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Structural Calculations

for

CBISC-08 Series

Prepared for:

PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

Date: August 22, 2018

Project Number: PV1805

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

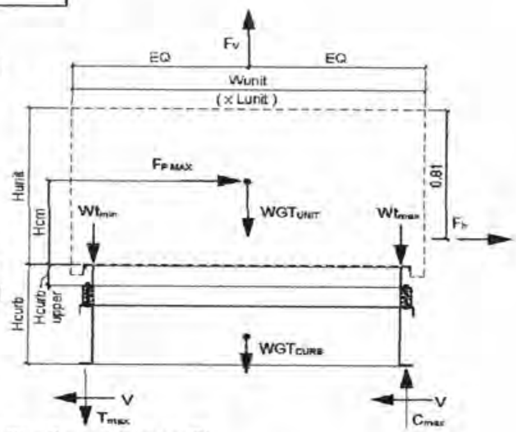
Client: ProVent PV1805
Project: CBISC-08 Iso Curb (CBISCSLM1830**Upper curb rail
Unit: ZJ,ZR 180-300; XP 180-240, ZF 210-300

Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	125.75	in	(Length of curb)
wcurb =	83.5	in	(Width of curb)
WGTcurb =	628	lbs	(Weight of curb)
# Clips long side =	3		# Clips short side = 3

Unit Information

WGTunit =	3061.3	lbs	(Weight of Unit)
Wtmax =	908	lbs	(Maximum corner weight)
Wtmin =	306	lbs	(Minimum corner weight)
Hunit =	52.625	in	(Height of unit above curb)
Hcm =	26.3125	in	(Height to center of mass)
Lunit =	136.25	in	(Length of unit)
Wunit =	92	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 =	8143	lbs	(0.7*Fpmax)

(unit only)

FpmaxASD = 9814 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)
$F_{h\,ASD\,trans}$ =	2039	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb upper) (Eq. 29.5-2)
$F_{h\,ASD\,long}$ =	1377	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb upper)
$F_{vert\,ASD}$ =	2548	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	4865	lbs	$=(FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb)/wcurb$
$Tension_{SEISMIC}$ =	3843	lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	458	lbs	$=(F_{h\,transASD}*Hcm+2*0.6*Wtmax*wcurb-F_{vertASD}*wcurb/2)/wcurb$
$Tension_{WIND}$ =	1169	lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Longitudinal:

$Compression_{SEISMIC}$ =	4003	lbs	$=(FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb)/Lcurb$
$Tension_{SEISMIC}$ =	2980	lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	104	lbs	$=(F_{h\,transASD}*Hcm+2*0.6*Wtmax*Lcurb-F_{vertASD}*Lcurb/2)/Lcurb$
$Tension_{WIND}$ =	815	lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	4865	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	3843	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	4003	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2980	lbs	---> Along short edge of curb.

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

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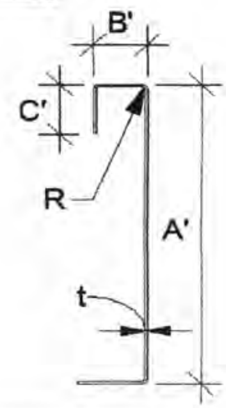
Curb Design

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 in^2	
rx =	2.03 in	
ry =	0.432 in	
rmin =	0.432 in	

Axial Compression

Pu = 4.072 k (Max Axial Comp) Ω_c = 1.80
Pn/Ωc = 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)

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

Compression Check = O.K.

Check Web Crippling

h = 5.5 in -- Check limits:
t = 0.0713 in h/t = 77.14 ≤ 200
N = 7.00 N/t = 98.18 ≤ 210
Ω_w = 1.75 N/h = 1.273 ≤ 2.0
P_n = 1.947 k R/t = 1.50 ≤ 12.0
P_n/Ω_w = 1.112 k
Long side: Pu_{Trans} = 1.622 k **web stiffener REQ'D** # clips = 3
Short side: Pu_{Long} = 1.334 k **web stiffener REQ'D** # clips = 3

C = 7.50, C_R = 0.08, C_N = 0.12, C_h = 0.048 (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 in^2
Pn = 14.669 k
Pn/Ω_c = 8.629 k **O.K.**

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

Tcrnmax = 2036 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 1921 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 = 0.8
# of Bolts required for Shear = 1.8 ***If combined fails:
# of Bolts Used = 2.0 USE --> 3.0
Check Combined Stress in Bolts & Inserts: 1.287 N.G. StressComb = 0.858 **O.K.**

