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Structural Calculations

for

CBISC-06 Series

REGISTERED PROFESSIONAL ENGINEER
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NO. SE 3578
EXP. 6/30/19
STRUCTURAL
STATE OF CALIFORNIA

8/23/18

Prepared for:

PROVENT / RRS

3847 Wabash Drive
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Date: August 22, 2018

Project Number: PV1805

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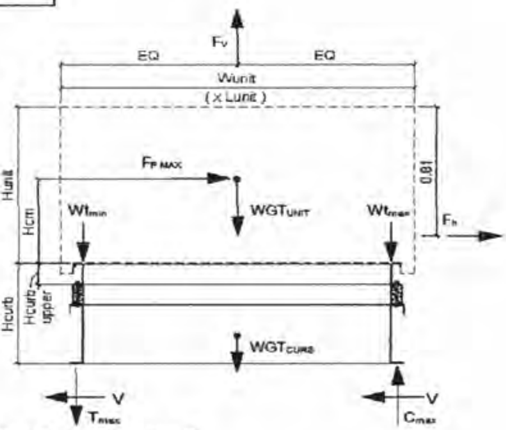
San Diego, CA 92120
(619)727-4800

Client: ProVent PV1805
Project: CBISC-06 Iso Curb (CBISCPRL**) Upper curb rail
Unit: ZX 08-14; XX 08-12; ZY 07-12; XY 07-09



Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	84	in	(Length of curb)
wcurb =	53	in	(Width of curb)
WGTcurb =	425	lbs	(Weight of curb)
# Clips long side =	2		# Clips short side = 2

Unit Information

WGTunit =	1167	lbs	(Weight of Unit)
Wtmax =	359	lbs	(Maximum corner weight)
Wtmin =	211	lbs	(Minimum corner weight)
Hunit =	48.56	in	(Height of unit above curb)
Hcm =	24.28	in	(Height to center of mass)
Lunit =	87.18	in	(Length of unit)
Wunit =	61.69	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 =	3104	lbs	(0.7*Fpmax) FpmaxASD = 4235 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)
$F_{h\,ASD\,trans}$ =	1213	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb upper) (Eq. 29.5-2)
$F_{h\,ASD\,long}$ =	859	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb upper)
$F_{vert\,ASD}$ =	1093	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	2330	lbs	$=(FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb)/wcurb$
$Tension_{SEISMIC}$ =	1940	lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	440	lbs	$=(F_{h\,transASD}*Hcm+2*0.6*Wtmax*wcurb-F_{vertASD}*wcurb/2)/wcurb$
$Tension_{WIND}$ =	832	lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Longitudinal:

$Compression_{SEISMIC}$ =	1805	lbs	$=(FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb)/Lcurb$
$Tension_{SEISMIC}$ =	1415	lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	132	lbs	$=(F_{h\,transASD}*Hcm+2*0.6*Wtmax*Lcurb-F_{vertASD}*Lcurb/2)/Lcurb$
$Tension_{WIND}$ =	525	lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	2330	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1940	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1805	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1415	lbs	---> Along short edge of curb.

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

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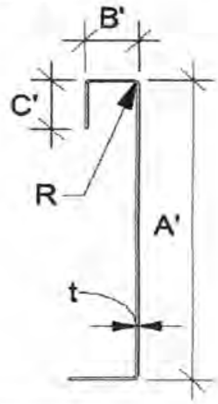
Curb Design

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

Calculate Section Properties of Curb



A' =	5.500 in		a =	4.992 in	= A'-(2r+t)
B' =	1.500 in		a' =	5.398 in	= A'-t
C' =	0.000 in	(0 if no lips)	b =	1.246 in	= B'-(r+t/2+α(r+t/2))
α =	0.000	(0 - no Lip; 1 w/ lip)	b' =	1.449 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 = 0.259 in (Distance between centroid and web centerline)
Ix = 3.349 in (Moment of Inertia about X-Axis)
Iy = 0.151 in (Moment of Inertia about Y-Axis)
A = 0.83 in^2
rx = 2.01 in
ry = 0.427 in
rmin = 0.427 in

Axial Compression

Pu = 1.552 k (Max Axial Comp) Ω_c = 1.80
Pn/Ωc = 4.739 k
Fe = 11.77 ksi
λc = 2.06
Fn = 10.33 ksi
Ly = 84.00 in Lateral unbraced length
k_yL_y/r_y = 157 (assume k=0.8)

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

Compression Check = O.K.

