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

Structural Calculations
for
CBISC-04 Series

CBISCPRD3715** SERIES

REGISTERED PROFESSIONAL ENGINEER
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Exp. 6/30/25
STRUCTURAL
STATE OF CALIFORNIA

Prepared for:

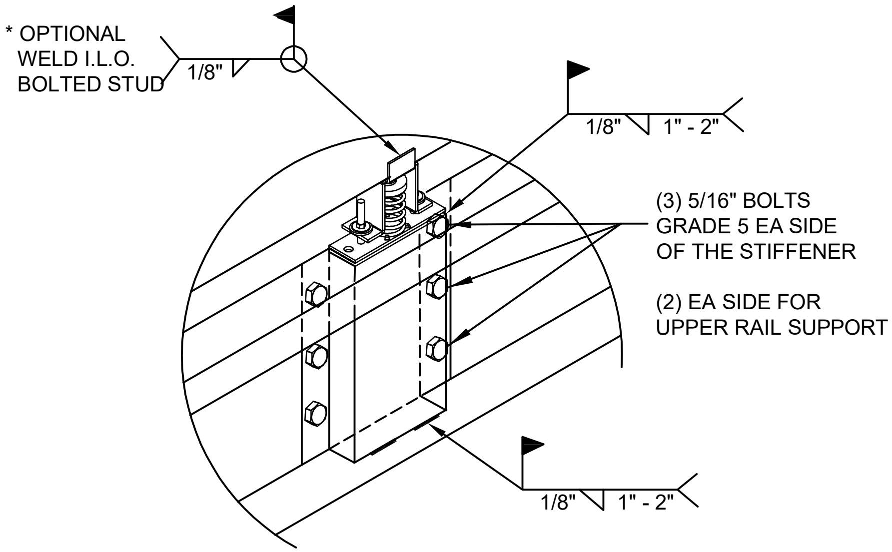
PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

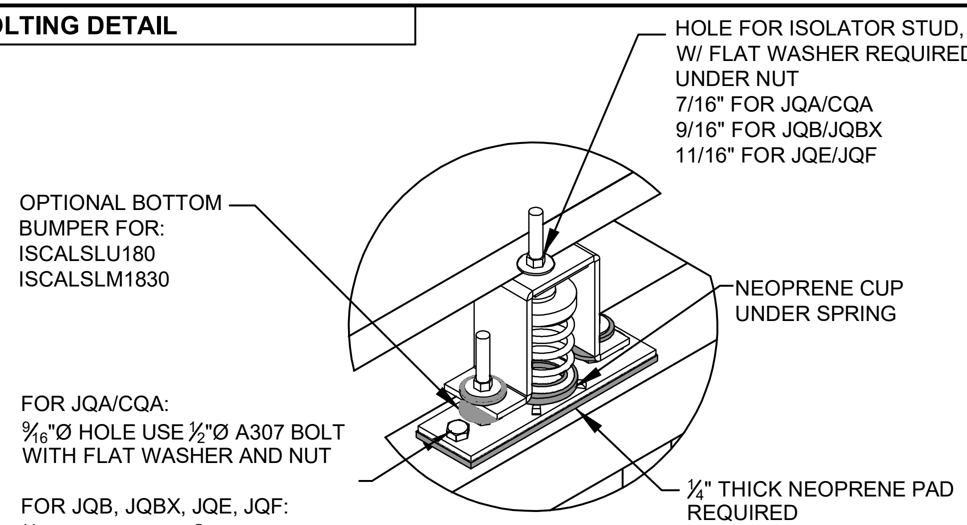
Date: August 23, 2023

Project Number: PV2312

WELDMENT AND BOLTING DETAIL



BASE CURB SUPPORT



FOR BOLT ON ISOLATORS

Note: * - INDICATES WELD REQUIRED I.L.O.
BOLTED STUD FOR THE FOLLOWING CURBS:
- -LXL (CBISC-02)
- -PRD3715 (CBISC-04)
- -SAV1518 (CBISC-12)
- -SAV2025 (CBISC-13)
- -SAV28 (CBISC-14)

ProVent
3847 WABASH DRIVE
MIRA LOMA, CA 91725
PHONE (951) 685-1101
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SUBMITTED TO:__________
COMPANY:__________
JOB NAME:__________
EQUIPMENT:__________
NOTES:__________

FORM NO:		
CB-61		
DATE:	REV:	DRAWN BY:
08/14/23	2	FMM

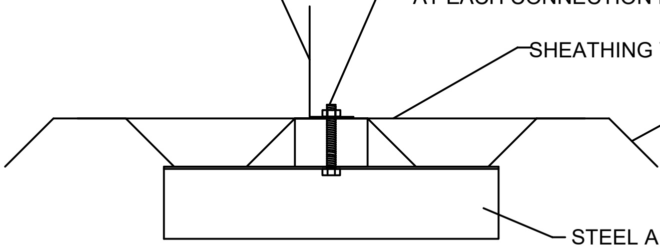
STEEL ATTACHMENT

WELDED CURB

CENTER ON CURB FLANGE. SEE TABLE FOR QUANTITY OF EVENLY SPACED 1/2 " Ø A307 BOLTS ATTACHED TO STEEL ANGLE BELOW DECK AT EACH CONNECTION POINT.

