MOUR GROUP
ENGINEERING + DESIGN

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

Structural Calculations
for
CBISC-14 Series

CBISCSAV28** SERIES

Prepared for:

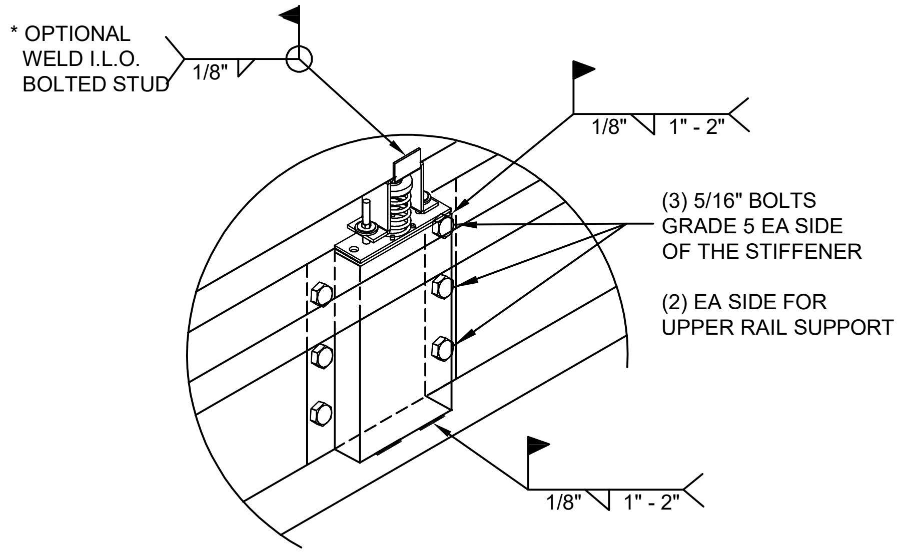
PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

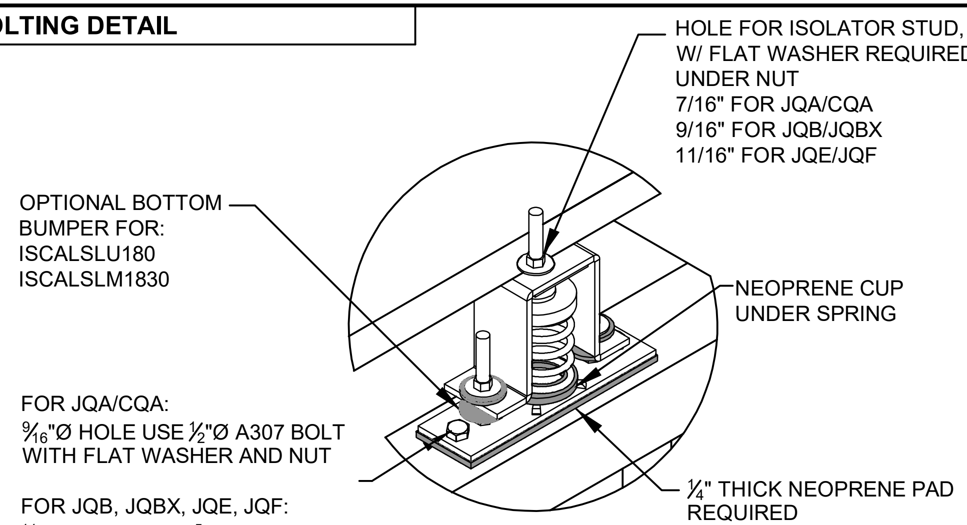
Date: August 23, 2023

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)

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

ProVent

3847 WABASH DRIVE
MIRA LOMA, CA 91725

PHONE (951) 685-1101
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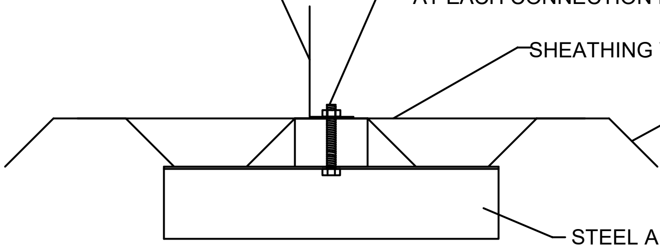
SUBMITTED TO:____________
COMPANY:____________
JOB NAME:____________
EQUIPMENT:____________
NOTES:____________

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

STEEL ATTACHMENT



	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.

