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ENGINEERING + DESIGN

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

Structural Calculations

for

CBISC-12 Curb

CBISCSAV1518**

Prepared for:

PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

Date: June 24, 2021

Project Number: PV2103

For wood, concrete and steel attachment see Roof Anchorage Detail, Form No. CB-52.

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

FEATURES

- Roof curb base 12 ga.
- Roof curb upper rail 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.

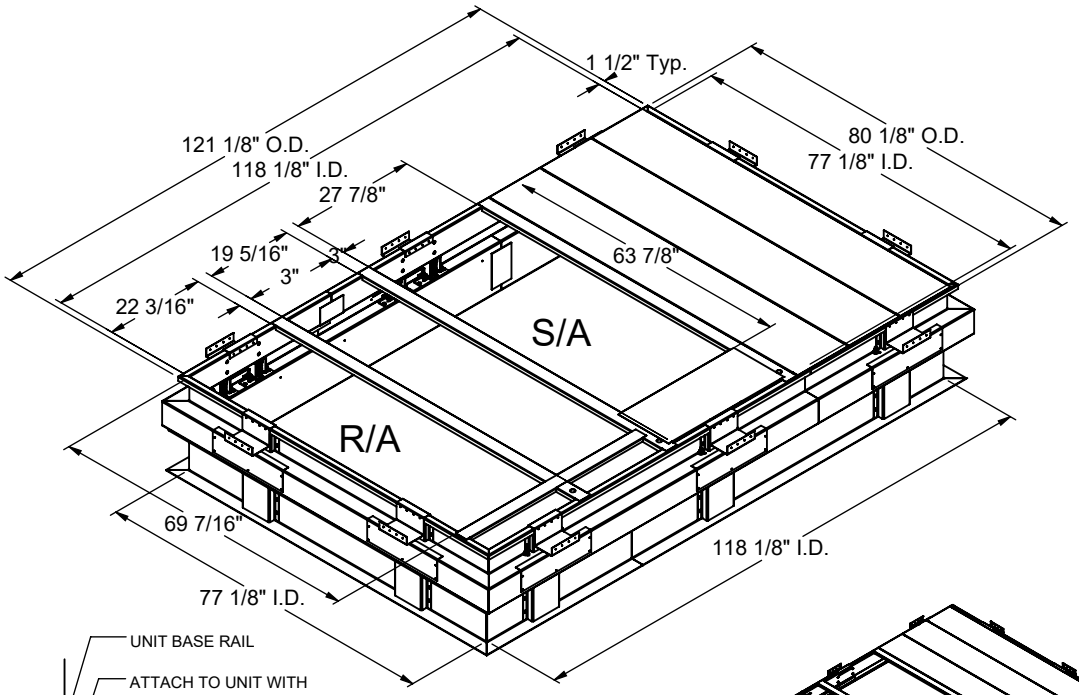
VIBRATION ISOLATION ROOF CURBS
SUNCHOICE UNITS

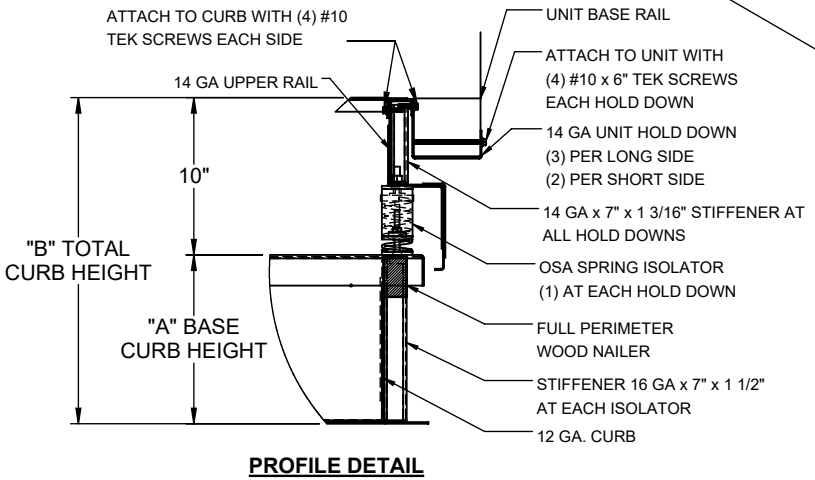
15-18

PROVENT P/N	A	B	EST. WEIGHT
CBISCSAV151818**	8"	18"	556 Lbs
CBISCSAV151821**	11"	21"	606 Lbs
CBISCSAV151824**	14"	24"	656 Lbs

