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

Structural Calculations
for
CBISC-13 Series

CBISCSAV2025** SERIES

Prepared for:

PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

Date: July 13, 2022

Project Number: PV2203

For wood, concrete and steel attachment see Roof Anchorage Detail, Form No. CB-62.	VIBRATION ISOLATION ROOF CURBS SUNCHOICE UNITS
Welded Isolation springs housingare standard. For bolted spring housing, neoprene pads and spring cups see Weldment and Bolting Detail, Form No. CB-61	AV 20-25

VIBRATION ISOLATION ROOF CURBS SUNCHOICE UNITS

AV 20-25

PROVENT P/N	A	B	EST. WEIGHT
CBISCSAV202518**	8"	18"	615 Lbs
CBISCSAV202521**	11"	21"	660 Lbs
CBISCSAV202524**	14"	24"	710 Lbs

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

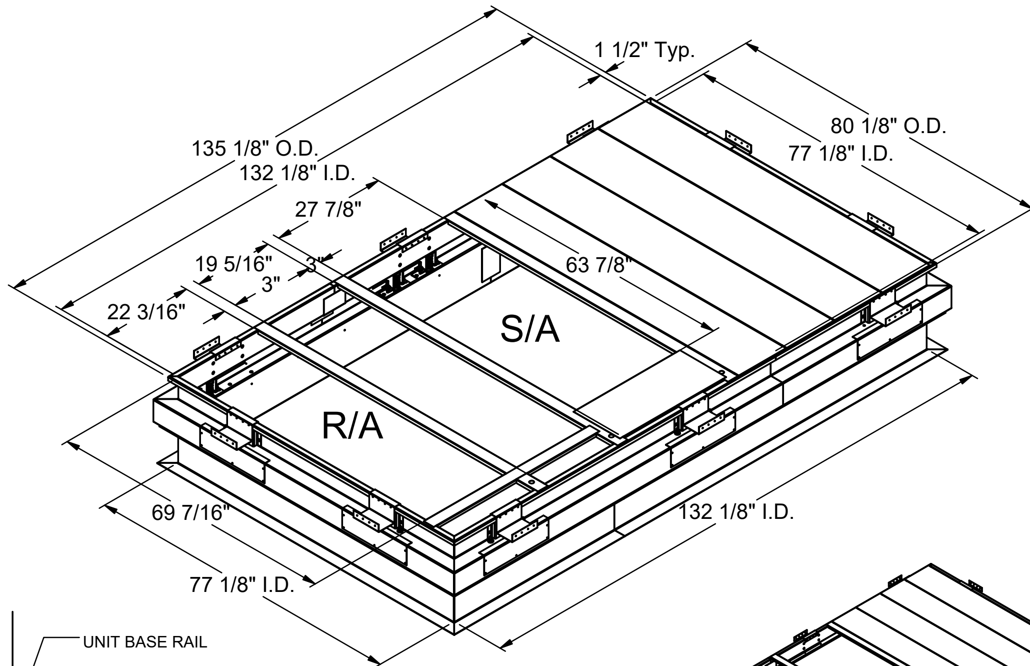
Meets seismic requirements for the following codes:
CBC 2019
IBC 2018