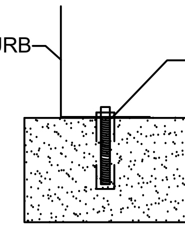
ASSUMES:

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

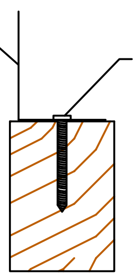
CONCRETE ATTACHMENT



	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



	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.

FOUR INCHES FROM EACH CORNER EVENLY SPACED

ProVent

3847 WABASH DRIVE
MIRA LOMA, CA 91752

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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

CALCULATED VIBRATION ISOLATION ROOF CURBS SUNCHOICE UNITS

AV 28, AD 28, AE 18-23, AW 18-23, AH 25, AL 25, HV 25

PROVENT P/N	A	B	EST. WEIGHT
CBISCSAV2818**	8"	18"	653 Lbs
CBISCSAV2821**	11"	21"	698 Lbs
CBISCSAV2824**	14"	24"	748 Lbs

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

Weight of upper portion supported by spring isolators= 365 Lbs.

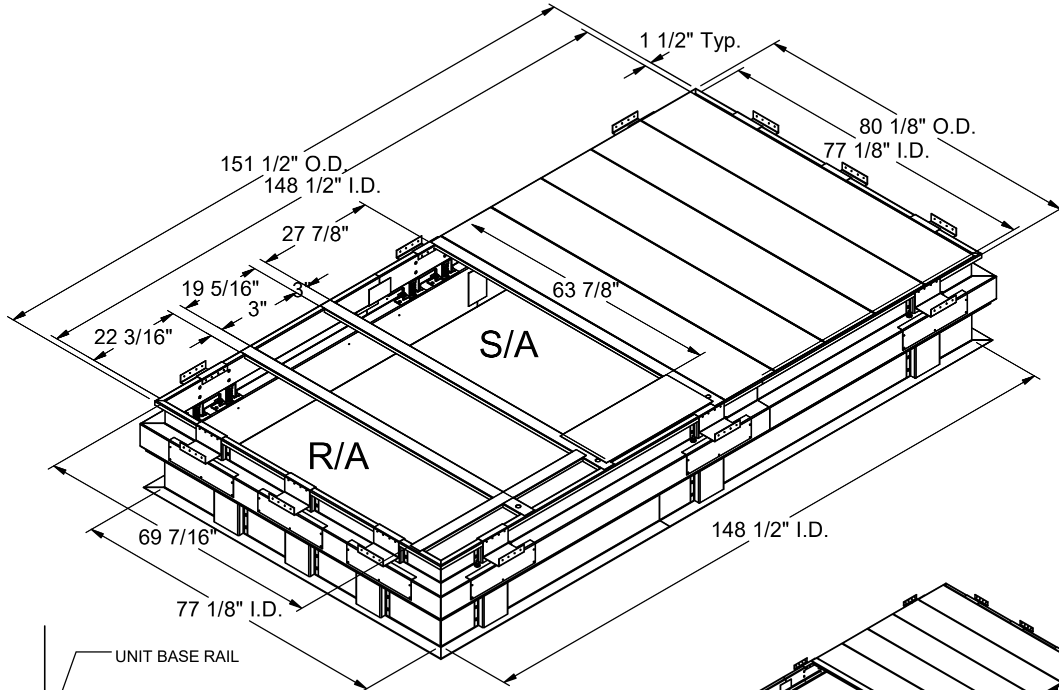
Meets seismic requirements for the following codes:
CBC 2022
IBC 2021

