COMPONENT RAIL SYSTEM

The Component Rail System (CRS) is a guardrail system constructed using standard components that are assembled using appropriate adhesives.

Typical post spacing 5'0"

The guardrail is intended to comply with the requirements of the 1997 Uniform Building Code, 2000 and 2003 International Building Codes. Aluminum components are designed in accordance with the 2001 and 2005 Aluminum Design Manual. Stainless steel components are designed in accordance with SEI ASCE 8-02.

DESIGN LOADS:

Top rail loads:

200 lb concentrated load, any direction, or

50 plf distributed load any direction.

Infill loads (not concurrent with top rail loads):

Infill loads are horizontal over area of rail including voids.

50 lbs concentrated load on 1 sf, or

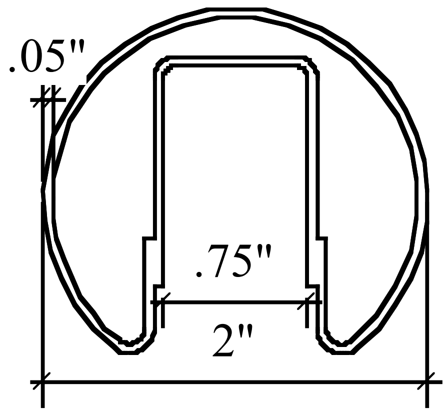
25 psf uniform load

Wind load (not concurrent with live loads)

25 psf minimum over projected surface area.

Maximum wind load as stated in other sections.

CRL GR 20 SERIES TOP RAIL
Used as the top rail on glass balustrade panel guardrails



Area: 0.473 sq in
Perim: 17.78 in
I_{xx}: 0.142 in^4
I_{yy}: 0.174 in^4
r_{xx}: 0.548 in
r_{yy}: 0.606 in
C_{xx}: 0.959 in
C_{yy}: 1.028 in
S_{xx}: 0.148 in^3
S_{yy}: 0.169 in^3

Allowable stresses:
For stainless steel options: design using SEI/ASCE 8-02
From Table A1, Fy = 75 ksi for 1/4 hard A304 stainless steel sheet used to form the rail.

$$F_{cr} = \frac{\pi^2 k \eta E_0}{12(1-\mu^2)(w/t)^2} \qquad \text{(eq 3.3.1.1-9)}$$

$\eta = 0.49$ (from table A8a)
$k = 3(Is/Ia)^{1/3}+1<4.0 = 4.0$ for circular shape
$\mu = 0.3$
$E_0 = 27.0 \text{ x}10^3$ psi

$$F_{cr} = \frac{\pi^2 * 4.0 * 0.49 * 27.0 \text{ x}10^3 \text{ ksi}}{12(1-0.3^2)(1.375''/0.05'')^2} = 63.2 \text{ ksi but} \le F_y$$

$M_n = S_e F_y = 0.148*75$ ksi = 11.1k" Vertical loading
0.169*75 ksi = 12.675k" Horizontal load
or $M_n = S_f F_{cr} = 0.148*63.2$ ksi = 9.36k" Vertical load Controls
0.169*63.2 ksi = 10.68k" Horizontal load Controls

Determine allowable rail spans (ignoring deflection)
Live loads: 50 plf uniform or 200 lb concentrated load
Horizontal → uniform → $L= (10680/12 \bullet 8/(1.6*50plf))^{1/2} = 9.43'$
concentrated → $L = 10680*4/(1.6*200\#) = 133.5'' = 11.12'$

Vertical → uniform → $L= (9360/12 \bullet 8/(1.6*50plf))^{1/2} = 8.83'$
concentrated → $L = 9360*4/(1.6*200\#) = 117'' = 9.75'$

RAIL HAS ADEQUATE STRENGTH TO SUPPORT DESIGN LIVE LOADS FOR THE DESIGN SPAN OF 5 FEET.

Other top rails with similar or greater strength may be used, see Additional Top Rail sections herein.

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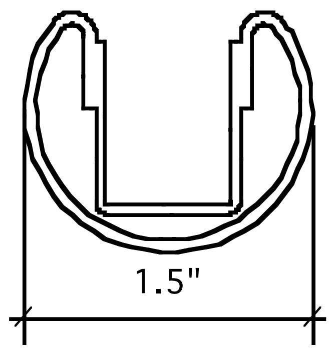
CRS 1.5' SERIES RAIL
Rail be used as either top or bottom rail.
Used as the top rail to capture top of glass lite and support top rail forces

Area: 0.332 sq in
Perim: 13.265 in
I_{xx}: 0.058 in^4
I_{yy}: 0.072 in^4
r_{xx}: 0.417 in
r_{yy}: 0.465 in
C_{xx}: 0.76 in
C_{yy}: 0.75 in
S_{xx}: 0.076 in^3 or 0.097 in^3
S_{yy}: 0.096 in^3



Allowable stresses:
For stainless steel options: design using SEI/ASCE 8-02
From Table A1, Fy = 75 ksi for 1/4 hard A304 stainless steel sheet used to form the rail.

$$Fcr = \frac{\pi^2 k\eta E_0}{12(1-\mu^2)(w/t)^2} \qquad \text{(eq 3.3.1.1-9)}$$

$\eta = 0.49$ (from table A8a)
$k = 3(Is/Ia)^{1/3}+1<4.0 = 4.0$ for circular shape
$\mu = 0.3$
$E_0 = 27.0 \times 10^3$ psi

$$Fcr = \frac{\pi^2 * 4.0 * 0.49 * 27.0 \times 10^3 \text{ ksi}}{12(1-0.3^2)(1.375''/0.05'')^2} = 63.2 \text{ ksi but} \leq Fy$$

$Mn = S_e F_y$ = 0.076*75 ksi = 5.7 k" Vertical loading Controls
0.096*75 ksi = 7.2 k" Horizontal load
or $Mn = S_f F_{cr}$ = 0.097*63.2 ksi = 6.15 k" Vertical load
0.096*63.2 ksi = 6.07 k" Horizontal load Controls

