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Structural Calculations
for
CBISC-04 Series

REGISTERED PROFESSIONAL ENGINEER
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EXP. 6/30/19
STRUCTURAL
STATE OF CALIFORNIA
8/23/18

Prepared for:

PROVENT / RRS

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Date: August 22, 2018

Project Number: PV1805

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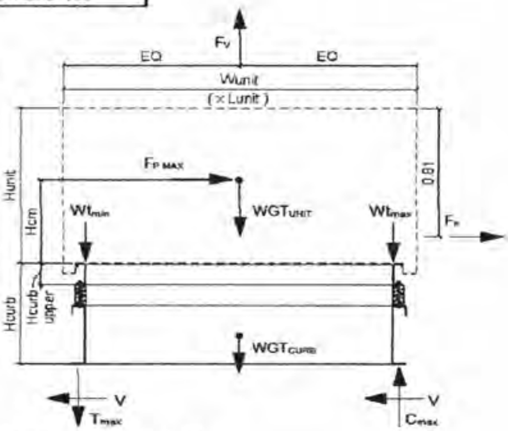
6593 Riverdale St.
San Diego, CA 92120
(619)727-4800

Client: ProVent PV1805
Project: CBISC-04 Iso Curb (CBISCPRD3715**Upper curb rail
Unit: ZT,ZR,ZJ 037-150; ZF,ZH,ZJ,ZR,XP,DH,DM,DF,DR,BP 078-150



Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	80.375	in	(Length of curb)
wcurb =	50.5	in	(Width of curb)
WGTcurb =	370	lbs	(Weight of curb)

Clips long side = 2 # Clips short side = 2

Unit Information

WGTunit =	1700	lbs	(Weight of Unit)
Wtmax =	329	lbs	(Maximum corner weight)
Wtmin =	191	lbs	(Minimum corner weight)
Hunit =	50.75	in	(Height of unit above curb)
Hcm =	25.375	in	(Height to center of mass)
Lunit =	89	in	(Length of unit)
Wunit =	59	in	(Width of unit)

Seismic Loading - 2015 IBC/2016 CBC

Ss =	2.850		(Worst case for majority of CA - Design Category D)
Fa =	1.000		(Interpolated from Table 11.4-1 ASCE 7-10)
Sms =	2.850		(Fa*Ss)
Sds =	1.900		(2/3*Sms)
Ip =	1.25		(Importance Factor Category III Building)
Fpmax =	3.800	Wp	(1.6*Sds*Ip)*Wp
FpmaxASD =	4522	lbs	(0.7*Fpmax) FpmaxASD = 5506 lbs

(unit only) (unit and curb)

Wind Loading - 2015 IBC/2016 CBC

*** Exposure Category C ***

Kz =	1.13		(For 60 ft roof height, Exposure C - Table 29.3-1 ACSE 7-10)
Kzt =	1.0		(No topographic effects assumed for rooftop mounted units)
Kd =	0.85		(Directionality factor Table 26.6-1 ASCE 7-10)
V =	115		(Max wind velocity, mph for Cat III & IV bldgs Exp. Cat C)
$GCr_{(horiz)}$ =	1.9		(Refer Sect 29.5.1 ASCE 7-10)
$GCr_{(vert)}$ =	1.5		(Refer Sect 29.5.1 ASCE 7-10)
qz	32.5	psf	= $0.00256*Kz*Kzt*Kd*V^2$ (Eq. 29.3-1 ASCE 7-10)
$F_{h\ ASD\ trans}$ =	1289	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb upper) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	854	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb upper)
$F_{vert\ ASD}$ =	1067	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	3105	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	2537	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	509	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	556	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate Compression load rather than Tension.

Longitudinal:

$Compression_{SEISMIC}$ =	2261	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1693	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	131	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	178	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate Compression load rather than Tension.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	3105	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	2537	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	2261	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1693	lbs	---> Along short edge of curb.

---> Negative values indicate Compression load rather than Tension.

