MOUR GROUP
ENGINEERING + DESIGN

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

Structural Calculations
for
CBISC-08 Series

CBISCSLM1830** SERIES

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

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.

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

ZJ, ZR 180-300; XP 180-240
ZF 210-300; ZT 180-276

PROVENT P/N	A	B	EST. WEIGHT
CBISCSLM183018**	8"	18"	556 Lbs
CBISCSLM183021**	11"	21"	606 Lbs
CBISCSLM183024**	14"	24"	656 Lbs

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

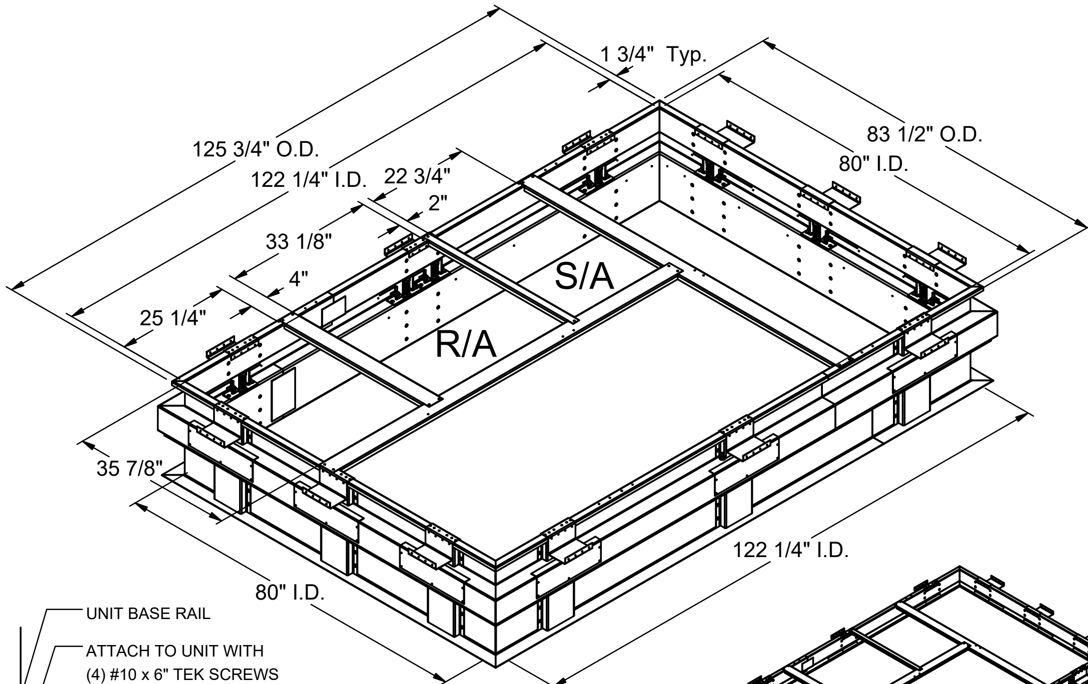
Meets seismic requirements for the following codes:
CBC 2019
IBC 2018

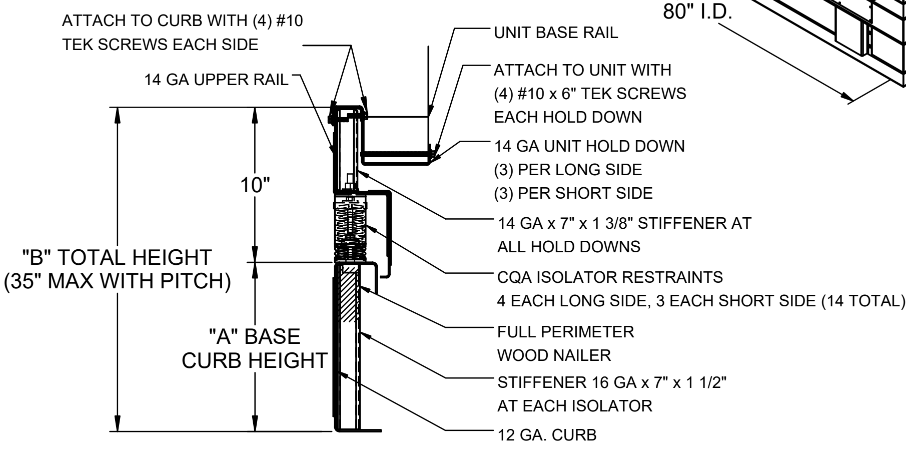
FEATURES

- 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).

