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

Structural Calculations

for

CBISC-12 Series

CBISCSAV1518** SERIES

REGISTERED PROFESSIONAL ENGINEER
GLENN A. MOURITZEN
SE 3578
Exp. 6/30/25
STRUCTURAL
STATE OF CALIFORNIA

Prepared for:

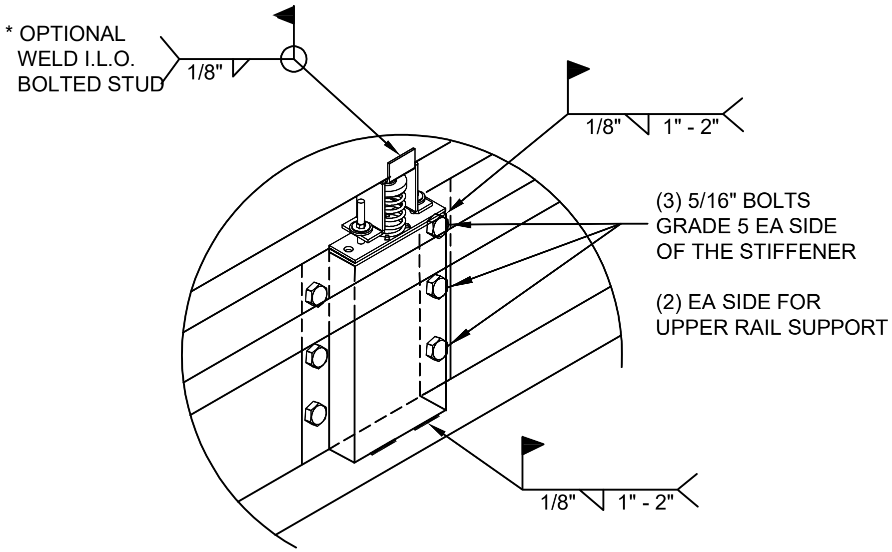
PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

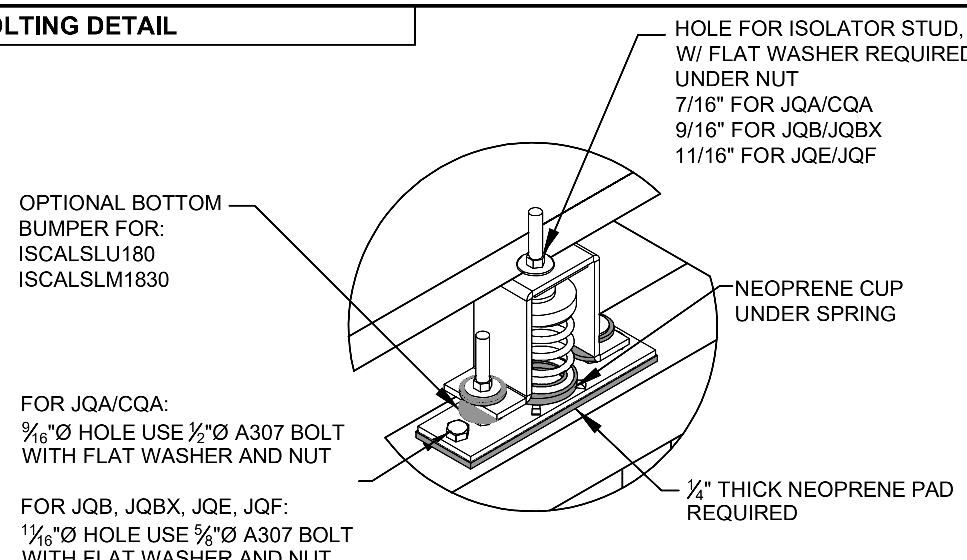
Date: August 23, 2023

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
FAX (619) 872-9799

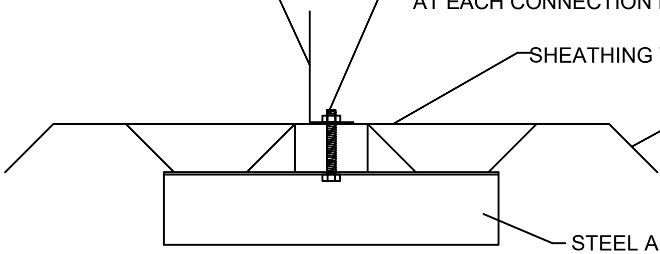
SUBMITTED TO:__________
COMPANY:__________
JOB NAME:__________
EQUIPMENT:__________
NOTES:__________

