MOUR GROUP
ENGINEERING + DESIGN

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

Structural Calculations
for
CBISC-07 Series

CBISCSLU180** 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.

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

ZF 180

PROVENT P/N	A	B	EST. WEIGHT
CBISCSLU18018**	8"	18"	475 Lbs
CBISCSLU18021**	11"	21"	525 Lbs
CBISCSLU18024**	14"	24"	575 Lbs

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

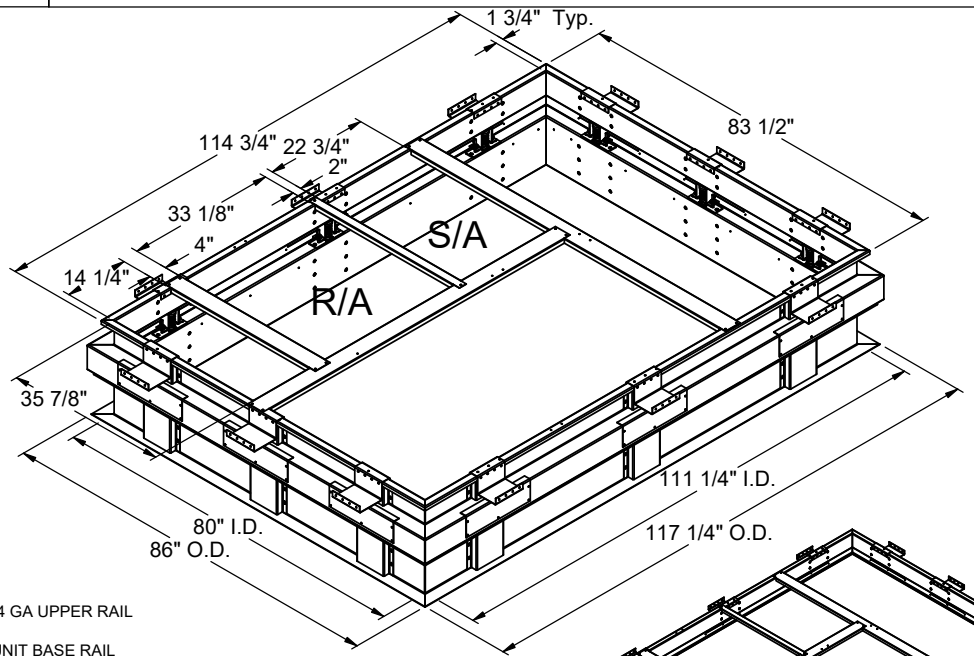
Meets seismic requirements for the following codes:
CBC 2019
IBC 2018

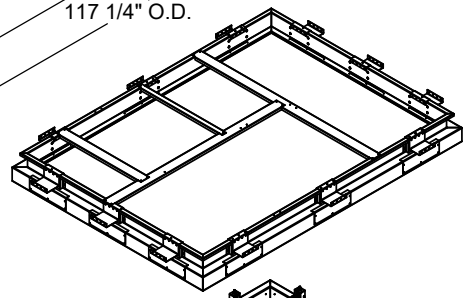
FEATURES

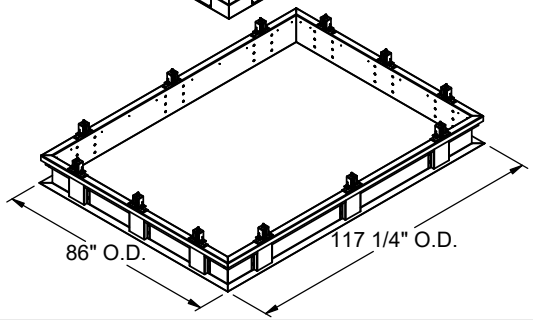
- Roof curb base 12 ga.
- Roof curb upper rail 14 ga.
- Fully welded construction.
- Gasketing package provided.
- Heat treated wood nailer provided.
- insulated deck pans provided.
- Pitched curbs and taller curbs are available.
- CalDyn OSHPd pre-approved seismic restraints. (OPM-0401-13), (CQA).