Check Web Crippling

h =	5.5 in	-- Check limits:		C = 7.50	(See table C3.4.1-2, fastened to support, two flange, end loading)
t =	0.1017 in	h/t =	54.08 ≤ 200	C_R = 0.08	
N =	7.00	N/t =	68.83 ≤ 210	C_N = 0.12	
Ω_w =	1.75	N/h =	1.273 ≤ 2.0	C_h = 0.048	
P_n =	4.038 k	R/t =	1.50 ≤ 12.0		
P_n/Ω_w =	2.308 k				
Long side: Pu_{Trans} =	1.165 k	**O.K.**	# clips = 2		
Short side: Pu_{Long} =	0.903 k	**O.K.**	# clips = 2		

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

Check Web Stiffener N/A

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

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

Pwc = 4.038 k Ae = 0.380 in^2
Pn = 16.133 k
Pn/Ω_c = 9.490 k **Not Req'd**

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

Tcrnmax = 776 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 970 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 = 0.3
# of Bolts required for Shear = 0.9 ***If combined fails:
# of Bolts Used = 1.0 USE --> 2.0
Check Combined Stress in Bolts & Inserts: 1.198 N.G. StressComb = 0.599 **O.K.**

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

Assume L/t > 25: 25*t = 2.543 in
Lreq'd = 0.460 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 | #10 SMS screw | Ω = 3.0

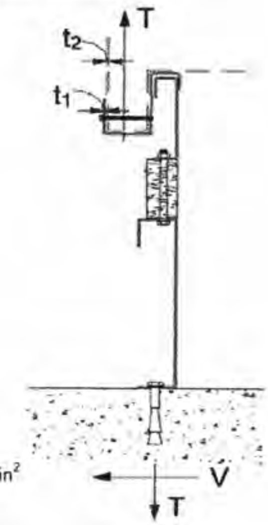
t1 = 0.0713 in (clip thickness) | Fu1 = 65 ksi
t2 = 0.1017 in (unit base rail thickness) | Fu2 = 65 ksi
d = 0.190 in (screw diameter) | dw = 0.375 in (nom. washer diameter)
t2/t1 = 1.4

For t2/t1 ≤ 1.0: Pns = 2377 # | For t2/t1 ≥ 2.5:

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ 3.86 k | Pns = 2377 #
$P_{ns} = 2.7t_1 dF_{u1}$ 2.38 k | $P_{ns} = 2.7t_1 dF_{u1}$ 2.38 k
$P_{ns} = 2.7t_2 dF_{u2}$ 3.39 k | $P_{ns} = 2.7t_2 dF_{u2}$ 3.39 k

Pns/Ω = 792 #
Pss/Ω = 540 # <- Controls

Tension: Pnot = 1.068 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 = 356 # <- Controls
Pts/Ω = 820 # (full tensile screw capacity)



	Shear (k)	# clips	V_{clip} (k)	V_{allow}(lb)	# screws	spacing
Long side:	3.104	2	1.55	540 #	4	2.00 in
Short side:	3.104	2	1.55	540 #	4	2.00 in

clip width (in) = 7.00 | clip height = 2.5 in
min spacing = 0.57 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 = 0.416 in^2 | Ant = 0.082 in^2
Rn/Ω = 8.674 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)

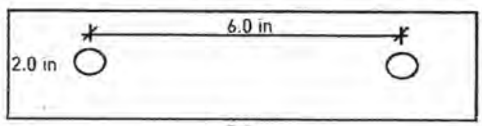
Curb Loads (copied from above)

Transverse: (on long edge)	$Comp_{MAX}$ =	2330	lbs
	$Tens_{MAX}$ =	1940	lbs
	$Shear_{MAX}$ =	1552	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	1805	lbs
	$Tens_{MAX}$ =	1415	lbs
	$Shear_{MAX}$ =	1552	lbs

