

2"x 2"x .250" wall structural steel end post construction

2"x1" top rail and bottom rail (if applicable)

Frame components can be carbon steel or stainless steel. This style has been designed to perform satisfactorily. When subjected to the tension encountered when multiple load points (cables) are attached and tensioned properly to your end posts (400 lbs. or more per line).
Detailed downloadable drawings (see bottom of this page) 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" ball shall not pass through at any point.
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.

Note the tubed corner sections that are illustrated. They replace corner posts with hardware mounted on two sides or two posts with cable pulled between them. The cable runs through tubes welded to two posts. It makes a nice looking corner with uniform curves going around the corner.

Round pipe and round steel tubing posts

Frame components can be carbon steel or stainless steel. This style has been designed to perform satisfactorily when subjected to the tension encountered when multiple load points (cables) are attached and tensioned properly to your end posts (400 lbs. or more per line).
Detailed downloadable drawings for 1-1/4", 1-1/2" and 2" standard pipe are available (see page 13). Minimum schedule 80 pipe is required for your end posts. The drawings show proper spacing of the cables vertically on the end posts for standard round pipe. Those spacing allow for cable flex within allowable limits to meet code requirements that a 4" ball shall not pass through at any point.

Round tubing can be used with a wall thickness at least comparable to schedule 80 pipe.

If you are using round tubing, the downloadable drawings must be modified to allow for the different diameters of tubing versus pipe.

Note the tubed corner sections that are illustrated. They replace corner posts with hardware mounted on two sides or two posts with cable pulled between them. The cable runs through tubes welded to two posts. It makes a nice looking corner with uniform curves going around the corner. See Tubed Corner Sections on page 10 for detailed drawings.

Other metal frame materials

Frame components other than those shown in this guide can be used 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 (400 lbs. or more per line).

Center-to-center spacing of the cables vertically on the end posts should not exceed the spacing shown in the Engineering Data section, to allow for cable flex within allowable limits to meet code requirements that a 4" sphere shall not pass through at any point.

End posts using structural Tees

Frame components can be carbon steel or stainless steel. These styles have been designed to perform satisfactorily when subjected to the tension encountered when multiple load points (cables) are attached and tensioned properly to your end posts (400 lbs. or more per line).

Detailed downloadable drawings (see page 13) 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.

Frame material	**Top 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"

Tubed corner sections

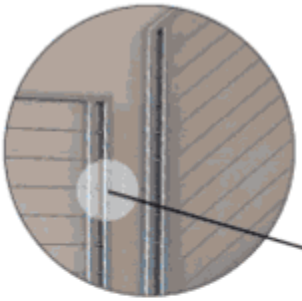
Tubed corner sections can replace corner posts with hardware mounted on two sides or two posts with cable pulled between them. The cable runs through tubes welded to two posts. It makes a nice looking corner with uniform curves going around the corner.

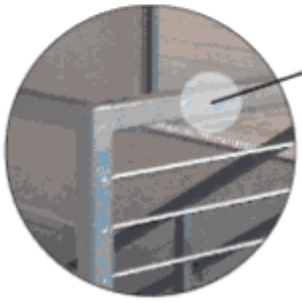
See bottom of this page for detailed downloadable drawings you can use or modify for your project.

Frame components can be carbon steel or stainless steel, and your vertical posts can be the same material used for your intermediate posts. (See Railing Frame Components Material Specifications, below).

Material specifications for railings with horizontally run cables

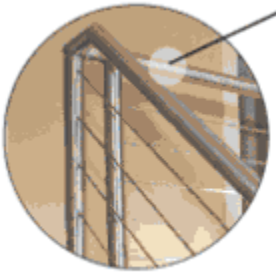
NOTE: We strongly recommend stainless steel for exterior applications.





Carbon or Stainless Steel Structural Tubing	Minimum Wall Thickness	
Size and Shape	**End Posts**	**Top and Bottom Rails and Intermediate Posts**
2" x 1" Rectangular 3" x 2" Rectangular	.120" *See Note	.120"
2" x 2" Square	.250"	

*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.