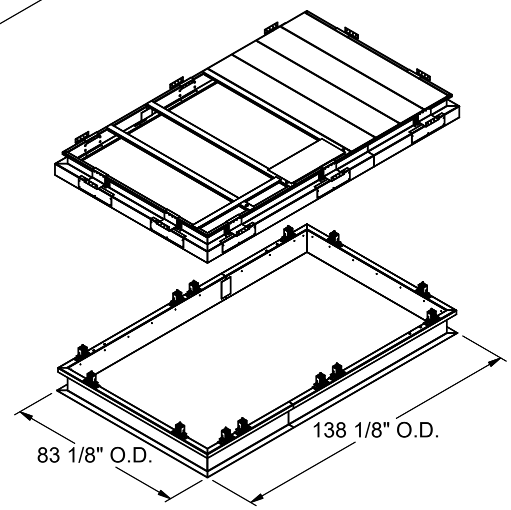
FEATURES

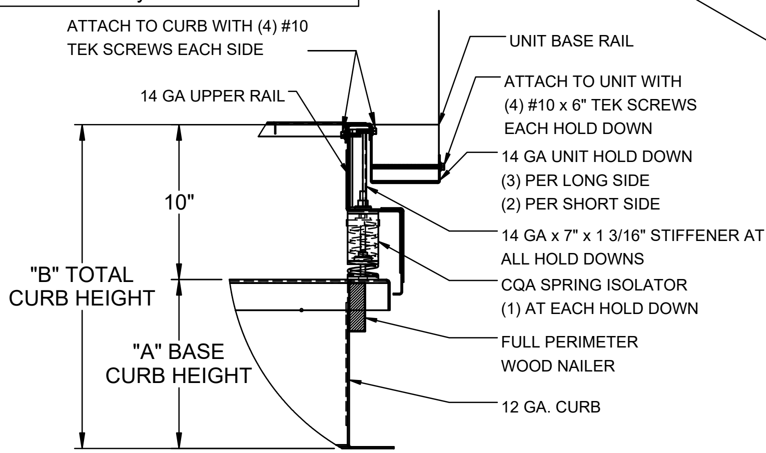
- Roof curb base 12 ga.
- Roof curb upper rail 14 ga.
- Fully welded construction.
- Gasketing package provided.
- Heat treated wood nailer provided.
- insulated deck pans provided.
- Pitched curbs and taller curbs are available.
- CalDyn OSHPd pre-approved seismic restraints. (OPM-0401-13), (CQA).

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

ProVent

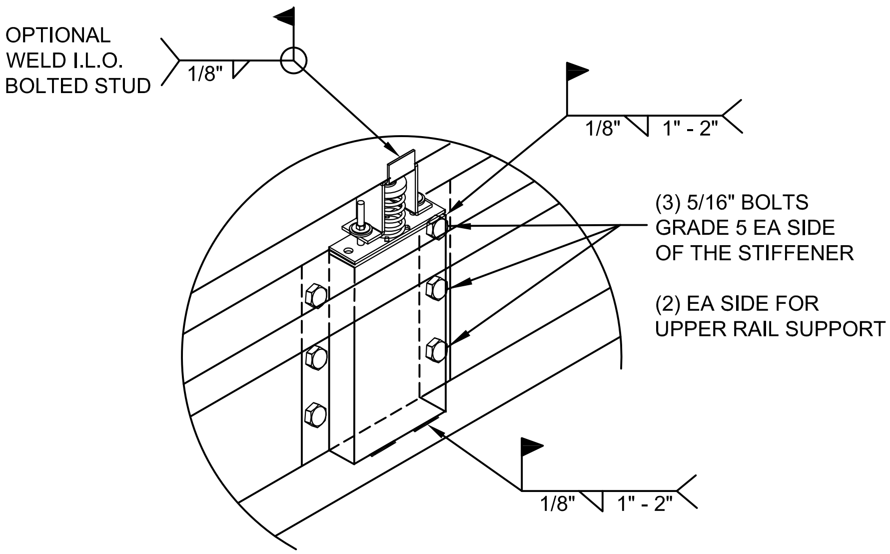
3847 WABASH DRIVE
MIRA LOMA, CA 91752

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

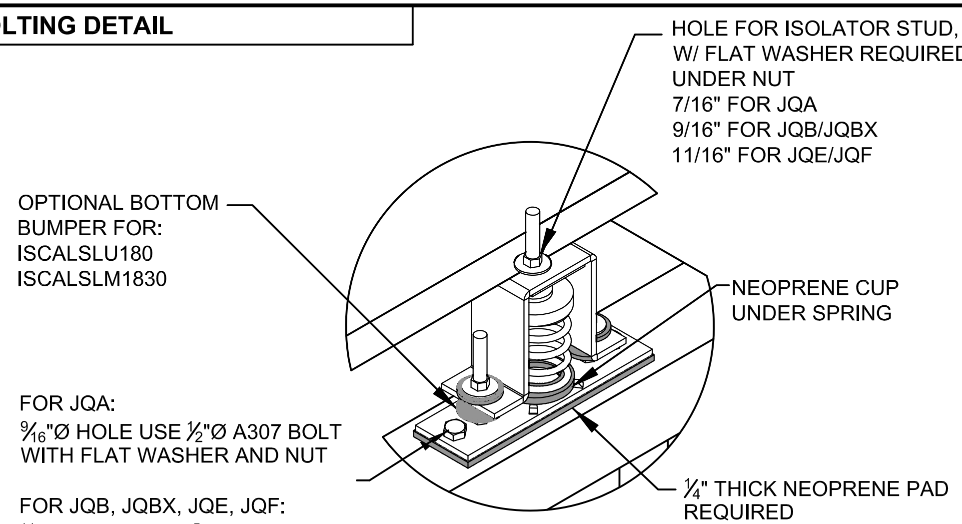
SUBMITED TO: ____________
COMPANY: ____________
JOB NAME: ____________
EQUIPMENT: ____________
NOTES: ____________

FORM NO:	PART NUMBER:	
CBISC-13	CBISCSAV2025 SERIES	
DATE:	REV:	DRAWN BY:
4/20/2022	1	FMM

WELDMENT AND BOLTING DETAIL



BASE CURB SUPPORT



FOR BOLT ON ISOLATORS

ProVent

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SUBMITTED TO:________________
COMPANY:________________
JOB NAME:________________
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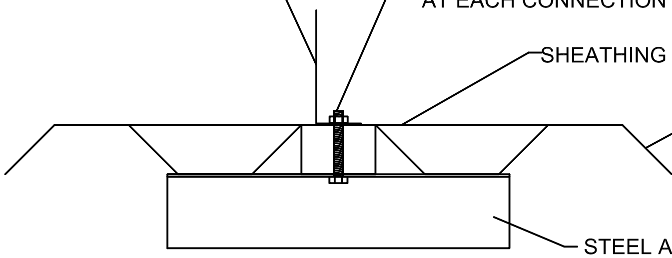
NOTES:________________