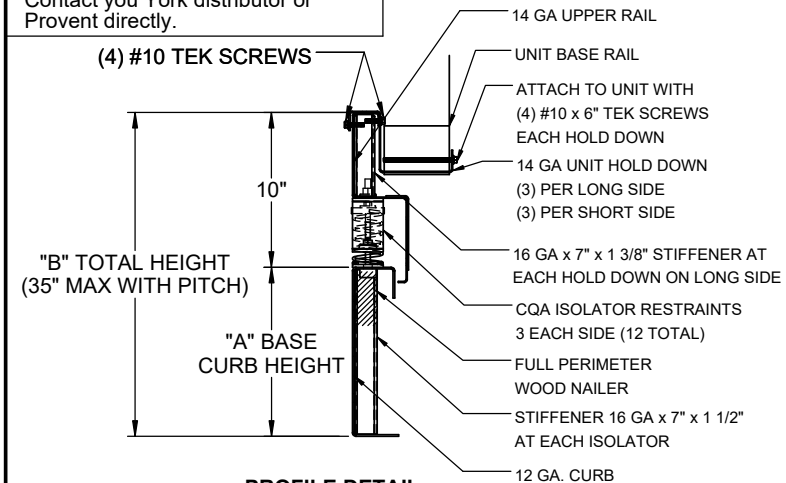
NOTES

- 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

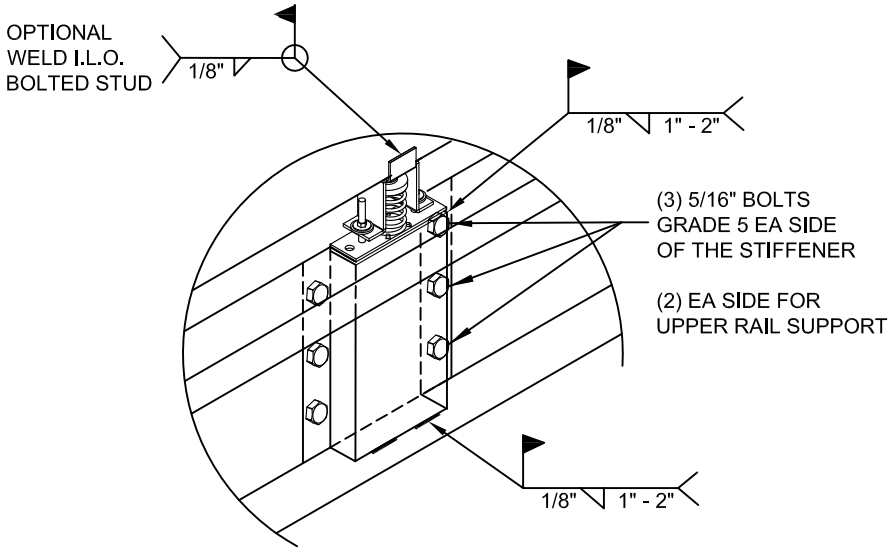
3847 WABASH DRIVE
MIRA LOMA, CA 91752

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

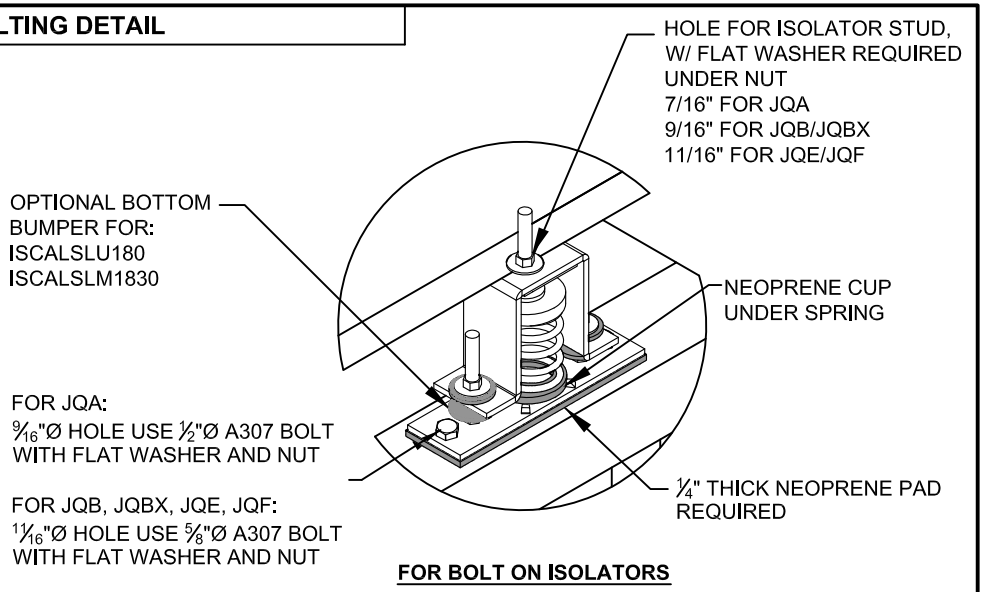
SUBMITED TO: _____
COMPANY: _____
JOB NAME: _____
EQUIPMENT: _____
NOTES: _____