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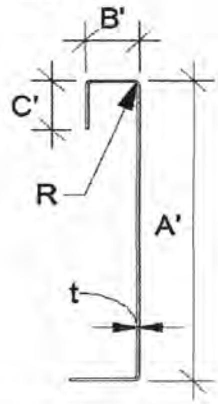
Curb Design

Fy = 50 ksi   Fu = 65 ksi   t = 0.0713 | 14 Gauge |
E = 29500 ksi

Calculate Section Properties of Curb



A' =	5.500 in		a =	5.144 in	= A'-(2r+t)
B' =	1.500 in		a' =	5.429 in	= A'-t
C' =	0.000 in	(0 if no lips)	b =	1.322 in	= B'-(r+t/2+α(r+t/2))
α =	0.000	(0 - no Lip; 1 w/ lip)	b' =	1.464 in	= B'-(t/2+αt/2)
R =	0.1069	(Inside bend radius)	c =	0.000 in	= α(C'-(r+t/2))
t =	0.0713 in		c' =	0.000 in	= α(C'-t/2)
r' =	0.143 in	= R+t/2	u =	0.224 in	= πr/2
x =	0.261 in	(Distance between centroid and web centerline)			
Ix =	2.424 in	(Moment of Inertia about X-Axis)			
Iy =	0.109 in	(Moment of Inertia about Y-Axis)			
A =	0.59 in²				
rx =	2.03 in				
ry =	0.432 in				
rmin =	0.432 in				

Axial Compression

Pu =	2.261 k	(Max Axial Comp)
P_n/Ω_c =	4.894 k	
Fe =	17.11 ksi	
λc =	1.71	
Fn =	15.00 ksi	
Ly =	70.38 in	Lateral unbraced length
k_yL_y/r_y =	130	(assume k=0.8)

Ω_c = 1.80

$$\frac{P_n}{\Omega_c}=\frac{F_nA}{\Omega_c}\qquad If\ \lambda_c\le 1.5;\ F_n=\left(0.658^{\lambda_c^2}\right)F_y\qquad If\ \lambda_c>1.5;\ F_n=\frac{0.877}{\lambda_c^2}F_y$$

$$\lambda_c=\sqrt{\frac{F_y}{F_e}}\qquad F_e=\frac{\pi^2E}{\left(kl/r\right)^2}$$

Compression Check = O.K.

Check Web Crippling

h =	5.5 in	-- Check limits:		C = 7.50
t =	0.0713 in	h/t =	77.14 ≤ 200	C_R = 0.08
N =	7.00	N/t =	98.18 ≤ 210	C_N = 0.12
Ω_w =	1.75	N/h =	1.273 ≤ 2.0	C_h = 0.048
P_n =	1.947 k	R/t =	1.50 ≤ 12.0	
P_n/Ω_w =	1.112 k			
Long side: Pu_{Trans} =	1.553 k	**web stiffener REQ'D**	# clips = 2	
Short side: Pu_{Long} =	1.130 k	**web stiffener REQ'D**	# clips = 2	

(See table C3.4.1-2, fastened to support, two flange, end loading)

$$P_n=Ct^2F_y\sin(90)\left(1-C_R\sqrt{\frac{R}{t}}\right)\left(1+C_N\sqrt{\frac{N}{t}}\right)\left(1-C_h\sqrt{\frac{h}{t}}\right)$$

Check Web Stiffener   16Ga x 3/4in x 7in (C-channel)

width of stiffener =	7.000 in	ts =	0.0566 16 Gauge
web of stiff. w =	6.717 in	Rs =	0.0849 in
***Check w/ts ≤ 1.28√E/Fys		Ω_c =	1.70

w/ts = 118.675
1.28√(E/Fys) = 31.091 --> w/ts over limit Use C3.7.2

$P_n=0.7(P_{wc}+A_eF_y)\ge P_{wc}$

Pwc = 1.947 k   Ae = 0.380 in²
Pn = 14.669 k
P_n/Ω_c = 8.629 k   **O.K.**

Corner Connections   **1/4" φ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts**

Tcrnmax = 1131 lbs   Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 1269 lbs   (Max Ten/2 corner connections per side)

Bolt:	Tall = 2480 lbs	Vall = 1096 lbs
Threaded Insert:	Tall = 2860 lbs	Vall = 1714 lbs