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

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

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

STEEL ATTACHMENT

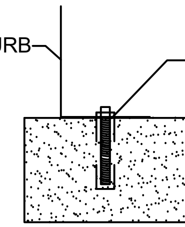


CURB	NO. OF ANCHORAGE BOLTS REQUIRED	
	LONG SIDE	SHORT SIDE
LXS	3 @ 19.25" O.C.	2 @ 23" O.C.
LXL	3 @ 19.25" O.C.	2 @ 33" O.C.
SUN3672	4 @ 21" O.C.	2 @ 27.25" O.C.
PRD3715	6 @ 14.28" O.C.	3 @ 20.75" O.C.
PRS	4 @ 20.46" O.C.	2 @ 31.13" O.C.
PRL	5 @ 17.44" O.C.	2 @ 41.5" O.C.
SAV1518	6 @ 22.43" O.C	3 @ 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.

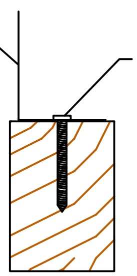
CONCRETE ATTACHMENT



CURB	NO. OF ANCHORAGE BOLTS REQUIRED	
	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



CURB	NO. OF ANCHORAGE SCREWS REQUIRED	
	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.

FOUR INCHES FROM EACH CORNER EVENLY SPACED

ProVent

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MIRA LOMA, CA 91752

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

SUBMITTED TO: ____________
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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

CALCULATED VIBRATION ISOLATION ROOF CURBS SUNCHOICE UNITS

AV 15-18, AD 15-18, AH 15, AL 15, HV 13

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

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

Weight of upper portion supported by spring isolators= 295 Lbs.

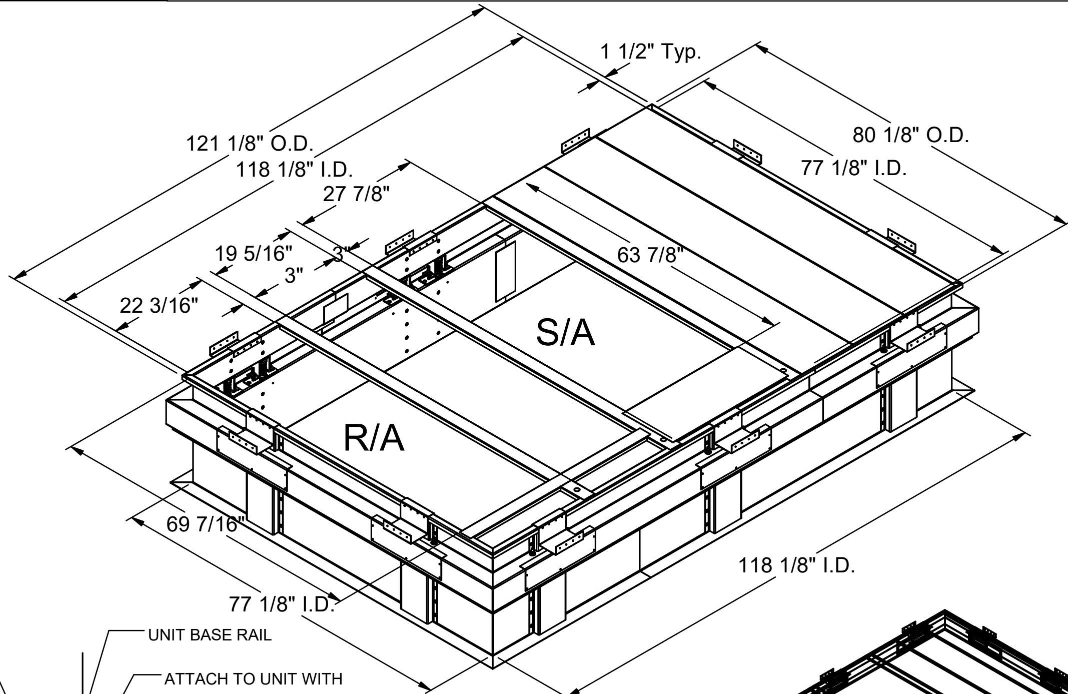
Meets seismic requirements for the following codes:
CBC 2022
IBC 2021