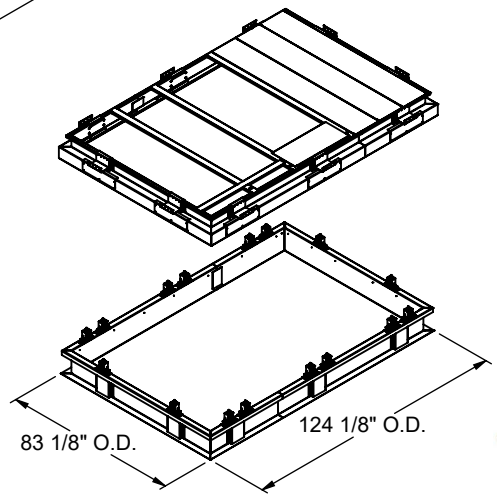
**Note: Spring configuration must be added to part number at time of order

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





PROFILE DETAIL



REGISTERED PROFESSIONAL ENGINEER
GLENN A. MOURITZEN
SE 3578
Exp. 6/30/23
STRUCTURAL
STATE OF CALIFORNIA

ProVent

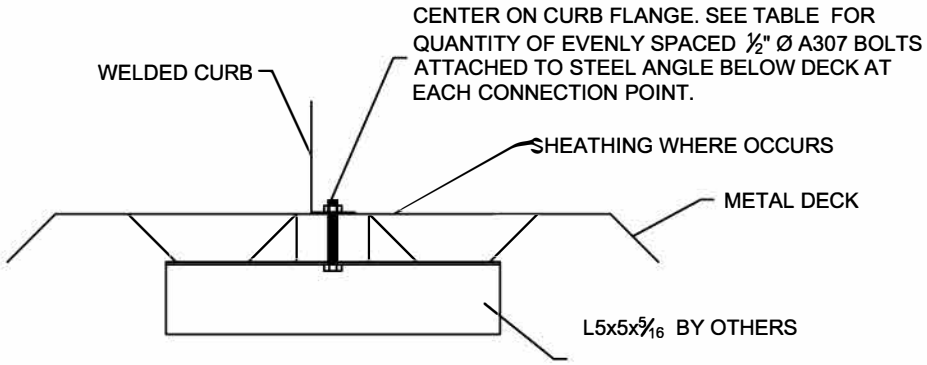
3847 WABASH DRIVE
MIRA LOMA, CA 91752

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

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

FORM NO:	PART NUMBER:	
CBISC-12	-	
DATE:	**REV:**	**DRAWN BY:**
6/23/2021	1	ALL

STEEL ATTACHMENT



	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
SAV1518	4 @ 37.21" O.C.	3 @ 35.31" O.C.
SAV28	3 @ 70" O.C.	2 @ 68.6" O.C.

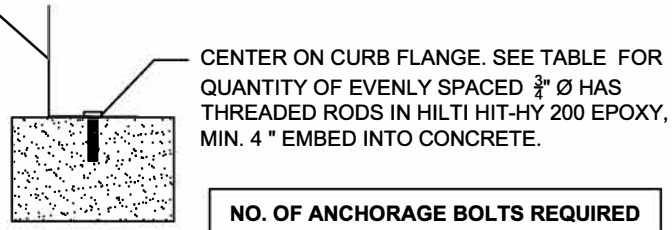
Meets seismic requirements for the following codes:
CBC 2019
IBC 2018

ROOF ANCHORAGE DETAIL

CBISC Series	ISCAL Series	CBKD Series	CBWC Series
SAV1518			
	SAV28	SAV28	SAV28

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

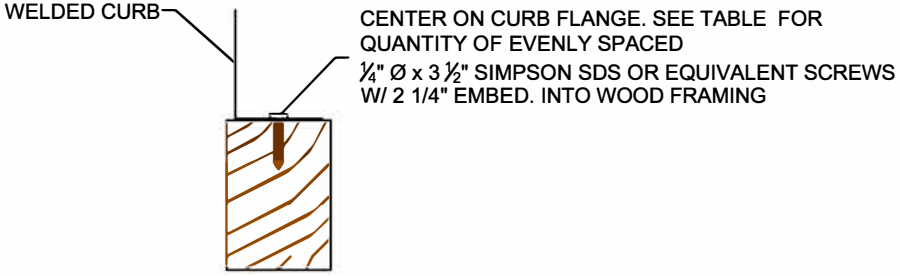
CONCRETE ATTACHMENT



	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
SAV1518	10 @ 12.4" O.C.	7 @ 11.77" O.C.
SAV28	4 @ 46.7" O.C.	3 @ 34.3" O.C.