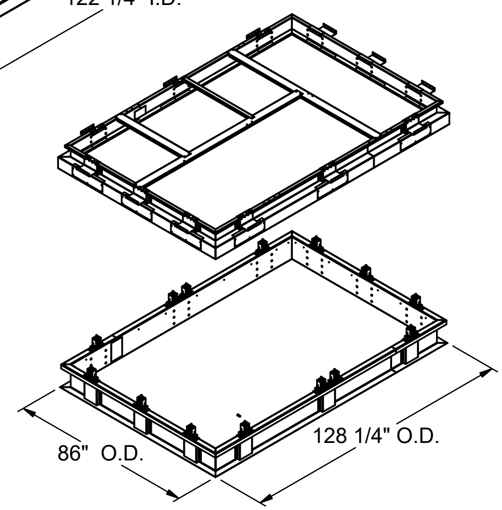
NOTES

- 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

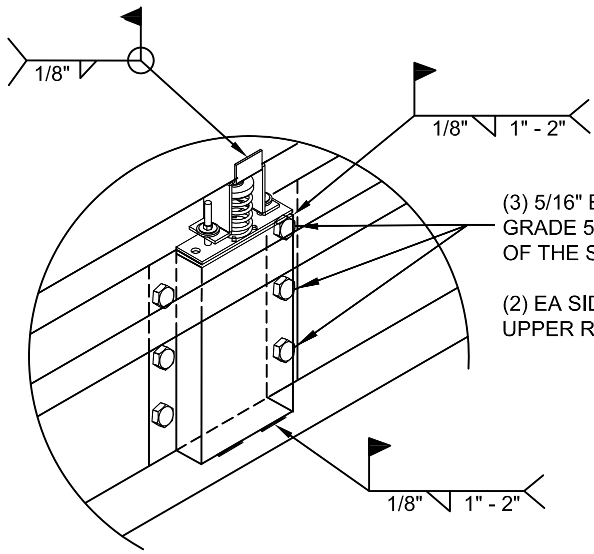
3847 WABASH DRIVE
MIRA LOMA, CA 91752

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

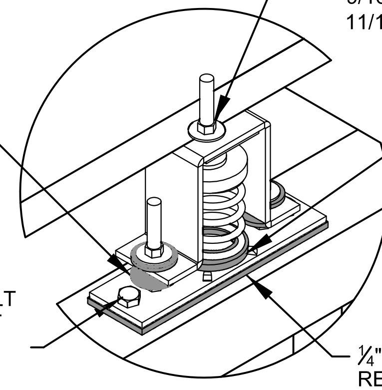
SUBMITED TO: ____________
COMPANY: ____________
JOB NAME: ____________
EQUIPMENT: ____________
NOTES: ____________

FORM NO:	PART NUMBER:	
CBISC-08	-	
DATE:	REV:	DRAWN BY:
4/20/2022	3	FMM

WELDMENT AND BOLTING DETAIL



BASE CURB SUPPORT



FOR BOLT ON ISOLATORS

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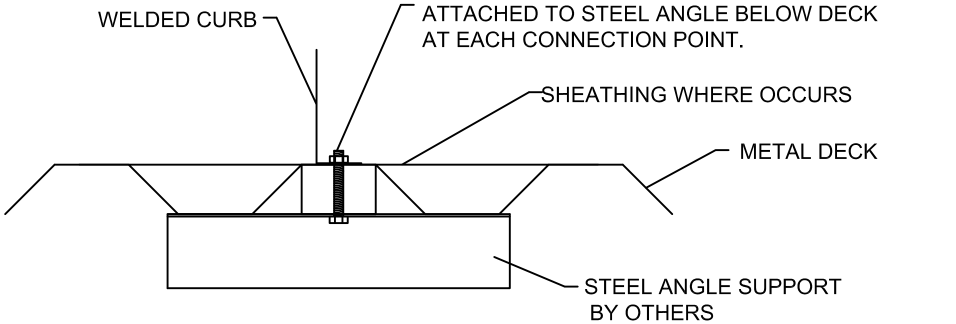
NOTES:____________________