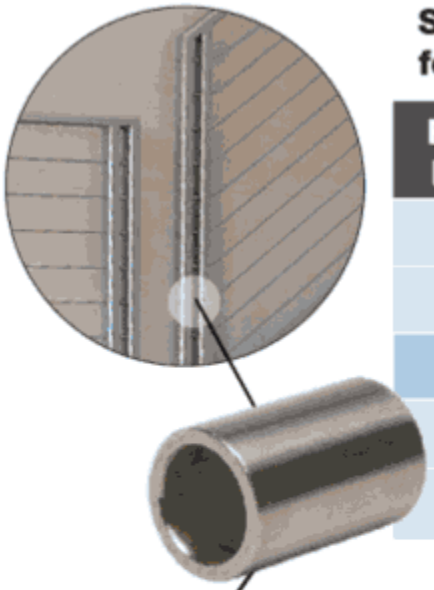
Round Steel or Stainless Steel Pipe **See note		Minimum Wall Thickness	
Size	**Outside Diameter**	**End Posts** Use Minimum Schedule 80	**Top and Bottom Rails and Intermediate Posts** Use Minimum Schedule 40
1-1/4" Pipe	1.660"	.191"	.140"
1-1/2" Pipe	1.900"	.200"	.145"
2" Pipe	2.375"	.218"	.154"

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

See bottom of this page 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
Carbon Steel	1/4" x 1" carbon steel cold-finish flat bar
Stainless Steel	1/4" x 1" 304 cold-finish flat bar, #4 finish or 1/4" x 1" 304 cold-finish flat bar, mil finish

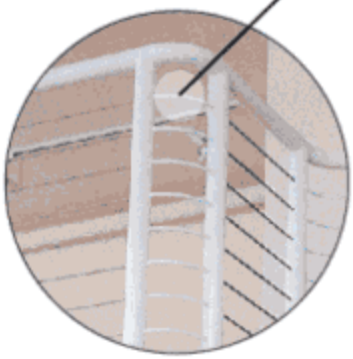


Stainless Steel Spacers
for double end post railing construction

For Cable Diameter	Outside Diameter	Wall Thickness	Cut to Length of
1/8"	5/8"	.083"	.970"
3/16"			
1/4"	3/4"	.095"	
5/16"	7/8"	.083"	
3/8"			

Stainless Steel Spacers
for use with Invisiware® Fixed Tabs

For Cable Diameter	Outside Diameter	Wall Thickness	Cut to Length of
1/8"	5/8"	.083"	.970"
3/16"			
1/4"	3/4"		



Corner Section Tubing

For use in 90° corners using tubing in the corner sections through which the cable passes. *See note.

For Cable Diameter	Outside Diameter	Wall Thickness
1/8"	3/8"	.065"
3/16"		
1/4"		.042"
5/16"	7/16"	.035"
3/8"	1/2"	.042"

*Note: The inside of the tubing cannot be sealed to prevent moisture inside the tubes. Therefore, we recommend stainless steel tubing for all *exterior* tubed corner section applications to prevent rust inside the tubing.

Downloadable drawings - Horizontal railing

Double End Post construction with stainless steel spacers between vertical elements	
D1	3" x 1" or 2" x 1" x 36-1/2" high rectangular tubing with bottom rail
D2	3" x 1" or 2" x 1" x 36-1/2" high rectangular tubing without bottom rail
D3	3" x 1" or 2" x 1" x 42-1/2" high rectangular tubing with bottom rail
D4	3" x 1" or 2" x 1" 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 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
End Posts Using Structural Tees	
H21	Structural tee material specifications and 2" square tube drawings

D9	3" x 1" and 2" x 1" x 42-1/2" high with and without bottom rail
Tubed Corner Sections	
D13	Square or rectangular tubing with cable tubes and bottom rail
D14	Square or rectangular tubing with cable tubes without bottom rail
D29	Pipe or round tubing with bottom rail
D30	Pipe or round tubing without bottom rail
D31	Plan view for 1-1/4" pipe
D32	Plan view for 1-1/2" pipe
D33	Plan view for 2" pipe
D15	Plan view for square and rectangular tubing
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" x 1" or 2" x 1" double end post - concrete embedding
D111	Intermediate post - concrete embedding
D114	Steel post - fascia mounting
D115	Wood 1-1/2" post - fascia mounting