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

WOOD ATTACHMENT



	NO. OF ANCHORAGE SCREWS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
SAV1518	15 @ 8.26" O.C.	10 @ 8.29" O.C.
SAV28	9 @ 18" O.C.	8 @ 10.4" O.C.

FOUR INCHES FROM EACH CORNER EVENLY SPACED

ProVent
3847 WABASH DRIVE
MIRA LOMA, CA 91725
PHONE (951) 685-1101
FAX (619) 872-9799

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

FORM NO:		
CB-52		
DATE:	REV:	DRAWN BY:
6/17/2021	3	ALL

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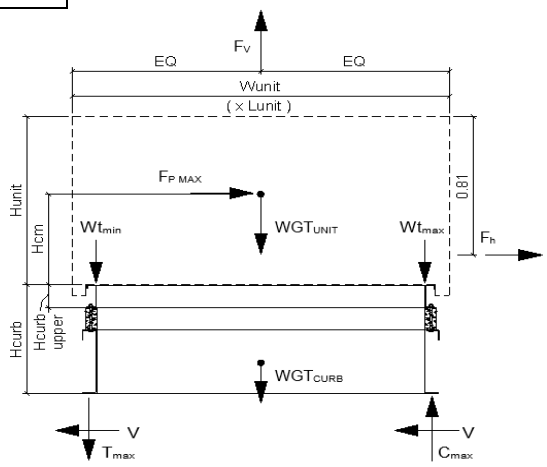
Client:	ProVent	PV2103		
Project:	CBISC-12	Iso Curb	CBISCSAV1518	Upper curb rail
Unit:	Sunchoice 15-18			

Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	121.125	in	(Length of curb)
wcurb =	80.125	in	(Width of curb)
WGTcurb =	97	lbs	(Weight of curb)
# Clips long side =	3	# Clips short side =	2

Unit Information

WGTunit =	1921.5	lbs	(Oper. Weight of Unit + 5%)
Wtmax =	538	lbs	(Maximum corner weight)
Wtmin =	408	lbs	(Minimum corner weight)
Hunit =	49.25	in	(Height of unit above curb)
Hcm =	24.625	in	(Height to center of mass)
Lunit =	129.75	in	(Length of unit)
Wunit =	88.75	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 =	6900	lbs	(0.7*Fpmax)	FpmaxASD =	7248 lbs
	(unit only)				(unit + upper rail)

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)
$F_{h\ ASD\ trans}$ =	1673	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	1145	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	2141	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	3712	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	3479	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	89	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1078	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	2994	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	2761	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	-192	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	796	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	3712	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	3479	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	2994	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2761	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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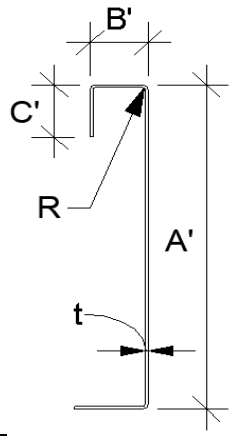
Curb Design

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'=	[1.500]	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 = 3.450 k (Max Axial Comp) Ω_c = 1.80

Pn/Ωc = 4.075 k

Fe = 14.24 ksi

λc = 1.87

Fn = 12.49 ksi

Ly = 77.13 in Lateral unbraced length

k_yL_y/r_y = 143 (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
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			

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

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

Long side: Pu_{Trans} = 1.237 k **web stiffener REQ'D** # clips = 3

Short side: Pu_{Long} = 1.497 k **web stiffener REQ'D** # clips = 2

Check Web Stiffener

16Ga x 1 3/16in 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 = 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 = 1725 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)

Vcrnmax = 1739 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 = 0.7

# of Bolts required for Shear = 1.6 ***If combined fails:

# of Bolts Used = [2.0] USE --> 3.0

Check Combined Stress in Bolts & Inserts: 1.141 N.G. StressComb = 0.761 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35