FORM NO:		
CB-61		
DATE:	REV:	DRAWN BY:
02/08/18	1	ALL

STEEL ATTACHMENT



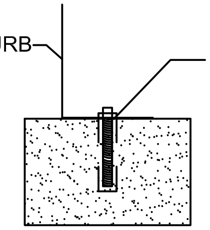
	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	**LONG SIDE**	**SHORT SIDE**
LXS	3 @ 19.25" O.C.	2 @ 23" O.C.
LXL	3 @ 19.25" O.C.	2 @ 33" O.C.
SUN3672	4 @ 21" O.C.	2 @ 27.25" O.C.
PRD3715	6 @ 14.28" O.C.	3 @ 20.75" O.C.
PRS	4 @ 20.46" O.C.	2 @ 31.13" O.C.
PRL	3 @ 36.13" O.C.	2 @ 44" O.C.
SLU180	4 @ 35.08" O.C.	3 @ 37" O.C.
SLM1830	5 @ 29.06" O.C	4 @ 24.67" O.C.
SAV1518	4 @ 37.38" O.C	3 @ 35.56" O.C.
SAV2025	4 @ 42.04" O.C	3 @ 35.56" O.C.
SAV28	5 @ 35.63" O.C	3 @ 35.56" O.C.

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

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

ROOF ANCHORAGE DETAIL
CBISC Series
LXS
LXL
SUN3672
PRD3715
PRS
PRL
SLU180
SLM1830
SAV1518
SAV2025
SAV28

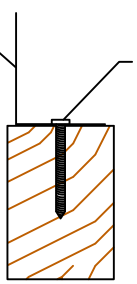
CONCRETE ATTACHMENT



	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	**LONG SIDE**	**SHORT SIDE**
LXS	7 @ 6.42" O.C.	4 @ 7.67" O.C.
LXL	7 @ 6.42" O.C.	5 @ 8.25" O.C.
SUN3672	9 @ 7.88" O.C.	4 @ 9.08" O.C.
PRD3715	14 @ 5.49" O.C.	9 @ 5.19" O.C.
PRS	10 @ 6.82" O.C.	5 @ 7.78" O.C.
PRL	11 @ 7.23" O.C.	6 @ 8.8" O.C.
SLU180	12 @ 9.57" O.C.	8 @ 10.57" O.C.
SLM1830	18 @ 6.84" O.C.	11 @7.4" O.C.
SAV1518	12 @ 10.19" O.C.	6 @ 14.23" O.C.
SAV2025	14 @ 14.97" O.C.	6 @ 14.23" O.C.
SAV28	14 @ 10.96" O.C.	6 @ 14.23" O.C.

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

WOOD ATTACHMENT



FOUR INCHES FROM EACH CORNER EVENLY SPACED

	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.	7 @ 6.17" O.C.
SUN3672	9 @ 8.38" O.C.	5 @ 7.81" O.C.
PRD3715	15 @ 5.38" O.C.	10 @ 5.06" O.C.
PRS	10 @ 7.26" O.C.	6 @ 7.03" O.C.
PRL	12 @ 6.93" O.C.	8 @ 6.86" O.C.
SLU180	14 @ 8.4" O.C.	10 @ 8.67" O.C.
SLM1830	19 @ 6.68" O.C.	13 @ 6.5" O.C.
SAV1518	13 @ 9.68" O.C.	9 @ 9.39" O.C.
SAV2025	15 @ 9.29" O.C.	9 @ 9.39" O.C.
SAV28	16 @ 9.77" O.C.	9 @ 9.39" O.C.

ProVent
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MIRA LOMA, CA 91752

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

FORM NO: CB-62

DATE:	**REV:**	**DRAWN BY:**
6/30/2022	2	FMM

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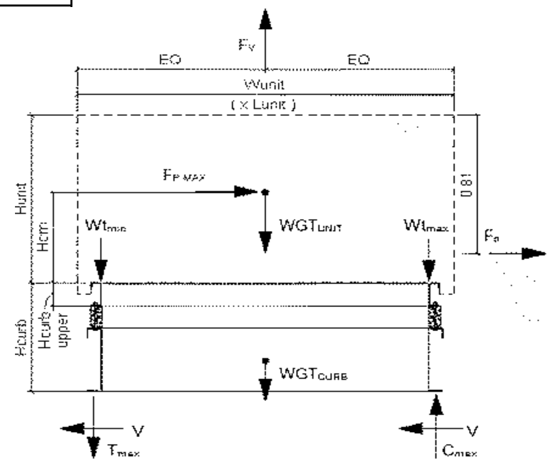
Client:	ProVent PV2203 Upper curb rail
Project:	CBISC-13 Iso Curb CBISCSAV2025
Unit:	Sunchoice 20-25



