MOUR GROUP
ENGINEERING + DESIGN

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

Structural Calculations

for

CBISC-04 Series

CBISCPRD3715** Curb

Prepared for:

PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

Date: April 2, 2021

Project Number: PV2101

For wood, concrete and steel attachment see Roof Anchorage Detail, Form No. CB-62.

Welded Isolation springs housingare standard. For bolted spring housing, neoprene pads and spring cups see Weldment and Bolting Detail, Form No. CB-61

VIBRATION ISOLATION ROOF CURBS
YORK UNITS

ZT, ZH, ZJ, ZR 037-150
ZF, XP, ZB 078-150

PROVENT P/N	A	B	EST. WEIGHT
CBISCPRD371518**	8"	18"	365 Lbs
CBISCPRD371521**	11"	21"	387 Lbs
CBISCPRD371524**	14"	24"	410 Lbs

**Note: Spring configuration must be added to part number at time of order

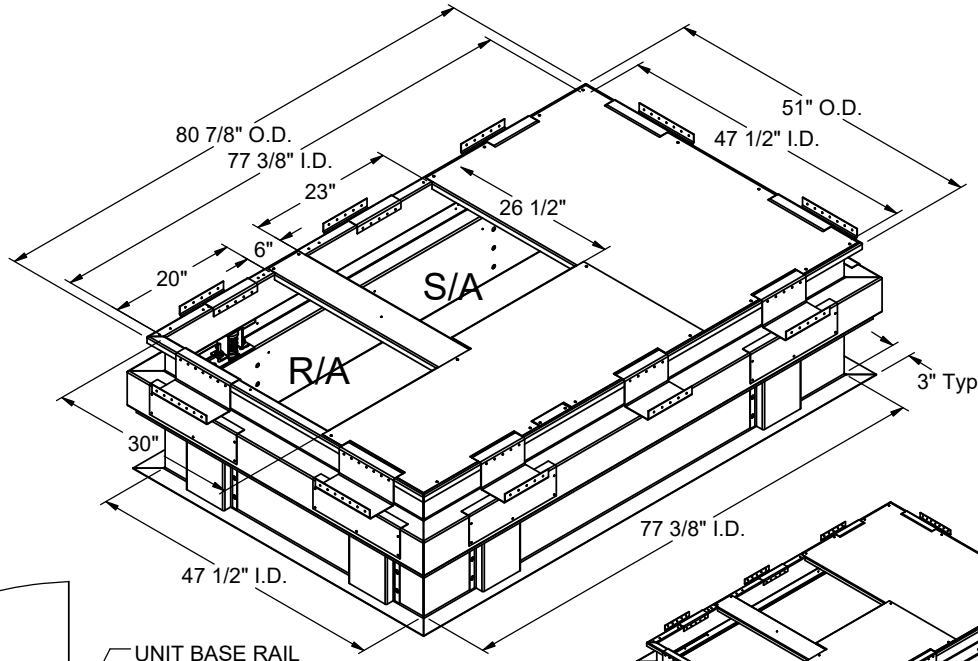
Meets seismic requirements for the following codes:
CBC 2019
IBC 2018

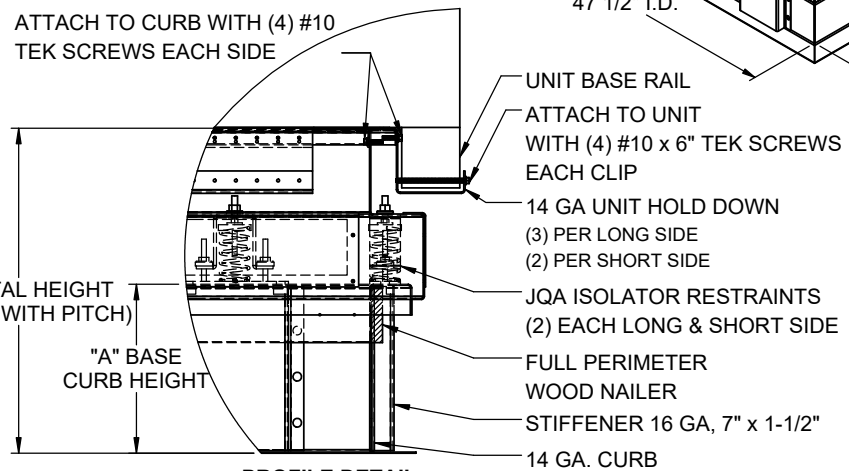
FEATURES

- Roof curbs sides and ends are 14 ga.
- Fully welded construction.
- Gasketing package provided.
- Heat treated wood nailer provided.
- insulated deck pans provided.
- Pitched curbs and taller curbs are available.