Assume L/t > 25: 25*t = 1.783 in

Lreq'd = 1.176 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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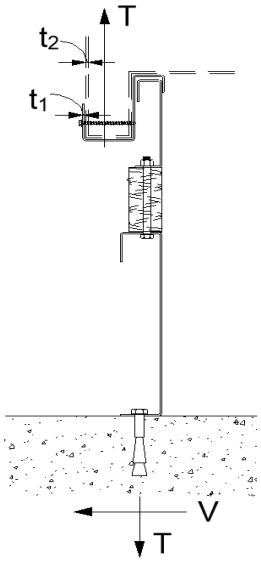
Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

t1 = 0.0713 in (clip thickness) | t2/t1 = 1.4 | 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)



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

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ 3.86 k | $P_{ns} = 2.7t_1 dF_{u1}$ 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:	3.450	3	1.15	540 #	4	2.00 in
Short side:	3.450	2	1.73	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 $R_n = 0.6F_yA_{gv} + F_uA_{nt} \le 0.6F_uA_{nv} + F_uA_{nt}$

BSR O.K. (AISI Sect. E5.3)

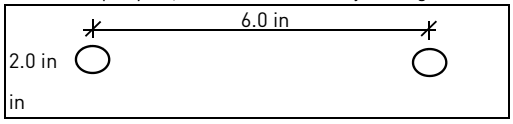
Curb Loads (copied from above)

Transverse: (on long edge)	$Comp_{MAX}$ =	3712	lbs
	$Tens_{MAX}$ =	3479	lbs
	$Shear_{MAX}$ =	6900	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	2994	lbs
	$Tens_{MAX}$ =	2761	lbs
	$Shear_{MAX}$ =	6900	lbs

Loads at each Isolator Type: **OSA**

Transverse loading: (on long edge)** # isolators: 3	$Comp_{MAX}$ =	1237.3	lbs
	$Tens_{MAX}$ =	1159.7	lbs
	$Shear_{MAX}$ =	690.0	lbs
Longitudinal loading: (on short edge) # isolators: 2	$Comp_{MAX}$ =	1497.0	lbs
	$Tens_{MAX}$ =	1380.6	lbs
	$Shear_{MAX}$ =	690.0	lbs

**assumes capacity of 1/4 holddown from each adjacent edge



Max compression force on isolator: 1.497 k ≤ 1.660 k **O.K.**

Max uplift on isolator: 1.381 k ≤ 1.660 k **O.K.**

Max shear on isolator: 0.690 k ≤ 0.800 k **O.K.**

Forces on top bolt:

Tension = 1.381 k | d_b = 0.375

Shear = 0.690 k | per rail, t = 0.1017 in

Shear on curb rail: $P_n = teF_u$ | Ω = 2.00 (Appendix A, Section E3.1 AISI)

Shear O.K. Pn/Ω = 6.611 k | e = 1.0 in

Net section rupture: $P_n = A_nF_t$ | 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 $P_{nt} = A_bF_{nt}$ | 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 $P_{nv} = A_bF_{nv}$ | 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 = 12.50 ksi | fv = 6.25 ksi | O.K.

F'nt = 27.35 ksi | Fnv/Ω = 10.00 ksi

$P'_{nt} = A_bF'_{nt}$ | P'nt/Ω = 1.342 k **No Good - Use Welds**

Longitudinal weld loading: | L = | $1.5P_n/\Omega = \frac{1}{\Omega}\left(1 - \frac{0.01L}{t_2}\right)Lt_2F_{u2} \ge V_{req}$ | Ω = 2.55

If L/t < 25: L/t = 21.04 | t = 0.0713 | Pn/Ω = 2.153 k

Transverse weld loading: | t = 0.0713 | $P_n/\Omega = \frac{1}{\Omega}tLF_u \ge T_{req}$ | Ω = 2.35

L = 1 | Fu = 65 ksi | Pn/Ω = 1.972 k

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Client:	ProVent	PV2101	Previous:	PV1805
Project:	CBISC-12	Iso Curb	CBISCSAV1518	Base curb
Unit:	Sunchoice 15-18			

Curb Information

Hcurb =	14	in	(Height of curb)
Lcurb =	123.625	in	(Length of curb)
wcurb =	82.625	in	(Width of curb)
WGTcurb =	559	lbs	(Weight of curb)
# Springs long side =	3	# Springs short side =	2