FORM NO:	PART NUMBER:	
CBISC-07	-	
DATE:	**REV:**	**DRAWN BY:**
01/29/18	1	FMM

WELDMENT AND BOLTING DETAIL



BASE CURB SUPPORT



FOR BOLT ON ISOLATORS

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-61		
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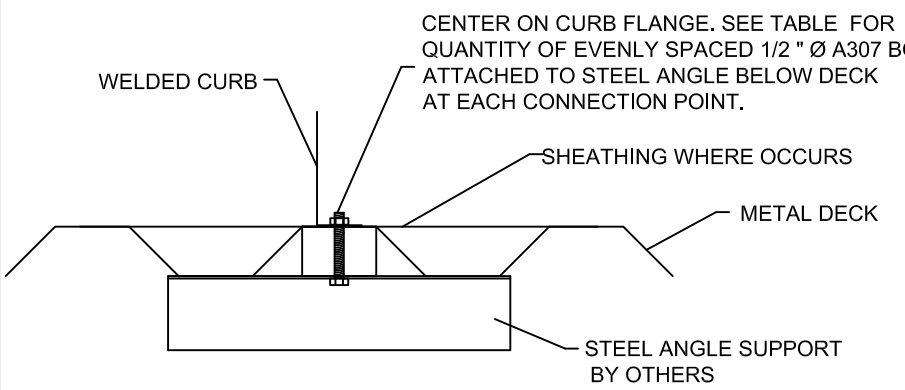
02/08/18	1	ALL

STEEL ATTACHMENT



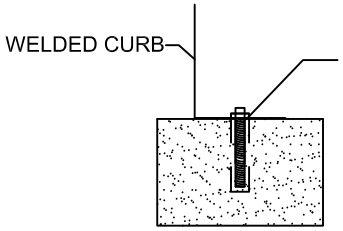
	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
LXS	3 @ 19.25" O.C.	2 @ 23" O.C.
LXL	3 @ 19.25" O.C.	2 @ 33" O.C.
SUN3672	4 @ 21" O.C.	2 @ 27.25" O.C.
PRD3715	6 @ 14.28" O.C.	3 @ 20.75" O.C.
PRS	4 @ 20.46" O.C.	2 @ 31.13" O.C.
PRL	3 @ 36.13" O.C.	2 @ 44" O.C.
SLU180	4 @ 35.08" O.C.	3 @ 37" 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

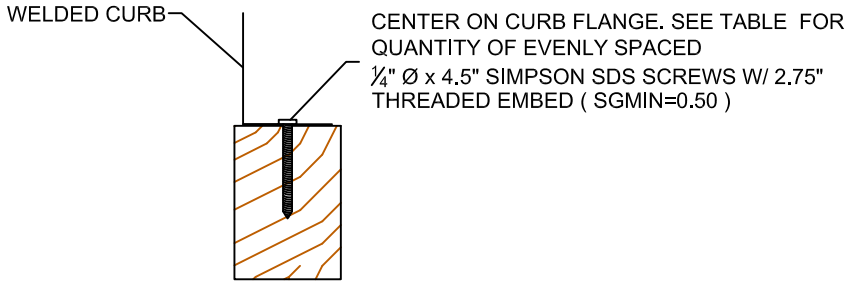
CONCRETE ATTACHMENT



	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



	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.

FOUR INCHES FROM EACH CORNER EVENLY SPACED

ProVent

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San Diego, CA 92120
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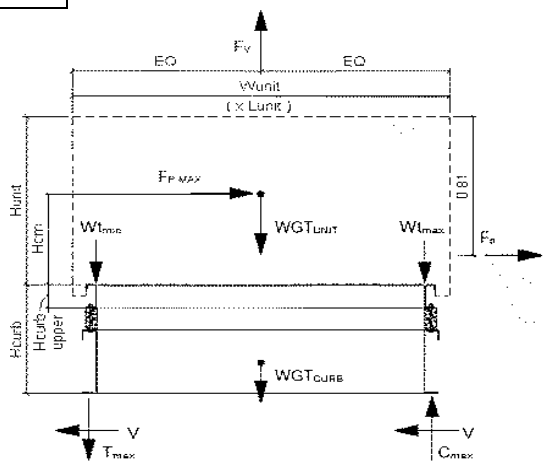
Client:	ProVent	PV2203		Upper curb rail
Project:	CBISC-07	Iso Curb	CBISCSLU180	
Unit:	ZF180			