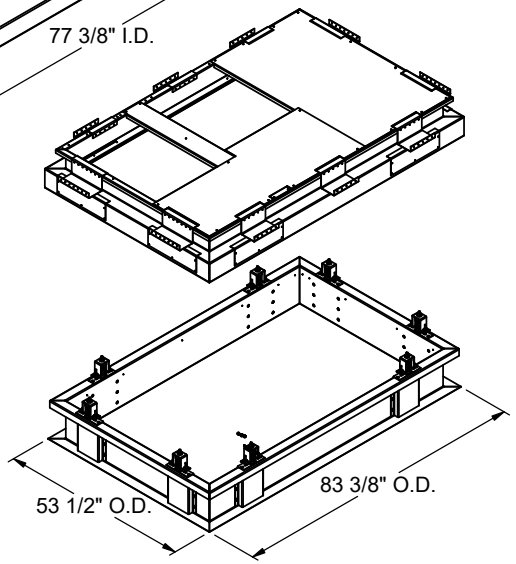
NOTES

- Attach ductwork to roof curb. Flanges of duct rest on top of the curb, Support ductwork below the curb.
- Thru the curb utillities are available. Contact you York distributor or Provent directly.





PROFILE DETAIL



REGISTERED PROFESSIONAL ENGINEER
GLENN A. MOURITZEN
SE 3578
Exp. 6/30/21
STRUCTURAL
STATE OF CALIFORNIA

ProVent

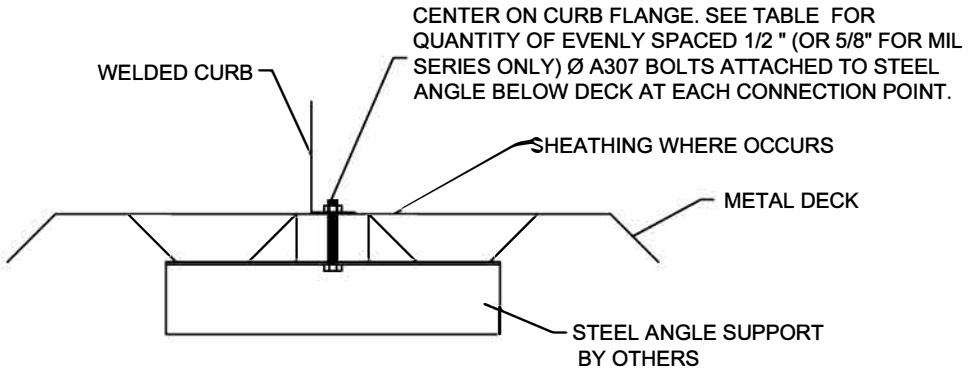
3847 WABASH DRIVE
MIRA LOMA, CA 91752

PHONE (951) 685-1101
FAX (619) 872-9799

SUBMITED TO: _____
COMPANY: _____
JOB NAME: _____
EQUIPMENT: _____
NOTES: _____

FORM NO:	PART NUMBER:	
CBISC-04	-	
DATE:	**REV:**	**DRAWN BY:**
4/2/2021	3	ALL

STEEL ATTACHMENT



	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	**LONG SIDE**	**SHORT SIDE**
LXS	2 @ 38.5" O.C.	2 @ 23" O.C.
LXL	2 @ 38.5" O.C.	2 @ 33" O.C.
SUN3672	2 @ 63" O.C.	2 @ 27.25" O.C.
PRD3715	3 @ 35.69" O.C.	2 @ 41.5" O.C.
PRS	2 @ 61.38" O.C.	2 @ 31.13" O.C.
PRL	3 @ 36.13" O.C.	2 @ 44" O.C.
SLU180	3 @ 58.13" O.C.	3 @ 37" O.C.
SLM1830	4 @ 38.75" O.C	3 @ 37" O.C.