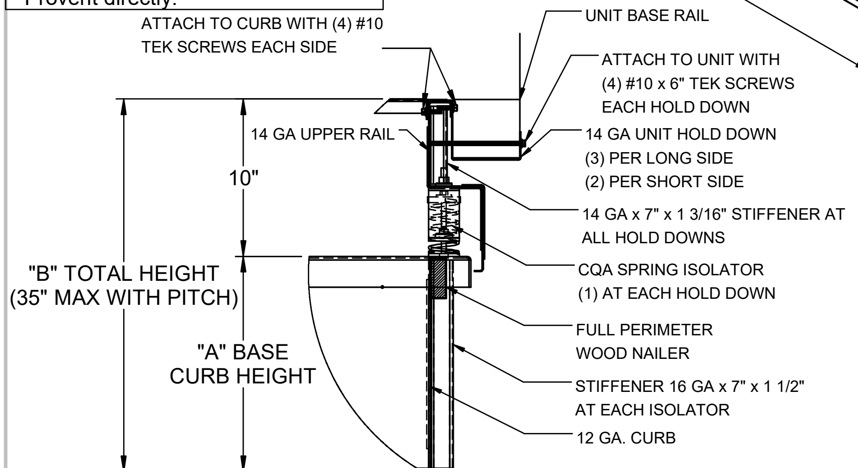
FEATURES

- 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).

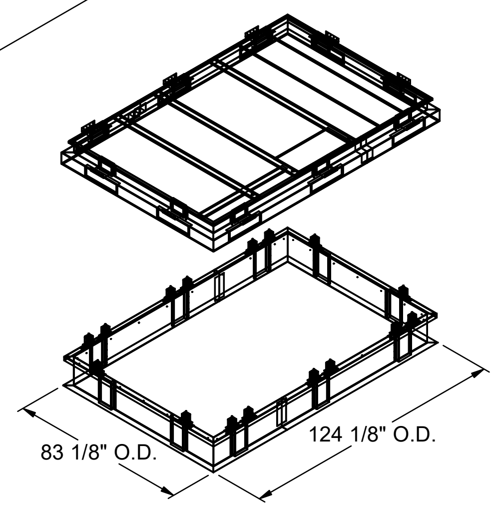
NOTES

- 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



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FORM NO:	PART NUMBER:	
CBISC-12	-	
DATE:	REV:	DRAWN BY:
8/14/2023	3	FMM

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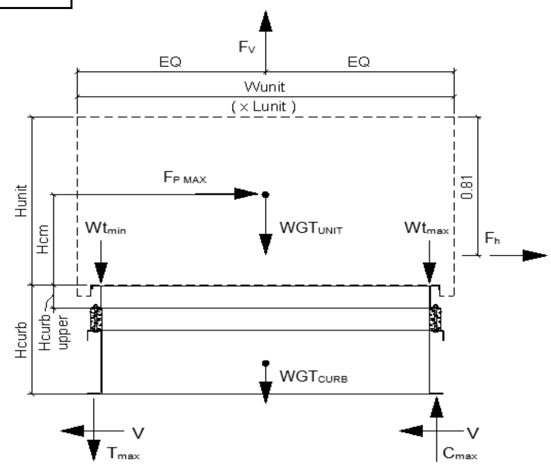
San Diego, CA 92120
(619)727-4800

Client:	ProVent	PV2312	Upper curb rail
Project:	CBISC-12	Iso Curb	CBISCSAV1518
Unit:	AV 15-18; AD 15-18; AH/AL 15; HV 13		



Upper Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	121.125	in	(Length of upper curb)
wcurb =	80.125	in	(Width of upper curb)
WGTupper =	295	lbs	(Weight of upper curb)
# Clips long side =	3		# Clips short side = 2

Unit Information

WGTunit =	2385	lbs	(Weight of Unit)
Wtmax =	716	lbs	(Maximum corner weight)
Wtmin =	507	lbs	(Minimum corner weight)
Hunit =	49.25	in	(Height of unit above curb)
Hcm =	24.625	in	(Height to center of mass)
Lunit =	129.75	in	(Length of unit)
Wunit =	88.75	in	(Width of unit)

Seismic Loading - 2021 IBC/2022CBC

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 =	8565	lbs	(0.7*Fpmax)	FpmaxASD = 9624 lbs
	(unit only)			(unit + upper rail)