Determine allowable rail spans (ignoring deflection)
Live loads: 50 plf uniform or 200 lb concentrated load
Vertical → uniform → L= $(5{,}700/12 \bullet 8/(1.6*50plf))^{1/2}$ = 6.89'
concentrated →L = 5700*4/(1.6*200#) = 71.25" = 5' 11"

Horizontal → uniform → L= $(6070/12 \bullet 8/(1.6*50plf))^{1/2}$ = 7.11' = 7' 1.5"
concentrated →L = 6070*4/(1.6*200#) = 75.88" = 6' 3-7/8"

Maximum allowable distributed load on the rail for 5' span, Horizontal load case:
W = $(6070\#''*8)/60^2$ = 13.5 ppi = 162 plf

RAIL HAS ADEQUATE STRENGTH TO SUPPORT DESIGN LIVE LOADS FOR THE DESIGN SPAN OF 5 FEET.

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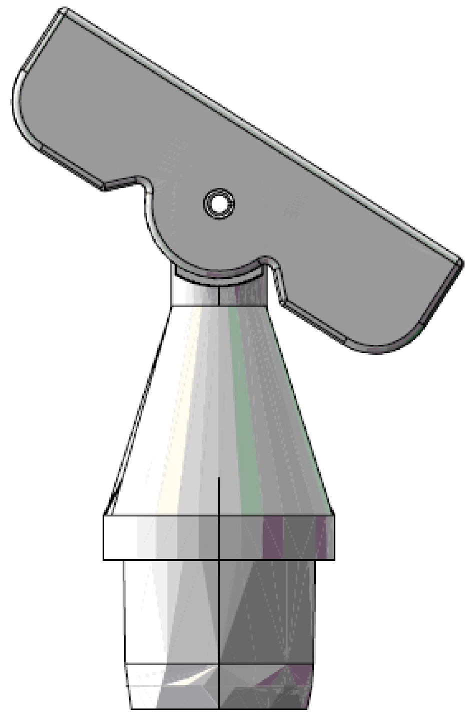
POST TOP FITTING:
ADJUSTABLE TOP RAIL ANGLE
Top rail locks onto bar on top of post top fitting. Horizontal forces and downward vertical forces are transferred by direct bearing between the top rail and fitting bar.

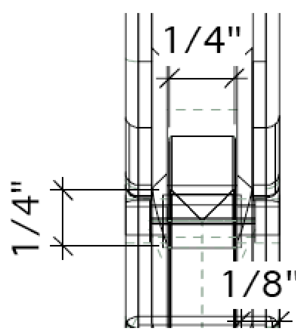


Bearing area for vertical forces:
4” long by 3/4” wide. Maximum bearing force = 200 lb or 50 plf, 50*5’ = 250# for live load.

Resistance for uplift:
Silicone adhesive, CRL 95C, Dow Corning 995 or equivalent, tear strength = 49 ppi.
Tear length = 4”x 3 sides = 12”
$R_{tearing}$ = 12*49 = 588#
SF = 588/250 > 2.0
This is okay for uplift.
For Loctite 326 lap strength = 12”x.5”*2,200# = 13,200#, SF = 13,200/250= 52.8
Bar connection to top of fitting:
For vertical forces direct bearing on connection pin:

1/4” pin in double shear, bearing width = 1/4”

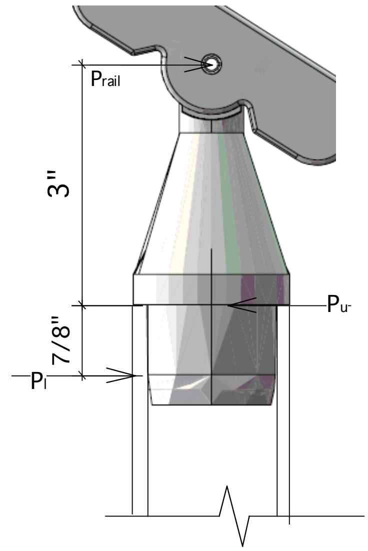
Fb = 250#/(0.25*0.25) = 4,000 psi



Pin strength:
Area = 0.049 in2
Shear strength = 46 ksi for A304/316 SS
Vs = 2øAFv/1.6 = 2*0.65*0.049*46/1.6 =1,830#
Pin okay for shear strength and bearing

Fitting connection to top post:
Vertical loads: downward direct bearing
Bearing area is full post end area therefore okay, For uplift:
Attached with Loctite 326 adhesive or CRL95C
Bond strength: 2,200 psi lap shear strength from Technical Data Sheet
Lap Area = 1”*1.5”*2π = 9.42 in^2
Lap strength = 9.42*2,200psi = 20,724#
SF = 20,724/250 = 82.9, okay for uplift.
CRL95C Lap strength = 9.42* 250 psi = 2,355#
SF = 2,355/259 = 9.42

Horizontal forces resisted by a couple formed between the fitting and top of pipe.



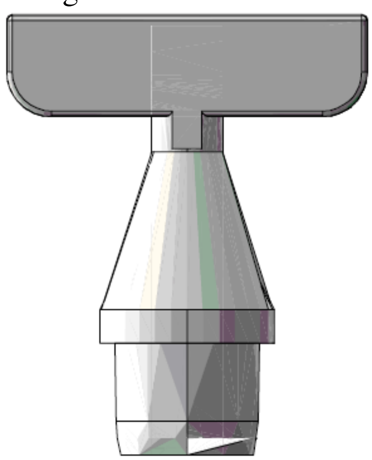
From $\sum M$ about the fitting base = 0
$P_u = 3.875\text{"} * P_{rail} / 0.875\text{"} = 4.43\ P$

Bearing strength Pn= 1/3(75 ksi*1.5"*0.4325) = 16.4k

Ps = øPn/1.6 = 0.85*16.4/1.6 = 8.7 k > 4.43 k

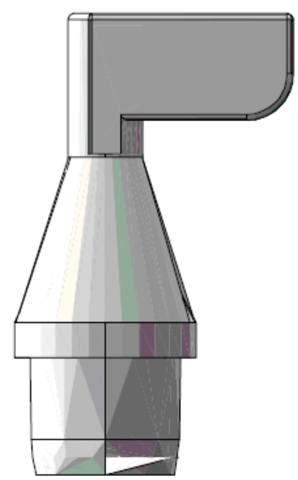
Bearing of fitting in posts is adequate for all imposed loads

Straight line fittings and end fittings will have similar strengths and therefore are okay by inference.