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

Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 1.299 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 #14 SMS screw Ω = 3.0

t1 = 0.0713 in (clip thickness) Fu1 = 65 ksi
t2 = 0.1017 in (unit base rail thickness) Fu2 = 65 ksi
d = 0.242 in (screw diameter) dw = 0.500 in (nom. washer diameter)
t2/t1 = 1.4

For t2/t1 ≤ 1.0: Pns = 3028 # For t2/t1 ≥ 2.5:

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ 4.36 k Pns = 3028 #

$P_{ns} = 2.7t_1 dF_{u1}$ 3.03 k $P_{ns} = 2.7t_1 dF_{u1}$ 3.03 k

$P_{ns} = 2.7t_2 dF_{u2}$ 4.32 k $P_{ns} = 2.7t_2 dF_{u2}$ 4.32 k

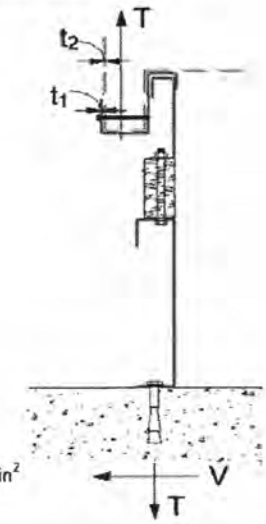
Pns/Ω = 1009 # <- Controls
Pss/Ω = 1045 #

Tension: Pnot = 1.360 k (screw pull-out strength) $P_{not} = 0.85t_c dF_{u2})$ $t_c = \min(t_1, t_2)$
Pnov = 3.476 k (screw pull-over strength) $P_{nov} = 1.5t_1 d_w F_{u1}$
Pts/Ω = 453 # <- Controls
Pts/Ω = 1220 # (full tensile screw capacity)

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	8.143	3	2.71	1009 #	4	2.00 in
Short side:	8.143	3	2.71	1009 #	4	2.00 in

clip width (in) = 7.00 clip height = 2.5 in
min spacing = 0.73 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 = 0.403 in^2 Ant = 0.080 in^2
Rn/Ω = 8.620 k $R_n = 0.6F_y A_{gv} + F_u A_{nt} \leq 0.6F_u A_{nv} + F_u A_{nt}$
BSR O.K. (AISI Sect. E5.3)



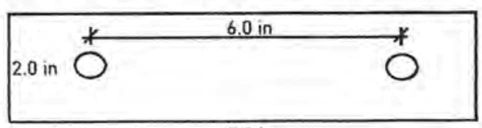
Curb Loads (copied from above)

Transverse: (on long edge)	$Comp_{MAX}$ =	4865	lbs
	$Tens_{MAX}$ =	3843	lbs
	$Shear_{MAX}$ =	8143	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	4003	lbs
	$Tens_{MAX}$ =	2980	lbs
	$Shear_{MAX}$ =	8143	lbs

Loads at each Isolator Type: **JQA**

Transverse loading:	$Comp_{MAX}$ =	1621.7	lbs
(on long edge)	$Tens_{MAX}$ =	1280.9	lbs
# isolators: 3	$Shear_{MAX}$ =	678.6	lbs
Longitudinal loading:	$Comp_{MAX}$ =	1334.3	lbs
(on short edge)	$Tens_{MAX}$ =	993.5	lbs
# isolators: 3	$Shear_{MAX}$ =	678.6	lbs

Max compression force on isolator: 1.622 k ≤ 1.660 k **O.K.**
Max uplift on isolator: 1.281 k ≤ 1.660 k **O.K.**
Max shear on isolator: 0.679 k ≤ 0.800 k **O.K.**



Forces on top bolt:
d_b = 0.375 in
upper rail, t = 0.1017 in
Tension = 1.281 k
Shear = 0.679 k

Shear on curb rail: $P_n = teF_u$ Ω = 2.00 (Appendix A, Section E3.1 AISI)
Pn/Ω = 6.611 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 = 7.117 k An = 0.165 in
N.S.R. O.K. $F_t = (0.1 + 3d/s)F_u \leq F_u =$ 43.063 ksi

Bolt Bearing Strength: $P_n = Cm_f dtF_u$ Ω = 2.50 (Section E3.3.1 AISI)
Pn/Ω = 2.975 k d/t = 3.69
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.**

$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \leq F_{nt}$ fv = 6.14 ksi O.K.