Vertical railing frame styles

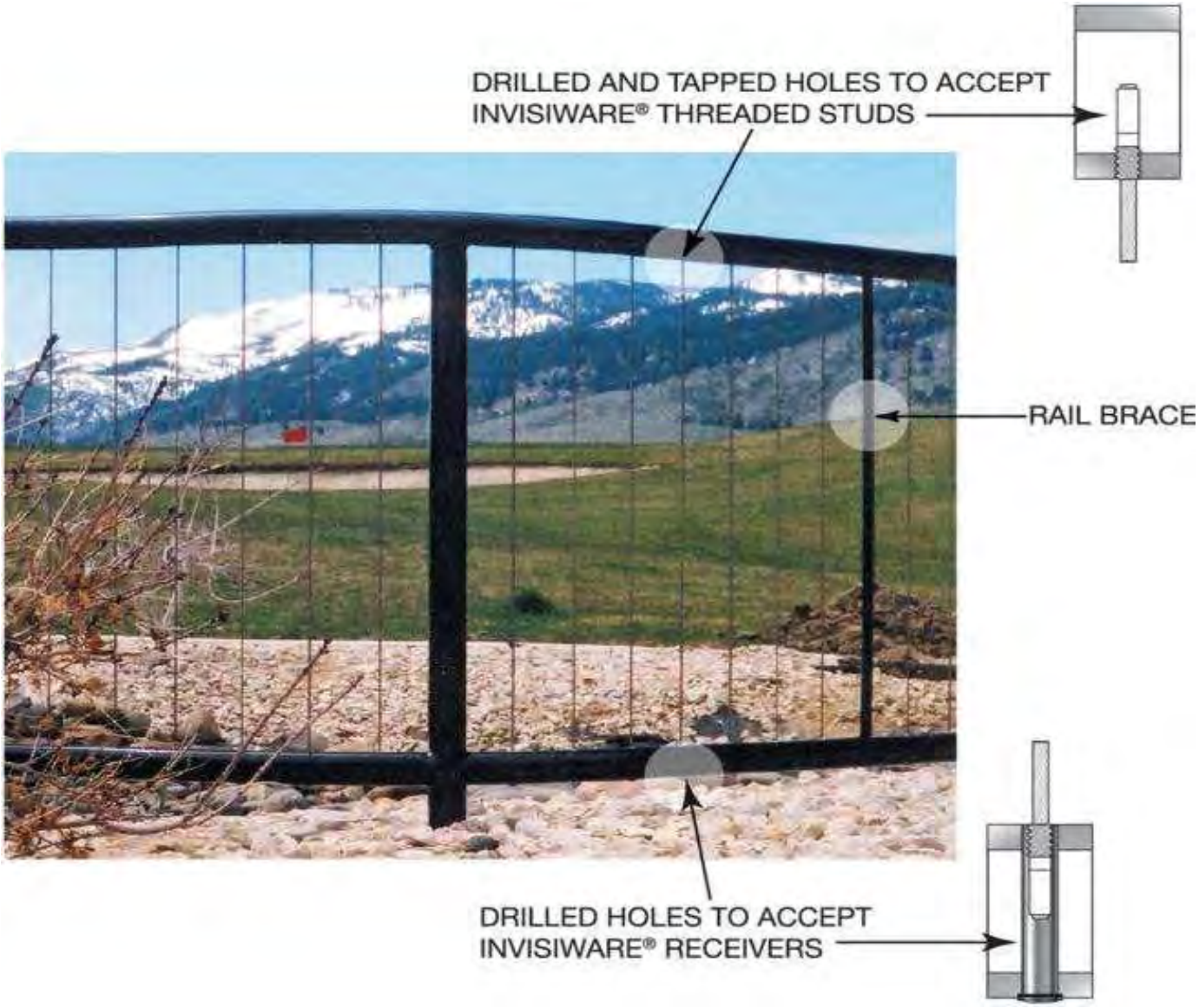
This railing frame style facilitates the use of cables in the vertical position, running from the top rail to the bottom rail.

The drawings 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 style has been designed 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 (400 lbs. or more per line). Detailed downloadable drawings (see page 18) show proper spacing of the cables horizontally 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 special rail braces to replace every eighth cable, to keep the top and bottom rails from bending when the cables are tensioned.



Material specifications for railings with vertically run cables

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

Carbon or Stainless Steel Structural Tubing

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

Round Steel or Stainless Steel 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 tubing, use wall thickness approximating wall thickness of pipe schedule shown.

Rail Braces

For use in place of a cable at least every eighth cable on 3.25" centers between structural posts to support top and bottom rails under tension.

Material	Specify
Steel	.625" diameter x .120" wall type 4130 Chrom./Moly tubing
Stainless Steel	.625" diameter x .120" wall seamless stainless steel tubing

Downloadable drawings - Vertical railing

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
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