SHEATHING WHERE OCCURS

METAL DECK



STEEL ANGLE SUPPORT BY OTHERS

	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	5 @ 17.44" O.C.	2 @ 41.5" O.C.
SAV1518	6 @ 22.43" O.C	3 @ 35.56" O.C.
SAV2025	7 @ 21.02" O.C	3 @ 35.56" O.C.
SAV28	7 @ 23.75" O.C	3 @ 35.56" O.C.

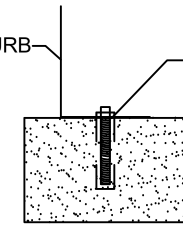
ASSUMES:
CONC SLAB
f'c= 4000PSI MINIMUM
6" MIN THICKNESS
NORMAL WEIGHT CONCRETE
MIN. 9-1/8" EDGE DISTANCE.

Meets seismic requirements for the following codes:
CBC 2022
IBC 2021

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

CONCRETE ATTACHMENT

WELDED CURB



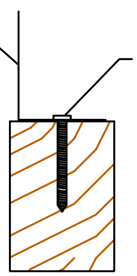
CENTER ON CURB FLANGE.
SEE TABLE FOR QUANTITY OF EVENLY SPACED 5/8" Ø THREADED ROD IN HILTI HIT-HY 200 V3 EPOXY WITH 4" EMBED

	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
LXS	4 @ 12.83" O.C.	2 @ 23.0" O.C.
LXL	4 @ 12.83" O.C.	3 @ 16.50" O.C.
SUN3672	4 @ 21.0" O.C.	2 @ 27.25" O.C.
PRD3715	9 @ 8.92" O.C.	6 @ 8.30" O.C.
PRS	5 @ 15.34" O.C.	3 @ 15.56" O.C.
PRL	7 @ 11.63" O.C.	4 @ 13.83" O.C.
SAV1518	8 @ 16.02" O.C.	6 @ 14.23" O.C.
SAV2025	9 @ 15.77" O.C.	6 @ 14.23" O.C.
SAV28	10 @ 15.83" O.C.	6 @ 14.23" O.C.

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

WOOD ATTACHMENT

WELDED CURB



CENTER ON CURB FLANGE. SEE TABLE FOR QUANTITY OF EVENLY SPACED ¼" Ø x 4.5" SIMPSON SDS SCREWS W/ 2.75" THREADED EMBED (SGMIN=0.50)

FOUR INCHES FROM EACH CORNER EVENLY SPACED

	NO. OF ANCHORAGE SCREWS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
LXS	8 @ 6.07" 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 @ 6.70" O.C.	8 @ 6.50" O.C.
SAV1518	15 @ 8.29" O.C.	10 @ 8.35" O.C.
SAV2025	18 @ 7.65" O.C.	10 @ 8.35" O.C.
SAV28	20 @ 7.71" O.C.	10 @ 8.35" O.C.

ProVent

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

FORM NO:		
CB-62		
DATE:	**REV:**	**DRAWN BY:**
6/28/2023	4	FMM

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

STRUCTURALLY CALCULATED VIBRATION ISOLATION ROOF CURBS FOR PREDATOR (SUN PRO) UNITS

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

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

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

Weight of upper portion supported by spring isolators= 243 Lbs.