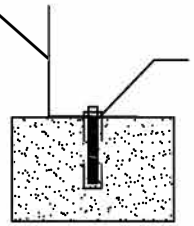
Meets seismic requirements for the following codes:
CBC 2019
IBC 2018

ROOF ANCHORAGE DETAIL

CBISC Series
LXS
LXL
SUN3672
PRD3715
PRS
PRL
SLU180
SLM1830

ASSUMES:
CONC SLAB
f'c= 4000PSI MINIMUM
6" MIN THICKNESS
NORMAL WEIGHT CONCRETE
OR SAND LIGHT WEIGHT

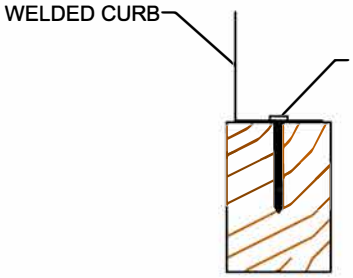
CONCRETE ATTACHMENT



	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	**LONG SIDE**	**SHORT SIDE**
LXS	9 @ 4.81" O.C.	6 @ 4.6" O.C.
LXL	8 @ 5.5" O.C.	7 @ 5.5" O.C.
SUN3672	9 @ 7.88" O.C.	5 @ 6.81" O.C.
PRD3715	18 @ 4.2" O.C.	12 @ 3.77" O.C.
PRS	11 @ 6.14" O.C.	7 @ 5.19" O.C.
PRL	14 @ 5.56" O.C.	10 @ 4.89" O.C.
SLU180	18 @ 6.84" O.C.	13 @ 6.17" O.C.
SLM1830	23 @ 5.28" O.C.	16 @ 4.93" O.C.

*** SIX INCHES FROM EACH CORNER EVENLY SPACED.**
**** CENTERED.**

WOOD ATTACHMENT



	NO. OF ANCHORAGE SCREWS REQUIRED	
CURB	**LONG SIDE**	**SHORT SIDE**
LXS	7 @ 7.08" O.C.	5 @ 6.75" O.C.
LXL	7 @ 7.08" O.C.	6 @ 7.4" O.C.
SUN3672	8 @ 9.57" O.C.	5 @ 7.81" O.C.
PRD3715	16 @ 5.03" O.C.	11 @ 4.55" O.C.
PRS	10 @ 7.26" O.C.	7 @ 5.88" O.C.
PRL	13 @ 6.35" O.C.	9 @ 6" O.C.
SLU180	18 @ 7.07" O.C.	13 @ 6.5" O.C.
SLM1830	23 @ 5.47" O.C.	17 @ 4.88" O.C.

FOUR INCHES FROM EACH CORNER EVENLY SPACED

ProVent
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MIRA LOMA, CA 91725
PHONE (951) 685-1101
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SUBMITTED TO: _____
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JOB NAME: _____
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NOTES: _____

FORM NO: CB-62

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3/30/2021	-	ALL

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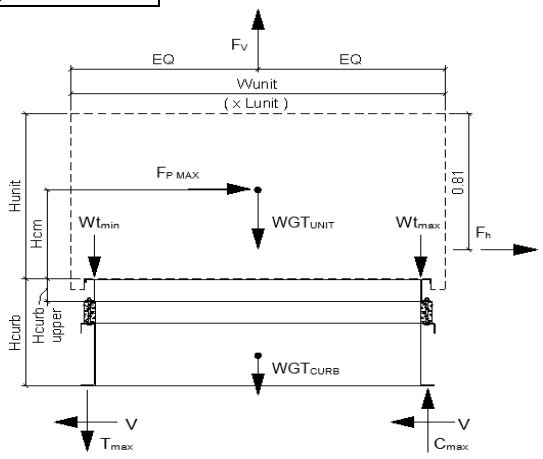
Client:	ProVent	PV2101	Previous: PV1805	
Project:	CBISC-04	Iso Curb	CBISCPRD3715	Upper curb rail
Unit:	ZT,ZR,ZJ 037-150; ZF,ZH,ZJ,ZR,XP,DH, DM,DF,DR,BP 078-150			

Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	80.875	in	(Length of curb)
wcurb =	51	in	(Width of curb)
WGTcurb =	410	lbs	(Weight of curb)
# Clips long side =	3		# Clips short side = 2

Unit Information

WGTunit =	1560	lbs	(Weight of Unit)
Wtmax =	443	lbs	(Maximum corner weight)
Wtmin =	331	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 - 2018 IBC/2019 CBC

Ss =	2.85		(Worst case for majority of California)		
Fa =	1.20		(Default Site Class D - Table 11.4-1 ASCE 7-16)		
Ip =	1.50		(Importance Factor Category III Building)		
Sms =	3.420		(Fa*Ss)	ap =	2.5
Sds =	2.280		(2/3*Sms)	Rp =	2
Fpmax =	5.130	Wp	(0.4*ap*Sds*Ip)*Wp*3/Rp <=1.6*Sds*Ip*Wp		
FpmaxASD =	5602	lbs	(0.7*Fpmax)	FpmaxASD =	7074 lbs
	(unit only)				(unit and curb)

Wind Loading - 2018 IBC/2019 CBC *** Exposure Category C ***

Kz =	1.13		(For 60 ft roof height, Exposure C - Table 26.10-1 ACSE 7-16)
Kzt =	1.00		(Max. assumed topographic factor)
Kd =	0.85		(Directionality factor Table 26.6-1 ASCE 7-16)
Ke =	1.00		(Ground Elevation Factor Table 26.9-1 ASCE 7-16)
V =	110		(Wind velocity, mph for Occupancy Cat III-IV bldgs Exp. Cat C, Fig 26.5-1D - ASCE7-16)
$GCr_{(horiz)}$ =	1.9		(Refer Sect 29.4.1 ASCE 7-16)
$GCr_{(vert)}$ =	1.5		(Refer Sect 29.4.1 ASCE 7-16)
qz	29.8	psf	= 0.00256*Kz*Kzt*Kd*Ke*V^2 (Eq. 26.10-1 ASCE 7-16)
$F_{h\ ASD\ trans}$ =	1179	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	782	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	976	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	4097	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	3908	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	630	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	671	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	3068	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	2879	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	289	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	329	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	4097	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	3908	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	3068	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2879	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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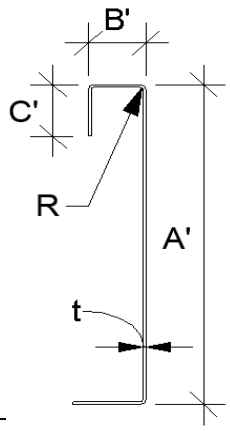
Curb Design

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'=	1.750 in		a'=	5.429 in	= A'-t
C'=	0.000 in	(0 if no lips)	b =	1.572 in	= B'-[r+t/2+a(r+t/2)]
a =	0.000	(0 - no Lip; 1 w/ lip)	b'=	1.714 in	= B'-(t/2+at/2)
R =	0.1069	(Inside bend radius)	c =	0.000 in	= a[C'-(r+t/2)]
t =	0.0713 in		c'=	0.000 in	= a(C'-t/2)
r'=	0.143 in	= R+t/2	u =	0.224 in	= πr/2
x =	0.337 in	(Distance between centroid and web centerline)			
Ix =	2.687 in	(Moment of Inertia about X-Axis)			
Iy =	0.169 in	(Moment of Inertia about Y-Axis)			
A =	0.62 in^2				
rx =	2.08 in				
ry =	0.521 in				
rmin =	0.521 in				

Axial Compression

Pu = 2.801 k (Max Axial Comp) Ω_c = 1.80
Pn/Ωc = 7.466 k
Fe = 24.90 ksi
λc = 1.42
Fn = 21.58 ksi
Ly = 70.38 in Lateral unbraced length
k_yL_y/r_y = 108 (assume k=0.8)

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

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

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 =	0.0713 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} =	1.024 k	**O.K.**	# clips = 3		
Short side: Pu_{Long} =	1.023 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 = 1.947 k Ae = 0.380 in^2
Pn = 14.669 k
Pn/Ω_c = 8.629 k **Not Req'd**