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

STEEL ATTACHMENT



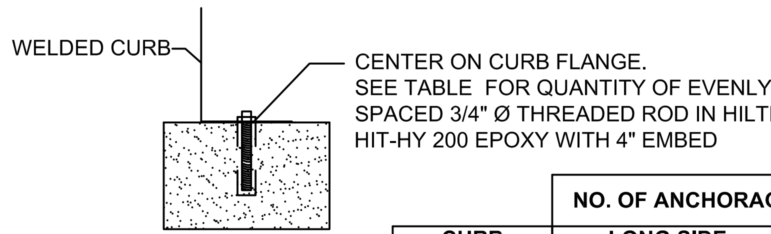
	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	**LONG SIDE**	**SHORT SIDE**
LXS	3 @ 19.25" O.C.	2 @ 23" O.C.
LXL	3 @ 19.25" O.C.	2 @ 33" O.C.
SUN3672	4 @ 21" O.C.	2 @ 27.25" O.C.
PRD3715	6 @ 14.28" O.C.	3 @ 20.75" O.C.
PRS	4 @ 20.46" O.C.	2 @ 31.13" O.C.
PRL	3 @ 36.13" O.C.	2 @ 44" O.C.
SLU180	4 @ 35.08" O.C.	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

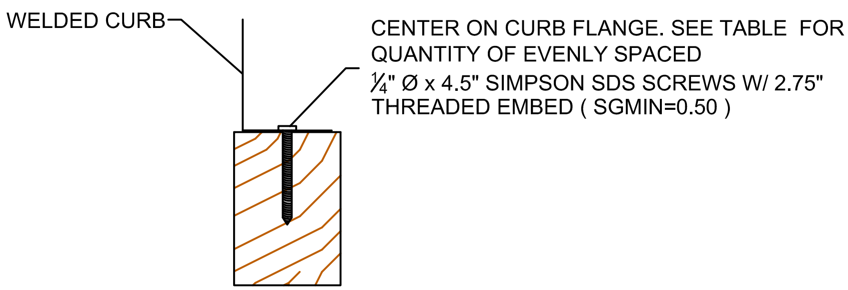
CONCRETE ATTACHMENT



	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.

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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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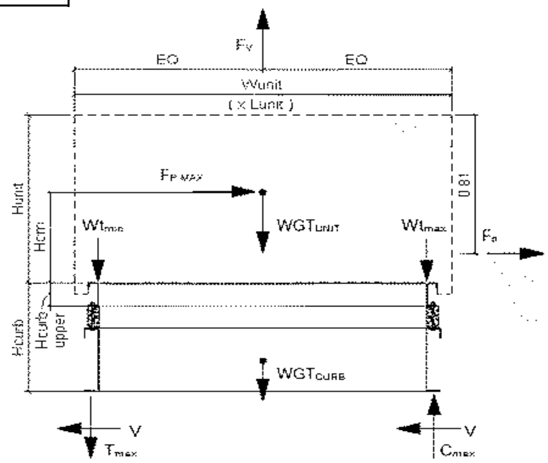
San Diego, CA 92120
(619)727-4800

Client:	ProVent PV2203 Upper curb rail
Project:	CBISC-08 Iso Curb CBISCSLM1830
Unit:	ZJ,ZR 180-300; XP 180-240, ZF 210-300



Upper Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	125.75	in	(Length of upper curb)
wcurb =	83.5	in	(Width of upper curb)
WGTupper =	107	lbs	(Weight of upper curb)
# Clips long side =	3		# Clips short side = 3