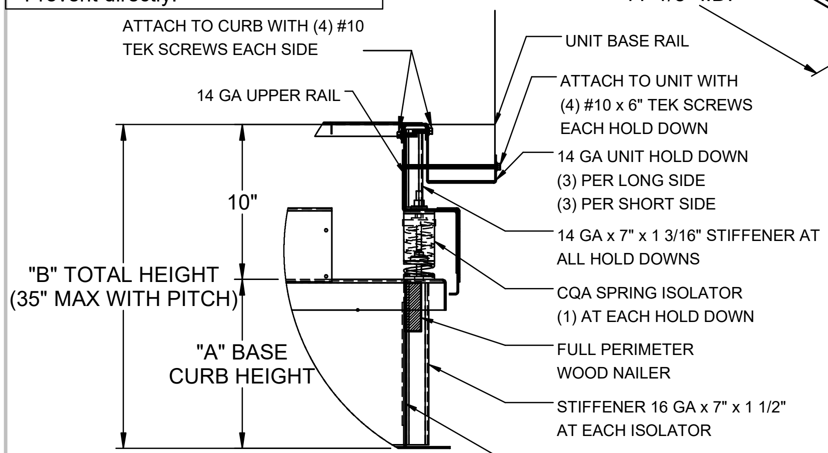
FEATURES

- 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).

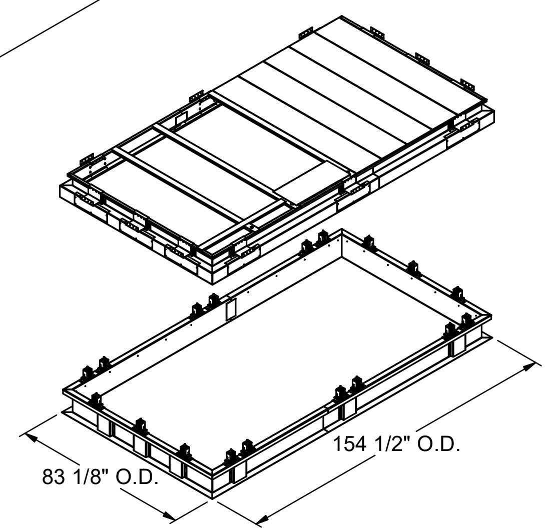
NOTES

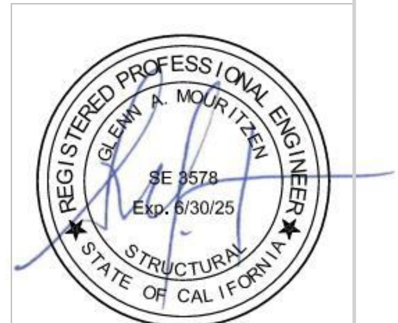
- Attach ductwork to roof curb. Flanges of duct rest on top of the curb, Support ductwork below the curb.
- Thru the curb utillities are available. Contact you York distributor or Provent directly.





PROFILE DETAIL





ProVent

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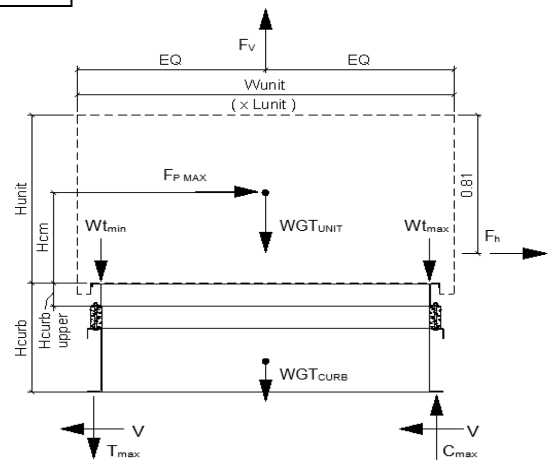
SUBMITED TO: ______
COMPANY: ______
JOB NAME: ______
EQUIPMENT: ______
NOTES: ______

FORM NO:	PART NUMBER:	
CBISC-14	CBISCSAV28 SERIES	
DATE:	REV:	DRAWN BY:
8/16/2023	2	FMM

MOUR GROUP
ENGINEERING + DESIGN

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

Client:	ProVent	PV2312	Upper curb rail
Project:	CBISC-14	Iso Curb	CBISCSAV28
Unit:	AV/AD 28; AE/AW 18-23; AH/AL 25; HV 25		