# of Bolts required for Tension = 0.5
# of Bolts required for Shear = 1.2   ***If combined fails:
# of Bolts Used = 2.0   USE --> 3.0
Check Combined Stress in Bolts & Inserts: 0.807 O.K.   StressComb = 0.538 **O.K.**

Check 1/8" welded connection   <---- USE WELD   Ω = 2.35

Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 0.858 in

$$P_n/_{\Omega}=\frac{1}{\Omega}0.75tLF_u\ge V_{req}\qquad L_{req'd}=\frac{V_{req}\Omega}{0.75tF_u}$$

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Connection Unit to Curb Clip | #12 SMS screw | Ω = 3.0

t1 = 0.0713 in (clip thickness) | Fu1 = 65 ksi
t2 = 0.0713 in (unit base rail thickness) | Fu2 = 65 ksi
d = 0.216 in (screw diameter) | dw = 0.375 in (nom. washer diameter)
t2/t1 = 1.0

For t2/t1 ≤ 1.0: Pns = 2416 # | For t2/t1 ≥ 2.5:

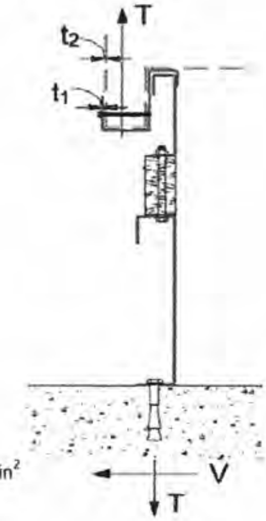
Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ 2.42 k | Pns = 2703 #
$P_{ns} = 2.7t_1 dF_{u1}$ 2.70 k | $P_{ns} = 2.7t_1 dF_{u1}$ 2.70 k
$P_{ns} = 2.7t_2 dF_{u2}$ 2.70 k | $P_{ns} = 2.7t_2 dF_{u2}$ 2.70 k
Pns/Ω = 805 # <- Controls
Pss/Ω = 840 #

Tension: Pnot = 0.851 k (screw pull-out strength) | $P_{not} = 0.85t_c dF_{u2})$, $t_c = \min(t_1, t_2)$
Pnov = 2.607 k (screw pull-over strength) | $P_{nov} = 1.5t_1 d_w F_{u1}$
Pts/Ω = 284 # <- Controls
Pts/Ω = 845 # (full tensile screw capacity)

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	4.522	2	2.26	805 #	4	2.00 in
Short side:	4.522	2	2.26	805 #	4	2.00 in

clip width (in) = 7.00 | clip height = 2.5 in
min spacing = 0.65 in | edge distance = 0.5 in (min. 1.5d)

Check Block shear rupture: O.K. | thinnest part = 0.0713 AISI BSR applies
Fy = 50 ksi | Ω = 2.22 bolt/screw connection
Agv = 0.463 in^2 | Anv = 0.410 in^2 | Ant = 0.081 in^2
Rn/Ω = 8.647 k | $R_n = 0.6F_y A_{gv} + F_u A_{nt} \le 0.6F_u A_{nv} + F_u A_{nt}$
BSR O.K. (AISI Sect. E5.3)



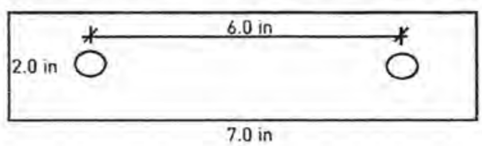
Curb Loads (copied from above)

Transverse:	$Comp_{MAX}$ =	3105	lbs
(on long edge)	$Tens_{MAX}$ =	2537	lbs
	$Shear_{MAX}$ =	2261	lbs
Longitudinal:	$Comp_{MAX}$ =	2261	lbs
(on short edge)	$Tens_{MAX}$ =	1693	lbs
	$Shear_{MAX}$ =	2261	lbs