Unit Information

WGTunit =	3305	lbs	(Weight of Unit)
Wtmax =	950	lbs	(Maximum corner weight)
Wtmin =	702	lbs	(Minimum corner weight)
Hunit =	52.625	in	(Height of unit above curb)
Hcm =	26.3125	in	(Height to center of mass)
Lunit =	136.25	in	(Length of unit)
Wunit =	92	in	(Width of unit)

Seismic Loading - 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 IV 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 =	11868	lbs	(0.7*Fpmax)	FpmaxASD =	12252 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)
$F_{h\ ASD\ trans}$ =	1865	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	1260	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	2331	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Upper Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	6247	lbs	$=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb$
$Tension_{SEISMIC}$ =	3346	lbs	$=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*wcurb]]/wcurb$
$Compression_{WIND}$ =	563	lbs	$=[F_{h\ ASD\ trans}*Hcm+2*0.6*Wtmax*wcurb-F_{vert\ ASD}*wcurb/2]/wcurb$
$Tension_{WIND}$ =	910	lbs	$=[F_{h\ ASD\ trans}*Hcm-2*0.6*Wtmin*wcurb+F_{vertASD}*wcurb/2]/wcurb$

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	4990	lbs	$=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb$
$Tension_{SEISMIC}$ =	2089	lbs	$=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*Lcurb]]/Lcurb$
$Compression_{WIND}$ =	238	lbs	$=[F_{h\ ASD\ long}*Hcm+2*0.6*Wtmax*Lcurb-F_{vertASD}*Lcurb/2]/Lcurb$
$Tension_{WIND}$ =	586	lbs	$=[F_{h\ ASD\ long}*Hcm-2*0.6*Wtmin*Lcurb+F_{vertASD}*Lcurb/2]/Lcurb$

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	6247	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	3346	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	4990	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2089	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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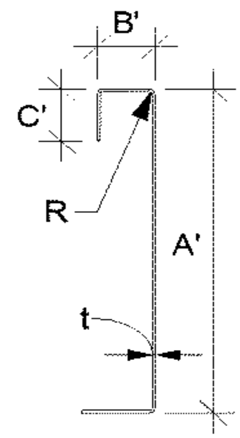
Curb Design

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'=	1.750 in	a'=	5.429 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 =	0.337 in (Distance between centroid and web centerline)		
Ix =	2.687 in^4	rx =	2.08 in
Iy =	0.169 in^4	ry =	0.521 in
A =	0.62 in^2	rmin =	0.521 in

Axial Compression

Pa = 5.934 k (Max Axial Comp) Ω_c = 1.80
Pn/Ωc = 5.848 k
Fe = 19.27 ksi
λc = 1.61
Fn = 16.90 ksi
Ly = 80.00 in Lateral unbraced length
k_yL_y/r_y = 123 (assume k=0.8)
Compression Check = N.G.

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

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

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				

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

Long side: Pu_{Trans} = 2.082 k web stiffener REQ'D # clips = 3
Short side: Pu_{Long} = 1.663 k web stiffener REQ'D # clips = 3

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 = 3063 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 3123 lbs Max(Tens/2 -OR- Comp/2 corner connections per side)

Bolt:	Tall =	2480 lbs	Vall =	1208 lbs
Threaded Insert:	Tall =	2860 lbs	Vall =	1096 lbs

# of Bolts required for Tension = 1.2
# of Bolts required for Shear = 2.8
# of Bolts Used = 4.0
Check Combined Stress in Bolts & Inserts: 1.021 N.G.