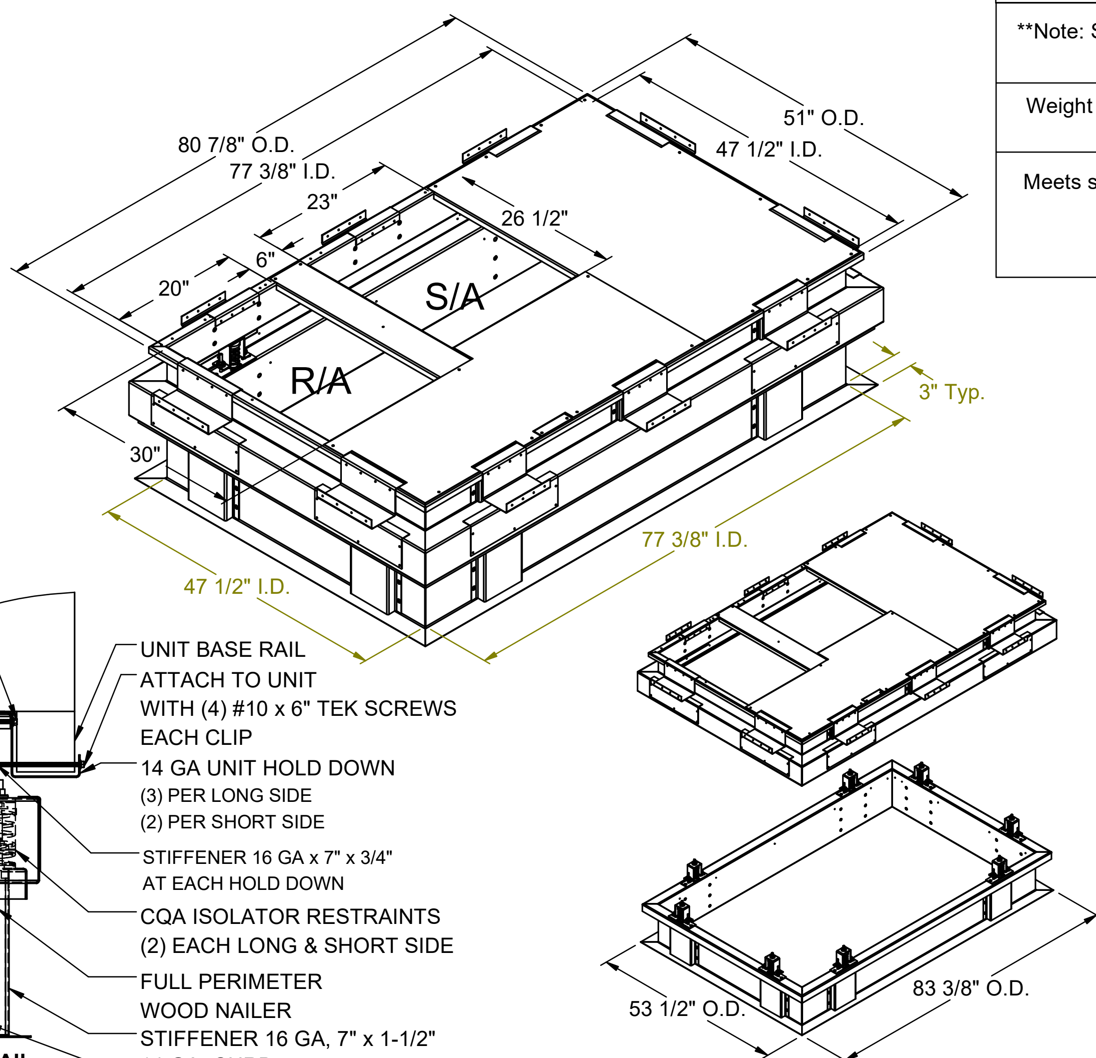
Meets seismic requirements for the following codes:
CBC 2022
IBC 2021

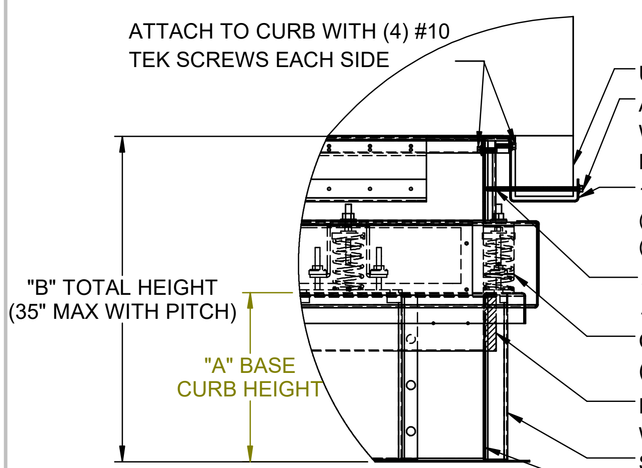
FEATURES

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

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

FORM NO:	PART NUMBER:	
CBISC-04	-	
DATE:	**REV:**	**DRAWN BY:**
8/14/2023	**5**	FMM

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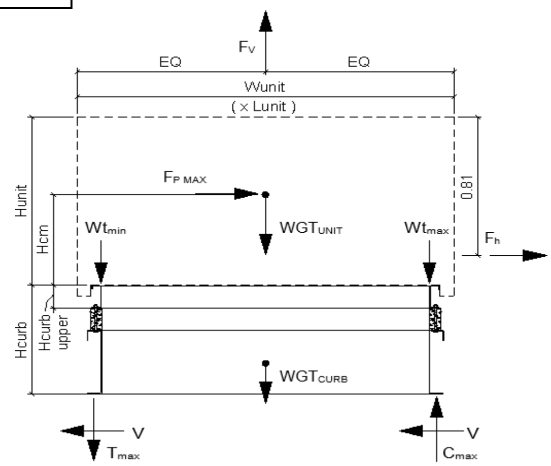
Client:	ProVent	PV2312	Upper curb rail
Project:	CBISC-04	Iso Curb	CBISCPRD3715
Unit:	ZT,ZH, ZR,ZJ 037-150; ZF, XP, ZB 078-150		



Upper Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	80.875	in	(Length of upper curb)
wcurb =	51	in	(Width of upper curb)
WGTupper =	243	lbs	(Weight of upper curb)
# Clips long side =	3		# Clips short side = 2

Unit Information

WGTunit =	1736	lbs	(Weight of Unit)
Wtmax =	521	lbs	(Maximum corner weight)
Wtmin =	369	lbs	(Minimum corner weight)
Hunit =	50.75	in	(Height of unit above curb)
Hcm =	25.375	in	(Height to center of mass)
Lunit =	89	in	(Length of unit)
Wunit =	59	in	(Width of unit)