Upper Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	135.125	in	(Length of upper curb)
wcurb =	80.125	in	(Width of upper curb)
WGTupper =	105	lbs	(Weight of upper curb)
# Clips long side =	3		# Clips short side = 2

Unit Information

WGTunit =	2640	lbs	(Oper. Weight of Unit)
Wtmax =	739	lbs	(Maximum corner weight)
Wtmin =	561	lbs	(Minimum corner weight)
Hunit =	57.25	in	(Height of unit above curb)
Hcm =	28.625	in	(Height to center of mass)
Lunit =	143.8125	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 =	9480	lbs	(0.7*Fpmax) FpmaxASD = 9857 lbs
	(unit only)		(unit + upper rail)

Wind Loading - 2018 IBC/2019 CBC

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)
$F_{h\ ASD\ trans}$ =	2126	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	1312	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	2373	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Upper Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	5337	lbs	$=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb$
$Tension_{SEISMIC}$ =	3072	lbs	$=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*wcurb]]/wcurb$
$Compression_{WIND}$ =	460	lbs	$=[F_{h\ ASD\ trans}*Hcm+2*0.6*Wtmax*wcurb-F_{vert\ ASD}*wcurb/2]/wcurb$
$Tension_{WIND}$ =	1273	lbs	$=[F_{h\ ASD\ trans}*Hcm-2*0.6*Wtmin*wcurb+F_{vertASD}*wcurb/2]/wcurb$

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	3959	lbs	$=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb$
$Tension_{SEISMIC}$ =	1693	lbs	$=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*Lcurb]]/Lcurb$
$Compression_{WIND}$ =	-22	lbs	$=[F_{h\ ASD\ long}*Hcm+2*0.6*Wtmax*Lcurb-F_{vertASD}*Lcurb/2]/Lcurb$
$Tension_{WIND}$ =	791	lbs	$=[F_{h\ ASD\ long}*Hcm-2*0.6*Wtmin*Lcurb+F_{vertASD}*Lcurb/2]/Lcurb$

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	5337	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	3072	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	3959	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1693	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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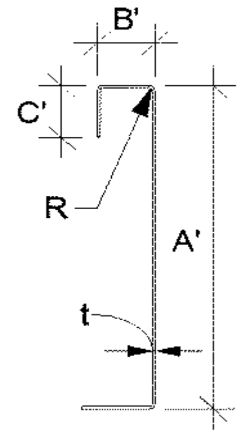
Curb Design

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

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'=	0.500 in (0 if no lips)	b =	1.233 in = B'-[r+t/2+α(r+t/2)]
α =	0.500 (0 - no Lip; 1 w/ lip)	b'=	1.447 in = B'-(t/2+αt/2)
R =	0.1069 (Inside bend radius)	c =	0.161 in = α[C'-(r+t/2)]
t =	0.0713 in	c'=	0.232 in = α(C'-t/2)
r'=	0.143 in = R+t/2	u =	0.224 in = πr/2
x =	0.292 in (Distance between centroid and web centerline)		
Ix =	2.515 in^4	rx =	2.04 in
Iy =	0.133 in^4	ry =	0.470 in
A =	0.60 in^2	rmin =	0.470 in



Axial Compression

Pa =	4.740 k	(Max Axial Comp)
Pn/Ωc =	4.957 k	
Fe =	16.90 ksi	
λc =	1.72	
Fn =	14.82 ksi	
Ly =	77.13 in	Lateral unbraced length
k_yL_y/r_y =	131	(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 =	5.5 in	-- Check limits:		C = 7.50
t =	0.0713 in	h/t =	77.14 ≤ 200	C_R = 0.08
N =	7.00	N/t =	98.18 ≤ 210	C_N = 0.12
Ω_w =	1.75	N/h =	1.273 ≤ 2.0	C_h = 0.048
P_n =	1.947 k	R/t =	1.50 ≤ 12.0	
P_n/Ω_w =	1.112 k			
Long side: Pu_{Trans} =	1.779 k	web stiffener REQ'D	# clips = 3	
Short side: Pu_{Long} =	1.979 k	web stiffener REQ'D	# clips = 2	

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

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

Check Web Stiffener

16Ga x 1-3/16in x 7in (C-channel)

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

width of stiffener =	7.000 in	ts =	0.0566 16 Gauge	Pwc =	1.947 k
web of stiff. w =	6.717 in	Rs =	0.0849 in	Pn =	14.669 k
***Check w/ts ≤ 1.28√E/Fys		Ω_c =	1.70	Ae =	0.380 in^2
w/ts =	118.675				
1.28√(E/Fys) =	31.091	--> w/ts over limit	Use C3.7.2	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 =	2464 lbs	Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax =	2669 lbs	Max(Tens/2 -OR- Comp/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 = 1.0

# of Bolts required for Shear = 2.2

# of Bolts Used = 4.0

Check Combined Stress in Bolts & Inserts: 0.801 O.K.