Unit Information

WGTunit =	1921.5	lbs	(Oper. Weight of Unit + 5%)
Wtmax =	538	lbs	(Maximum corner weight)
Wtmin =	408	lbs	(Minimum corner weight)
Hunit =	49.25	in	(Height of unit above curb)
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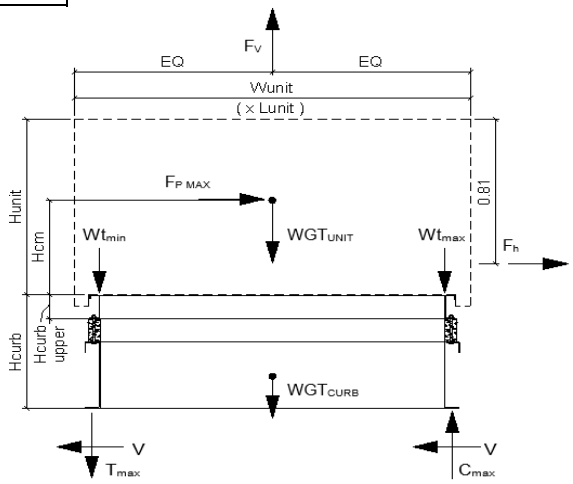

Seismic Loading - 2018 IBC/2019 CBC

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 =	7248	lbs	(0.7*Fpmax)	FpmaxASD =	9256 lbs
	(unit + upper rail)				(unit + upper rail + base 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)
$F_{h\ ASD\ trans}$ =	1933	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	1322	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	2141	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	3752	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	3519	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	151	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1139	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	3035	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	2802	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	-162	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	827	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	3752	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	3519	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	3035	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2802	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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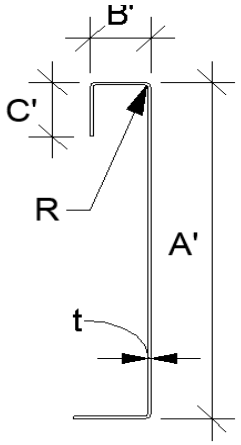
Curb Design

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



Calculate Section Properties of Curb

A'=	[14.000] in		a =	13.492 in	= A'-(2r+t)
B'=	[1.500] in		a'=	13.898 in	= A'-t
C'=	[1.000] in	(0 if no lips)	b =	0.992 in	= B'-[r+t/2+α(r+t/2)]
α =	[1.000]	(0 - no Lip; 1 w/ lip)	b'=	1.398 in	= B'-(t/2+αt/2)
R =	0.1525	(Inside bend radius)	c =	0.746 in	= α[C'-(r+t/2)]
t =	0.1017 in		c'=	0.949 in	= α(C'-t/2)
r'=	0.203 in	= R+t/2	u =	0.319 in	= πr/2
x =	0.239 in	(Distance between centroid and web centerline)			
Ix =	42.880 in		rx =	4.81 in	
Iy =	0.420 in		ry =	0.476 in	
A =	1.86 in^2		rmin =	0.476 in	

Axial Compression

Pu = 3.624 k (Max Axial Comp) Ω_c = 1.80
Pn/Ωc = 6.734 k
Fe = 7.45 ksi
λc = 2.59
Fn = 6.53 ksi
Ly = 117.63 in Lateral unbraced length
k_yL_y/r_y = 198 (assume k=0.8)

$$\frac{P_n}{\Omega_c} = \frac{F_nA}{\Omega_c}$$

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

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

Compression Check = O.K.

Check Web Crippling

h = 14 in -- Check limits: C = 4.00
t = 0.1017 in h/t = 137.66 ≤ 200 C_R = 0.14
N = 7.00 N/t = 68.83 ≤ 210 C_N = 0.35
Ω_w = 1.75 N/h = 0.5 ≤ 2.0 C_h = 0.02
P_n = 4.578 k R/t = 1.50 ≤ 9.0
P_n/Ω_w = 2.616 k
Long side: Pu_{Trans} = 1.251 k O.K. # clips = 3
Short side: Pu_{Long} = 1.518 k O.K. # clips = 2

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

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

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 = 4.578 k Ae = 0.380 in^2
Pn = 16.511 k
Pn/Ω_c = 9.712 k **Not Req'd**

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

Tcrnmax = 1812 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 1759 lbs (Max Ten/2 corner connections per side)

Bolt:	Tall =	[2480] lbs	Vall =	[1208] lbs	
Threaded Insert:	Tall =	[2860] lbs	Vall =	[1536] lbs	