Loads at each Isolator Type: **JQA**

Transverse loading:	$Comp_{MAX}$ =	1552.6	lbs
(on long edge)	$Tens_{MAX}$ =	1268.7	lbs
# isolators: 2	$Shear_{MAX}$ =	565.3	lbs
Longitudinal loading:	$Comp_{MAX}$ =	1130.3	lbs
(on short edge)	$Tens_{MAX}$ =	846.4	lbs
# isolators: 2	$Shear_{MAX}$ =	565.3	lbs

Max compression force on isolator: 1.553 k ≤ 1.660 k **O.K.**
Max uplift on isolator: 1.269 k ≤ 1.660 k **O.K.**
Max shear on isolator: 0.565 k ≤ 0.800 k **O.K.**



Forces on top bolt:
d_b = 0.375 in
upper rail, t = 0.0713 in
Tension = 1.269 k
Shear = 0.565 k

Shear on curb rail: $P_n = teF_u$ | Ω = 2.00 (Appendix A, Section E3.1 AISI)
Pn/Ω = 4.635 k | e = 1.0 in
Shear O.K.

Net section rupture: $P_n = A_n F_t$ | Ω = 2.22 (Appendix A, Section E3.2 AISI)
Pn/Ω = 4.989 k | An = 0.116 in
N.S.R. O.K. | $F_t = (0.1 + 3d/s)F_u \le F_u =$ 43.063 ksi

Bolt Bearing Strength: $P_n = Cm_f dtF_u$ | Ω = 2.50 (Section E3.3.1 AISI)
Pn/Ω = 2.086 k | d/t = 5.26
Bearing O.K. | C = 3.00 | mf = 1.00

Shear and tension in bolt: (Appendix A, Section E3.4 AISI)

Tension: $P_{nt} = A_b F_{nt}$ | Fnt = 40.5 ksi | A_b = 0.1104 in^2
Pnt/Ω = 1.988 k **Bolt tension O.K.** | Ωt = 2.25 (Table E3.4-1, AISI)

Shear: $P_{nv} = A_b F_{nv}$ | Fnv = 24.0 ksi | Ωv = 2.40 (Table E3.4-1, AISI)
Pnv/Ω = 1.104 k **Bolt shear O.K.**

$$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \le F_{nt}$$

fv = 5.12 ksi O.K.

Combined Not Applicable | F'nt = 31.92 ksi | Fnv/Ω = 10.00 ksi

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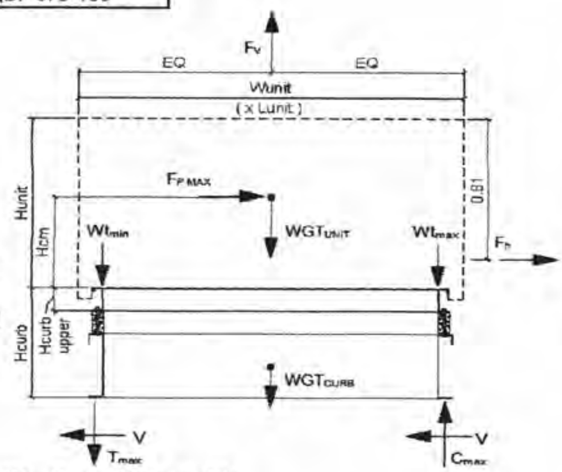
Client: ProVent PV1805
Project: CBISC-04 Iso Curb (CBISCPRD3715**) Base curb
Unit: ZT,ZR,ZJ 037-150; ZF,ZH,ZJ,ZR,XP,DH,DM,DF,DR,BP 078-150

Curb Information

Hcurb =	25	in	(Height of curb)
Lcurb =	83.375	in	(Length of curb)
wcurb =	53.5	in	(Width of curb)
WGTcurb =	370	lbs	(Weight of curb)
# Clips long side =	2		# Clips short side = 2

Unit Information

WGTunit =	1700	lbs	(Weight of Unit)
Wtmax =	329	lbs	(Maximum corner weight)
Wtmin =	191	lbs	(Minimum corner weight)
Hunit =	50.75	in	(Height of unit above curb)
Hcm =	25.375	in	(Height to center of mass)
Lunit =	89	in	(Length of unit)
Wunit =	59	in	(Width of unit)