Check 1/8" welded connection

<--- USE WELD Ω = 2.35

Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 2.112 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 = 1.0	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: $P_{ns} = 2.7t_1 dF_{u1}$ 2.38 k

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

For t2/t1 ≥ 2.5:

Pns = 2377 #

$P_{ns} = 2.7t_1 dF_{u1}$ 2.38 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 = 2.607 k (screw pull-over strength)

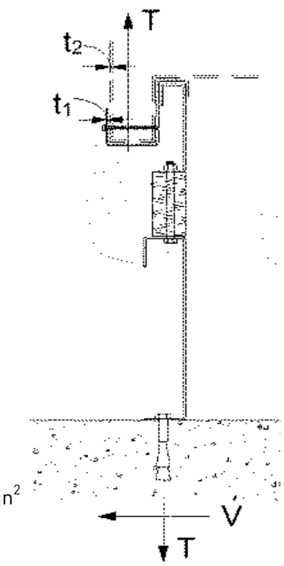
Pts/Ω = 249 # <- Controls

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

$P_{not} = 0.85t_c dF_{u2})$

$t_c = \min(t_1, t_2)$

$P_{nov} = 1.5t_1 d_w F_{u1}$



	Shear (k)	# clips	V_{clip} (k)	V_{allow}(lb)	# screws	spacing
Long side:	5.934	3	1.98	540 #	4	2.00 in
Short side:	5.934	3	1.98	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)	$Comp_{MAX}$ =	6919	lbs
	$Tens_{MAX}$ =	4189	lbs
	$Shear_{MAX}$ =	12252	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	5350	lbs
	$Tens_{MAX}$ =	2621	lbs
	$Shear_{MAX}$ =	12252	lbs

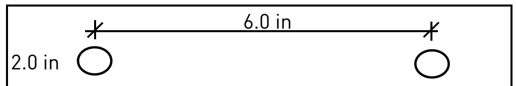
Loads at each Isolator Type: **CQA**

Transverse loading:	$Comp_{MAX}$ =	2306.2	lbs
(on long edge)	$Tens_{MAX}$ =	1396.3	lbs
# isolators: 3	$Shear_{MAX}$ =	1021.0	lbs
Longitudinal loading:	$Comp_{MAX}$ =	1783.4	lbs
(on short edge)	$Tens_{MAX}$ =	873.5	lbs
# isolators: 3	$Shear_{MAX}$ =	1021.0	lbs

Max compression force on isolator: 2.306 k ≤ 3.176 k O.K.

Max uplift on isolator: 1.396 k ≤ 3.176 k O.K.

Max shear on isolator: 1.021 k ≤ 1.163 k O.K.



Forces on top bolt:

Tension = 1.396 k d_b = 0.375 in

Shear = 1.021 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. $F_t = (0.1 + 3d/s)F_u \le F_u =$ 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 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:

$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \le F_{nt}$ ft = 12.64 ksi fv = 9.24 ksi O.K.

F'nt = 15.21 ksi Fnv/Ω = 10.00 ksi

$P'_{nt} = A_b F'_{nt}$ P'nt/Ω = 0.747 k No Good - Use Welds

Longitudinal weld loading: L = 1.5 $P_n/_\Omega = \frac{1}{\Omega}\left(1 - \frac{0.01L}{t_2}\right) Lt_2 F_{u2} \ge V_{req}$ 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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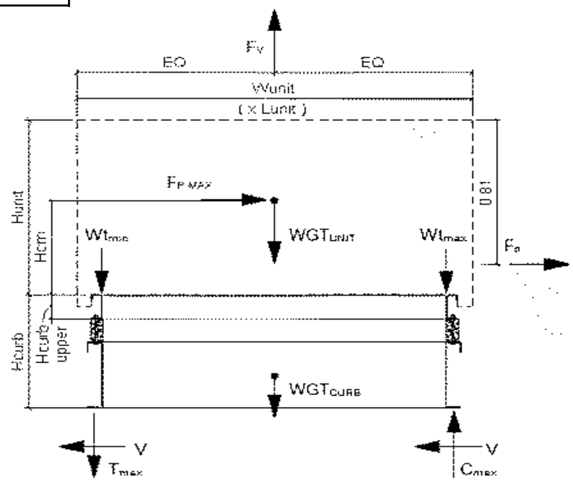
Client:	ProVent PV2203 Base curb
Project:	CBISC-08 Iso Curb CBISCSLM1830
Unit:	ZJ,ZR 180-300; XP 180-240, ZF 210-300