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

Upper Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	4520	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	2348	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*wcurb)]/wcurb
$Compression_{WIND}$ =	302	lbs	=[$F_{h\ ASD\ trans}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	977	lbs	=[$F_{h\ ASD\ trans}$*Hcm-2*0.6*Wtmin*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	3629	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1457	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*Lcurb)]/Lcurb
$Compression_{WIND}$ =	21	lbs	=[$F_{h\ ASD\ long}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	695	lbs	=[$F_{h\ ASD\ long}$*Hcm-2*0.6*Wtmin*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	4520	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	2348	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	3629	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1457	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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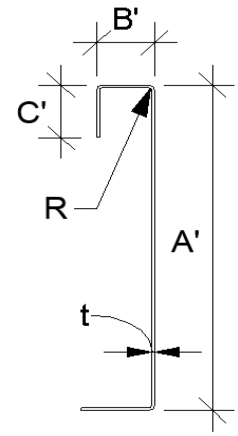
Curb Design

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

Calculate Section Properties of Curb

A'=	5.500	in	a =	5.144	in = A'-(2r+t)
B'=	1.500	in	a'=	5.429	in = A'-t
C'=	0.500	in (0 if no lips)	b =	1.233	in = B'-[r+t/2+α(r+t/2)]
α =	0.500	(0 - no Lip; 1 w/ lip)	b'=	1.447	in = B'-(t/2+αt/2)
R =	0.1069	(Inside bend radius)	c =	0.161	in = α[C'-(r+t/2)]
t =	0.0713	in	c'=	0.232	in = α(C'-t/2)
r'=	0.143	in = R+t/2	u =	0.224	in = πr/2
x =	0.292	in (Distance between centroid and web centerline)			
Ix =	2.515	in^4	rx =	2.04	in
Iy =	0.133	in^4	ry =	0.470	in
A =	0.60	in^2	rmin =	0.470	in



Axial Compression

Pa =	4.282	k	(Max Axial Comp)
Pn/Ωc =	4.957	k	
Fe =	16.90	ksi	
λc =	1.72		
Fn =	14.82	ksi	
Ly =	77.13	in	Lateral unbraced length
k_yL_y/r_y =	131		(assume k=0.8)

Ω_c = 1.80

$$\frac{P_n}{\Omega_c} = \frac{F_n A}{\Omega_c} \quad \begin{array}{l} If\ \lambda_c \le 1.5;\ \ F_n = \left(0.658^{\lambda_c^2}\right) F_y \\ If\ \lambda_c > 1.5;\ \ F_n = \dfrac{0.877}{\lambda_c^2} F_y \end{array} \quad \lambda_c = \sqrt{\frac{F_y}{F_e}} \quad F_e = \frac{\pi^2 E}{\left(kl/r\right)^2}$$

Compression Check = O.K.

Check Web Crippling

h =	5.5	in	-- Check limits:		
t =	0.0713	in	h/t =	77.14	≤ 260
N =	7.00		N/t =	98.18	≤ 210
Ω_w =	1.75		N/h =	1.273	≤ 2.0
P_n =	1.947	k	R/t =	1.50	≤ 12.0
P_n/Ω_w =	1.112	k			

C = 7.50
C_R = 0.08
C_N = 0.12
C_h = 0.048
(See table C3.4.1-2, fastened to support, two flange, end loading)

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

Long side: Pu_{Trans} =	1.507	k	**web stiffener REQ'D**	# clips = 3
Short side: Pu_{Long} =	1.814	k	**web stiffener REQ'D**	# clips = 2

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 =	2406	lbs	Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax =	2260	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 = 1.0
# of Bolts required for Shear = 2.1
# of Bolts Used = 4.0
Check Combined Stress in Bolts & Inserts: 0.758 **O.K.**

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

Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 1.528 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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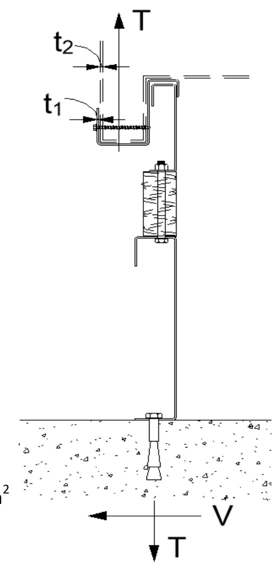
Connection Unit to Curb Clip #10 SMS screw Ω = 3.0

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:	4.282	3	1.43	540 #	4	2.00 in
Short side:	4.282	2	2.14	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)

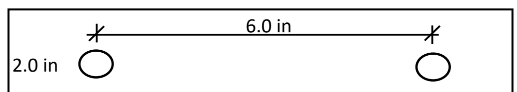
Curb Loads (copied from above)