Seismic Loading - 2021 IBC/2022CBC

Ss =	2.80		(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 =	3.360		(Fa*Ss) ap = 2.5
Sds =	2.240		(2/3*Sms) Rp = 2
Fpmax =	5.040	Wp	(0.4*ap*Sds*Ip)*Wp*3/Rp <=1.6*Sds*Ip*Wp
FpmaxASD =	6125	lbs	(0.7*Fpmax) FpmaxASD = 6982 lbs (unit + upper rail)
	(unit only)		

Wind Loading - 2021 IBC/2022 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)
$F_{h\ ASD\ trans}$ =	1179	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	782	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	976	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Upper Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	4416	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	2836	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*wcurb)]/wcurb
$Compression_{WIND}$ =	723	lbs	=[$F_{h\ ASD\ trans}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	632	lbs	=[$F_{h\ ASD\ trans}$*Hcm-2*0.6*Wtmin*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	3290	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1710	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*Lcurb)]/Lcurb
$Compression_{WIND}$ =	382	lbs	=[$F_{h\ ASD\ long}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	291	lbs	=[$F_{h\ ASD\ long}$*Hcm-2*0.6*Wtmin*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	4416	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	2836	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	3290	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1710	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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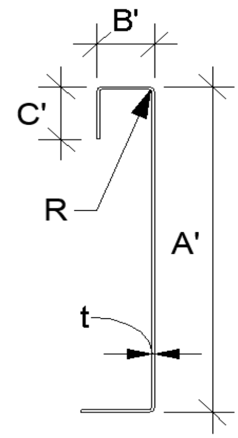
Curb Design

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 =	3.062 k	(Max Axial Comp)	Ω_c = 1.80
Pn/Ωc =	11.798 k		
Fe =	54.67 ksi		
λc =	0.96		
Fn =	34.10 ksi		
Ly =	47.50 in	Lateral unbraced length	
k_yL_y/r_y =	73	(assume k=0.8)	

$$\frac{P_n}{\Omega_c} = \frac{F_n A}{\Omega_c}$$

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

$$If\ \lambda_c > 1.5;\ F_n = \frac{0.877}{\lambda_c^2} F_y$$

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

Compression Check = O.K.

Check Web Crippling

h =	5.5 in	-- Check limits:		C = 7.50
t =	0.0713 in	h/t =	77.14 ≤ 260	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} =	1.472 k	**web stiffener REQ'D**	# clips = 3	
Short side: Pu_{Long} =	1.645 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 3/4in 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 = 1745 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 2208 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 = 0.7
# of Bolts required for Shear = 2.0
# of Bolts Used = 4.0
Check Combined Stress in Bolts & Inserts: 0.680 **O.K.**

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

Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 1.493 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

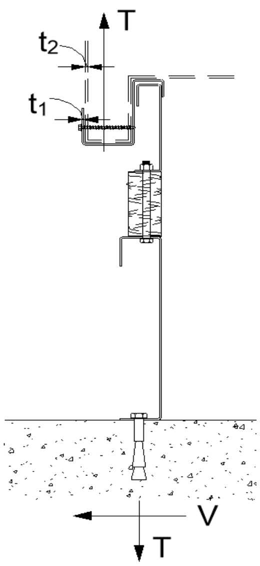
$P_{ns} = 2.7t_2 dF_{u2}$ 2.38 k

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:	3.062	3	1.02	540 #	4	2.00 in
Short side:	3.062	2	1.53	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)

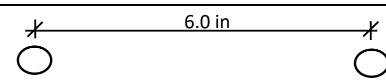
Curb Loads (copied from above)

Transverse: (on long edge)	$Comp_{MAX}$ =	5527	lbs
	$Tens_{MAX}$ =	3943	lbs
	$Shear_{MAX}$ =	6982	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	3965	lbs
	$Tens_{MAX}$ =	2382	lbs
	$Shear_{MAX}$ =	6982	lbs

Loads at each Isolator Type: **CQA**

Transverse loading: (on long edge)	$Comp_{MAX}$ =	2763.3	lbs
	$Tens_{MAX}$ =	1971.7	lbs
# isolators: 2	$Shear_{MAX}$ =	872.7	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	1982.6	lbs
	$Tens_{MAX}$ =	1191.0	lbs
# isolators: 2	$Shear_{MAX}$ =	872.7	lbs

Max compression force on isolator: 2.763 k ≤ 3.176 k **O.K.**
Max uplift on isolator: 1.972 k ≤ 3.176 k **O.K.**
Max shear on isolator: 0.873 k ≤ 1.163 k **O.K.**

2.0 in


7.0 in

Forces on top bolt:
Tension = 1.972 k | d_b = 0.375 in
Shear = 0.873 k | upper 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 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:

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

$$P'_{nt} = A_b F'_{nt}$$

ft = 17.85 ksi | fv = 7.90 ksi O.K.
F'nt = 20.65 ksi | Fnv/Ω = 10.00 ksi
P'nt/Ω = 1.014 k **No Good - Use Welds**