Combined Not Applicable F'nt = 27.77 ksi Fnv/Ω = 10.00 ksi

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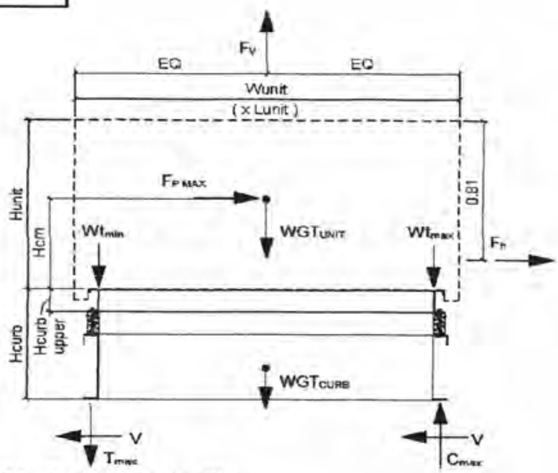
Client: ProVent PV1805
Project: CBISC-08 Iso Curb (CBISCSLM1830**) Base curb
Unit: ZJ,ZR 180-300; XP 180-240, ZF 210-300



Curb Information

Hcurb =	25	in	(Height of curb)
Lcurb =	128.25	in	(Length of curb)
wcurb =	86	in	(Width of curb)
WGTcurb =	628	lbs	(Weight of curb)
# Clips long side =	3		# Clips short side = 3

Unit Information

WGTunit =	3061.3	lbs	(Weight of Unit)
Wtmax =	908	lbs	(Maximum corner weight)
Wtmin =	306	lbs	(Minimum corner weight)
Hunit =	52.625	in	(Height of unit above curb)
Hcm =	26.3125	in	(Height to center of mass)
Lunit =	136.25	in	(Length of unit)
Wunit =	92	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 =	8143	lbs	(0.7*Fpmax) FpmaxASD = 9814 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)
$F_{h\ ASD\ trans}$ =	2723	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	1839	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	2548	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	4791	lbs	$=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb$
$Tension_{SEISMIC}$ =	3768	lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	649	lbs	$=[F_{h\ transASD}*Hcm+2*0.6*Wtmax*wcurb-F_{vertASD}*wcurb/2]/wcurb$
$Tension_{WIND}$ =	1360	lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Longitudinal:

$Compression_{SEISMIC}$ =	3970	lbs	$=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb$
$Tension_{SEISMIC}$ =	2947	lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	193	lbs	$=[F_{h\ transASD}*Hcm+2*0.6*Wtmax*Lcurb-F_{vertASD}*Lcurb/2]/Lcurb$
$Tension_{WIND}$ =	904	lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	4791	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	3768	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	3970	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2947	lbs	---> Along short edge of curb.

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

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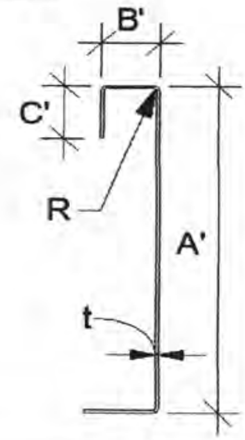
Curb Design

Fy = 50 ksi   Fu = 65 ksi   t = 0.1017 [12 Gauge]
E = 29500 ksi



Calculate Section Properties of Curb

A' =	25.000 in	a =	24.492 in = A'-(2r+t)
B' =	1.750 in	a' =	24.898 in = A'-t
C' =	0.000 in (0 if no lips)	b =	1.496 in = B'-[r+t/2+α(r+t/2)]
α =	0.000 (0 - no Lip; 1 w/ lip)	b' =	1.699 in = B'-(t/2+αt/2)
R =	0.1525 (Inside bend radius)	c =	0.000 in = α[C'-(r+t/2)]
t =	0.1017 in	c' =	0.000 in = α(C'-t/2)
r' =	0.203 in = R+t/2	u =	0.319 in = πr/2
x =	0.103 in (Distance between centroid and web centerline)		
Ix =	181.709 in (Moment of Inertia about X-Axis)		
Iy =	0.302 in (Moment of Inertia about Y-Axis)		
A =	2.86 in^2		
rx =	7.97 in		
ry =	0.325 in		
rmin =	0.325 in		

Axial Compression

Pu = 4.072 k   (Max Axial Comp) Ω_c = 1.80
Pn/Ωc = 12.449 k
Fe = 8.93 ksi
λc = 2.37
Fn = 7.83 ksi
Ly = 73.38 in   Lateral unbraced length
k_yL_y/r_y = 181   (assume k=0.8)

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

Compression Check = O.K.