Upper Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	151.5	in	(Length of upper curb)
wcurb =	80.125	in	(Width of upper curb)
WGTupper =	365	lbs	(Weight of upper curb)
# Clips long side =	3		# Clips short side = 3

Unit Information

WGTunit =	3010	lbs	(Weight of Unit)
Wtmax =	903	lbs	(Maximum corner weight)
Wtmin =	640	lbs	(Minimum corner weight)
Hunit =	57.25	in	(Height of unit above curb)
Hcm =	28.625	in	(Height to center of mass)
Lunit =	160.0625	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 =	10809	lbs	(0.7*Fpmax)	FpmaxASD =	12120 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)
$F_{h\ ASD\ trans}$ =	2366	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	1312	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	2642	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Upper Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	6244	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	3502	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*wcurb)]/wcurb
$Compression_{WIND}$ =	608	lbs	=[$F_{h\ ASD\ trans}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1398	lbs	=[$F_{h\ ASD\ trans}$*Hcm-2*0.6*Wtmin*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	4425	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1683	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*Lcurb)]/Lcurb
$Compression_{WIND}$ =	11	lbs	=[$F_{h\ ASD\ long}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	801	lbs	=[$F_{h\ ASD\ long}$*Hcm-2*0.6*Wtmin*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	6244	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	3502	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	4425	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1683	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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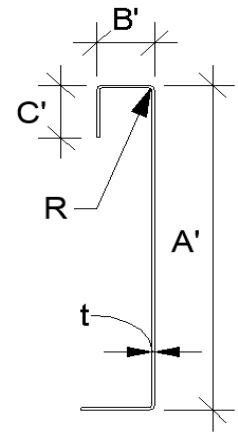
Curb Design

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 =	0.282	in (Distance between centroid and web centerline)			
Ix =	2.641	in	rx =	2.06	in
Iy =	0.157	in	ry =	0.502	in
A =	0.623	in^2	rmin =	0.502	in



Axial Compression

Pa =	5.404	k	(Max Axial Comp)
Pn/Ωc =	5.838	k	
Fe =	19.23	ksi	
λc =	1.61		
Fn =	16.87	ksi	
Ly =	77.13	in	Lateral unbraced length
k_yL_y/r_y =	123		(assume k=0.8)

Ω_c = 1.80

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

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

Compression Check = O.K.

Check Web Crippling

h =	5.5	in	-- Check limits:			C = 7.50
t =	0.0713	in	h/t =	77.14	≤ 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				

(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} =	2.081	k	**web stiffener REQ'D**	# clips = 3
Short side: Pu_{Long} =	1.475	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 =	3030	lbs	Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax =	3122	lbs	Max(Tens/2 -OR- Comp/2 corner connections per side)

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

# of Bolts required for Tension =	1.2
# of Bolts required for Shear =	2.8
# of Bolts Used =	5.0
Check Combined Stress in Bolts & Inserts:	0.814 **O.K.**

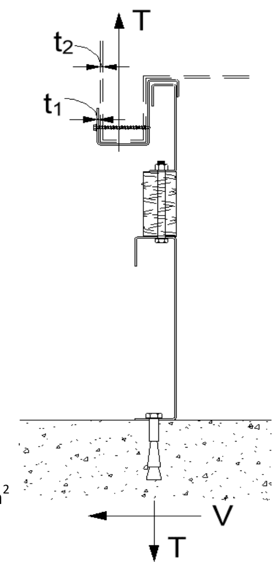
Check 1/8" welded connection <--- USE WELD Ω = 2.35

Assume L/t > 25: 25*t =	1.783	in
Lreq'd =	2.111	in

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

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

t1 = 0.0713 in (clip thickness) t2/t1 = 1.0 Fu1 = 65 ksi
t2 = 0.0713 in (unit base rail thickness) Fu2 = 65 ksi
d = 0.190 in (screw diameter) dw = 0.375 in (nom. washer diameter)