Seismic Loading - 2015 IBC/2016 CBC

Ss =	2.850	(Worst case for majority of CA - Design Category D)
Fa =	1.000	(Interpolated from Table 11.4-1 ASCE 7-10)
Sms =	2.850	(Fa*Ss)
Sds =	1.900	(2/3*Sms)
Ip =	1.25	(Importance Factor Category III Building)
Fpmax =	3.800 Wp	(1.6*Sds*Ip)*Wp
FpmaxASD =	4522 lbs (unit only)	(0.7*Fpmax) FpmaxASD = 5506 lbs (unit and curb)

Wind Loading - 2015 IBC/2016 CBC

*** Exposure Category C ***

Kz =	1.13	(For 60 ft roof height, Exposure C - Table 29.3-1 ACSE 7-10)
Kzt =	1.0	(No topographic effects assumed for rooftop mounted units)
Kd =	0.85	(Directionality factor Table 26.6-1 ASCE 7-10)
V =	115	(Max wind velocity, mph for Cat III & IV bldgs Exp. Cat C)
$GCr_{(horiz)}$ =	1.9	(Refer Sect 29.5.1 ASCE 7-10)
$GCr_{(vert)}$ =	1.5	(Refer Sect 29.5.1 ASCE 7-10)
qz	32.5 psf	= $0.00256*Kz*Kzt*Kd*V^2$ (Eq. 29.3-1 ASCE 7-10)
$F_{h\,ASD\,trans}$ =	1736 lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\,ASD\,long}$ =	1151 lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\,ASD}$ =	1067 lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	2978 lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	2410 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	684 lbs	=[$F_{h\,transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	732 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate Compression load rather than Tension.

Longitudinal:

$Compression_{SEISMIC}$ =	2209 lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1641 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	211 lbs	=[$F_{h\,transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	259 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate Compression load rather than Tension.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	2978	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	2410	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	2209	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1641	lbs	---> Along short edge of curb.

---> Negative values indicate Compression load rather than Tension.

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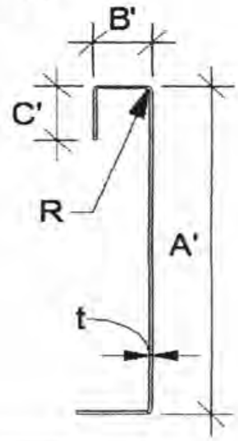
Curb Design

Fy =	50 ksi	Fu =	65 ksi	t =	0.0713 [14 Gauge]
E =	29500 ksi				

Calculate Section Properties of Curb



A'=	25.000 in		a =	24.644 in	= A'-(2r+t)
B'=	1.750 in		a'=	24.929 in	= A'-t
C'=	0.000 in	(0 if no lips)	b =	1.572 in	= B'-[r+t/2+α(r+t/2)]
α =	0.000	(0 - no Lip; 1 w/ lip)	b'=	1.714 in	= B'-(t/2+αt/2)
R =	0.1069	(Inside bend radius)	c =	0.000 in	= α[C'-(r+t/2)]
t =	0.0713 in		c'=	0.000 in	= α(C'-t/2)
r'=	0.143 in	= R+t/2	u =	0.224 in	= πr/2
x =	0.104 in	(Distance between centroid and web centerline)			
Ix =	128.737 in	(Moment of Inertia about X-Axis)			
Iy =	0.218 in	(Moment of Inertia about Y-Axis)			
A =	2.01 in^2				
rx =	8.00 in				
ry =	0.329 in				
rmin =	0.329 in				

Axial Compression

Pu =	2.261 k	(Max Axial Comp)
Pn/Ωc =	8.960 k	
Fe =	9.14 ksi	
λc =	2.34	
Fn =	8.01 ksi	
Ly =	73.38 in	Lateral unbraced length
k_yL_y/r_y =	179	(assume k=0.8)

Ω_c = 1.80

$$\frac{P_n}{\Omega_c} = \frac{F_n A}{\Omega_c} \qquad If\ \lambda_c \le 1.5;\ F_n = \left(0.658^{\lambda_c^2}\right) F_y \qquad If\ \lambda_c > 1.5;\ F_n = \frac{0.877}{\lambda_c^2} F_y \qquad \lambda_c = \sqrt{\frac{F_y}{F_e}} \qquad F_e = \frac{\pi^2 E}{\left(kl/r\right)^2}$$

Compression Check = O.K.