Check Web Crippling

h =	25 in	-- Check limits:		C = 4.00
t =	0.1017 in	h/t =	245.82 ≤ 200	C_R = 0.14
N =	7.00	N/t =	68.83 ≤ 210	C_N = 0.35
Ω_w =	1.75	N/h =	0.28 ≤ 2.0	C_h = 0.02
P_n =	4.106 k	R/t =	1.50 ≤ 9.0	
P_n/Ω_w =	2.346 k			
Long side: Pu_{Trans} =	1.597 k	**O.K.**	# clips = 3	
Short side: Pu_{Long} =	1.323 k	**O.K.**	# clips = 3	

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

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

*****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

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

Pwc = 4.106 k   Ae = 0.380 in^2
Pn = 16.181 k
P_n/Ω_c = 9.518 k   **O.K.**

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

Tcrnmax = 2036 lbs   Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 1884 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 = 0.8
# of Bolts required for Shear = 1.7   ***If combined fails:
# of Bolts Used = 2.0   USE --> 4.0
Check Combined Stress in Bolts & Inserts: 1.270 N.G.   StressComb = 0.635 **O.K.**

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Check 1/8" welded connection <--- USE WELD $\Omega =$ 2.35

Assume L/t > 25: 25*t = 2.543 in
Lreq'd = 0.893 in

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

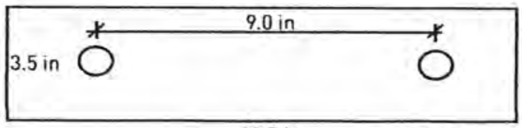
Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	4865	lbs
	$Tens_{MAX}$ =	3843	lbs
	$Shear_{MAX}$ =	8143	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	4003	lbs
	$Tens_{MAX}$ =	2980	lbs
	$Shear_{MAX}$ =	8143	lbs

Loads at each Isolator Type: JQBX

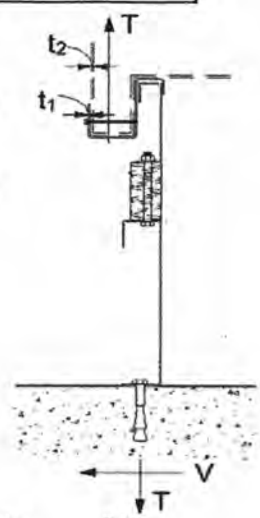
Transverse loading: (on long edge)	$Comp_{MAX}$ =	1621.7	lbs
	$Tens_{MAX}$ =	1280.9	lbs
# isolators: 3	$Shear_{MAX}$ =	678.6	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	1334.3	lbs
	$Tens_{MAX}$ =	993.5	lbs
# isolators: 3	$Shear_{MAX}$ =	678.6	lbs

Max compression force on isolator: 1.622 k ≤ 2.000 k **O.K.**
Max uplift on isolator: 1.281 k ≤ 2.000 k **O.K.**
Max shear on isolator: 0.679 k ≤ 1.500 k **O.K.**



Forces on bottom bolts:

d_b = 0.625 in
base curb, t = 0.1017 in
Tension = 0.640 k / bolt
Shear = 0.339 k / bolt



Shear on base curb: $P_n = teF_u$ $\Omega =$ 2.00 (Appendix A, Section E3.1 AISI)
Pn/Ω = 6.611 k e = 1.0 in
Shear O.K.

Net section rupture: $P_n = A_nF_t$ $\Omega =$ 2.22 (Appendix A, Section E3.2 AISI)
Pn/Ω = 9.089 k An = 0.140 in
N.S.R. O.K. $F_t = (0.1 + 3d/s)F_u \leq F_u =$ 65.000 ksi

Bolt Bearing Strength: $P_n = Cm_fdtF_u$ $\Omega =$ 2.50 (Section E3.3.1 AISI)
Pn/Ω = 4.958 k d/t = 6.15
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 = 1.11 ksi O.K.