# of Bolts required for Tension = 0.7
# of Bolts required for Shear = 1.5 ***If combined fails:
# of Bolts Used = [2.0] USE --> 3.0

Check Combined Stress in Bolts & Inserts: 1.094 N.G. StressComb = 0.729 **O.K.**

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

Assume L/t > 25: 25*t = 2.543 in
Lreq'd = 0.834 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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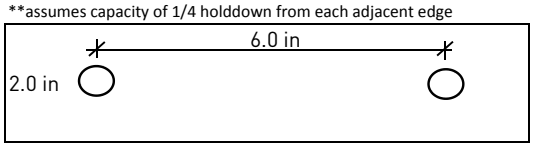
Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	3712	lbs
	$Tens_{MAX}$ =	3479	lbs
	$Shear_{MAX}$ =	6900	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	2994	lbs
	$Tens_{MAX}$ =	2761	lbs
	$Shear_{MAX}$ =	6900	lbs

Loads at each Isolator Type: **OSA**

Transverse loading: (on long edge)**	$Comp_{MAX}$ =	1237.3	lbs
	$Tens_{MAX}$ =	1159.7	lbs
# isolators: 3	$Shear_{MAX}$ =	690.0	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	1497.0	lbs
	$Tens_{MAX}$ =	1380.6	lbs
# isolators: 2	$Shear_{MAX}$ =	690.0	lbs

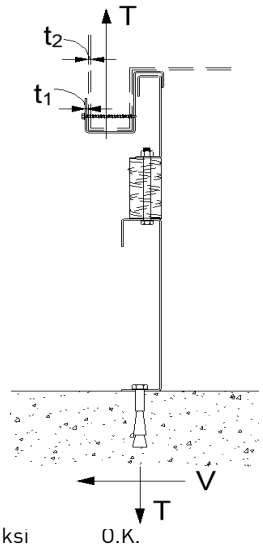
**assumes capacity of 1/4 holddown from each adjacent edge



Max compression force on isolator: 1.497 k ≤ 1.660 k **O.K.**
Max uplift on isolator: 1.381 k ≤ 1.660 k **O.K.**
Max shear on isolator: 0.690 k ≤ 0.800 k **O.K.**

Forces on bottom bolts:

d_b = 0.5 in
base curb, t = 0.1017 in
Tension = 0.690 k / bolt
Shear = 0.345 k / bolt



7.0 in

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

Net section rupture: $P_n = A_nF_t$ Ω = 2.22 (Appendix A, Section E3.2 AISI)
Pn/Ω = 8.428 k An = 0.153 in
N.S.R. O.K. $F_t = (0.1 + 3d/s)F_u \le F_u$ = 55.250 ksi

Bolt Bearing Strength: $P_n = Cm_f dtF_u$ Ω = 2.50 (Section E3.3.1 AISI)
Pn/Ω = 3.966 k d/t = 4.92
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)***

Combined Shear and tension in bolt:

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

ft = 7.03 ksi fv = 1.76 ksi O.K.
F'nt = 45.00 ksi Fnv/Ω = 11.25 ksi
$P'_{nt} = A_bF'_{nt}$ 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:	$Uplift_{MAX}$ =	5860 lbs	$Shear_{MAX}$ =	4628 lbs
$Compression_{SEISMIC}$ =	6161 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb		
$Tension_{SEISMIC}$ =	5860 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)		
$Compression_{WIND}$ =	577 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb		
$Tension_{WIND}$ =	1230 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb		
Longitudinal:	$Uplift_{MAX}$ =	4425 lbs	$Shear_{MAX}$ =	4628 lbs
$Compression_{SEISMIC}$ =	4726 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb		
$Tension_{SEISMIC}$ =	4425 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)		
$Compression_{WIND}$ =	87 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb		
$Tension_{WIND}$ =	740 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 screw w/ 2.25" threaded emb** (SGmin = 0.43)

Transverse:
$Tall_{metal}$ = 1397 lbs $Vall_{metal}$ = 1230 lbs
$Tall_{wood}$ = 616 lbs $Vall_{wood}$ = 672 lbs

# of Screws Req'd for Uplift = 9.51 COMBINED LOADING: 0.910 O.K.
# of Screws Req'd for Shear = 6.89 Req'd Min Spacing = 8.3 in o.c.
Total # of screws required = 15