Base Curb Information

Hbase curb = 25 in (Height of base curb)
Lcurb = 128.25 in (Length of base curb)
wcurb = 86 in (Width of base curb)
WGTbase = 549 lbs (Weight of base curb)
# Springs long side = 3 # Springs short side = 3

Unit Information

WGTunit = 3305 lbs (Weight of Unit)
Wt'max = 977 lbs (Wtmax+1/4*WGTupper)
Wt'min = 729 lbs (Wtmin+1/4*WGTupper))
Hunit = 52.625 in (Height of unit above curb)
H'cm = 36.3125 in (Hcm+10"(upper+spring))
Lunit = 136.25 in (Length of unit)
Wunit = 92 in (Width of unit)
$WGT_{unit+upper+base}$ = 3961 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 = 12252 lbs (0.7*Fpmax) FpmaxASD = 14224 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 $= 0.00256*Kz*Kzt*Kd*Ke*V^2$ (Eq. 26.10-1 ASCE 7-16)
$F_{h\ ASD\ trans}$ = 2812 lbs = 0.6*qz*GCr*Lunit*(Hunit+Hbase curb+10") (Eq. 29.4-2)
$F_{h\ ASD\ long}$ = 1899 lbs = 0.6*qz*GCr*Wunit*(Hunit+Hbase curb+10")
$F_{vert\ ASD}$ = 2331 lbs = 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Base Curb Loading

Transverse:

$Compression_{SEISMIC}$ = 7751 lbs =[FpmaxASD*H'cm+2*(1+0.14S_{DS})*Wt'max*wcurb]/wcurb
$Tension_{SEISMIC}$ = 4764 lbs =[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*wcurb]]/wcurb
$Compression_{WIND}$ = 1194 lbs =[$F_{h\ ASD\ trans}$*H'cm+2*0.6*Wt'max*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ = 1478 lbs =[$F_{h\ ASD\ trans}$*H'cm-2*0.6*Wt'min*wcurb+$F_{vertASD}$*wcurb/2]/wcurb
---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ = 6047 lbs =[FpmaxASD*H'cm+2*(1+0.14*S_{DS})*Wt'max*Lcurb]/Lcurb
$Tension_{SEISMIC}$ = 3060 lbs =[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*Lcurb]]/Lcurb
$Compression_{WIND}$ = 544 lbs =[$F_{h\ ASD\ long}$*H'cm+2*0.6*Wt'max*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ = 828 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:	$Comp_{MAX}$ =	7751	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	4764	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	6047	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	3060	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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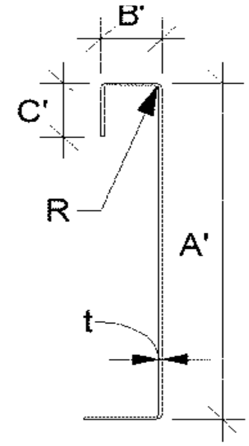

Curb Design

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

Calculate Section Properties of Curb

A'=	25.000	in	a =	24.492	in	= A'-(2r+t)
B'=	1.750	in	a'=	24.898	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 =	0.187	in (Distance between centroid and web centerline)				
Ix =	205.037	in	rx =	8.23	in	
Iy =	0.672	in	ry =	0.471	in	
A =	3.02	in^2	rmin =	0.471	in	

Axial Compression

Pu =	6.126	k	(Max Axial Comp)
Pn/Ωc =	9.973	k	
Fe =	6.77	ksi	
λc =	2.72		
Fn =	5.93	ksi	
Ly =	122.25	in	Lateral unbraced length
k_yL_y/r_y =	207		(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 =	0.1017	in	h/t =	245.82 ≤ 200	C_R = 0.14	(See table C3.4.1-2, fastened to support, one flange, end loading)
N =	7.00		N/t =	68.83 ≤ 210	C_N = 0.35	
Ω_w =	1.75		N/h =	0.28 ≤ 2.0	C_h = 0.02	
P_n =	4.106	k	R/t =	1.50 ≤ 9.0		
P_n/Ω_w =	2.346	k				
Long side: Pu_{Trans} =	2.584	k	web stiffener REQ'D	# clips = 3		
Short side: Pu_{Long} =	2.016	k	O.K.	# clips = 3		