Transverse:	$Comp_{MAX}$ =	5386	lbs
(on long edge)	$Tens_{MAX}$ =	3242	lbs
	$Shear_{MAX}$ =	9624	lbs
Longitudinal:	$Comp_{MAX}$ =	4161	lbs
(on short edge)	$Tens_{MAX}$ =	2017	lbs
	$Shear_{MAX}$ =	9624	lbs

Loads at each Isolator Type: **CQA**

Transverse loading:	$Comp_{MAX}$ =	1795.4	lbs
(on long edge)	$Tens_{MAX}$ =	1080.7	lbs
# isolators: 3	$Shear_{MAX}$ =	962.4	lbs
Longitudinal loading:	$Comp_{MAX}$ =	2080.6	lbs
(on short edge)	$Tens_{MAX}$ =	1008.6	lbs
# isolators: 2	$Shear_{MAX}$ =	962.4	lbs

Max compression force on isolator: 2.081 k ≤ 3.176 k **O.K.**
Max uplift on isolator: 1.081 k ≤ 3.176 k **O.K.**
Max shear on isolator: 0.962 k ≤ 1.163 k **O.K.**



Forces on top bolt:
Tension = 1.081 k d_b = 0.375 in
Shear = 0.962 k ıpper 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 = 9.78 ksi fv = 8.71 ksi O.K.
F'nt = 17.36 ksi Fnv/Ω = 10.00 ksi

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

P'nt/Ω = 0.852 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

$$P_n/\Omega = \frac{1}{\Omega}\left(1 - \frac{0.01L}{t_2}\right) Lt_2 F_{u2} \ge V_{req}$$

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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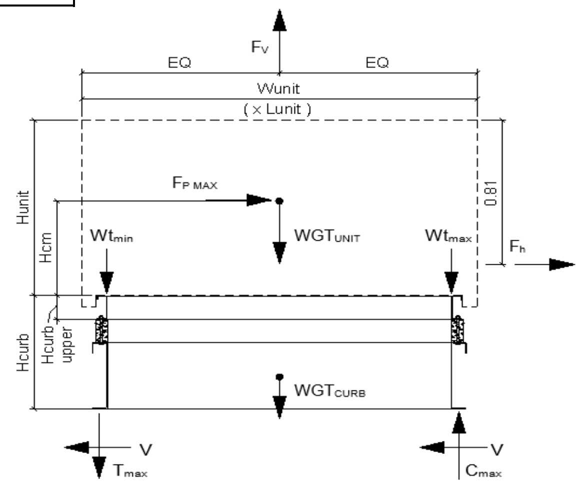
Client:	ProVent PV2312 Base curb
Project:	CBISC-12 Iso Curb CBISCSAV1518
Unit:	AV 15-18; AD 15-18; AH/AL 15; HV 13



Base Curb Information

Hbase curb =	25	in	(Height of base curb)
Lcurb =	124.125	in	(Length of base curb)
wcurb =	83.125	in	(Width of base curb)
WGTbase =	361	lbs	(Weight of base curb)
# Springs long side =	3		# Springs short side = 2

Unit Information

WGTunit =	2385	lbs	(Weight of Unit)
Wt'max =	789	lbs	(Wtmax+1/4*WGTupper)
Wt'min =	581	lbs	(Wtmin+1/4*WGTupper))
Hunit =	49.25	in	(Height of unit above curb)
H'cm =	34.625	in	(Hcm+10"(upper+spring))
Lunit =	129.75	in	(Length of unit)
Wunit =	88.75	in	(Width of unit)
WGTunit+upper+base =	3041	lbs	(Total weight)

Seismic Loading - 2021 IBC/2022CBC

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 =	9624	lbs	(0.7*Fpmax)	FpmaxASD =	10920 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)
$F_{h\ ASD\ trans}$ =	2575	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hbase curb+10") (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	1761	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hbase curb+10")
$F_{vert\ ASD}$ =	2141	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Base Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	6091	lbs	$=[FpmaxASD*H'cm+2*(1+0.14S_{DS})*Wt'max*wcurb]/wcurb$
$Tension_{SEISMIC}$ =	3683	lbs	$=[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*wcurb)]/wcurb$
$Compression_{WIND}$ =	949	lbs	$=[F_{h\ ASD\ trans}*H'cm+2*0.6*Wt'max*wcurb-F_{vert\ ASD}*wcurb/2]/wcurb$
$Tension_{WIND}$ =	1446	lbs	$=[F_{h\ ASD\ trans}*H'cm-2*0.6*Wt'min*wcurb+F_{vertASD}*wcurb/2]/wcurb$