Upper Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	114.75	in	(Length of upper curb)
wcurb =	83.5	in	(Width of upper curb)
WGTupper =	102	lbs	(Weight of upper curb)
# Clips long side =	3	# Clips short side =	3

Unit Information

WGTunit =	2120	lbs	(Weight of Unit)
Wtmax =	636	lbs	(Maximum corner weight)
Wtmin =	530	lbs	(Minimum corner weight)
Hunit =	48.625	in	(Height of unit above curb)
Hcm =	24.3125	in	(Height to center of mass)
Lunit =	125.25	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 =	7613	lbs	(0.7*Fpmax)	FpmaxASD =	7979 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)
$F_{h\ ASD\ trans}$ =	1597	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	1173	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	2143	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Upper Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	3895	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1919	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*wcurb)]/wcurb
$Compression_{WIND}$ =	157	lbs	=[$F_{h\ ASD\ trans}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	900	lbs	=[$F_{h\ ASD\ trans}$*Hcm-2*0.6*Wtmin*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	3291	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1315	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*Lcurb)]/Lcurb
$Compression_{WIND}$ =	-60	lbs	=[$F_{h\ ASD\ long}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	684	lbs	=[$F_{h\ ASD\ long}$*Hcm-2*0.6*Wtmin*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	3895	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1919	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	3291	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1315	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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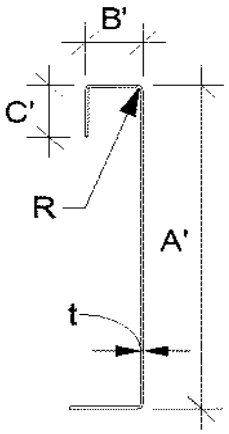
Curb Design

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 =	3.806 k	(Max Axial Comp)	Ω_c =	1.80
Pn/Ωc =	5.848 k			
Fe =	19.27 ksi	$\frac{P_n}{\Omega_c} = \frac{F_n A}{\Omega_c}$	$If\ \lambda_c \le 1.5;\ F_n = \left(0.658^{\lambda_c^2}\right)F_y$	$\lambda_c = \sqrt{\frac{F_y}{F_e}}$
λc =	1.61		$If\ \lambda_c > 1.5;\ F_n = \frac{0.877}{\lambda_c^2}F_y$	$F_e = \frac{\pi^2 E}{\left(kl/r\right)^2}$
Fn =	16.90 ksi			
Ly =	80.00 in	Lateral unbraced length		
k_yL_y/r_y =	123	(assume k=0.8)		

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				

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

Long side: Pu_{Trans} = 1.298 k **web stiffener REQ'D** # clips = 3

Short side: Pu_{Long} = 1.117 k **web stiffener REQ'D** # clips = 3

Check Web Stiffener

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

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

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 = 1995 lbs — Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)

Vcrnmax = 1947 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 = 0.8

# of Bolts required for Shear = 1.8

# of Bolts Used = 3.0

Check Combined Stress in Bolts & Inserts: 0.860 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35

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

Lreq'd = 1.317 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 # | For t2/t1 ≥ 2.5: | Pns = 2377 #

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 | $P_{ns} = 2.7t_1 dF_{u1}$ | 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

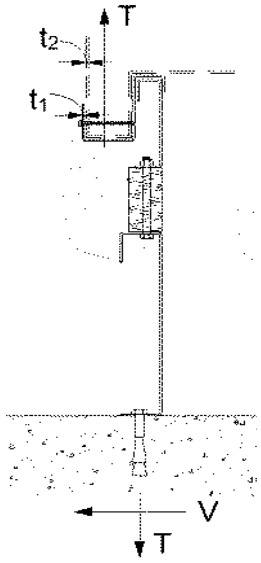
Pnot = 0.748 k (screw pull-out strength) $P_{not} = 0.85t_c dF_{u2})$