Longitudinal weld loading: L = 1.5 | Ω = 2.55
If L/t < 25: L/t = 21.04 | t = 0.0713 | Pn/Ω = 2.153 k

$$P_n/\Omega = \frac{1}{\Omega}\left(1 - \frac{0.01L}{t_2}\right) L t_2 F_{u2} \ge V_{req}$$

Transverse weld loading: t = 0.0713 | Ω = 2.35
L = 1 | Fu = 65 ksi | Pn/Ω = 1.972 k

$$P_n/\Omega = \frac{1}{\Omega} tLF_u \ge T_{req}$$

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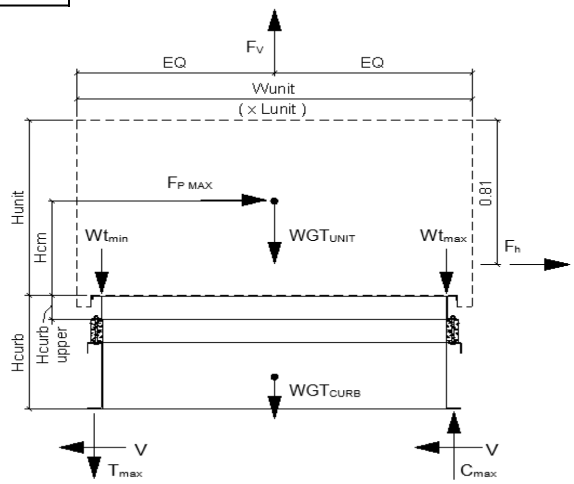
Client:	ProVent	PV2312	Base curb
Project:	CBISC-04	Iso Curb	CBISCPRD3715
Unit:	ZT,ZH, ZR,ZJ 037-150; ZF, XP, ZB 078-150		



Base Curb Information

Hbase curb = 25 in (Height of base curb)
Lcurb = 83.375 in (Length of base curb)
wcurb = 53.5 in (Width of base curb)
WGTbase = 167 lbs (Weight of base curb)
# Springs long side = 2 # Springs short side = 2

Unit Information

WGTunit = 1736 lbs (Weight of Unit)
Wt'max = 582 lbs (Wtmax+1/4*WGTupper)
Wt'min = 430 lbs (Wtmin+1/4*WGTupper))
Hunit = 50.75 in (Height of unit above curb)
H'cm = 35.375 in (Hcm+10"(upper+spring))
Lunit = 89 in (Length of unit)
Wunit = 59 in (Width of unit)
$WGT_{unit+upper+base}$ = 2146 lbs (Total weight)

Seismic Loading - 2021 IBC/2022CBC

Ss = 2.80 (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 = 3.360 (Fa*Ss) ap = 2.5
Sds = 2.240 (2/3*Sms) Rp = 2
Fpmax = 5.040 Wp (0.4*ap*Sds*Ip)*Wp*3/Rp <=1.6*Sds*Ip*Wp
FpmaxASD = 6982 lbs (0.7*Fpmax) FpmaxASD = 7571 lbs
(unit + upper rail) (unit + upper rail + base curb)

Wind Loading - 2021 IBC/2022 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)
$F_{h\ ASD\ trans}$ = 1798 lbs = 0.6*qz*GCr*Lunit*(Hunit+Hbase curb+10") (Eq. 29.4-2)
$F_{h\ ASD\ long}$ = 1192 lbs = 0.6*qz*GCr*Wunit*(Hunit+Hbase curb+10")
$F_{vert\ ASD}$ = 976 lbs = 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Base Curb Loading

Transverse:

$Compression_{SEISMIC}$ = 6144 lbs =[FpmaxASD*H'cm+2*(1+0.14S_{DS})*Wt'max*wcurb]/wcurb
$Tension_{SEISMIC}$ = 4370 lbs =[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*wcurb)]/wcurb
$Compression_{WIND}$ = 1398 lbs =[$F_{h\ ASD\ trans}$*H'cm+2*0.6*Wt'max*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ = 1161 lbs =[$F_{h\ ASD\ trans}$*H'cm-2*0.6*Wt'min*wcurb+$F_{vertASD}$*wcurb/2]/wcurb
---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ = 4490 lbs =[FpmaxASD*H'cm+2*(1+0.14*S_{DS})*Wt'max*Lcurb]/Lcurb
$Tension_{SEISMIC}$ = 2716 lbs =[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*Lcurb)]/Lcurb
$Compression_{WIND}$ = 715 lbs =[$F_{h\ ASD\ long}$*H'cm+2*0.6*Wt'max*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ = 478 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:	$Comp_{MAX}$ =	6144	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	4370	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	4490	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2716	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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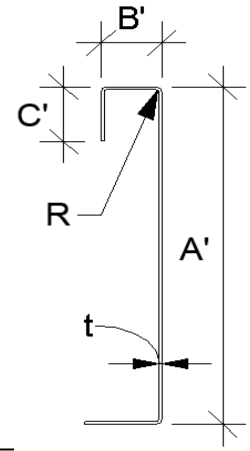
Curb Design