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

Tcrnmax = 1400 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 1954 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 = 0.6
# of Bolts required for Shear = 1.8 ***If combined fails:
# of Bolts Used = 2.0 USE --> 3.0
Check Combined Stress in Bolts & Inserts: 1.174 N.G. StressComb = 0.783 **O.K.**

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

Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 1.321 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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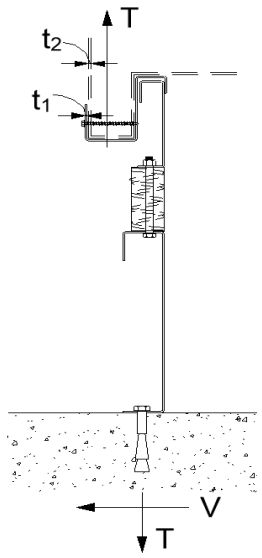
Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

t1 = 0.0713 in (clip thickness) | Fu1 = 65 ksi

t2 = 0.0713 in (unit base rail thickness) | Fu2 = 65 ksi

d = 0.190 in (screw diameter) | dw = 0.375 in (nom. washer diameter)

t2/t1 = 1.0



For t2/t1 ≤ 1.0:		Pns = 2266 #	For t2/t1 ≥ 2.5:	
Shear:	$P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$	2.27 k	Pns =	2377 #
	$P_{ns} = 2.7t_1 dF_{u1}$	2.38 k	$P_{ns} = 2.7t_1 dF_{u1}$	2.38 k
	$P_{ns} = 2.7t_2 dF_{u2}$	2.38 k	$P_{ns} = 2.7t_2 dF_{u2}$	2.38 k

Pns/Ω = 755 #

Pss/Ω = 540 # <- Controls

Tension: Pnot = 0.748 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 = 249 # <- Controls

Pts/Ω = 820 # (full tensile screw capacity)

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	2.801	3	0.93	540 #	4	2.00 in
Short side:	2.801	2	1.40	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 in² | Anv = 0.416 in² | Ant = 0.082 in²

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)	$Comp_{MAX}$ =	4097	lbs
	$Tens_{MAX}$ =	3908	lbs
	$Shear_{MAX}$ =	2801	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	3068	lbs
	$Tens_{MAX}$ =	2879	lbs
	$Shear_{MAX}$ =	2801	lbs

Loads at each Isolator Type: **JQA**

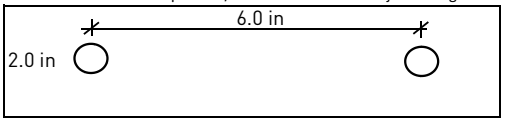
Transverse loading: (on long edge)** # isolators: 2	$Comp_{MAX}$ =	1639.0	lbs
	$Tens_{MAX}$ =	1563.4	lbs
	$Shear_{MAX}$ =	350.1	lbs
Longitudinal loading: (on short edge) # isolators: 2	$Comp_{MAX}$ =	1533.9	lbs
	$Tens_{MAX}$ =	1439.4	lbs
	$Shear_{MAX}$ =	350.1	lbs

Max compression force on isolator: 1.639 k ≤ 1.660 k **O.K.**

Max uplift on isolator: 1.563 k ≤ 1.660 k **O.K.**

Max shear on isolator: 0.350 k ≤ 0.800 k **O.K.**

**assumes assistance equiv to 1/4 isolator from each adjacent edge



Forces on top bolt:

d_b = 0.375 in

upper rail, t = 0.0713 in

Tension = 1.563 k

Shear = 0.350 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 in²

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.**

Combined Shear and tension in bolt:

$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \le F_{nt}$ | ft = 14.15 ksi | fv = 3.17 ksi | O.K.