Loads at each Isolator Type: **JQA**

Transverse loading:	$Comp_{MAX}$ =	1165.0	lbs
(on long edge)	$Tens_{MAX}$ =	970.1	lbs
# isolators: 2	$Shear_{MAX}$ =	776.1	lbs
Longitudinal loading:	$Comp_{MAX}$ =	902.6	lbs
(on short edge)	$Tens_{MAX}$ =	707.7	lbs
# isolators: 2	$Shear_{MAX}$ =	776.1	lbs

Max compression force on isolator: 1.165 k ≤ 1.660 k **O.K.**
Max uplift on isolator: 0.970 k ≤ 1.660 k **O.K.**
Max shear on isolator: 0.776 k ≤ 0.800 k **O.K.**



Forces on top bolt:
d_b = 0.375 in
upper rail, t = 0.1017 in
Tension = 0.970 k
Shear = 0.776 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. | $F_t = (0.1 + 3d/s)F_u \le F_u =$ 43.063 ksi

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

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

fv = 7.03 ksi O.K.

Combined Not Applicable | F'nt = 24.19 ksi | Fnv/Ω = 10.00 ksi

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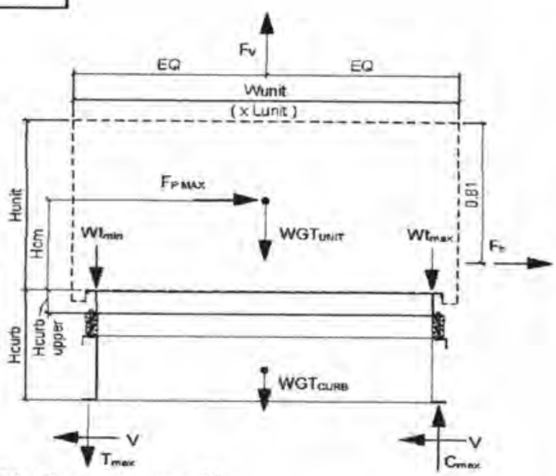
Client:	ProVent PV1805
Project:	CBISC-06 Iso Curb (CBISCPRL**) Base curb
Unit:	ZX 08-14; XX 08-12; ZY 07-12; XY 07-09



Curb Information

Hcurb =	25	in	(Height of curb)
Lcurb =	84.25	in	(Length of curb)
wcurb =	56	in	(Width of curb)
WGTcurb =	425	lbs	(Weight of curb)
# Clips long side =	2		# Clips short side = 2

Unit Information

WGTunit =	1167	lbs	(Weight of Unit)
Wtmax =	359	lbs	(Maximum corner weight)
Wtmin =	211	lbs	(Minimum corner weight)
Hunit =	48.56	in	(Height of unit above curb)
Hcm =	24.28	in	(Height to center of mass)
Lunit =	87.18	in	(Length of unit)
Wunit =	61.69	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 =	3104 lbs (unit only)	(0.7*Fpmax) FpmaxASD = 4235 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)
$F_{h\ ASD\ trans}$ =	1651 lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	1168 lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	1093 lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	2254 lbs	$=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb$
$Tension_{SEISMIC}$ =	1864 lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	600 lbs	$=[F_{h\ transASD}*Hcm+2*0.6*Wtmax*wcurb-F_{vertASD}*wcurb/2]/wcurb$
$Tension_{WIND}$ =	992 lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Longitudinal:

$Compression_{SEISMIC}$ =	1803 lbs	$=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb$
$Tension_{SEISMIC}$ =	1413 lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	220 lbs	$=[F_{h\ transASD}*Hcm+2*0.6*Wtmax*Lcurb-F_{vertASD}*Lcurb/2]/Lcurb$
$Tension_{WIND}$ =	613 lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	2254	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1864	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1803	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1413	lbs	---> Along short edge of curb.

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

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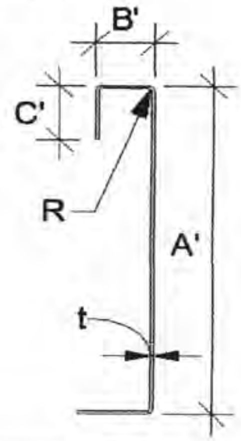
Curb Design

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 =	1.552 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

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

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

Compression Check = O.K.