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



Calculate Section Properties of Curb

A'=	25.000	in	a =	24.644	in	= A'-(2r+t)
B'=	1.750	in	a'=	24.929	in	= A'-t
C'=	0.000	in (0 if no lips)	b =	1.572	in	= B'-[r+t/2+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 =	0.104	in (Distance between centroid and web centerline)				
Ix =	128.737	in	rx =	8.00	in	
Iy =	0.218	in	ry =	0.329	in	
A =	2.01	in^2	rmin =	0.329	in	

Axial Compression

Pu =	3.491	k	(Max Axial Comp)
Pn/Ωc =	6.940	k	
Fe =	7.08	ksi	
λc =	2.66		
Fn =	6.21	ksi	
Ly =	83.38	in	Lateral unbraced length
k_yL_y/r_y =	203		(assume k=0.8)

Ω_c = 1.80

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

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

Compression Check = O.K.

Check Web Crippling

h =	25	in	-- Check limits:		
t =	0.0713	in	h/t =	350.63	≤ 260
N =	7.00		N/t =	98.18	≤ 210
Ω_w =	1.75		N/h =	0.28	≤ 2.0
P_n =	2.105	k	R/t =	1.50	≤ 9.0
P_n/Ω_w =	1.203	k			
Long side: Pu_{Trans} =	3.072	k	web stiffener REQ'D	# clips = 2	
Short side: Pu_{Long} =	2.245	k	web stiffener REQ'D	# clips = 2	

C = 4.00
C_R = 0.14
C_N = 0.35
C_h = 0.02
(See table C3.4.1-2, fastened to support, one flange, end loading)

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

*****h/t > 260; use web stiffeners**

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

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

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

Pwc =	2.105	k	Ae =	0.380	in^2
Pn =	14.780	k			
Pn/Ω_c =	8.694	k	**O.K.**		

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

Tcrnmax =	1893	lbs	Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax =	3072	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 =	2.8	
# of Bolts Used =	4.0	
Check Combined Stress in Bolts & Inserts:	0.892	**O.K.**

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

Assume L/t > 25: 25*t =	1.783	in
Lreq'd =	2.077	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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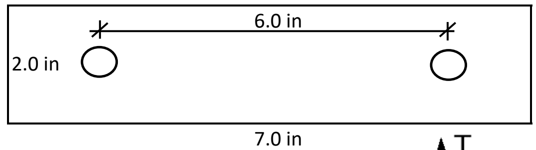
Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	5527	lbs
	$Tens_{MAX}$ =	3943	lbs
	$Shear_{MAX}$ =	6982	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	3965	lbs
	$Tens_{MAX}$ =	2382	lbs
	$Shear_{MAX}$ =	6982	lbs

Loads at each Isolator Type: **CQA**

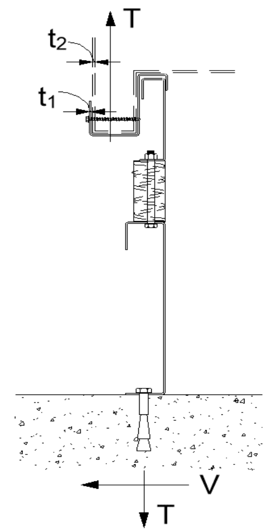
Transverse loading: (on long edge)	$Comp_{MAX}$ =	2763.3	lbs
	$Tens_{MAX}$ =	1971.7	lbs
# isolators: 2	$Shear_{MAX}$ =	872.7	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	1982.6	lbs
	$Tens_{MAX}$ =	1191.0	lbs
# isolators: 2	$Shear_{MAX}$ =	872.7	lbs

Max compression force on isolator: 2.763 k ≤ 3.176 k **O.K.**
Max uplift on isolator: 1.972 k ≤ 3.176 k **O.K.**
Max shear on isolator: 0.873 k ≤ 1.163 k **O.K.**



Forces on bottom bolts:

d_b = 0.5 in
base curb, t = 0.0713 in
Tension = 0.986 k / bolt
Shear = 0.436 k / bolt



Shear on base curb: $P_n = teF_u$ Ω = 2.00 (Appendix A, Section E3.1 AISI)
Pn/Ω = 4.635 k e = 1.0 in
Shear O.K.