Inline fitting used when top rail is continuous over the top of the post or rail is spliced at the post in a straight run.

Fitting will behave the same as the adjustable fitting except that rail is fixed at perpendicular to the post. The top bar is fixed to the fitting.



End post fitting used when top rail ends at or close to the post. Bar length into top rail is 1.5" shorter but uplift load is one half that for the inline posts. Consequently by inference from the inline case the fitting strength is adequate.

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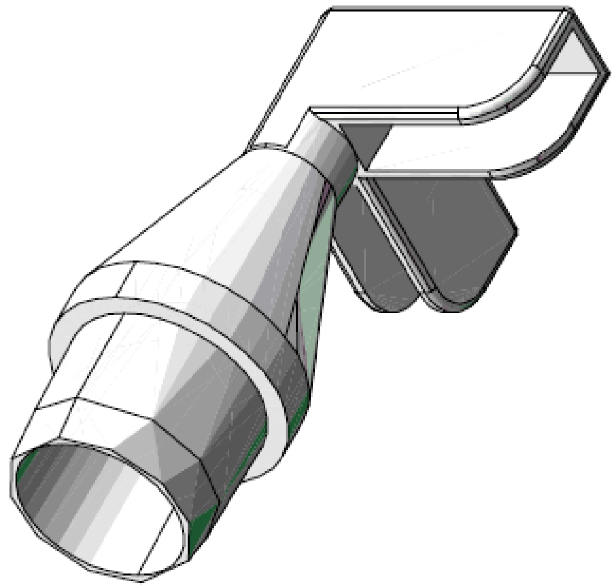
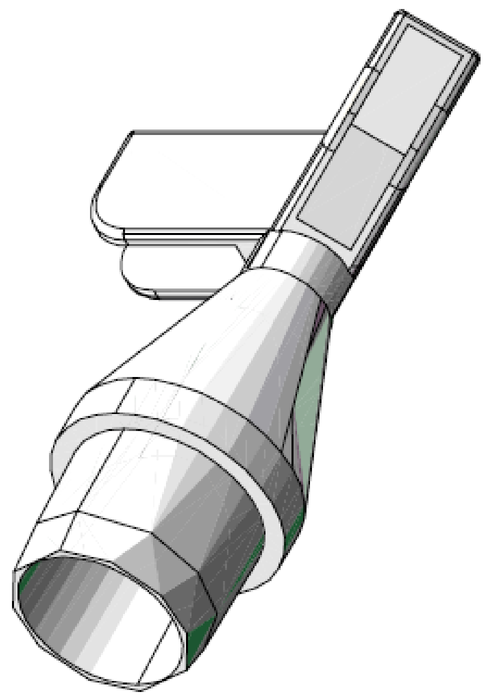
Top fitting at corners:
Two different fittings may be used at corners one with a 90˚ corner and the other with 135˚ corner.



The top rails meeting at the corner are mitered to fit together. Each rail is secured to the fitting using the structural adhesive. The strength of the silicone connection is 1/2 of the strength of the inline fitting. Likewise loading is a maximum of 1/2 of the live load case.

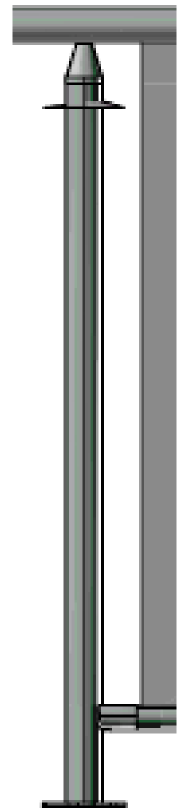
The strength of the connection of the fitting to the post is the same as for the inline fitting.

By inference the corner fittings have adequate strength to support all design loads at the 5 foot post spacing.



Custom angles may be made by fabricating the top bar to the required angle. The custom angle fitting will behave similar and have similar strength to the stock fittings and therefore are acceptable by inference.

1-1/2" SCHEDULE 40 PIPE RAIL POST
For guardrail applications



Pipe properties:
O.D. = 1.90"
I.D. = 1.61", t = 0.145"
A = 0.799 in^2
I = 0.310 in^4
S = 0.326 in^3
Z = 0.448 in^3 minimum
r = 0.623 in

Brushed stainless steel, Fy = 45 ksi
øMn= 0.9*Z*Fy = 0.9*.448*45 ksi
øMn = 18,114"#
Ml = øMn/1.6 = 11,340#" = 945#' Maximum allowable post height:
h_4 = 11,340#/200# = 56.7" for 4' o.c. spacing (or where 50 plf load doesn't apply).
h_5 = 11,340#/250# = 45.36" for 5' o.c. spacing

Weld strength
Z weld = 0.6182 in^3 for 3/16" effective fillet throat all around
øMn = 0.55*Z*F_{au} = 0.55*0.6182 in^3*75 ksi = 25,500#" > 18,114
Therefore will develop full post strength, okay for 5' post spacing.