Check Web Crippling

h =	25 in	-- Check limits:		C = 4.00
t =	0.0713 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} =	1.127 k	**O.K.** # clips = 2		
Short side: Pu_{Long} =	0.901 k	**O.K.** # clips = 2		

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

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

*****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 =	776 lbs	Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax =	932 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 = 0.3

# of Bolts required for Shear = 0.9 ***If combined fails:

# of Bolts Used = 1.0 USE --> 4.0

Check Combined Stress in Bolts & Inserts: 1.163 N.G. StressComb = 0.291 **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 = 0.630 in

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

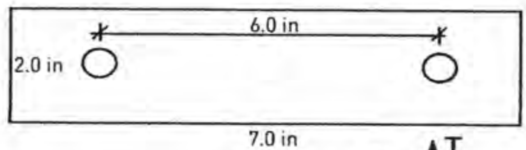
Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	2330	lbs
	$Tens_{MAX}$ =	1940	lbs
	$Shear_{MAX}$ =	1552	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	1805	lbs
	$Tens_{MAX}$ =	1415	lbs
	$Shear_{MAX}$ =	1552	lbs

Loads at each Isolator Type: JOA

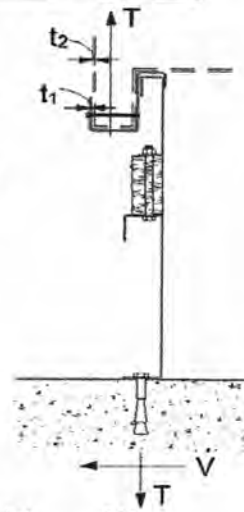
Transverse loading: (on long edge)	$Comp_{MAX}$ =	1165.0	lbs
	$Tens_{MAX}$ =	970.1	lbs
# isolators: 2	$Shear_{MAX}$ =	776.1	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	902.6	lbs
	$Tens_{MAX}$ =	707.7	lbs
# isolators: 2	$Shear_{MAX}$ =	776.1	lbs

Max compression force on isolator: 1.165 k ≤ 1.660 k **O.K.**
Max uplift on isolator: 0.970 k ≤ 1.660 k **O.K.**
Max shear on isolator: 0.776 k ≤ 0.800 k **O.K.**



Forces on bottom bolts:

d_b = 0.5 in
base curb, t = 0.0713 in
Tension = 0.485 k / bolt
Shear = 0.388 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 = 5.909 k An = 0.107 in
N.S.R. O.K. $F_t = (0.1 + 3d/s)F_u \leq F_u =$ 55.250 ksi

Bolt Bearing Strength: $P_n = Cm_f dtF_u$ Ω = 2.50 (Section E3.3.1 AISI)
Pn/Ω = 2.781 k d/t = 7.01
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 = 0.1963 in^2
Pnt/Ω = 3.927 k **Bolt tension O.K.** Ωt = 2.25

Shear $P_{nv} = A_bF_{nv}$ Fnv = 27.0 ksi Ωv = 2.40
Pnv/Ω = 2.209 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 = 1.98 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:	$Uplift_{MAX}$ = 4203 lbs	$Shear_{MAX}$ = 2117 lbs
$Compression_{SEISMIC}$ =	4734 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb
$Tension_{SEISMIC}$ =	4203 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ =	1384 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1522 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb
Longitudinal:	$Uplift_{MAX}$ = 2953 lbs	$Shear_{MAX}$ = 2117 lbs
$Compression_{SEISMIC}$ =	3485 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	2953 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ =	614 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	752 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)

	$Tall_{metal}$ =	946.67 lbs	$Vall_{metal}$ =	1043.33 lbs
Transverse:	$Tall_{wood}$ =	671.25 lbs	$Vall_{wood}$ =	224 lbs
	# of Screws Req'd for Uplift =	6.26	COMBINED LOADING:	1.048 NO GOOD
	# of Screws Req'd for Shear =	9.45	Req'd Min Spacing =	5.4 in o.c.
	Total # of screws required =	15		