Net section rupture: $P_n = A_nF_t$ Ω = 2.22 (Appendix A, Section E3.2 AISI)
Pn/Ω = 5.909 k An = 0.107 in
N.S.R. O.K. $F_t = (0.1 + 3d/s)F_u \le F_u =$ 55.250 ksi

Bolt Bearing Strength: $P_n = Cm_fdtF_u$ Ω = 2.50 (Section E3.3.1 AISI)
Pn/Ω = 2.781 k d/t = 7.01
Bearing O.K. C = 3.00 mf = 1.00

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

Tension $P_{nt} = A_bF_{nt}$ 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 = 10.04 ksi fv = 2.22 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: $Uplift_{MAX}$ = 8237 lbs $Shear_{MAX}$ = 3786 lbs

$Compression_{SEISMIC}$ =	9954 lbs	$=[FpmaxASD*(H'cm+Hbase\ curb)+(1+0.14S_{DS})*WGT_{unit+upper+base}*wcurb/2]/wcurb$
$Tension_{SEISMIC}$ =	8237 lbs	$=[FpmaxASD*(H'cm+Hbase\ curb)-(0.6-0.14S_{DS})*WGT_{unit+upper+base}*wcurb/2]/wcurb$
$Compression_{WIND}$ =	2184 lbs	$=[F_{h\ ASD\ trans}*(H'cm+Hbase\ curb)+0.6*WGT_{unit+upper+base}*wcurb/2-F_{vert\ ASD}*wcurb/2]/wcurb$
$Tension_{WIND}$ =	1873 lbs	$=[F_{h\ ASD\ trans}*(H'cm+Hbase\ curb)-0.6*WGT_{unit+upper+base}*wcurb/2+F_{vertASD}*wcurb/2]/wcurb$

Longitudinal: $Uplift_{MAX}$ = 5175 lbs $Shear_{MAX}$ = 3786 lbs

$Compression_{SEISMIC}$ =	6892 lbs	$=[FpmaxASD*(H'cm+Hbase\ curb)+(1+0.14S_{DS})*WGT_{unit+upper+base}*Lcurb/2]/Lcurb$
$Tension_{SEISMIC}$ =	5175 lbs	$=[FpmaxASD*(H'cm+Hbase\ curb)-(0.6-0.14S_{DS})*WGT_{unit+upper+base}*Lcurb/2]/Lcurb$
$Compression_{WIND}$ =	1019 lbs	$=[F_{h\ ASD\ long}*(H'cm+Hbase\ curb)+0.6*WGT_{unit+upper+base}*Lcurb/2-F_{vert\ ASD}*Lcurb/2]/Lcurb$
$Tension_{WIND}$ =	707 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)

Transverse:

$Tall_{metal}$ =	997 lbs	$Vall_{metal}$ =	1097 lbs
$Tall_{wood}$ =	760 lbs	$Vall_{wood}$ =	672 lbs

# of Screws Req'd for Uplift = 10.84 COMBINED LOADING: 0.948 O.K.
# of Screws Req'd for Shear = 5.63 Req'd Min Spacing = 5.38 in o.c.
Total # of screws required = 15

Use 15 - 1/4"ϕ x 4.5" Simpson SDS screws @ 5.4 in o.c. along long side of curb w/ 2.75" threaded embed

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Longitudinal:

# of Screws Req'd for Uplift = 6.81 | COMBINED LOADING: 0.906 O.K.

# of Screws Req'd for Shear = 5.63 | Screw Spacing = 5.06 in o.c.

Total # of screws required = 10

Use 10 - 1/4"ϕ x 4.5" Simpson SDS screws @ 5.1 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: $Tall_{metal}$ = 2086 lbs | $Vall_{metal}$ = 2192 lbs

# of Bolts Req'd for Uplift = 3.95 | COMBINED LOADING: 0.850 O.K.

# of Bolts Req'd for Shear = 1.73 | Bolt Spacing = 14.28 in o.c.

Total # of bolts required = 6

Use 6 - 1/2" ϕ A307 Bolts to steel angle below deck @ 14.3 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 2.48 | COMBINED LOADING: 0.605 O.K.

# of Bolts Req'd for Shear = 1.73 | Bolt Spacing = 20.75 in o.c.

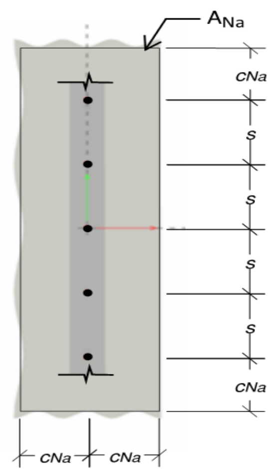
Total # of bolts required = 3

Use 3 - 1/2" ϕ A307 Bolts to steel angle below deck @ 20.8 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 = 2.5

Concrete Attachment: 0.625in ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy w/ 4in embed

Epoxy: Hilti HIT-HY 200 V3 (ICC ESR 4868)



f'c = 4000 psi

h = 6 in (concrete thickness, t_min = h_ef + 2do) O.K.

h_ef = 4 in (effective embedment)

da = 0.625 in (anchor diameter) do = 0.75 in (hole diameter)

n = 5 (number of dummy anchors to check capacity with spacing effect)

s = 8 in (initial spacing estimate)

τk,cr / uncr = 1170 2220 psi (from ESR 4868, Table 14, Temp range B)

τk,cr / uncr = 1226 2327 psi If $f'_c > 2500$, $multiply\ by\ (f'_c/2500)^{0.1}$

c_{Na}= 9.0625 in (min. edge distance for full capacity); $c_{Na} = 10d_a\sqrt{\frac{\tau_{uncr}}{1100}}$