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

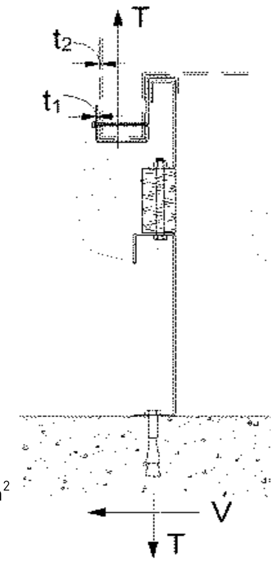
Assume L/t > 25: 25*t = 1.783 in

Lreq'd = 1.804 in

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

Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

t1 =	0.1017 in (clip thickness)	t2/t1 = 0.7	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)



For t2/t1 ≤ 1.0: Pns = 2266 #

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ 2.27 k

Tension: $P_{ns} = 2.7t_1 dF_{u1}$ 3.39 k

$P_{ns} = 2.7t_2 dF_{u2}$ 2.38 k

For t2/t1 ≥ 2.5: Pns = 2377 #

$P_{ns} = 2.7t_1 dF_{u1}$ 3.39 k

$P_{ns} = 2.7t_2 dF_{u2}$ 2.38 k

Pns/Ω = 755 #

Pss/Ω = 540 # <- Controls

Pnot = 0.748 k (screw pull-out strength)

Pnov = 3.718 k (screw pull-over strength)

Pts/Ω = 249 # <- Controls

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

$$P_{not} = 0.85t_c dF_{u2}) \quad t_c = \min(t_1, t_2) \quad P_{nov} = 1.5t_1 d_w F_{u1}$$

	Shear (k)	# clips	V_{clip} (k)	V_{allow}(lb)	# screws	spacing
Long side:	4.740	3	1.58	540 #	4	2.00 in
Short side:	4.740	2	2.37	540 #	5	1.50 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 = 0.661 in^2 Anv = 0.574 in^2 Ant = 0.117 in^2

Rn/Ω = 12.372 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)	$Comp_{MAX}$ =	6009	lbs
	$Tens_{MAX}$ =	3813	lbs
	$Shear_{MAX}$ =	9857	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	4300	lbs
	$Tens_{MAX}$ =	2104	lbs
	$Shear_{MAX}$ =	9857	lbs

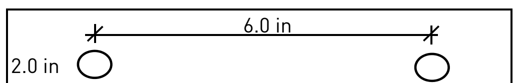
Loads at each Isolator Type: **CQA**

Transverse loading: (on long edge)	$Comp_{MAX}$ =	2002.9	lbs
	$Tens_{MAX}$ =	1270.9	lbs
# isolators: 3	$Shear_{MAX}$ =	985.7	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	2150.0	lbs
	$Tens_{MAX}$ =	1052.0	lbs
# isolators: 2	$Shear_{MAX}$ =	985.7	lbs

Max compression force on isolator: 2.150 k ≤ 3.176 k O.K.

Max uplift on isolator: 1.271 k ≤ 3.176 k O.K.

Max shear on isolator: 0.986 k ≤ 1.163 k O.K.



Forces on top bolt:

Tension = 1.271 k d_b = 0.375 in

Shear = 0.986 k)per rail, t = 0.0713 in 7.0 in

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

Shear O.K. Pn/Ω = 4.635 k e = 1.0 in

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. $F_t = (0.1 + 3d/s)F_u \leq F_u$ = 43.063 ksi

Bolt Bearing Strength: $P_n = Cm_f dtF_u$ Ω = 2.50 (Section E3.3.1 AISI)

Pn/Ω = 2.086 k d/t = 5.26

Bearing O.K. C = 3.00 mf = 1.00

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

Tension $P_{nt} = A_b F_{nt}$ Fnt = 40.5 ksi A_b = 0.1104 in^2

Pnt/Ω = 1.988 k Bolt tension O.K. Ωt = 2.25 (Table E3.4-1, AISI)

Shear $P_{nv} = A_b F_{nv}$ Fnv = 24.0 ksi Ωv = 2.40 (Table E3.4-1, AISI)

Pnv/Ω = 1.104 k Bolt shear O.K.

Combined Shear and tension in bolt:

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

ft = 11.51 ksi fv = 8.92 ksi O.K.