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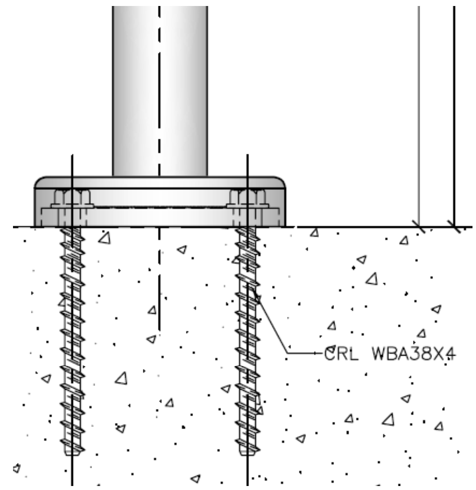
BASEPLATE ANCHORAGE –



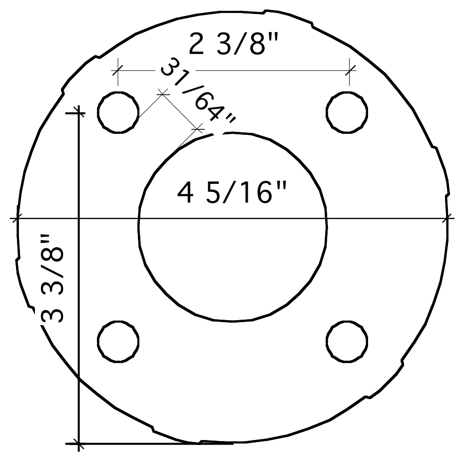
The maximum allowable moment for base plate mounting is M_l=11,430"# for wind and guardrail live loads and M_d= 8,573"# for other types of loading. For maximum moment the bolt tension is:

T = 11,430/(#bolts* B)=1306#

Where # bolts is the number of bolts in tension and B = distance from compression edge of plate to centerline of tension bolts.

Design moment and shear for typical design:

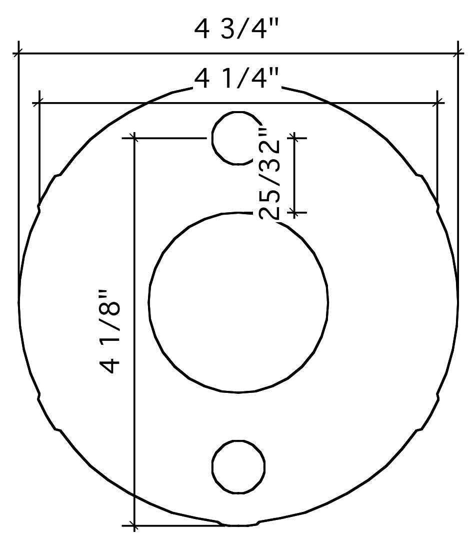
M = 10,500"#
V = 250#



4 HOLE ROUND BASE PLATE
4 bolt pattern, two bolts in tension
B = 3.375"

T = 10,500#"/(2*3.375) = 1,556#

Check plate bending:
M = 1,556#*(31/64) = 754#"
$S = bt^2/6$;
fb = M/S
$t = [M*6/(Fb*b))]^{1/2}$
$t = [6*754\#"/(45,000*2.375)]^{1/2} = 0.21$
Use 1/4" minimum thickness.



2 BOLT ROUND BASE PLATE
4-3/4" DIAMETER
1 Bolt in tension
B = 4.125"
T = 10,500/(1*4.125) = 2,545#

Plate bending:
M = 2,545#*0.781" = 1,988#"
$t = [M*6/(Fb*b))]^{1/2}$
$t = [6*1,988\#"/(45,000*4.25)]^{1/2} = 0.25"$

2 BOLT ROUND BASE PLATE
4-1/4” DIAMETER
1 Bolt in tension
B = 3.875”
T = 10,500/(1*3.875) = 2,710#

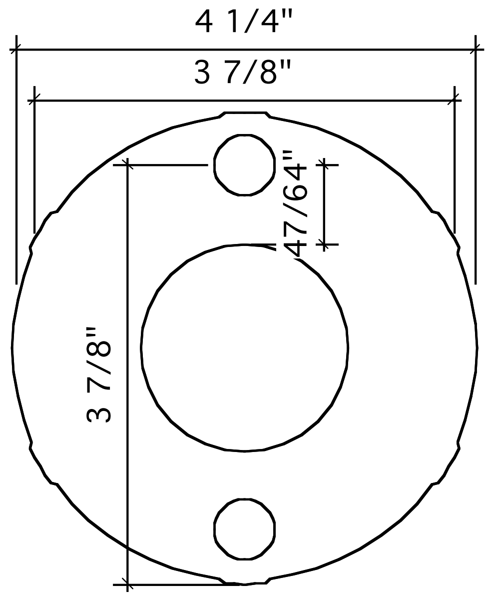


Plate bending:
M = 2,710#*0.73” = 1,978#”
$t = [M*6/(Fb*b)]^{1/2}$
$t = [6*1{,}978\#"/(45{,}000*4.25)]^{1/2} = 0.25"$

1/4” thickness may be used for all base plates.

NOTE: If two hole base plates are turned 90˚ the bolt tension will be the same but the bearing pressure at the compression side will be doubled. This may be used only for installations on steel or high strength concrete, f’c ≥ 5,420 psi.

ANCHORS

To steel:
Tension on bolts
For 4 hole configurations:
Tn = 1.6*1,556#/0.75 = 3,320#
Strength of bolt 316 Condition CW ASTM F593-86a
Fy = 71.2 ksi
area required = 3,320/71,200 = 0.047 in^2

For 2 hole configurations:
Tn = 1.6*2,710#/0.75 = 5,781#
Strength of bolt 316 Condition CW ASTM F593-86a
Fy = 71.2 ksi
area required = 5,781/71,200 = 0.0812 in^2

3/8” bolt, a = 0.0775 in^2 CAN USE FOR 4 BOLT BASE PLATES ONLY
7/16” bolt, a = 0.1063 in^2
1/2” bolt, a = 0.1419in^2

For concrete installations
Design Anchor
Powers 3/8” x 4” Screw-In anchor

FOUR BOLT CONFIGURATION
T_{req} = 1,556#
Check Anchor strength
3/8” x 4” anchor, Powers Wedge-bolt, or CRL equivalent designation screw in type anchor.
Embed = 4”-0.375”-1/8” = 3.5”
3.5” embed
Allowable tension load from ESR-1678

T = 2,535# Based on 4,000 psi concrete strength
Spacing = 2.375”: 4.5” for full strength, 1.5” for minimum
Cs = 0.70 + 0.3*((2.5-1.5)/(4.5-1.5)) = 0.80
Edge distance = 16d = 16*3/8” = 6”
T’= 2535*.8 = 2,028#

Allowable shear load = 1,860# > 250# Okay

Shear load will be carried by anchors not loaded in tension because baseplate in this area will be in compression against the concrete.