Check Web Crippling

h =	25 in	-- Check limits:		C = 4.00	(See table C3.4.1-2, fastened to support, one flange, end loading)
t =	0.0713 in	h/t =	350.63 ≤ 200	C_R = 0.14	
N =	7.00	N/t =	98.18 ≤ 210	C_N = 0.35	
Ω_w =	1.75	N/h =	0.28 ≤ 2.0	C_h = 0.02	
P_n =	2.105 k	R/t =	1.50 ≤ 9.0		
P_n/Ω_w =	1.203 k				
Long side: Pu_{Trans} =	1.489 k	**web stiffener REQ'D**	# clips = 2		
Short side: Pu_{Long} =	1.105 k	**O.K.**	# clips = 2		

$$P_n = Ct^2 F_y \sin(90)\left(1 - C_R\sqrt{\frac{R}{t}}\right)\left(1 + C_N\sqrt{\frac{N}{t}}\right)\left(1 - C_h\sqrt{\frac{h}{t}}\right)$$

*****h/t > 200; use web stiffeners**

Check Web Stiffener 16Ga x 1.5in x 7in (C-channel)

width of stiffener =	7.000 in	ts =	0.0566 [16 Gauge]
web of stiff. w =	6.717 in	Rs =	0.0849 in
***Check w/ts ≤ 1.28√E/Fys		Ω_c =	1.70

w/ts =	118.675	
1.28√(E/Fys) =	31.091	--> w/ts over limit Use C3.7.2

$P_n = 0.7(P_{wc} + A_e F_y) \ge P_{wc}$

Pwc =	2.105 k	Ae =	0.380 in^2
Pn =	14.780 k		
Pn/Ω_c =	8.694 k	**O.K.**	

Corner Connections **1/4" φ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts**

Tcrnmax =	1131 lbs	Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax =	1205 lbs	(Max Ten/2 corner connections per side)

Bolt:	Tall = 2480 lbs	Vall = 1096 lbs
Threaded Insert:	Tall = 2860 lbs	Vall = 1714 lbs

\# of Bolts required for Tension = 0.5

\# of Bolts required for Shear = 1.1 ***If combined fails:

\# of Bolts Used = 2.0 USE --> 4.0

Check Combined Stress in Bolts & Inserts: 0.778 O.K. StressComb = 0.389 **O.K.**

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Check 1/8" welded connection <--- USE WELD Ω = 2.35

Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 0.815 in

$$P_n/_\Omega = \frac{1}{\Omega}0.75tLF_u \geq V_{req} \qquad L_{req'd} = \frac{V_{req}\Omega}{0.75tF_u}$$

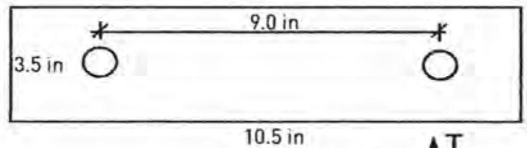
Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	3105	lbs
	$Tens_{MAX}$ =	2537	lbs
	$Shear_{MAX}$ =	2261	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	2261	lbs
	$Tens_{MAX}$ =	1693	lbs
	$Shear_{MAX}$ =	2261	lbs

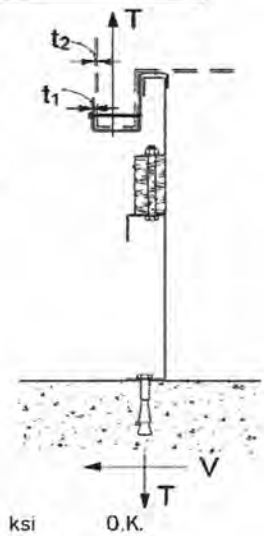
Loads at each Isolator Type: **JQBX**

Transverse loading:	$Comp_{MAX}$ =	1552.6	lbs
(on long edge)	$Tens_{MAX}$ =	1268.7	lbs
# isolators: 2	$Shear_{MAX}$ =	565.3	lbs
Longitudinal loading:	$Comp_{MAX}$ =	1130.3	lbs
(on short edge)	$Tens_{MAX}$ =	846.4	lbs
# isolators: 2	$Shear_{MAX}$ =	565.3	lbs