F'nt = 16.50 ksi Fnv/Ω = 10.00 ksi

$P'_{nt} = A_b F'_{nt}$ P'nt/Ω = 0.810 k No Good - Use Welds

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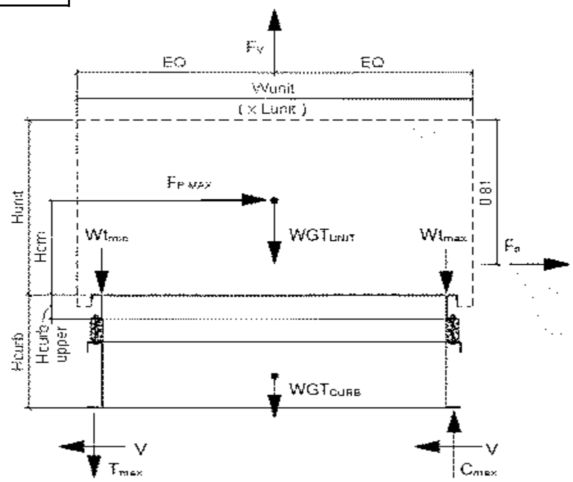
Client:	ProVent	PV2203	Base curb
Project:	CBISC-13	Iso Curb	CBISCSAV2025
Unit:	Sunchoice 20-25		



Base Curb Information

Hbase curb = 14 in (Height of base curb)
Lcurb = 138.125 in (Length of base curb)
wcurb = 83.125 in (Width of base curb)
WGTbase = 605 lbs (Weight of base curb)
# Springs long side = 3 # Springs short side = 2

Unit Information

WGTunit = 2640 lbs (Oper. Weight of Unit + 5%)
Wt'max = 765 lbs (Wtmax+1/4*WGTupper)
Wt'min = 587 lbs (Wtmin+1/4*WGTupper))
Hunit = 57.25 in (Height of unit above curb)
H'cm = 38.625 in (Hcm+10"(upper+spring))
Lunit = 143.8125 in (Length of unit)
Wunit = 88.75 in (Width of unit)
$WGT_{unit+upper+base}$ = 3350 lbs (Total weight)

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 = 9857 lbs (0.7*Fpmax) FpmaxASD = 12030 lbs
(unit + upper rail) (unit + upper rail + base curb)

Wind Loading - 2018 IBC/2019 CBC

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 = $0.00256 \cdot Kz \cdot Kzt \cdot Kd \cdot Ke \cdot V^2$ (Eq. 26.10-1 ASCE 7-16)
$F_{h\ ASD\ trans}$ = 2752 lbs = 0.6*qz*GCr*Lunit*(Hunit+Hbase curb+10") (Eq. 29.4-2)
$F_{h\ ASD\ long}$ = 1698 lbs = 0.6*qz*GCr*Wunit*(Hunit+Hbase curb+10")
$F_{vert\ ASD}$ = 2373 lbs = 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Base Curb Loading

Transverse:

$Compression_{SEISMIC}$ = 6600 lbs =[FpmaxASD*H'cm+2*(1+0.14S_{DS})*Wt'max*wcurb]/wcurb
$Tension_{SEISMIC}$ = 4251 lbs =[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*wcurb]]/wcurb
$Compression_{WIND}$ = 1011 lbs =[$F_{h\ ASD\ trans}$*H'cm+2*0.6*Wt'max*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ = 1761 lbs =[$F_{h\ ASD\ trans}$*H'cm-2*0.6*Wt'min*wcurb+$F_{vertASD}$*wcurb/2]/wcurb
---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ = 4776 lbs =[FpmaxASD*H'cm+2*(1+0.14*S_{DS})*Wt'max*Lcurb]/Lcurb
$Tension_{SEISMIC}$ = 2427 lbs =[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*Lcurb]]/Lcurb
$Compression_{WIND}$ = 207 lbs =[$F_{h\ ASD\ long}$*H'cm+2*0.6*Wt'max*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ = 957 lbs =[$F_{h\ ASD\ long}$*H'cm-2*0.6*Wt'min*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb
---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	6600	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	4251	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	4776	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2427	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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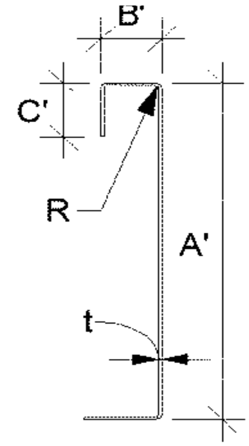

Curb Design

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'=	1.750 in		a'=	13.898 in	= A'-t
C'=	1.000 in	(0 if no lips)	b =	1.242 in	= B'-[r+t/2+α(r+t/2)]
α =	1.000	(0 - no Lip; 1 w/ lip)	b'=	1.648 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 =	0.297 in	(Distance between centroid and web centerline)			
Ix =	45.336 in		rx =	4.88 in	
Iy =	0.610 in		ry =	0.566 in	
A =	1.91 in^2		rmin =	0.566 in	

Axial Compression

Pu =	4.929 k	(Max Axial Comp)
Pn/Ωc =	7.751 k	
Fe =	8.34 ksi	
λc =	2.45	
Fn =	7.32 ksi	
Ly =	132.13 in	Lateral unbraced length
k_yL_y/r_y =	187	(assume k=0.8)

Ω_c = 1.80

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

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

Compression Check = O.K.