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:	$Uplift_{MAX}$ = 6958 lbs	$Shear_{MAX}$ = 4907 lbs	
$Compression_{SEISMIC}$ =	8191 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(W$GT_{unit+curb}$/2)*wcurb]/wcurb	
$Tension_{SEISMIC}$ =	6958 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)	
$Compression_{WIND}$ =	1458 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*(W$GT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb	
$Tension_{WIND}$ =	1792 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*(W$GT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb	
Longitudinal:	$Uplift_{MAX}$ = 5029 lbs	$Shear_{MAX}$ = 4907 lbs	
$Compression_{SEISMIC}$ =	6262 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(W$GT_{unit+curb}$/2)*Lcurb]/Lcurb	
$Tension_{SEISMIC}$ =	5029 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)	
$Compression_{WIND}$ =	569 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*(W$GT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb	
$Tension_{WIND}$ =	903 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*(W$GT_{unit+curb}$/2)*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb	

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

$Tall_{metal}$ = 946.67 lbs $Vall_{metal}$ = 1043.33 lbs
Transverse: $Tall_{wood}$ = 671.25 lbs $Vall_{wood}$ = 224 lbs

# of Screws Req'd for Uplift = 10.37 COMBINED LOADING: 0.949 O.K.
# of Screws Req'd for Shear = 21.91 Req'd Min Spacing = 3.6 in o.c.
Total # of screws required = 34

Use 34 - 1/4" ϕ 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 =	7.49	COMBINED LOADING:	0.980 O.K.
# of Screws Req'd for Shear =	21.91	Screw Spacing =	2.7 in o.c.
Total # of screws required =	30		

Use 30 - 1/4" ϕ wood lag screws @ 2.7 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 =	1.01	COMBINED LOADING:	0.780 O.K.
# of Bolts Req'd for Shear =	1.33	Bolt Spacing =	58.1 in o.c.
Total # of bolts required =	3		

Use 3 - 1/2" ϕ A307 Bolts to steel angle below deck @ 58.1 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift =	0.73	COMBINED LOADING:	0.687 O.K.
# of Bolts Req'd for Shear =	1.33	Bolt Spacing =	37.0 in o.c.
Total # of bolts required =	3		

Use 3 - 1/2" ϕ A307 Bolts to steel angle below deck @ 37 in o.c. along short side of curb

For Concrete anchorage: SEISMIC (0.6-0.14SDS)D + $0.7\Omega_o$E (Ω_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: $Uplift_{MAX}$ = 15741 lbs $Shear_{MAX}$ = 12267 lbs

$Compression_{SEISMIC}$ =	16974 lbs	=[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb
$Tension_{SEISMIC}$ =	15741 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Shear_{SEISMIC}$ =	12267 lbs	=2.5*FpmaxASD/2

Min Bolts Req'd Uplift =	15.34	spacing = 6.95 in o.c.		Tapplied =	828.5 lbs
Min Bolts Req'd Shear =	7.20	spacing = 14.89286 in o.c.		Vapplied =	645.6 lbs

Try using 19 bolts spaced at 6.46 in o.c. COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.19

Use 19 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 6.5 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 10919 lbs $Shear_{MAX}$ = 12267 lbs

$Compression_{SEISMIC}$ =	12151 lbs	=[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	10919 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Shear_{SEISMIC}$ =	12267 lbs	=2.5*FpmaxASD/2

Min Bolts Req'd Uplift =	10.64	spacing = 6.2 in o.c.		Tapplied =	727.9 lbs
Min Bolts Req'd Shear =	7.20	spacing = 8.857143 in o.c.		Vapplied =	817.8 lbs

Try using 15 bolts spaced at 5.29 in o.c. COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 1.19

Use 15 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 5.3 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: (CBISCSLM1(CBISCSLM1! Unit: ZJ,ZR 180-300; XP 180-240, ZF 210-300

UPPER CURB RAIL THICKNESS: 0.0713 in 14 Gauge
UNIT CLIP THICKNESS: 0.0713 in 14 Gauge
 # OF CLIPS (LONG SIDE) - 3 clips with 4 - #14 SMS screws each clip
WEB STIFFENER: 16Ga x 3/4in x 7in (C-channel) stiffener at each clip
 # OF CLIPS (SHORT SIDE) - 3 clips with 4 - #14 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: 0.1017 in 12 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	34 @ 3.64 in o.c.	3 @ 58.13 in o.c.	19 @ 6.46 in o.c.
SHORT DIRECTION	30 @ 2.69 in o.c.	3 @ 37 in o.c.	15 @ 5.29 in o.c.