Max compression force on isolator: 1.553 k ≤ 2.000 k **O.K.**
Max uplift on isolator: 1.269 k ≤ 2.000 k **O.K.**
Max shear on isolator: 0.565 k ≤ 1.500 k **O.K.**



Forces on bottom bolts:
d_b = 0.625 in
base curb, t = 0.0713 in
Tension = 0.634 k / bolt
Shear = 0.283 k / bolt



Shear on base curb: $P_n = teF_u$ Ω = 2.00 (Appendix A, Section E3.1 AISI)
Pn/Ω = 4.635 k e = 1.0 in
Shear O.K.

Net section rupture: $P_n = A_nF_t$ Ω = 2.22 (Appendix A, Section E3.2 AISI)
Pn/Ω = 6.372 k An = 0.098 in
N.S.R. O.K. $F_t = (0.1 + 3d/s)F_u \leq F_u =$ 65.000 ksi

Bolt Bearing Strength: $P_n = Cm_fdtF_u$ Ω = 2.50 (Section E3.3.1 AISI)
Pn/Ω = 3.476 k d/t = 8.77
Bearing O.K. C = 3.00 mf = 1.00

Shear and tension in bolt: (Appendix A, Section E3.4 AISI)

Tension: $P_{nt} = A_bF_{nt}$ Fnt = 45.0 ksi A_b = 0.3068 in^2
Pnt/Ω = 6.136 k **Bolt tension O.K.** Ωt = 2.25

Shear: $P_{nv} = A_bF_{nv}$ Fnv = 27.0 ksi Ωv = 2.40
Pnv/Ω = 3.451 k **Bolt shear O.K.** ***(Table E3.4-1, AISI)***

$$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}}f_v \leq F_{nt}$$

fv = 0.92 ksi
Combined Not Applicable F'nt = 45.0 ksi Fnv/Ω = 11.25 ksi

Connection of Curb to Supporting Structure

Roof Loading SEISMIC: (0.6-0.14SDS)D + 0.7E WIND: 0.6D + W

Transverse:	$Uplift_{MAX}$ = 5804 lbs	$Shear_{MAX}$ = 2753 lbs
$Compression_{SEISMIC}$ =	6495 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb
$Tension_{SEISMIC}$ =	5804 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ =	1722 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1547 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb
Longitudinal:	$Uplift_{MAX}$ = 3946 lbs	$Shear_{MAX}$ = 2753 lbs
$Compression_{SEISMIC}$ =	4637 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	3946 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ =	783 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	608 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

Wood Attachment: **1/4" φ wood lag screws** **w/ 3.5" Min. Embed** (SGmin = 0.43)

Transverse:
$Tall_{metal}$ = 946.67 lbs $Vall_{metal}$ = 1043.33 lbs
$Tall_{wood}$ = 671.25 lbs $Vall_{wood}$ = 224 lbs
# of Screws Req'd for Uplift = 8.65 COMBINED LOADING: 0.952 O.K.
# of Screws Req'd for Shear = 12.29 Req'd Min Spacing = 3.6 in o.c.
Total # of screws required = 22

Use 22 - 1/4" ф wood lag screws @ 3.6 in o.c. along long side of curb w/ 3.5" Min. Embed

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Longitudinal:

# of Screws Req'd for Uplift =	5.88	COMBINED LOADING:	0.956	O.K.
# of Screws Req'd for Shear =	12.29	Screw Spacing =	2.5	in o.c.
Total # of screws required =	19			

Use 19 - 1/4" ϕ wood lag screws @ 2.5 in o.c. along short side of curb w/ 3.5" Min. Embed