Use 15 - 1/4" φ wood lag screws @ 5.4 in o.c. along long side of curb w/ 3.5" Min. Embed

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Longitudinal:

# of Screws Req'd for Uplift =	4.40	COMBINED LOADING:	1.066 NO GOOD
# of Screws Req'd for Shear =	9.45	Screw Spacing =	4.0 in o.c.
Total # of screws required =	13		

Use 13 - 1/4" ф wood lag screws @ 4 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 =	0.61	COMBINED LOADING:	0.592 O.K.
# of Bolts Req'd for Shear =	0.58	Bolt Spacing =	72.3 in o.c.
Total # of bolts required =	2		

Use 2 - 1/2" ф A307 Bolts to steel angle below deck @ 72.3 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift =	0.43	COMBINED LOADING:	0.501 O.K.
# of Bolts Req'd for Shear =	0.58	Bolt Spacing =	44.0 in o.c.
Total # of bolts required =	2		

Use 2 - 1/2" ф A307 Bolts to steel angle below deck @ 44 in o.c. along short side of curb

For Concrete anchorage: SEISMIC (0.6-0.14SDS)D + 0.7Ω_oE (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 $\propto = (1 + 0.2SDS)D + 2.5E = 1.87$

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

Transverse: $Uplift_{MAX}$ = 9792 lbs $Shear_{MAX}$ = 5293 lbs

$Compression_{SEISMIC}$ =	10324 lbs	=[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb
$Tension_{SEISMIC}$ =	9792 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Shear_{SEISMIC}$ =	5293 lbs	=2.5*FpmaxASD/2

Min Bolts Req'd Uplift =	9.54	spacing =	6.69 in o.c.	Tapplied =	890.2 lbs
Min Bolts Req'd Shear =	3.10	spacing =	20.08333 in o.c.	Vapplied =	481.2 lbs

Try using 11 bolts spaced at 7.23 in o.c.   COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 1.15

Use 11 - 3/4" ф thrd'd rods in Hilti Hit-HY 200 epoxy @ 7.2 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 6669 lbs $Shear_{MAX}$ = 5293 lbs

$Compression_{SEISMIC}$ =	7200 lbs	=[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	6669 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Shear_{SEISMIC}$ =	5293 lbs	=2.5*FpmaxASD/2

Min Bolts Req'd Uplift =	6.50	spacing =	5.333333 in o.c.	Tapplied =	833.6 lbs
Min Bolts Req'd Shear =	3.10	spacing =	10.66667 in o.c.	Vapplied =	661.7 lbs

Try using 8 bolts spaced at 6.29 in o.c.   COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 1.20

Use 8 - 3/4" ф thrd'd rods in Hilti Hit-HY 200 epoxy @ 6.3 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: (CBISCPRL* (CBISCPRL** Unit: ZX 08-14; XX 08-12; ZY 07-12; XY 07-09

UPPER CURB RAIL THICKNESS: 0.1017 in 12 Gauge
UNIT CLIP THICKNESS: 0.0713 in 14 Gauge
 # OF CLIPS (LONG SIDE) - 2 clips with 4 - #10 SMS screws each clip
WEB STIFFENER: NOT REQUIRED
 # OF CLIPS (SHORT SIDE) - 2 clips with 4 - #10 SMS screws each clip
WEB STIFFENER: NOT REQUIRED

VIBRATION ISOLATOR TYPE: JQA   Top stud diameter: 3/8
Anchor bolt diameter: 1/2   Anchor hole diamter: 9/16

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" ф SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts

CURB ANCHORAGE	WOOD 1/4" ф wood lag screws w/ 3.5" Min. Embed (SGmin = 0.43)	STEEL 1/2" ф A307 Bolts to steel angle below deck	CONCRETE 3/4" ф thrd'd rods in Hilti Hit-HY 200 epoxy w/ 4" embed
LONG DIRECTION	15 @ 5.45 in o.c.	2 @ 72.25 in o.c.	11 @ 7.23 in o.c.
SHORT DIRECTION	13 @ 4 in o.c.	2 @ 44 in o.c.	8 @ 6.29 in o.c.