F'nt = 39.81 ksi | Fnv/Ω = 10.00 ksi

$P'_{nt} = A_b F'_{nt}$ | P'nt/Ω = 1.954 k **Combined O.K.**

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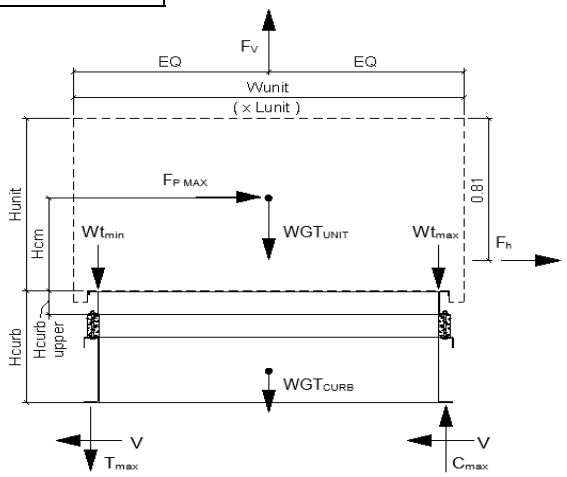
Client:	ProVent	PV2101	Previous:	PV1805
Project:	CBISC-04	Iso Curb CBISCPRD3715		Base curb
Unit:	ZT,ZR,ZJ 037-150; ZF,ZH,ZJ,ZR,XP,DH, DM,DF,DR,BP 078-150			

Curb Information

Hcurb =	25	in	(Height of curb)
Lcurb =	83.375	in	(Length of curb)
wcurb =	53.5	in	(Width of curb)
WGTcurb =	410	lbs	(Weight of curb)
# Springs long side =	2	# Springs short side =	2

Unit Information

WGTunit =	1560	lbs	(Weight of Unit)
Wtmax =	443	lbs	(Maximum corner weight)
Wtmin =	331	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 - 2018 IBC/2019 CBC

Ss =	2.85		(Worst case for majority of California)		
Fa =	1.20		(Default Site Class D - Table 11.4-1 ASCE 7-16)		
Ip =	1.50		(Importance Factor Category III Building)		
Sms =	3.420		(Fa*Ss)	ap =	2.5
Sds =	2.280		(2/3*Sms)	Rp =	2
Fpmax =	5.130	Wp	(0.4*ap*Sds*Ip)*Wp*3/Rp <=1.6*Sds*Ip*Wp		
FpmaxASD =	5602	lbs	(0.7*Fpmax)	FpmaxASD =	7074 lbs
	(unit only)				(unit and curb)

Wind Loading - 2018 IBC/2019 CBC *** Exposure Category C ***

Kz =	1.13		(For 60 ft roof height, Exposure C - Table 26.10-1 ACSE 7-16)
Kzt =	1.00		(Max. assumed topographic factor)
Kd =	0.85		(Directionality factor Table 26.6-1 ASCE 7-16)
Ke =	1.00		(Ground Elevation Factor Table 26.9-1 ASCE 7-16)
V =	110		(Wind velocity, mph for Occupancy Cat III-IV bldgs Exp. Cat C, Fig 26.5-1D - ASCE7-16)
$GCr_{(horiz)}$ =	1.9		(Refer Sect 29.4.1 ASCE 7-16)
$GCr_{(vert)}$ =	1.5		(Refer Sect 29.4.1 ASCE 7-16)
qz	29.8	psf	= 0.00256*Kz*Kzt*Kd*Ke*V^2 (Eq. 26.10-1 ASCE 7-16)
$F_{h\ ASD\ trans}$ =	1588	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	1053	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	976	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	3967	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	3778	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	797	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	837	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	3015	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	2826	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	364	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	404	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	3967	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	3778	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	3015	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2826	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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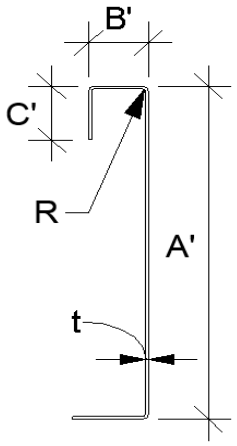
Curb Design

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+a(r+t/2)]
a =	0.000 (0 - no Lip; 1 w/ lip)		b'=	1.714 in	= B'-(t/2+at/2)
R =	0.1069 (Inside bend radius)		c =	0.000 in	= a[C'-(r+t/2)]
t =	0.0713 in		c'=	0.000 in	= a(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 = 2.801 k (Max Axial Comp) Ω_c = 1.80
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)