Steel Deck Attachment: 1/2" φ A307 Bolts to steel angle below deck

$Tall_{bolt}$ =	6903 lbs		$Vall_{bolt}$ =	3682 lbs
Transverse:	6903 lbs			3682 lbs
# of Bolts Req'd for Uplift =	0.84	COMBINED LOADING:	0.794 O.K.	
# of Bolts Req'd for Shear =	0.75	Bolt Spacing =	71.4 in o.c.	
Total # of bolts required =	2			

Use 2 - 1/2" ϕ A307 Bolts to steel angle below deck @ 71.4 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift =	0.57	COMBINED LOADING:	0.660 O.K.
# of Bolts Req'd for Shear =	0.75	Bolt Spacing =	41.5 in o.c.
Total # of bolts required =	2		

Use 2 - 1/2" ϕ A307 Bolts to steel angle below deck @ 41.5 in o.c. along short side of curb

For Concrete anchorage: SEISMIC $(0.6-0.14SDS)D + 0.7\Omega_o E$ $(\Omega_o = 2.5)$

Concrete Attachment: 3/4" φ thrd'd rods in Hilti Hit-HY 200 epoxy w/ 4" embed

$Tall_{LRFD}$ = 1919 lbs $Vall_{LRFD}$ = 3188 lbs $\alpha = (1 + 0.2SDS)D + 2.5E = 1.87$

$Tall_{ASD} = Tall_{LRFD}/\alpha$ = 1026.2 lbs $Vall_{ASD} = Vall_{LRFD}/\alpha$ = 1704.8 lbs $(D = 0.465, E = 0.535)$

Transverse: $Uplift_{MAX}$ = 13580 lbs $Shear_{MAX}$ = 6883 lbs

$Compression_{SEISMIC}$ = 14272 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 13580 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 6883 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 13.23 spacing = 4.57 in o.c. Tapplied = 905.4 lbs

Min Bolts Req'd Shear = 4.04 spacing = 14.84375 in o.c. Vapplied = 458.9 lbs

Try using 15 bolts spaced at 5.10 in o.c. COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.15

Use 15 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 5.1 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 8936 lbs $Shear_{MAX}$ = 6883 lbs

$Compression_{SEISMIC}$ = 9627 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 8936 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 6883 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 8.71 spacing = 3.6875 in o.c. Tapplied = 812.4 lbs

Min Bolts Req'd Shear = 4.04 spacing = 7.375 in o.c. Vapplied = 625.7 lbs

Try using 11 bolts spaced at 4.15 in o.c. COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.16

Use 11 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 4.2 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBISC-04 (CBISCPRD3: Unit: ZT,ZR,ZJ 037-150; ZF,ZH,ZJ,ZR,XP,DH,DM,DF,DR,BP 078-150

UPPER CURB RAIL THICKNESS: 0.0713 in 14 Gauge
UNIT CLIP THICKNESS: 0.0713 in 14 Gauge
 # OF CLIPS (LONG SIDE) - 2 clips with 4 - #12 SMS screws each clip
WEB STIFFENER: 16Ga x 3/4in x 7in (C-channel) stiffener at each clip
 # OF CLIPS (SHORT SIDE) - 2 clips with 4 - #12 SMS screws each clip
WEB STIFFENER: 16Ga x 3/4in x 7in (C-channel) stiffener at each clip

VIBRATION ISOLATOR TYPE: JQBX Top stud diameter: 3/8
Anchor bolt diameter: 5/8 Anchor hole diamter: 11/16

BASE CURB THICKNESS: 0.0713 in 14 Gauge
WEB STIFFENER: 16Ga x 1.5in x 7in (C-channel) stiffener at each clip on base curb

CORNER CONNECTION: Use minimum 4 - 1/4" ϕ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts

CURB ANCHORAGE	WOOD 1/4" ϕ wood lag screws w/ 3.5" Min. Embed (SGmin = 0.43)	STEEL 1/2" ϕ A307 Bolts to steel angle below deck	CONCRETE 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy w/ 4" embed
LONG DIRECTION	22 @ 3.59 in o.c.	2 @ 71.38 in o.c.	15 @ 5.1 in o.c.
SHORT DIRECTION	19 @ 2.53 in o.c.	2 @ 41.5 in o.c.	11 @ 4.15 in o.c.