TWO BOLT CONFIGURATION
Base plate with holes perpendicular to the guardrail.
T_{req}= 2,545# large and 2,710# small

Loads are too high for 3/8” anchors try 1/2” anchor
1/2” with 4” embed minimum length required = 4”+ 3/8” = 4-3/8”
Allowable tension load from ESR-1678

T = 3,155# Based on 4,000 psi or stronger concrete strength
Spacing , only 1 bolt in tension at a time therefore spacing is
Cs = 0.70 + 0.3*((2.5-1.5)/(4.5-1.5)) = 0.80
Edge distance = 16d = 16*3/8” = 6”
T’= 2535*.8 = 2,028#

Allowable shear load = 1,860# > 250# Okay

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SCREW-IN TYPE WEDGE ANCHOR
Manufactured by Powers Fasteners

TABLE 4—ALLOWABLE TENSION LOAD VALUES (pounds) FOR WEDGE-BOLT AND WEDGE-BOLT OT ANCHORS INSTALLED IN NORMAL-WEIGHT CONCRETE AT CRITICAL SPACING AND EDGE DISTANCES[1,2,3]

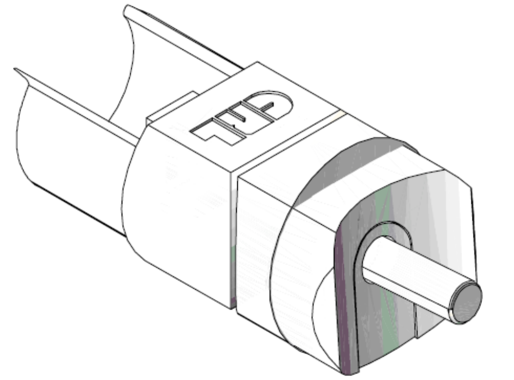
ANCHOR DIAMETER d (Inch)	MINIMUM EMBEDMENT h_v (Inches)	WITH SPECIAL INSPECTION[4] (Pounds) Concrete Strength, f'_c (Psi) 2,000	3,000	4,000	5,000	6,000	WITHOUT SPECIAL INSPECTION (Pounds) Concrete Strength, f'_c (Psi) 2,000	3,000	4,000	5,000	6,000
1/4	1	180	260	335	375	415	90	130	170	190	205
	1 1/2	360	450	535	580	620	180	225	270	290	310
	2	600	795	985	1,115	1,245	300	400	495	560	625
	2 1/2	880	1,025	1,165	1,240	1,315	440	515	585	620	660
3/8	1 1/2	475	555	630	695	760	240	280	315	350	380
	2	750	865	980	1,140	1,300	375	435	490	570	650
	2 1/2	1,025	1,180	1,330	1,585	1,835	515	590	665	795	920
	3	1,450	1,695	1,935	2,205	2,475	725	850	970	1,105	1,240
	3 1/2	1,875	2,205	2,535	2,825	3,110	940	1,100	1,270	1,415	1,555
1/2	2	715	850	985	1,090	1,195	360	425	490	545	600
	2 1/2	1,025	1,165	1,300	1,460	1,620	515	585	650	730	810
	3	1,480	1,715	1,950	2,150	2,345	740	860	975	1,075	1,170
	3 1/2	1,515	1,820	2,120	2,550	2,975	760	910	1,060	1,275	1,485
	4	1,890	2,525	3,155	3,155	3,155	955	1,265	1,575	1,575	1,575
5/8	2 1/2	855	1,020	1,180	1,455	1,725	430	510	590	730	865
	3	1,140	1,495	1,845	2,045	2,240	570	750	925	1,025	1,120
	3 1/2	1,430	1,970	2,510	2,635	2,760	715	985	1,255	1,320	1,380
	4	2,060	2,625	3,190	3,385	3,580	1,030	1,315	1,595	1,695	1,790
	4 1/2	2,695	3,285	3,875	4,135	4,400	1,350	1,645	1,935	2,070	2,200
	5	3,325	3,940	4,555	4,885	5,215	1,665	1,970	2,280	2,445	2,610
3/4	3	1,080	1,350	1,620	1,900	2,175	540	675	810	950	1,090
	3 1/2	1,430	1,880	2,330	2,585	2,840	715	940	1,165	1,295	1,425
	4	1,780	2,410	3,035	3,270	3,505	890	1,205	1,520	1,635	1,755
	4 1/2	2,310	2,855	3,395	3,790	4,180	1,155	1,430	1,700	1,895	2,090
	5	2,835	3,295	3,755	4,305	4,850	1,420	1,650	1,880	2,155	2,425
	5 1/2	3,360	3,740	4,115	4,820	5,520	1,680	1,870	2,060	2,410	2,760
	6	3,885	4,180	4,475	5,355	6,190	1,945	2,090	2,240	2,670	3,095

For SI: 1 inch = 25.4 mm, 1 Psi = 6.89 kPa, 1 lbf = 4.45 N
[1] The tabulated tension values are for anchors installed in normal-weight concrete having reached the minimum designated ultimate compressive strength at the time of installation. Linear interpolation of allowable loads may be used for concrete strengths between those listed.
[2] Refer to Section 5.3 of this report for modifying allowable loads of anchors to resist short-term loads.
[3] Linear interpolation for allowable loads for anchors may be used for intermediate spacing and edge distances using factors shown in Table 3. Linear interpolation for allowable loads for anchors at intermediate embedment depths may also be used.
[4] These tension load values are applicable only when the anchors are installed with special inspection as set forth in Section 4.4.