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

Compression Check = **O.K.**

Check Web Crippling

h = 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

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

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

Long side: Pu_{Trans} = 1.984 k **web stiffener REQ'D** springs = 2
Short side: Pu_{Long} = 1.508 k **web stiffener REQ'D** springs = 2

***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

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

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 = 1400 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 1889 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 = 0.6
# of Bolts required for Shear = 1.7 ***If combined fails:
# of Bolts Used = 2.0 USE --> 3.0

Check Combined Stress in Bolts & Inserts: 1.144 N.G. StressComb = 0.763 **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 $P_n/\Omega = \frac{1}{\Omega} 0.75 t L F_u \geq V_{req}$ $L_{req'd} = \frac{V_{req}\Omega}{0.75 t F_u}$

Lreq'd = 1.277 in

Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	4097	lbs
	$Tens_{MAX}$ =	3908	lbs
	$Shear_{MAX}$ =	2801	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	3068	lbs
	$Tens_{MAX}$ =	2879	lbs
	$Shear_{MAX}$ =	2801	lbs

Loads at each Isolator Type: **JQA**

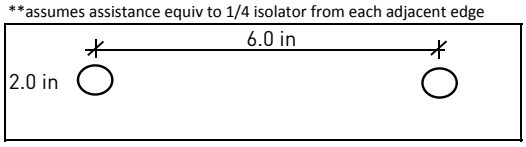
Transverse loading: (on long edge)**	$Comp_{MAX}$ =	1639.0	lbs
	$Tens_{MAX}$ =	1563.4	lbs
# isolators: 2	$Shear_{MAX}$ =	350.1	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	1533.9	lbs
	$Tens_{MAX}$ =	1439.4	lbs
# isolators: 2	$Shear_{MAX}$ =	350.1	lbs

**assumes assistance equiv to 1/4 isolator from each adjacent edge

Max compression force on isolator: 1.639 k ≤ 1.660 k **O.K.**

Max uplift on isolator: 1.563 k ≤ 1.660 k **O.K.**

Max shear on isolator: 0.350 k ≤ 0.800 k **O.K.**



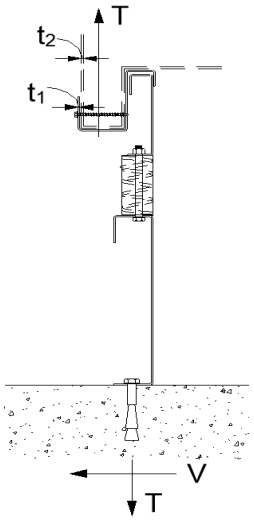
Forces on bottom bolts:

d_b = 0.5 in

base curb, t = 0.0713 in

Tension = 0.782 k / bolt

Shear = 0.175 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: $P_n = A_n F_t$ 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 $P_{nt} = A_b F_{nt}$ Fnt = 45.0 ksi A_b = 0.1963 in^2

Pnt/Ω = 3.927 k **Bolt tension O.K.** Ωt = 2.25

Shear $P_{nv} = A_b F_{nv}$ Fnv = 27.0 ksi Ωv = 2.40

Pnv/Ω = 2.209 k **Bolt shear O.K.** ***(Table E3.4-1, AISI)***

Combined Shear and tension in bolt:

$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \leq F_{nt}$ ft = 7.96 ksi fv = 0.89 ksi O.K.

F'nt = 45.00 ksi Fnv/Ω = 11.25 ksi

$P'_{nt} = A_b F'_{nt}$ P'nt/Ω = 3.927 k **Combined Not Applicable -> F'nt = Fnt**

Connection of Curb to Supporting Structure

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

Transverse:	$Uplift_{MAX}$ =	7879	lbs	$Shear_{MAX}$ =	3537 lbs
$Compression_{SEISMIC}$ =	8118	lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb		
$Tension_{SEISMIC}$ =	7879	lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)		
$Compression_{WIND}$ =	1598	lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb		
$Tension_{WIND}$ =	1392	lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb		
Longitudinal:	$Uplift_{MAX}$ =	5492	lbs	$Shear_{MAX}$ =	3537 lbs
$Compression_{SEISMIC}$ =	5731	lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb		
$Tension_{SEISMIC}$ =	5492	lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)		
$Compression_{WIND}$ =	739	lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb		
$Tension_{WIND}$ =	533	lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb		