Use 15 - 1/4"ϕ x 3.5" Simpson SDS screws @ 8.3 in o.c. along long side of curb w/ 2.25" threaded embed

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Longitudinal:

# of Screws Req'd for Uplift = 7.18 COMBINED LOADING: 0.994 O.K.

# of Screws Req'd for Shear = 6.89 Screw Spacing = 8.3 in o.c.

Total # of screws required = 10

Use 10 - 1/4"ϕ x 3.5" Simpson SDS screws @ 8.3 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

$Tall_{bolt}$ = 3927 lbs $Vall_{bolt}$ = 2209 lbs

Transverse: $Tall_{metal}$ = 2975 lbs $Vall_{metal}$ = 3072 lbs

# of Bolts Req'd for Uplift = 1.97 COMBINED LOADING: 0.792 O.K.

# of Bolts Req'd for Shear = 2.10 Bolt Spacing = 37.2 in o.c.

Total # of bolts required = 4

Use 4 - 1/2" ϕ A307 Bolts to steel angle below deck @ 37.2 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 1.49 COMBINED LOADING: 0.671 O.K.

# of Bolts Req'd for Shear = 2.10 Bolt Spacing = 35.3 in o.c.

Total # of bolts required = 3

Use 3 - 1/2" ϕ A307 Bolts to steel angle below deck @ 35.3 in o.c. along short side of curb

For Concrete anchorage: SEISMIC $(0.6-0.14SDS)D + 0.7\Omega_o E$ (Ω_o = 2.0)

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

$Tall_{LRFD}$ = 1957 lbs $Vall_{LRFD}$ = 4540 lbs $\propto = (1 + 0.2SDS)D + 2.5E = 1.708$

$Tall_{ASD} = Tall_{LRFD}/\alpha$ = 1146 lbs $Vall_{ASD} = Vall_{LRFD}/\alpha$ = 2658 lbs $(D = 0.758, E = 0.242)$

Transverse: $Uplift_{MAX}$ = 10187 lbs $Shear_{MAX}$ = 9256 lbs

$Compression_{SEISMIC}$ = 10488 lbs =[2.0*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 10187 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 9256 lbs =2.0*FpmaxASD/2

Min Bolts Req'd Uplift = 8.89 spacing = 13.95 in o.c. Tapplied = 1018.7 lbs

Min Bolts Req'd Shear = 3.48 spacing = 37.21 in o.c. Vapplied = 544.5 lbs

Try using 10 bolts
spaced at 12.40 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.09

Use 10 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 12.4 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 7317 lbs $Shear_{MAX}$ = 9256 lbs

$Compression_{SEISMIC}$ = 7618 lbs =[2.0*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 7317 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 9256 lbs =2.0*FpmaxASD/2

Min Bolts Req'd Uplift = 6.39 spacing = 11.77 in o.c. Tapplied = 1045.3 lbs

Min Bolts Req'd Shear = 3.48 spacing = 23.54 in o.c. Vapplied = 544.5 lbs

Try using 7 bolts
spaced at 11.77 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.12

Use 7 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 11.8 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY:	CBISC-12	CBISCSAV1518	Unit:	Sunchoice 15-18
UPPER CURB RAIL THICKNESS:	0.1017 in	12 Gauge		
UNIT CLIP THICKNESS:	0.0713 in	14 Gauge		
# OF CLIPS (LONG SIDE) -	3 clips with 4 - #10 SMS screws each clip			
WEB STIFFENER:	16Ga x 1 3/16in x 7in (C-channel) stiffener at each clip			
# OF CLIPS (SHORT SIDE) -	2 clips with 4 - #10 SMS screws each clip			
WEB STIFFENER:	16Ga x 1 3/16in x 7in (C-channel) stiffener at each clip			
VIBRATION ISOLATOR TYPE:	OSA	Top stud diameter:	3/8	(3) - OSA Isolators long side
Anchor bolt diameter:	1/2	Anchor hole diamter:	9/16	(2) - OSA Isolators short side
BASE CURB THICKNESS:	0.1017 in	12 Gauge		***Must weld top of OSA***
WEB STIFFENER:	NOT REQUIRED			
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	15 @ 8.26 in o.c.	4 @ 37.21 in o.c.	10 @ 12.4 in o.c.
SHORT DIRECTION	10 @ 8.29 in o.c.	3 @ 35.31 in o.c.	7 @ 11.77 in o.c.