For t2/t1 ≤ 1.0: Pns = 2266 #

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

Tension: $P_{ns} = 2.7t_1 dF_{u1}$ 2.38 k
$P_{ns} = 2.7t_2 dF_{u2}$ 2.38 k

For t2/t1 ≥ 2.5: Pns = 2377 #
$P_{ns} = 2.7t_1 dF_{u1}$ 2.38 k
$P_{ns} = 2.7t_2 dF_{u2}$ 2.38 k

Pns/Ω = 755 #
Pss/Ω = 540 # <- Controls
Pnot = 0.748 k (screw pull-out strength)
Pnov = 2.607 k (screw pull-over strength)
Pts/Ω = 249 # <- Controls
Pts/Ω = 820 # (full tensile screw capacity)

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

	Shear (k)	# clips	V_{clip} (k)	V_{allow}(lb)	# screws	spacing
Long side:	5.404	3	1.80	540 #	4	2.00 in
Short side:	5.404	3	1.80	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)

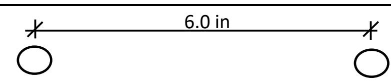
Curb Loads (copied from above)

Transverse: (on long edge)	$Comp_{MAX}$ =	7388	lbs
	$Tens_{MAX}$ =	4688	lbs
	$Shear_{MAX}$ =	12120	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	4956	lbs
	$Tens_{MAX}$ =	2256	lbs
	$Shear_{MAX}$ =	12120	lbs

Loads at each Isolator Type: **CQA**

Transverse loading: (on long edge)	$Comp_{MAX}$ =	2462.6	lbs
	$Tens_{MAX}$ =	1562.6	lbs
# isolators: 3	$Shear_{MAX}$ =	1010.0	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	1652.0	lbs
	$Tens_{MAX}$ =	752.0	lbs
# isolators: 3	$Shear_{MAX}$ =	1010.0	lbs

Max compression force on isolator: 2.463 k ≤ 3.176 k **O.K.**
Max uplift on isolator: 1.563 k ≤ 3.176 k **O.K.**
Max shear on isolator: 1.010 k ≤ 1.163 k **O.K.**



Forces on top bolt:
Tension = 1.563 k d_b = 0.375 in
Shear = 1.010 k upper 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 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 = 14.15 ksi fv = 9.14 ksi O.K.
F'nt = 15.62 ksi Fnv/Ω = 10.00 ksi
$P'_{nt} = A_b F'_{nt}$ P'nt/Ω = 0.767 k **No Good - Use Welds**

Longitudinal weld loading: L = 1.5 $P_n/\Omega = \frac{1}{\Omega}\left(1 - \frac{0.01L}{t_2}\right) L t_2 F_{u2} \ge V_{req}$ Ω = 2.55
If L/t < 25: L/t = 21.04 t = 0.0713 Pn/Ω = 2.153 k
Transverse weld loading: t = 0.0713 $P_n/\Omega = \frac{1}{\Omega} tLF_u \ge T_{req}$ Ω = 2.35
L = 1 Fu = 65 ksi Pn/Ω = 1.972 k

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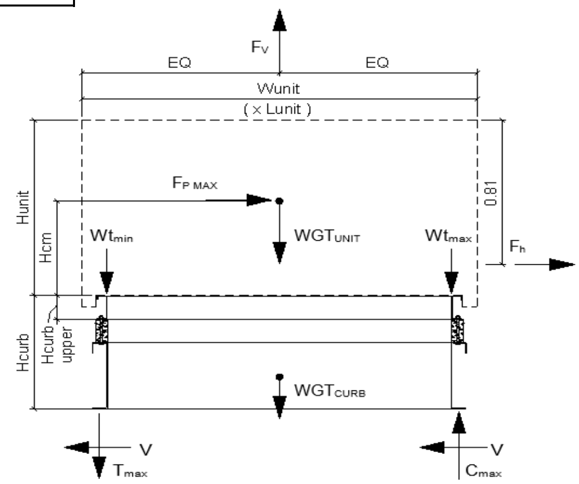
Client:	ProVent	PV2312		Base curb
Project:	CBISC-14	Iso Curb	CBISCSAV28	
Unit:	AV/AD 28; AE/AW 18-23; AH/AL 25; HV 25			