TABLE 7—ALLOWABLE SHEAR LOAD VALUES (pounds) FOR WEDGE-BOLT AND WEDGE-BOLT OT ANCHORS INSTALLED IN NORMAL-WEIGHT CONCRETE AT 16 DIAMETERS SPACING AND EDGE DISTANCES[1,2,3]

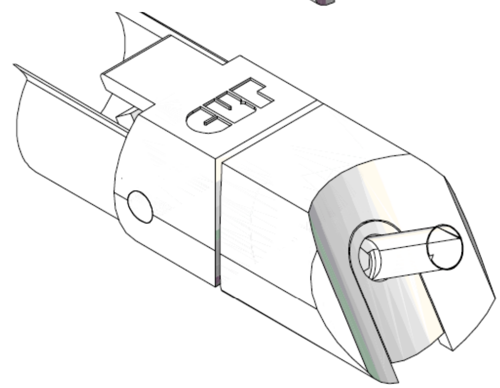
ANCHOR DIAMETER d (Inch)	MINIMUM EMBEDMENT h_v (Inches)	SPACING AND EDGE DISTANCE at 16d (Inches)	WITH OR WITHOUT SPECIAL INSPECTION (Pounds) Concrete Strength, f'_c (Psi) 2,000	3,000	4,000	5,000	6,000
1/4	1	4	260	395	525	570	610
	1 1/2		645	670	695	685	675
	2		695	695	695	770	840
	2 1/2		770	770	770	845	915
3/8	1 1/2	6	900	1,060	1,220	1,530	1,835
	2		1,135	1,215	1,295	1,565	1,835
	2 1/2		1,370	1,370	1,370	1,605	1,835
	3		1,600	1,610	1,615	1,745	1,870
	3 1/2		1,825	1,845	1,860	1,885	1,905

BOTTOM RAIL FITTING
Bottom rail connection fitting.
The fittings are constructed of stainless steel.



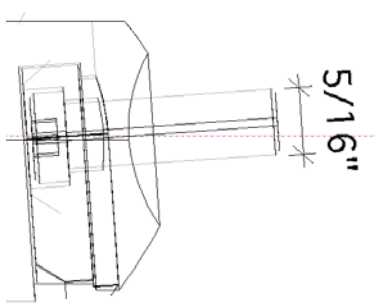
Bottom rail fitting is used to secure the bottom rail to the posts. The fitting is intended to act as a pinned connection.

The two styles of fitting may be used to connect the bottom rail either perpendicular to the post or at an angle.



The fitting end fits into the bottom rail where it is secured with silicone adhesive. Forces are transferred from the bottom rail to the fitting by direct bearing. Only shear forces are transferred.

The fitting transfers forces to the post by shear through a screw into the post.



The screw is inserted into the post and then the fitting is slid over the screw using the slot in the fitting end and locked in place.
Screw is 5/16” diameter.
$Av = 0.0454\ in^2$
$Vs = øAvFv/1.6 = 0.65*0.0454\ in^2*46\ ksi/1.6 = 848\#$

For bearing against threaded hole in post:
Vs = øD*t*Fy/1.6 = 0.75*0.3125*.185*45ksi/1.6 = 1,220#

Design shear force in fitting is:
H = 25psf*5’*3.5’/4 = 110#

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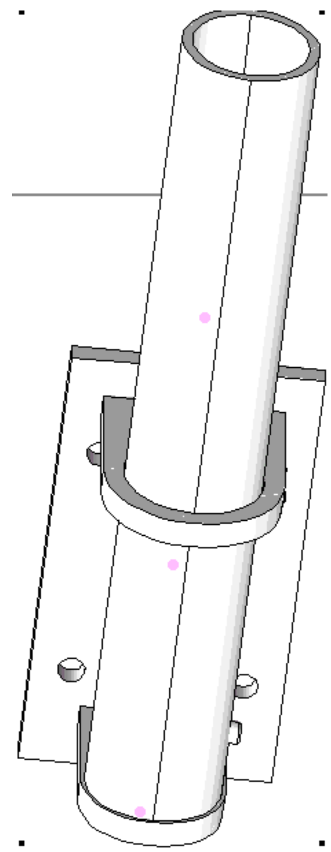
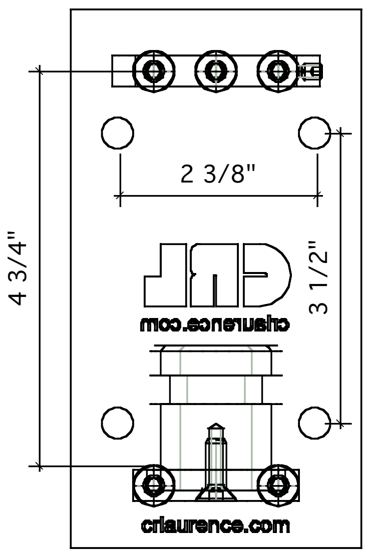
FASCIA BRACKET



Bracket is used to support railing posts by mounting to the side of a wall, beam, fascia or similar vertical surface.

The post is anchored at the bottom by fitting over a cylinder on a plate attached to the fascia plate. The upper ring locks the post from rotating and creates a couple with the bottom support to resist horizontal forces and induced moments

Maximum height from top of bracket to top of guardrail is 48”. For 5’ post spacing the design load on the post is 250# (50plf load controls).



Determine forces on the brackets:
On bottom bracket
Vertical forces
D = 5.5psf*3.5*5/2 + 40#
D = 100# (rounded up)
L = 250#

For horizontal forces bottom plate must also support vertical dead load.