Check Web Crippling

h =	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} =	2.200 k	O.K.	# clips = 3	
Short side: Pu_{Long} =	2.388 k	O.K.	# clips = 2	

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

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

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

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

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 = 3007 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 3300 lbs Max(Tens/2 -OR- Comp/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 = 1.2
# of Bolts required for Shear = 2.7
# of Bolts Used = 4.0
Check Combined Stress in Bolts & Inserts: 0.986 O.K.

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

Assume L/t > 25: 25*t = 2.543 in
Lreq'd = 1.564 in

$$P_n/\Omega = \frac{1}{\Omega} 0.75 t L F_u \ge V_{req} \qquad L_{req'd} = \frac{V_{req}\Omega}{0.75 t F_u}$$

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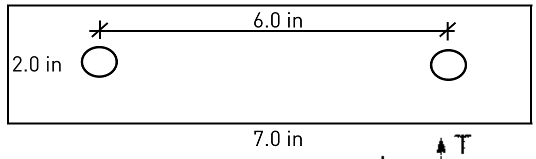
Curb Loads (copied from upper rail calcs)

Transverse:	$Comp_{MAX}$ =	6009	lbs
(on long edge)	$Tens_{MAX}$ =	3813	lbs
	$Shear_{MAX}$ =	9857	lbs
Longitudinal:	$Comp_{MAX}$ =	4300	lbs
(on short edge)	$Tens_{MAX}$ =	2104	lbs
	$Shear_{MAX}$ =	9857	lbs

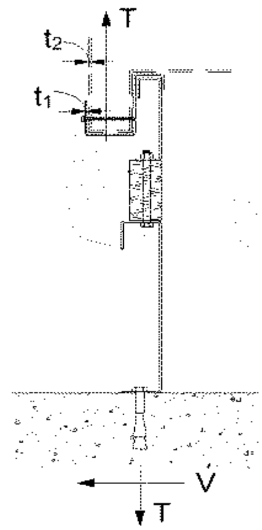
Loads at each Isolator Type: **CQA**

Transverse loading:	$Comp_{MAX}$ =	2002.9	lbs
(on long edge)	$Tens_{MAX}$ =	1270.9	lbs
# isolators: 3	$Shear_{MAX}$ =	985.7	lbs
Longitudinal loading:	$Comp_{MAX}$ =	2150.0	lbs
(on short edge)	$Tens_{MAX}$ =	1052.0	lbs
# isolators: 2	$Shear_{MAX}$ =	985.7	lbs

Max compression force on isolator: 2.150 k ≤ 3.176 k O.K.
Max uplift on isolator: 1.271 k ≤ 3.176 k O.K.
Max shear on isolator: 0.986 k ≤ 1.163 k O.K.



Forces on bottom bolts:
d_b = 0.5 in
base curb, t = 0.1017 in
Tension = 0.635 k / bolt
Shear = 0.493 k / bolt



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. $F_t = (0.1 + 3d/s)F_u \leq F_u =$ 55.250 ksi

Bolt Bearing Strength: $P_n = Cm_f dtF_u$ Ω = 2.50 (Section E3.3.1 AISI)
Pn/Ω = 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:
$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \leq F_{nt}$ ft = 6.47 ksi fv = 2.51 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: $(0.6\text{-}0.14S_{DS})D + 0.7E$ WIND: 0.6D + W

Transverse:	$Uplift_{MAX}$ = 7146 lbs	$Shear_{MAX}$ = 6015 lbs	
$Compression_{SEISMIC}$ =	9826 lbs	=[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb	
$Tension_{SEISMIC}$ =	7146 lbs	=[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb	
$Compression_{WIND}$ =	1561 lbs	=[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*wcurb/2-$F_{vert\ ASD}$*wcurb/2]/wcurb	
$Tension_{WIND}$ =	1924 lbs	=[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)-0.6*$WGT_{unit+upper+base}$*wcurb/2+$F_{vertASD}$*wcurb/2]/wcurb	
Longitudinal:	$Uplift_{MAX}$ = 4113 lbs	$Shear_{MAX}$ = 6015 lbs	
$Compression_{SEISMIC}$ =	6793 lbs	=[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb	
$Tension_{SEISMIC}$ =	4113 lbs	=[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb	
$Compression_{WIND}$ =	465 lbs	=[$F_{h\ ASD\ long}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*Lcurb/2-$F_{vert\ ASD}$*Lcurb/2]/Lcurb	
$Tension_{WIND}$ =	829 lbs	=[$F_{h\ ASD\ long}$*(H'cm+Hbase curb)-0.6*$WGT_{unit+upper+base}$*Lcurb/2+$F_{vertASD}$*Lcurb/2]/Lcurb	