Base Curb Information

Hbase curb = 25 in (Height of base curb)
Lcurb = 154.5 in (Length of base curb)
wcurb = 83.125 in (Width of base curb)
WGTbase = 383 lbs (Weight of base curb)
# Springs long side = 3 # Springs short side = 3

Unit Information

WGTunit = 3010 lbs (Weight of Unit)
Wt'max = 994 lbs (Wtmax+1/4*WGTupper)
Wt'min = 731 lbs (Wtmin+1/4*WGTupper))
Hunit = 57.25 in (Height of unit above curb)
H'cm = 38.625 in (Hcm+10"(upper+spring))
Lunit = 160.0625 in (Length of unit)
Wunit = 88.75 in (Width of unit)
$WGT_{unit+upper+base}$ = 3758 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 = 12120 lbs (0.7*Fpmax) FpmaxASD = 13495 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)
$F_{h\ ASD\ trans}$ = 3478 lbs = 0.6*qz*GCr*Lunit*(Hunit+Hbase curb+10") (Eq. 29.4-2)
$F_{h\ ASD\ long}$ = 1928 lbs = 0.6*qz*GCr*Wunit*(Hunit+Hbase curb+10")
$F_{vert\ ASD}$ = 2642 lbs = 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Base Curb Loading

Transverse:

$Compression_{SEISMIC}$ = 8255 lbs =[FpmaxASD*H'cm+2*(1+0.14S_{DS})*Wt'max*wcurb]/wcurb
$Tension_{SEISMIC}$ = 5221 lbs =[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*wcurb)]/wcurb
$Compression_{WIND}$ = 1488 lbs =[$F_{h\ ASD\ trans}$*H'cm+2*0.6*Wt'max*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ = 2060 lbs =[$F_{h\ ASD\ trans}$*H'cm-2*0.6*Wt'min*wcurb+$F_{vertASD}$*wcurb/2]/wcurb
---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ = 5653 lbs =[FpmaxASD*H'cm+2*(1+0.14*S_{DS})*Wt'max*Lcurb]/Lcurb
$Tension_{SEISMIC}$ = 2619 lbs =[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*Lcurb)]/Lcurb
$Compression_{WIND}$ = 354 lbs =[$F_{h\ ASD\ long}$*H'cm+2*0.6*Wt'max*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ = 926 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:	$Comp_{MAX}$ =	8255	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	5221	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	5653	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2619	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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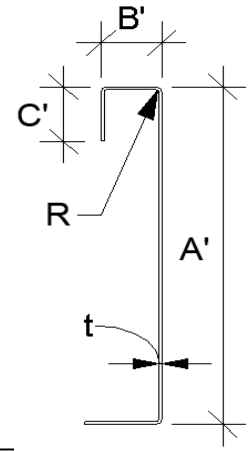
Curb Design

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



Calculate Section Properties of Curb

A'=	25.000	in	a =	24.492 in	= A'-(2r+t)
B'=	1.750	in	a'=	24.898 in	= A'-t
C'=	1.000	in (0 if no lips)	b =	1.242 in	= B'-[r+t/2+α(r+t/2)]
α =	1.000	(0 - no Lip; 1 w/ lip)	b'=	1.648 in	= B'-(t/2+αt/2)
R =	0.1525	(Inside bend radius)	c =	0.746 in	= α[C'-(r+t/2)]
t =	0.1017	in	c'=	0.949 in	= α(C'-t/2)
r'=	0.203	in = R+t/2	u =	0.319 in	= πr/2
x =	0.187	in (Distance between centroid and web centerline)			
Ix =	205.037	in	rx =	8.23 in	
Iy =	0.672	in	ry =	0.471 in	
A =	3.02	in^2	rmin =	0.471 in	

Axial Compression

Ω_c = 1.80

Pu =	6.060 k	(Max Axial Comp)
Pn/Ωc =	6.244 k	
Fe =	4.24 ksi	
λc =	3.44	
Fn =	3.72 ksi	
Ly =	154.50 in	Lateral unbraced length
k_yL_y/r_y =	262	(assume k=0.8)

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

Compression Check = O.K.