$t_c = \min(t_1, t_2)$

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:	3.806	3	1.27	540 #	4	2.00 in
Short side:	3.806	3	1.27	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)	$Comp_{MAX}$ =	4314	lbs
	$Tens_{MAX}$ =	2537	lbs
	$Shear_{MAX}$ =	7979	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	3539	lbs
	$Tens_{MAX}$ =	1761	lbs
	$Shear_{MAX}$ =	7979	lbs

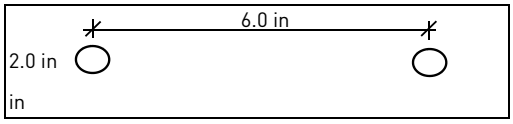
Loads at each Isolator Type: **CQA**

Transverse loading: (on long edge) # isolators: 3	$Comp_{MAX}$ =	1438.2	lbs
	$Tens_{MAX}$ =	845.6	lbs
	$Shear_{MAX}$ =	664.9	lbs
Longitudinal loading: (on short edge) # isolators: 3	$Comp_{MAX}$ =	1179.6	lbs
	$Tens_{MAX}$ =	587.0	lbs
	$Shear_{MAX}$ =	664.9	lbs

Max compression force on isolator: 1.438 k ≤ 3.176 k **O.K.**

Max uplift on isolator: 0.846 k ≤ 3.176 k **O.K.**

Max shear on isolator: 0.665 k ≤ 1.163 k **O.K.**



Forces on top bolt:

Tension = 0.846 k | d_b = 0.375

Shear = 0.665 k | per rail, t = 0.0713 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 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 = 7.66 ksi | fv = 6.02 ksi O.K.

F'nt = 28.27 ksi | Fnv/Ω = 10.00 ksi

$P'_{nt} = A_b F'_{nt}$ | P'nt/Ω = 1.388 k **Combined O.K.**

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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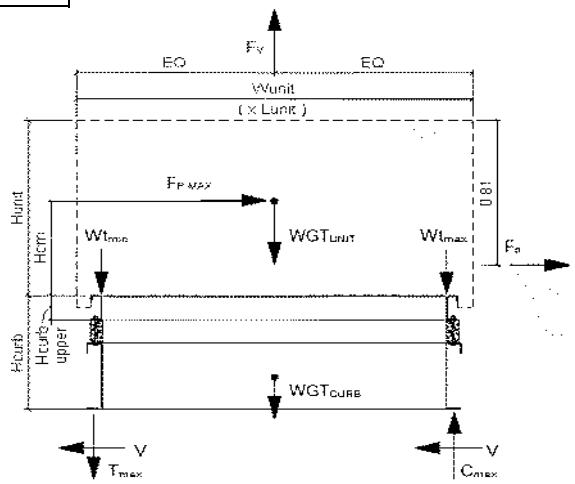
Client:	ProVent	PV2203	Base curb
Project:	CBISC-07	Iso Curb	CBISCSLU180
Unit:	ZF180		

Base Curb Information

Hbase curb =	25	in	(Height of base curb)
Lcurb =	117.25	in	(Length of base curb)
wcurb =	86	in	(Width of base curb)
WGTbase =	473	lbs	(Weight of base curb)

Springs long side = 3 # Springs short side = 3



Unit Information

WGTunit =	2120	lbs	(Weight of Unit)
Wt'max =	662	lbs	(Wtmax+1/4*WGTupper)
Wt'min =	556	lbs	(Wtmin+1/4*WGTupper))
Hunit =	48.625	in	(Height of unit above curb)
H'cm =	34.3125	in	(Hcm+10"(upper+spring))
Lunit =	125.25	in	(Length of unit)
Wunit =	92	in	(Width of unit)
WGTunit+upper+base =	2695	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 =	7979	lbs	(0.7*Fpmax) FpmaxASD = 9678 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)
$F_{h\ ASD\ trans}$ =	2467	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hbase curb+10") (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	1812	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hbase curb+10")
$F_{vert\ ASD}$ =	2143	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Base Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	4929	lbs	=[FpmaxASD*H'cm+2*(1+0.14S_{DS})*Wt'max*wcurb]/wcurb
$Tension_{SEISMIC}$ =	2872	lbs	=[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*wcurb)]/wcurb
$Compression_{WIND}$ =	707	lbs	=[$F_{h\ ASD\ trans}$*H'cm+2*0.6*Wt'max*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1389	lbs	=[$F_{h\ ASD\ trans}$*H'cm-2*0.6*Wt'min*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	4080	lbs	=[FpmaxASD*H'cm+2*(1+0.14*S_{DS})*Wt'max*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	2023	lbs	=[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*Lcurb)]/Lcurb
$Compression_{WIND}$ =	253	lbs	=[$F_{h\ ASD\ long}$*H'cm+2*0.6*Wt'max*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	935	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:	$Comp_{MAX}$ =	4929	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	2872	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	4080	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2023	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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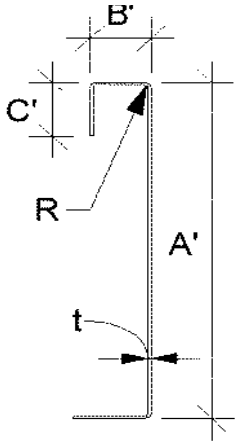
Curb Design