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	4767	lbs	$=[FpmaxASD*H'cm+2*(1+0.14*S_{DS})*Wt'max*Lcurb]/Lcurb$
$Tension_{SEISMIC}$ =	2359	lbs	$=[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*Lcurb)]/Lcurb$
$Compression_{WIND}$ =	368	lbs	$=[F_{h\ ASD\ long}*H'cm+2*0.6*Wt'max*Lcurb-F_{vertASD}*Lcurb/2]/Lcurb$
$Tension_{WIND}$ =	865	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:	$Comp_{MAX}$ =	6091	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	3683	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	4767	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2359	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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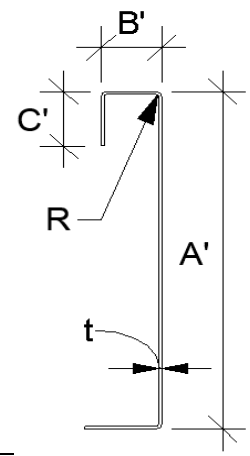
Curb Design

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'=	1.500 in		a'=	24.898 in	= A'-t
C'=	1.000 in	(0 if no lips)	b =	0.992 in	= B'-[r+t/2+α(r+t/2)]
α =	1.000	(0 - no Lip; 1 w/ lip)	b'=	1.398 in	= B'-(t/2+αt/2)
R =	0.1525	(Inside bend radius)	c =	0.746 in	= α[C'-(r+t/2)]
t =	0.1017 in		c'=	0.949 in	= α(C'-t/2)
r'=	0.203 in	= R+t/2	u =	0.319 in	= πr/2
x =	0.149 in	(Distance between centroid and web centerline)			
Ix =	197.156 in		rx =	8.14 in	
Iy =	0.460 in		ry =	0.393 in	
A =	2.97 in^2		rmin =	0.393 in	

Axial Compression

Pu =	4.812 k	(Max Axial Comp)
Pn/Ωc =	6.622 k	
Fe =	4.57 ksi	
λc =	3.31	
Fn =	4.01 ksi	
Ly =	124.13 in	Lateral unbraced length
k_yL_y/r_y =	252	(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	(See table C3.4.1-2, fastened to support, one flange, end loading)
t =	0.1017 in	h/t =	245.82 ≤ 260	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} =	2.030 k	**O.K.**	# clips = 3		
Short side: Pu_{Long} =	2.383 k	**web stiffener REQ'D**	# clips = 2		

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

Check Web Stiffener   16Ga x 1.5in 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 = 2730 lbs   Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)

Vcrnmax = 3046 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 = 1.1

# of Bolts required for Shear = 2.8

# of Bolts Used = 4.0

Check Combined Stress in Bolts & Inserts: 0.970 **O.K.**

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

Assume L/t > 25: 25*t = 2.543 in

Req'd = 1.444 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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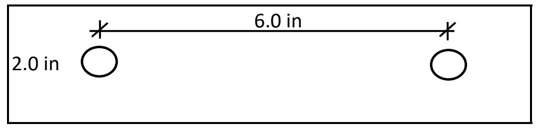
Curb Loads (copied from upper rail calcs)

Transverse:	$Comp_{MAX}$ =	5386	lbs
(on long edge)	$Tens_{MAX}$ =	3242	lbs
	$Shear_{MAX}$ =	9624	lbs
Longitudinal:	$Comp_{MAX}$ =	4161	lbs
(on short edge)	$Tens_{MAX}$ =	2017	lbs
	$Shear_{MAX}$ =	9624	lbs

Loads at each Isolator Type: **CQA**

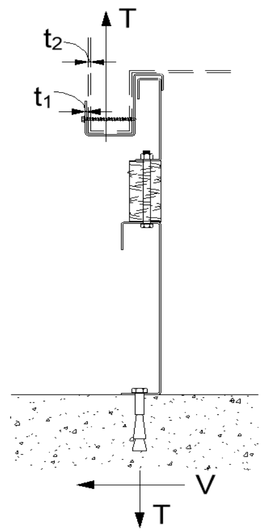
Transverse loading:	$Comp_{MAX}$ =	1795.4	lbs
(on long edge)	$Tens_{MAX}$ =	1080.7	lbs
# isolators: 3	$Shear_{MAX}$ =	962.4	lbs
Longitudinal loading:	$Comp_{MAX}$ =	2080.6	lbs
(on short edge)	$Tens_{MAX}$ =	1008.6	lbs
# isolators: 2	$Shear_{MAX}$ =	962.4	lbs