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

*****h/t > 200; use web stiffeners**

Check Web Stiffener 16Ga x 1.5in x 7in (C-channel)

width of stiffener =	7.000	in	ts =	0.0566	16 Gauge
web of stiff. w =	6.717	in	Rs =	0.0849	in
***Check w/ts ≤ 1.28√E/Fys			Ω_c =	1.70	
w/ts =	118.675				
1.28√(E/Fys) =	31.091	--> w/ts over limit	Use C3.7.2		

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

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

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

Tcrnmax =	3556	lbs	Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax =	3876	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 =	1.4	
# of Bolts required for Shear =	3.2	
# of Bolts Used =	5.0	
Check Combined Stress in Bolts & Inserts:	0.928	O.K.

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

Assume L/t > 25: 25*t =	2.543	in
Lreq'd =	1.837	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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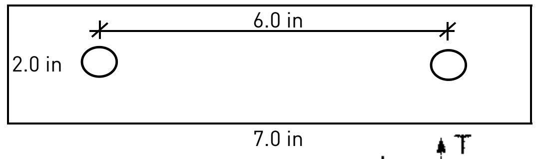
Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	6919	lbs
	$Tens_{MAX}$ =	4189	lbs
	$Shear_{MAX}$ =	12252	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	5350	lbs
	$Tens_{MAX}$ =	2621	lbs
	$Shear_{MAX}$ =	12252	lbs

Loads at each Isolator Type: **CQA**

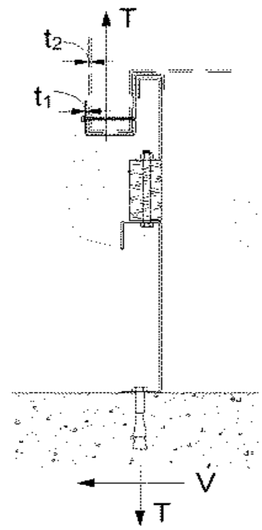
Transverse loading: (on long edge)	$Comp_{MAX}$ =	2306.2	lbs
	$Tens_{MAX}$ =	1396.3	lbs
# isolators: 3	$Shear_{MAX}$ =	1021.0	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	1783.4	lbs
	$Tens_{MAX}$ =	873.5	lbs
# isolators: 3	$Shear_{MAX}$ =	1021.0	lbs

Max compression force on isolator: 2.306 k ≤ 3.176 k O.K.
Max uplift on isolator: 1.396 k ≤ 3.176 k O.K.
Max shear on isolator: 1.021 k ≤ 1.163 k O.K.



Forces on bottom bolts:

d_b = 0.5 in
base curb, t = 0.1017 in
Tension = 0.698 k / bolt
Shear = 0.511 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 = 7.11 ksi fv = 2.60 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: $Uplift_{MAX}$ = 9585 lbs $Shear_{MAX}$ = 7112 lbs

$Compression_{SEISMIC}$ =	12753 lbs	=[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb
$Tension_{SEISMIC}$ =	9585 lbs	=[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb
$Compression_{WIND}$ =	2028 lbs	=[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*wcurb/2-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1982 lbs	=[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)-0.6*$WGT_{unit+upper+base}$*wcurb/2+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: $Uplift_{MAX}$ = 6244 lbs $Shear_{MAX}$ = 7112 lbs

$Compression_{SEISMIC}$ =	9413 lbs	=[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb
$Tension_{SEISMIC}$ =	6244 lbs	=[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb
$Compression_{WIND}$ =	931 lbs	=[$F_{h\ ASD\ long}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*Lcurb/2-$F_{vert\ ASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	885 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 screw: w/ 2.75" threaded emb** (SGmin = 0.5)

Transverse:

$Tall_{metal}$ = 1397 lbs $Vall_{metal}$ = 1230 lbs
$Tall_{wood}$ = 760 lbs $Vall_{wood}$ = 672 lbs

# of Screws Req'd for Uplift = 12.61 COMBINED LOADING: 0.994 O.K.
# of Screws Req'd for Shear = 10.58 Req'd Min Spacing = 6.68 in o.c.
Total # of screws required = 19

Use 19 - 1/4"ϕ x 4.5" Simpson SDS screws @ 6.7 in o.c. along long side of curb w/ 2.75" threaded embed

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Longitudinal:

# of Screws Req'd for Uplift =	8.22	COMBINED LOADING:	0.963	O.K.
# of Screws Req'd for Shear =	10.58	Screw Spacing =	6.50	in o.c.
Total # of screws required =	13			

Use 13 - 1/4"ϕ x 4.5" Simpson SDS screws @ 6.5 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	
Transverse: $Tall_{metal}$ =	2975 lbs	$Vall_{metal}$ =	3072 lbs	
# of Bolts Req'd for Uplift =	3.22	COMBINED LOADING:	0.997	O.K.
# of Bolts Req'd for Shear =	3.22	Bolt Spacing =	29.06	in o.c.
Total # of bolts required =	5			

Use 5 - 1/2" ϕ A307 Bolts to steel angle below deck @ 29.1 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift =	2.10	COMBINED LOADING:	0.777	O.K.
# of Bolts Req'd for Shear =	3.22	Bolt Spacing =	24.67	in o.c.
Total # of bolts required =	4			

Use 4 - 1/2" ϕ A307 Bolts to steel angle below deck @ 24.7 in o.c. along short side of curb

For Concrete anchorage: SEISMIC $(0.6-0.14S_{DS})D + 0.7\Omega_o E$ Ωo = 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: $Uplift_{MAX}$ = 19725 lbs $Shear_{MAX}$ = 14224 lbs

$Compression_{SEISMIC}$ = 22894 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+curb+base}$*wcurb/2]/wcurb

$Tension_{SEISMIC}$ = 19725 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+curb+base}$*wcurb/2]/wcurb

$Shear_{SEISMIC}$ = 14224 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift =	17.22	spacing =	6.84 in o.c.	Tapplied =	1095.9 lbs
Min Bolts Req'd Shear =	5.35	spacing =	23.25 in o.c.	Vapplied =	490.5 lbs

Try using 18 bolts, spaced at 6.84 in o.c.

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

Use 18 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 6.8 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 13044 lbs $Shear_{MAX}$ = 14224 lbs

$Compression_{SEISMIC}$ = 16213 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+curb+base}$*Lcurb/2]/Lcurb

$Tension_{SEISMIC}$ = 13044 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+curb+base}$*Lcurb/2]/Lcurb

$Shear_{SEISMIC}$ = 14224 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift =	11.39	spacing =	6.73 in o.c.	Tapplied =	1003.4 lbs
Min Bolts Req'd Shear =	5.35	spacing =	14.80 in o.c.	Vapplied =	490.5 lbs

Try using 11 bolts, spaced at 7.40 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \le 1.2$ = 1.06

Use 11 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 7.4 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY:	CBISC-08	CBISCSLM1830	Unit: ZJ,ZR 180-300; XP 180-240, ZF 210-300
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) -	3 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:	CQA	Top stud diameter: 3/8	(3) - CQA Isolators long side
Anchor bolt diameter:	1/2	Anchor hole diamter: 9/16	(3) - CQA Isolators short side
BASE CURB THICKNESS:	0.1017 in	12 Gauge	***Must weld top of CQA***
WEB STIFFENER:	16Ga x 1.5in x 7in (C-channel) stiffener at each clip on base curb		
CORNER CONNECTION:	Use minimum 5 - 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 = 0.5)	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	19 @ 6.68 in o.c.	5 @ 29.06 in o.c.	18 @ 6.84 in o.c.
SHORT DIRECTION	13 @ 6.5 in o.c.	4 @ 24.67 in o.c.	11 @ 7.4 in o.c.