From $\sum$M about the base = 0 determine upper ring load:
H_t = 250#*(48”+4.75”)/4.75” = 2,776#

Bottom bracket load: H_b = 2,776#-250# = 2,526# with V = 100#

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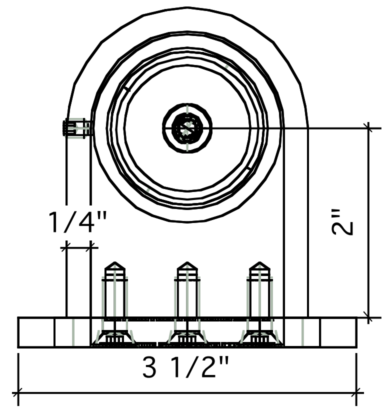
TOP RING:
Ring is secured to the back plate by three 5/16” screws installed through the back plate and into tapped holes in the ring. Screws A-2 or similar grade with minimum yield strength Fy ≥ 72 ksi ksi

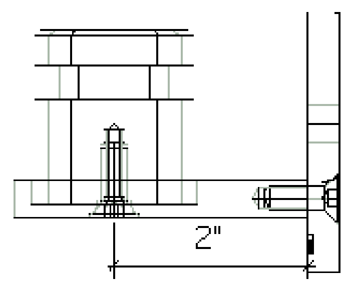


Screw tension strength:
$A_T = 0.0524$ in^2
$T = øA_TFy/1.6 = 0.75*0.0524$ in^2$*72$ ksi$/1.6 = 1{,}770\#$ each
$T_{total} = 3*1{,}770\# = 3{,}540\# > 2{,}776\#$ - okay

Shear strength, threads not in shear plane
$Av = 0.0524$ in^2
$Vs = øAvFv/1.6 = 0.65*0.0524$ in^2$*46$ ksi$/1.6 = 980\#$
$V_{total} = 3*980 = 2{,}940\#$

For loads that are not either parallel or perpendicular to the rail the reaction will be a combination of shear and tension. The interaction case will be okay since they have pure shear/pure tension cases.

Bottom fitting strength
Post end fitting is inlaid into bottom plate so that shear forces are directly transferred.



Bending stresses from vertical forces:
Vm = 350# (D+L)
Mv = 350#”*2” = 700#”

$V_D = 100\#$
$M_D = 100\# * 2” = 200\#”$

Tension on screw:
$H_L + V_D = 2{,}526\# + 200\#”/0.25” = 3{,}326\#$
For vertical load
$T_V = 700\#”/0.25” = 2{,}800\#”$

Allowable tension for three screws = 3,540# > 3,326# okay

Plate bending is okay from inference.

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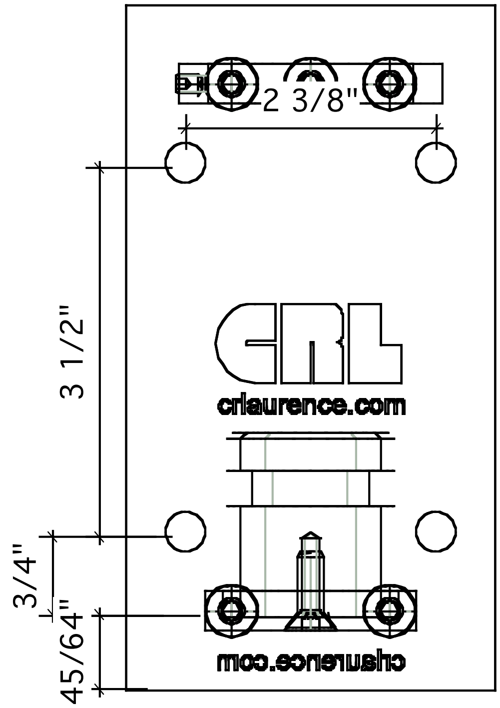
FASCIA BRACKET ATTACHMENT



Bracket is fastened to the structural support using four bolts.

For horizontal loads:
M_H = 250#*(48”+4.75”) = 13,187.5#”
Dead load will add shear and moment
M_D = 100#*2” = 200#”

M_T = 13,875.5#”+200#” = 14,075.5#”
V = 100#

Determine tension on anchors, will be greatest for outward force.
From $\sum$M about the bottom of the plate = 0

14,075.5#” – 2(1.45”*T_l) – 2(4.95*T_U) = 0
from similar triangles
$T_l = T_U$ *(1.45/4.95) = 0.29 T_U

Solving above for T_U
T_U = 14,075.5/(0.849+9.9) = 1,309#

From the anchor strengths calculated for the base plates the anchor alternatives are:
To steel 3/8” stud or bolt Grade A-2
To concrete 3/8” x 4” screw-in anchor with 3.5” embed.

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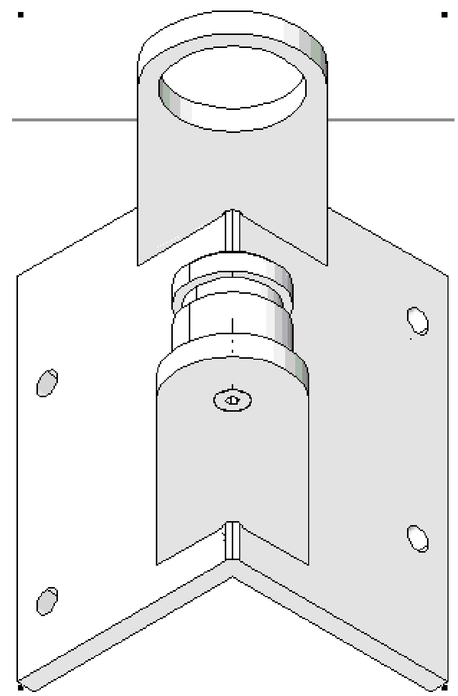
ALTERNATIVE BRACKET CONFIGURATIONS