Max compression force on isolator:	2.081 k	≤ 3.176 k	**O.K.**
Max uplift on isolator:	1.081 k	≤ 3.176 k	**O.K.**
Max shear on isolator:	0.962 k	≤ 1.163 k	**O.K.**



Forces on bottom bolts:

d_b = 0.5 in
base curb, t = 0.1017 in
Tension = 0.540 k / bolt
Shear = 0.481 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. $F_t = (0.1+3d/s)F_u \le F_u =$ 55.250 ksi

Bolt Bearing Strength: $P_n = Cm_f dtF_u$ Ω = 2.50 (Section E3.3.1 AISI)
Pn/Ω = 3.966 k d/t = 4.92
Bearing O.K. C = 3.00 mf = 1.00

Shear and tension in bolt: (Appendix A, Section E3.4 AISI)
Tension $P_{nt} = A_bF_{nt}$ Fnt = 45.0 ksi A_b = 0.1963 in^2
Pnt/Ω = 3.927 k **Bolt tension O.K.** Ωt = 2.25
Shear $P_{nv} = A_bF_{nv}$ Fnv = 27.0 ksi Ωv = 2.40
Pnv/Ω = 2.209 k **Bolt shear O.K.** ***(Table E3.4-1, AISI)***

Combined Shear and tension in bolt:

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

ft = 5.50 ksi fv = 2.45 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: $Uplift_{MAX}$ = 7406 lbs $Shear_{MAX}$ = 5460 lbs

$Compression_{SEISMIC}$ =	9839 lbs	=[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb
$Tension_{SEISMIC}$ =	7406 lbs	=[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb
$Compression_{WIND}$ =	1689 lbs	=[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*wcurb/2-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	2005 lbs	=[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)-0.6*$WGT_{unit+upper+base}$*wcurb/2+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: $Uplift_{MAX}$ = 4819 lbs $Shear_{MAX}$ = 5460 lbs

$Compression_{SEISMIC}$ =	7252 lbs	=[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb
$Tension_{SEISMIC}$ =	4819 lbs	=[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb
$Compression_{WIND}$ =	688 lbs	=[$F_{h\ ASD\ long}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*Lcurb/2-$F_{vert\ ASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	1004 lbs	=[$F_{h\ ASD\ long}$*(H'cm+Hbase curb)-0.6*$WGT_{unit+upper+base}$*Lcurb/2+$F_{vertASD}$*Lcurb/2]/Lcurb

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

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

# of Screws Req'd for Uplift = 9.74 COMBINED LOADING: 0.975 O.K.
# of Screws Req'd for Shear = 8.13 Req'd Min Spacing = 8.29 in o.c.
Total # of screws required = 15

Use 15 - 1/4"ϕ x 4.5" Simpson SDS screws @ 8.3 in o.c. along long side of curb w/ 2.75" threaded embed

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Longitudinal:

# of Screws Req'd for Uplift =	6.34	COMBINED LOADING:	0.959	O.K.
# of Screws Req'd for Shear =	8.13	Screw Spacing =	8.35	in o.c.
Total # of screws required =	10			

Use 10 - 1/4"ϕ x 4.5" Simpson SDS screws @ 8.3 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

	$T_{all,bolt}$ =	3927 lbs	$V_{all,bolt}$ =	2209 lbs	
Transverse:	$T_{all,metal}$ =	2086 lbs	$V_{all,metal}$ =	2192 lbs	
	# of Bolts Req'd for Uplift =	3.55	COMBINED LOADING:	0.868	O.K.
	# of Bolts Req'd for Shear =	2.49	Bolt Spacing =	22.43	in o.c.
	Total # of bolts required =	6			

Use 6 - 1/2" ϕ A307 Bolts to steel angle below deck @ 22.4 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift =	2.31	COMBINED LOADING:	0.662	O.K.
# of Bolts Req'd for Shear =	2.49	Bolt Spacing =	35.56	in o.c.
Total # of bolts required =	3			

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

For Concrete anchorage: SEISMIC $(0.6-0.14S_{DS})D + 0.7\Omega_o E$ $\Omega o = 2.5$

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)

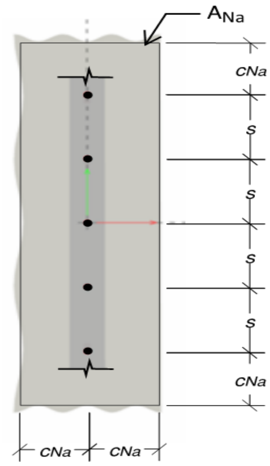
n = 5 (number of dummy anchors to check capacity with spacing effect)

s = 14 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}= 1343.52 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} = 38995 lbs (group) $\lambda_a = 1.0$