Wood Attachment: **1/4"φ x 4.5" Simpson SDS screws w/ 2.75" threaded emb** (SGmin = 0.43)

	$Tall_{metal}$ =	1397 lbs	$Vall_{metal}$ =	1230 lbs
Transverse:	$Tall_{wood}$ =	760 lbs	$Vall_{wood}$ =	672 lbs
	# of Screws Req'd for Uplift =	9.40	COMBINED LOADING:	1.000 O.K.
	# of Screws Req'd for Shear =	8.95	Req'd Min Spacing =	9.29 in o.c.
	Total # of screws required =	15		

Use 15 - 1/4"ϕ x 4.5" Simpson SDS screws @ 9.3 in o.c. along long side of curb w/ 2.75" threaded embed

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Longitudinal:

# of Screws Req'd for Uplift =	5.41	COMBINED LOADING:	0.974 O.K.
# of Screws Req'd for Shear =	8.95	Screw Spacing =	9.39 in o.c.
Total # of screws required =	9		

Use 9 - 1/4"ϕ x 4.5" Simpson SDS screws @ 9.4 in o.c. along short side of curb w/ 2.75" threaded embed

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

$Tall_{bolt}$ =	3927 lbs	$Vall_{bolt}$ =	2209 lbs
$Tall_{metal}$ =	2975 lbs	$Vall_{metal}$ =	3072 lbs

Transverse:

# of Bolts Req'd for Uplift =	2.40	COMBINED LOADING:	0.989 O.K.
# of Bolts Req'd for Shear =	2.72	Bolt Spacing =	42.04 in o.c.
Total # of bolts required =	4		

Use 4 - 1/2" ϕ A307 Bolts to steel angle below deck @ 42 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift =	1.38	COMBINED LOADING:	0.735 O.K.
# of Bolts Req'd for Shear =	2.72	Bolt Spacing =	35.56 in o.c.
Total # of bolts required =	3		

Use 3 - 1/2" ϕ A307 Bolts to steel angle below deck @ 35.6 in o.c. along short side of curb

For Concrete anchorage: SEISMIC $(0.6-0.14S_{DS})D + 0.7\Omega_o E$ $\Omega o = 2.0$

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: $Uplift_{MAX}$ = 14761 lbs $Shear_{MAX}$ = 12030 lbs

$Compression_{SEISMIC}$ = 17441 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+curb+base}$*wcurb/2]/wcurb

$Tension_{SEISMIC}$ = 14761 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+curb+base}$*wcurb/2]/wcurb

$Shear_{SEISMIC}$ = 12030 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift =	12.88	spacing =	10.51 in o.c.	Tapplied =	1054.4 lbs
Min Bolts Req'd Shear =	4.53	spacing =	31.53 in o.c.	Vapplied =	601.5 lbs

Try using 14 bolts spaced at 9.70 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.15

Use 14 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 9.7 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 8696 lbs $Shear_{MAX}$ = 12030 lbs

$Compression_{SEISMIC}$ = 11376 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+curb+base}$*Lcurb/2]/Lcurb

$Tension_{SEISMIC}$ = 8696 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+curb+base}$*Lcurb/2]/Lcurb

$Shear_{SEISMIC}$ = 12030 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift =	7.59	spacing =	10.16 in o.c.	Tapplied =	1087.0 lbs
Min Bolts Req'd Shear =	4.53	spacing =	17.78 in o.c.	Vapplied =	601.5 lbs

Try using 6 bolts spaced at 14.23 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.18

Use 6 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 14.2 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY:	CBISC-13 CBISCSAV2025	**Unit:**	Sunchoice 20-25
UPPER CURB RAIL THICKNESS:	0.1017 in 12 Gauge		
UNIT CLIP THICKNESS:	0.1017 in 12 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 5 - #10 SMS screws each clip		
WEB STIFFENER:	16Ga x 1-3/16in x 7in (C-channel) stiffener at each clip		
VIBRATION ISOLATOR TYPE:	CQA	Top stud diameter: 3/8	(3) - CQA Isolators long side
Anchor bolt diameter:	1/2	Anchor hole diamter: 9/16	(2) - CQA Isolators short side
BASE CURB THICKNESS:	0.1017 in 12 Gauge		***Must weld top of CQA***
WEB STIFFENER:	NOT REQUIRED		
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 x 4.5" Simpson SDS screws w/ 2.75" threaded embed (SGmin =	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	15 @ 9.29 in o.c.	4 @ 42.04 in o.c.	14 @ 9.7 in o.c.
SHORT DIRECTION	9 @ 9.39 in o.c.	3 @ 35.56 in o.c.	6 @ 14.23 in o.c.