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'=	[0.000] in (0 if no lips)		b =	1.496 in	= B'-[r+t/2+α(r+t/2)]
α =	[0.000] (0 - no Lip; 1 w/ lip)		b'=	1.699 in	= B'-(t/2+αt/2)
R =	0.1525 (Inside bend radius)		c =	0.000 in	= α[C'-(r+t/2)]
t =	0.1017 in		c'=	0.000 in	= α(C'-t/2)
r'=	0.203 in	= R+t/2	u =	0.319 in	= πr/2
x =	0.103 in	(Distance between centroid and web centerline)			
Ix =	181.709 in		rx =	7.97 in	
Iy =	0.302 in		ry =	0.325 in	
A =	2.86 in^2		rmin =	0.325 in	

Axial Compression

Pu = 3.990 k (Max Axial Comp) Ω_c = 1.80
Pn/Ωc = 5.415 k
Fe = 3.89 ksi
λc = 3.59
Fn = 3.41 ksi
Ly = 111.25 in Lateral unbraced length
k_yL_y/r_y = 274 (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 =	25 in	-- Check limits:		C = 4.00	(See table C3.4.1-2, fastened to support, one flange, end loading)
t =	0.1017 in	h/t =	245.82 ≤ 200	C_R = 0.14	
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} =	1.643 k	O.K.	# clips = 3		
Short side: Pu_{Long} =	1.360 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 = 2419 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 2464 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 = 2.0
# of Bolts Used = [4.0]
Check Combined Stress in Bolts & Inserts: 0.754 O.K.

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 2.543 in
Lreq'd = 1.168 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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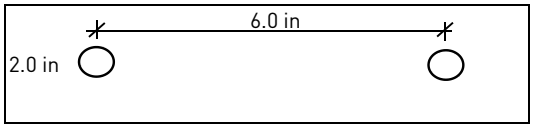
Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	4314	lbs
	$Tens_{MAX}$ =	2537	lbs
	$Shear_{MAX}$ =	7979	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	3539	lbs
	$Tens_{MAX}$ =	1761	lbs
	$Shear_{MAX}$ =	7979	lbs

Loads at each Isolator Type: **CQA**

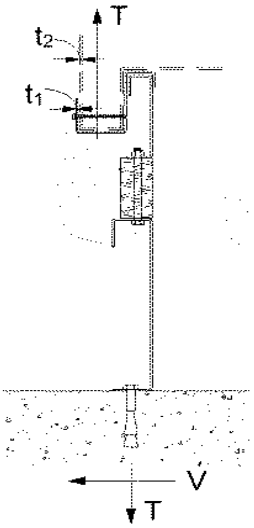
Transverse loading: (on long edge) # isolators: 3	$Comp_{MAX}$ =	1438.2	lbs
	$Tens_{MAX}$ =	845.6	lbs
	$Shear_{MAX}$ =	664.9	lbs
Longitudinal loading: (on short edge) # isolators: 3	$Comp_{MAX}$ =	1179.6	lbs
	$Tens_{MAX}$ =	587.0	lbs
	$Shear_{MAX}$ =	664.9	lbs

Max compression force on isolator: 1.438 k ⩽ 3.176 k **O.K.**
Max uplift on isolator: 0.846 k ⩽ 3.176 k **O.K.**
Max shear on isolator: 0.665 k ⩽ 1.163 k **O.K.**



Forces on bottom bolts:

d_b = 0.5 in
base curb, t = 0.1017 in
Tension = 0.423 k / bolt
Shear = 0.332 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 = 4.31 ksi fv = 1.69 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: $(0.6-0.14S_{DS})D + 0.7E$ WIND: 0.6D + W