$øN_{ag}$ = 19010 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} =	816 in^2	N_b = 8601	lbs	$ø_{conc}$ =	0.75
A_{Nco} =	144 in^2	kc = 17		$ø_{bond}$ =	0.65
N_{cbg} =	48741 lbs (group)			$ø_{seis}$ =	0.75
$øN_{cbg}$ =	27417 lbs (group)			$ø_{steel}$ =	0.65

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

Steel strength øVsa,eq = 3067

$T_{allLRFD}$ = 3802 lbs (anchor) $V_{allLRFD}$ = 3067 lbs $\propto = (1+0.2SDS)D + 2.5E$ =1.421

$T_{allASD} = T_{allLRFD}/\alpha$ = 2225 lbs $V_{allASD} = V_{allLRFD}/\alpha$ = 1795 lbs D =0.758 E = 0.242 $\propto$ =1.709

Transverse:	$Uplift_{MAX}$ = 9579 lbs	$Shear_{MAX}$ = 13650 lbs

$Compression_{SEISMIC}$ = 12104 lbs =[Ωo*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*$WGT_{unit+curb}$*wcurb/2]/wcurb

$Tension_{SEISMIC}$ = 9579 lbs =[Ωo*FpmaxASD*(Hcm+Hcurb)-(0.6-0.14S_{DS})*$WGT_{unit+curb}$*wcurb/2]/wcurb

$Shear_{SEISMIC}$ = 13650 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift =	4.30 spacing =	28.03 in o.c.	Tapplied =	1197.3	lbs
Min Bolts Req'd Shear =	7.60 spacing =	16.02 in o.c.	Vapplied =	975.0	lbs

Try using	8	bolts
spaced at	16.02	in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.08 O.K.

Use 8 - 0.625in ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy @ 16 in o.c. max. along long side of curb w/ 4in embed

Longitudinal:	$Uplift_{MAX}$ = 6268 lbs	$Shear_{MAX}$ = 13650 lbs

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$Compression_{SEISMIC}$ =	8794	lbs	=[Ωo*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*$WGT_{unit+curb}$*Lcurb/2]/Lcurb
$Tension_{SEISMIC}$ =	6268	lbs	=[Ωo*FpmaxASD*(Hcm+Hcurb)-(0.6-0.14S_{DS})*$WGT_{unit+curb}$*Lcurb/2]/Lcurb
$Shear_{SEISMIC}$ =	13650	lbs	=Ωo*FpmaxASD/2

Min Bolts Req'd Uplift =	2.82	spacing =	35.56	in o.c.	Tapplied =	1044.7	lbs
Min Bolts Req'd Shear =	7.60	spacing =	10.16	in o.c.	Vapplied =	975.0	lbs

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

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.01 O.K.

Use 6 - 0.625in ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy @ 14.2 in o.c. max. along short side of curb w/ 4in embed

CURB DESIGN SUMMARY:	CBISC-12 CBISCSAV1518	**Unit:**	AV 15-18; AD 15-18; AH/AL 15; HV 13
UPPER CURB RAIL THICKNESS:	0.1017 in 12 Gauge		
UNIT CLIP THICKNESS:	0.0713 in 14 Gauge		
# OF CLIPS (LONG SIDE) -	3 clips with 4 - #10 SMS screws each clip		
WEB STIFFENER:	16Ga x 1 3/16in x 7in (C-channel) stiffener at each clip		
# OF CLIPS (SHORT SIDE) -	2 clips with 4 - #10 SMS screws each clip		
WEB STIFFENER:	16Ga x 1 3/16in x 7in (C-channel) stiffener at each clip		
VIBRATION ISOLATOR TYPE:	CQA	Top stud diameter: 3/8	(3) - CQA Isolators long side
Anchor bolt diameter:	1/2	Anchor hole diamter: 9/16	(2) - CQA Isolators short side
BASE CURB THICKNESS:	0.1017 in 12 Gauge		***Must weld top of CQA***
WEB STIFFENER:	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 @ 8.29 in o.c.	6 @ 22.43 in o.c.	8 @ 16.02 in o.c.
SHORT DIRECTION	10 @ 8.35 in o.c.	3 @ 35.56 in o.c.	6 @ 14.23 in o.c.