Wood Attachment: **1/4"φ x 3.5" Simpson SDS screws w/ 2.25" threaded emb** (SGmin = 0.43)

	$Tall_{metal}$ =	946.67	lbs	$Vall_{metal}$ =	1043.33 lbs
Transverse:	$Tall_{wood}$ =	616	lbs	$Vall_{wood}$ =	672 lbs
# of Screws Req'd for Uplift =	12.79			COMBINED LOADING:	0.994 O.K.
# of Screws Req'd for Shear =	5.26			Req'd Min Spacing =	5.0 in o.c.
Total # of screws required =	16				

Use 16 - 1/4"φ x 3.5" Simpson SDS screws @ 5 in o.c. along long side of curb w/ 2.25" threaded embed

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Longitudinal:

# of Screws Req'd for Uplift =	8.92	COMBINED LOADING:	1.005 <1% OVER - O.K.
# of Screws Req'd for Shear =	5.26	Screw Spacing =	4.6 in o.c.
Total # of screws required =	11		

Use 11 - 1/4"ϕ x 3.5" Simpson SDS screws @ 4.6 in o.c. along short side of curb w/ 2.25" threaded embed

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

$Tall_{bolt}$ = 4418 lbs $Vall_{bolt}$ = 2356 lbs

Transverse:

	4418 lbs		2356 lbs
# of Bolts Req'd for Uplift =	1.78	COMBINED LOADING:	0.895 O.K.
# of Bolts Req'd for Shear =	1.50	Bolt Spacing =	35.7 in o.c.
Total # of bolts required =	3		

Use 3 - 1/2" ϕ A307 Bolts to steel angle below deck @ 35.7 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift =	1.24	COMBINED LOADING:	0.922 O.K.
# of Bolts Req'd for Shear =	1.50	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 + 0.7Ω_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: $Uplift_{MAX}$ = 17870 lbs $Shear_{MAX}$ = 8843 lbs

$Compression_{SEISMIC}$ = 18109 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 17870 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 8843 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 17.41 spacing = 4.20 in o.c. Tapplied = 992.8 lbs

Min Bolts Req'd Shear = 5.19 spacing = 14.275 in o.c. Vapplied = 294.8 lbs

Try using 18 bolts
spaced at 4.20 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.14

Use 18 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 4.2 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 11904 lbs $Shear_{MAX}$ = 8843 lbs

$Compression_{SEISMIC}$ = 12142 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 11904 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 8843 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 11.60 spacing = 3.77 in o.c. Tapplied = 992.0 lbs

Min Bolts Req'd Shear = 5.19 spacing = 8.3 in o.c. Vapplied = 294.8 lbs

Try using 12 bolts
spaced at 3.77 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.14

Use 12 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 3.8 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY:	CBISC-04	CBISCPRD3715	Unit:	ZT,ZR,ZJ 037-150;
UPPER CURB RAIL THICKNESS:	0.0713 in	14 Gauge		ZF,ZH,ZJ,ZR,XP,DH, DM,DF,DR,BP
UNIT CLIP THICKNESS:	0.0713 in	14 Gauge		078-150
# OF CLIPS (LONG SIDE) -	3 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	(2) - JQA Isolators long side
Anchor bolt diameter:	1/2	Anchor hole diamter:	9/16	(2) - JQA Isolators short side
BASE CURB THICKNESS:	0.0713 in	14 Gauge		
WEB STIFFENER:	16Ga x 1.5in x 7in (C-channel) stiffener at each spring on base curb			
CORNER CONNECTION:	Use minimum 3 - 1/4" ϕ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts			

CURB ANCHORAGE	WOOD	STEEL	CONCRETE
	1/4"ϕ x 3.5" Simpson SDS screws w/ 2.25" threaded embed (SGmin =	1/2" ϕ A307 Bolts to steel angle below deck	3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy w/ 4" embed
LONG DIRECTION	16 @ 5.03 in o.c.	3 @ 35.69 in o.c.	18 @ 4.2 in o.c.
SHORT DIRECTION	11 @ 4.55 in o.c.	2 @ 41.5 in o.c.	12 @ 3.77 in o.c.