Transverse:	$Uplift_{MAX}$ =	6296 lbs	$Shear_{MAX}$ =	4839 lbs
$Compression_{SEISMIC}$ =	8452 lbs	=[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb		
$Tension_{SEISMIC}$ =	6296 lbs	=[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb		
$Compression_{WIND}$ =	1439 lbs	=[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*wcurb/2-$F_{vert\ ASD}$*wcurb/2]/wcurb		
$Tension_{WIND}$ =	1964 lbs	=[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)-0.6*$WGT_{unit+upper+base}$*wcurb/2+$F_{vertASD}$*wcurb/2]/wcurb		
Longitudinal:	$Uplift_{MAX}$ =	4517 lbs	$Shear_{MAX}$ =	4839 lbs
$Compression_{SEISMIC}$ =	6673 lbs	=[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb		
$Tension_{SEISMIC}$ =	4517 lbs	=[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb		
$Compression_{WIND}$ =	654 lbs	=[$F_{h\ ASD\ long}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*Lcurb/2-$F_{vert\ ASD}$*Lcurb/2]/Lcurb		
$Tension_{WIND}$ =	1180 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 emt** (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 = 8.28 COMBINED LOADING: 0.892 O.K.
# of Screws Req'd for Shear = 7.20 Req'd Min Spacing = 8.40 in o.c.
Total # of screws required = 14

Use 14 - 1/4"ϕ x 4.5" Simpson SDS screws @ 8.4 in o.c. along long side of curb w/ 2.75" threaded embed

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Longitudinal:

# of Screws Req'd for Uplift = 5.94 COMBINED LOADING: 0.894 O.K.

# of Screws Req'd for Shear = 7.20 Screw Spacing = 8.67 in o.c.

Total # of screws required = 10

Use 10 - 1/4"ϕ x 4.5" Simpson SDS screws @ 8.7 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 = 2.12 COMBINED LOADING: 0.842 O.K.

# of Bolts Req'd for Shear = 2.19 Bolt Spacing = 35.08 in o.c.

Total # of bolts required = 4

Use 4 - 1/2" ϕ A307 Bolts to steel angle below deck @ 35.1 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 1.52 COMBINED LOADING: 0.693 O.K.

# of Bolts Req'd for Shear = 2.19 Bolt Spacing = 37.00 in o.c.

Total # of bolts required = 3

Use 3 - 1/2" ϕ A307 Bolts to steel angle below deck @ 37 in o.c. along short side of curb

For Concrete anchorage: SEISMIC $(0.6\text{-}0.14S_{DS})D + 0.7\Omega_o E$ 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: $Uplift_{MAX}$ = 12971 lbs $Shear_{MAX}$ = 9678 lbs

$Compression_{SEISMIC}$ = 15127 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+curb+base}$*wcurb/2]/wcurb

$Tension_{SEISMIC}$ = 12971 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+curb+base}$*wcurb/2]/wcurb

$Shear_{SEISMIC}$ = 9678 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift = 11.32 spacing = 9.57 in o.c. Tapplied = 1080.9 lbs

Min Bolts Req'd Shear = 3.64 spacing = 35.08 in o.c. Vapplied = 483.9 lbs

Try using 12 bolts
spaced at 9.57 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.13

Use 12 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 9.6 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 9413 lbs $Shear_{MAX}$ = 9678 lbs

$Compression_{SEISMIC}$ = 11569 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+curb+base}$*Lcurb/2]/Lcurb

$Tension_{SEISMIC}$ = 9413 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+curb+base}$*Lcurb/2]/Lcurb

$Shear_{SEISMIC}$ = 9678 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift = 8.22 spacing = 9.25 in o.c. Tapplied = 941.3 lbs

Min Bolts Req'd Shear = 3.64 spacing = 24.67 in o.c. Vapplied = 483.9 lbs

Try using 8 bolts
spaced at 10.57 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.00

Use 8 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 10.6 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY:	CBISC-07	CBISCSLU180	Unit:	ZF180
UPPER CURB RAIL THICKNESS:	0.0713 in	14 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		---Bolt or Weld O.K.---
WEB STIFFENER:	16Ga x 1.5in x 7in (C-channel) stiffener at each clip on base curb			
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	14 @ 8.4 in o.c.	4 @ 35.08 in o.c.	12 @ 9.57 in o.c.
SHORT DIRECTION	10 @ 8.67 in o.c.	3 @ 37 in o.c.	8 @ 10.57 in o.c.