Tension:

Bond strength

***Bond strength will govern over concrete breakout

$N_{ag} = \frac{A_{Na}}{A_{Nao}}\varphi_{ec,Na}\varphi_{ed,Na}\varphi_{cp,Na}N_{ba}$ (ACI318-14, 17.4.5.1b)

$\varphi_{ec,Na}\varphi_{ed,Na}\varphi_{cp,Na} = 1.0$

A_{Na}= 908.52 in^2

A_{Nao}= 328.52 in^2

N_{ba} = 9535 lbs $N_{ba} = \lambda_a\tau_{cr}\pi d_a h_{ef}\alpha_{n,seismic}$ $\alpha_{n,seismic} = 0.99$

N_{ag} = 26369 lbs (group) $\lambda_a = 1.0$

$\emptyset N_{ag}$ = 12855 lbs (group) CONTROLS λ_a =1.0 for normal weight conc; 0.6 for lightw

Breakout strength

$N_{cbg} = \frac{A_{Nc}}{A_{Nco}}\varphi_{ec,N}\varphi_{ed,N}\varphi_{cp,N}N_b$ $N_b = \lambda_a k_c\sqrt{f'_c}h_{ef}^{1.5}$

A_{Nc} = 528 in^2 N_b = 8601 lbs $\emptyset_{conc}$ = 0.75

A_{Nco} = 144 in^2 kc = 17 $\emptyset_{bond}$ = 0.65

N_{cbg} = 31538 lbs (group) $\emptyset_{seis}$ = 0.75

$\emptyset N_{cbg}$ = 17740 lbs (group) $\emptyset_{steel}$ = 0.65

Shear: Vsa,eq = 7865 (from ESR4868, Table 11) $\alpha_{v,seismic}$ = 0.6

Steel strength øVsa,eq = 3067

$Tall_{LRFD}$ = 2571 lbs (anchor) $Vall_{LRFD}$ = 3067 lbs $\propto = (1 + 0.2SDS)D + 2.5E$ =1.421

$Tall_{ASD} = Tall_{LRFD}/\alpha$ = 1513 lbs $Vall_{ASD} = Vall_{LRFD}/\alpha$ = 1805 lbs D =0.761 E =0.239 $\propto$ =1.699

Transverse: $Uplift_{MAX}$ = 11208 lbs | $Shear_{MAX}$ = 9464 lbs

$Compression_{SEISMIC}$ = 13069 lbs =[Ωo*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*$WGT_{unit+curb}$*wcurb/2]/wcurb

$Tension_{SEISMIC}$ = 11208 lbs =[Ωo*FpmaxASD*(Hcm+Hcurb)-(0.6-0.14S_{DS})*$WGT_{unit+curb}$*wcurb/2]/wcurb

$Shear_{SEISMIC}$ = 9464 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift = 7.41 spacing = 10.20 in o.c. Tapplied = 1245.4 lbs

Min Bolts Req'd Shear = 5.24 spacing = 14.28 in o.c. Vapplied = 630.9 lbs

Try using 9 bolts
spaced at 8.92 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.17 O.K.

Use 9 - 0.625in ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy @ 8.9 in o.c. max. along long side of curb w/ 4in embed

Longitudinal: $Uplift_{MAX}$ = 7073 lbs | $Shear_{MAX}$ = 9464 lbs

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$Compression_{SEISMIC}$ = 8934 lbs =[Ωo*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*$WGT_{unit+curb}$*Lcurb/2]/Lcurb

$Tension_{SEISMIC}$ = 7073 lbs =[Ωo*FpmaxASD*(Hcm+Hcurb)-(0.6-0.14S_{DS})*$WGT_{unit+curb}$*Lcurb/2]/Lcurb

$Shear_{SEISMIC}$ = 9464 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift = 4.67 spacing = 10.38 in o.c. Tapplied = 1178.8 lbs

Min Bolts Req'd Shear = 5.24 spacing = 8.30 in o.c. Vapplied = 630.9 lbs

Try using	6	bolts
spaced at	8.30	in o.c.

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

Use 6 - 0.625in ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy @ 8.3 in o.c. max. along short side of curb w/ 4in embed

CURB DESIGN SUMMARY:	CBISC-04	CBISCPRD3715	**Unit:** ZT,ZH, ZR,ZJ 037-150; ZF, XP, ZB 078-150
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 3/4in 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 3/4in x 7in (C-channel) stiffener at each clip		
VIBRATION ISOLATOR TYPE:	CQA	Top stud diameter: 3/8	(2) - CQA Isolators long side
Anchor bolt diameter:	1/2	Anchor hole diamter: 9/16	(2) - CQA Isolators short side
BASE CURB THICKNESS:	0.0713 in	14 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 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 0.625in ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy w/ 4in embed
LONG DIRECTION	15 @ 5.38 in o.c.	6 @ 14.28 in o.c.	9 @ 8.92 in o.c.
SHORT DIRECTION	10 @ 5.06 in o.c.	3 @ 20.75 in o.c.	6 @ 8.3 in o.c.