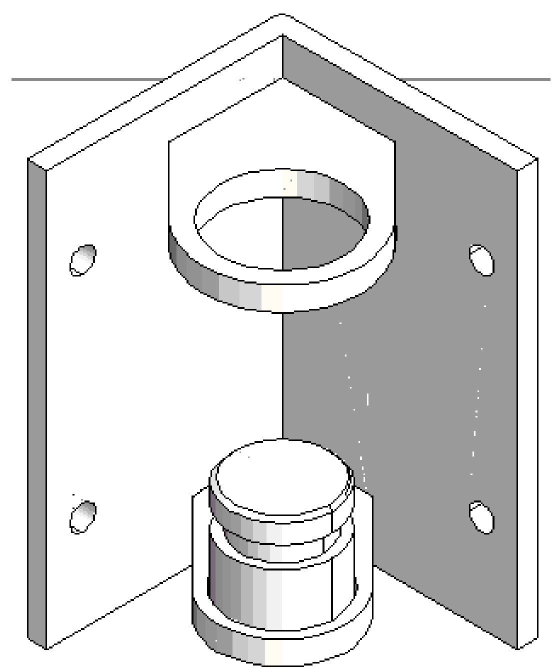
OUTSIDE CORNER BRACKET

Bracket strength is similar to that for the straight bracket. Connections at top and bottom are the same

Connections to support structure is the same.

Moments and vertical loads will be same or less than for straight bracket depending on the rail application.

Okay by inference from previous calculations.



INSIDE CORNER BRACKET

Bracket strength is similar to that for the straight bracket. Connections at top and bottom are the same

Connections to support structure is the same.

Moments and vertical loads will be same or less than for straight bracket depending on the rail application.

Okay by inference from previous calculations.

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GLASS

Glass lites are 3/8" or 1/2" fully tempered glass captured along the top and bottom. Loading limited by other components so 1/2" glass does not increase allowable wind load.

GLASS STRENGTH

All glass is fully tempered glass conforming to the specifications of ANSI Z97.1, ASTM C 1048-97b and CPSC 16 CFR 1201. The minimum Modulus of Rupture for the glass Fr is 20,000 psi. The actual Fr for the tempered glass is 24 ksi to 26 ksi minimum, therefore the true Safety Factors are larger than the 4.0 shown herein. In accordance with UBC 2406.6 or IBC 2407.1.1 glass used as structural balustrade panels shall be designed for a safety factor of 4.0. This is applicable only to structural panels (glass provides support to railing). Other locations the glass stress may be increased by 33% (SF = 3.0) for glass infill panels. Glass not used in guardrails may be designed for a safety factor of 2.5 in accordance with ASTM E1300-00.

Allowable glass bending stress: 24,000/4 = 6,000 psi. – Tension stress calculated.
Allowable compression stress = 30,000psi/4 = 7,500 psi.
Allowable bearing stress = 30,000 psi/4 = 7,500 psi.

Bending strength of glass for the given thickness:

$$S = \frac{12\text{''} * (t)^2}{6} = 2 * (t)^2 \text{ in}^3\text{/ft}$$

For 3/8" glass $S = 2*(0.366)^2 = 0.268 \text{ in}^3\text{/ft}$

$M_{allowable} = 6{,}000\text{psi}*0.268 \text{ in}^3\text{/ft} = 1{,}607\text{''\#/ft} = 134\text{'\#/'}$

For lites simply supported on two opposite sides the moment and deflection are calculated from basic beam theory

$Mw = W*L^2/8$ for uniform load W and span L or
$Mp = P*L/4$ for concentrated load P and span L, highest moment P @ center

Moment for 36" wide lite (infill for 42" rail height) 25 psf or 50 lb load
$Mw = 25\text{psf}*3\text{'}^2*12\text{''/'}/8 = 337.5\text{''\#}$
$Mp = 50*36\text{''}/4 = 450\text{''\#}$

Moment for 42" wide lite (infill for 48" rail height) 25 psf or 50 lb load
$Mw = 25\text{psf}*3.5\text{'}^2*12\text{''/'}/8 = 459.4\text{''\#}$
$Mp = 50*42\text{''}/4 = 525\text{''\#}$

The maximum wind load for a 3' wide lite:
$W = (134\text{\#''})*8/3^2 = 119$ psf with no stress increase

Thickness Glass Weight (lbs/ft2)

Thickness	Glass Weight (lbs/ft2)
1/4"	2.89
3/8"	4.75

Float Glass Thickness Tolerances

Thickness	Tolerance	Nominal
1/4"	.219 min to .244 max	.223
3/8"	.355 min to .406 max	.366

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ADDITIONAL TOP RAILS:
Any top rail with adequate strength and a channel able to receive the top fitting bar and glass glazing may be used. Typical options are:
GR15 and GR20 top rails already shown herein.

2-1/2", 3", 3-1/2", and 4" diameters.
These rails may all be used interchangeably with the CRS. Since design loads are limited by the post and base plate strengths there is no change in the allowable post spacing and rail height for using any of these rails.

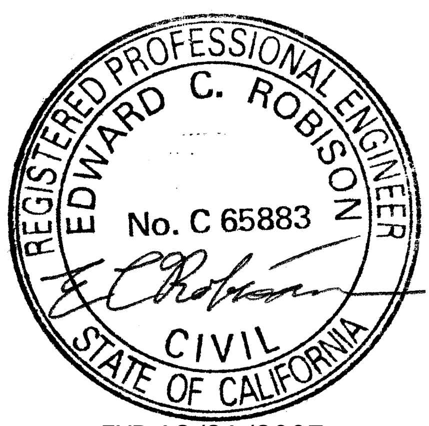
REFERENCES

1997 UNIFORM BUILDING CODE
2001 INTERNATIONAL BUILDING CODE
2003 INTERNATIONAL BUILDING CODE
SEI/ASCE 8-02 DESIGN SPECIFICATION FOR COLD FORMED STAINLESS STEEL

LOCTITE
Technical Data Sheets 326 and 7075

CRL

ESR 1678



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