Check Web Crippling

h =	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} =	2.752 k	**web stiffener REQ'D**	# clips = 3		
Short side: Pu_{Long} =	1.884 k	**O.K.**	# clips = 3		

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

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 =	3374 lbs	Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax =	4127 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 =	1.4
# of Bolts required for Shear =	3.8
# of Bolts Used =	6.0
Check Combined Stress in Bolts & Inserts:	0.854 **O.K.**

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

Assume L/t > 25: 25*t =	2.543 in
Lreq'd =	1.956 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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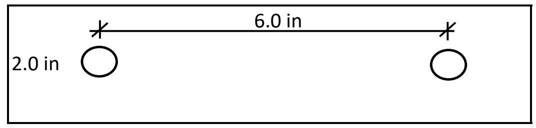
Curb Loads (copied from upper rail calcs)

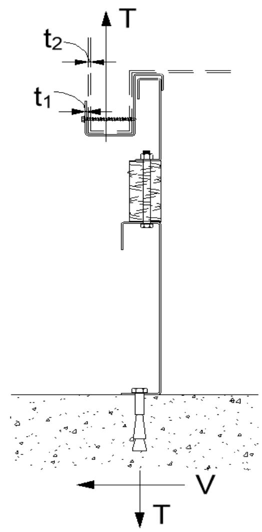
Transverse: (on long edge)	$Comp_{MAX}$ =	7388	lbs
	$Tens_{MAX}$ =	4688	lbs
	$Shear_{MAX}$ =	12120	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	4956	lbs
	$Tens_{MAX}$ =	2256	lbs
	$Shear_{MAX}$ =	12120	lbs

Loads at each Isolator Type: **CQA**

Transverse loading: (on long edge)	$Comp_{MAX}$ =	2462.6	lbs
	$Tens_{MAX}$ =	1562.6	lbs
# isolators: 3	$Shear_{MAX}$ =	1010.0	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	1652.0	lbs
	$Tens_{MAX}$ =	752.0	lbs
# isolators: 3	$Shear_{MAX}$ =	1010.0	lbs

Max compression force on isolator: 2.463 k ≤ 3.176 k **O.K.**
Max uplift on isolator: 1.563 k ≤ 3.176 k **O.K.**
Max shear on isolator: 1.010 k ≤ 1.163 k **O.K.**





Forces on bottom bolts:
d_b = 0.5 in
base curb, t = 0.1017 in
Tension = 0.781 k / bolt
Shear = 0.505 k / bolt

Shear on base curb: $P_n = teF_u$ Ω = 2.00 (Appendix A, Section E3.1 AISI)
Pn/Ω = 6.611 k e = 1.0 in
Shear O.K.

Net section rupture: $P_n = A_nF_t$ Ω = 2.22 (Appendix A, Section E3.2 AISI)
Pn/Ω = 8.428 k An = 0.153 in
N.S.R. O.K. $F_t = (0.1 + 3d/s)F_u \leq F_u =$ 55.250 ksi

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

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

Combined Shear and tension in bolt:
$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \leq F_{nt}$ ft = 7.96 ksi fv = 2.57 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: $Uplift_{MAX}$ = 9802 lbs $Shear_{MAX}$ = 6747 lbs

$Compression_{SEISMIC}$ =	12808 lbs	=[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb
$Tension_{SEISMIC}$ =	9802 lbs	=[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb
$Compression_{WIND}$ =	2469 lbs	=[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*wcurb/2-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	2855 lbs	=[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)-0.6*$WGT_{unit+upper+base}$*wcurb/2+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: $Uplift_{MAX}$ = 5030 lbs $Shear_{MAX}$ = 6747 lbs

$Compression_{SEISMIC}$ =	8036 lbs	=[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb
$Tension_{SEISMIC}$ =	5030 lbs	=[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb
$Compression_{WIND}$ =	601 lbs	=[$F_{h\ ASD\ long}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*Lcurb/2-$F_{vert\ ASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	988 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 = 12.90 COMBINED LOADING: 0.980 O.K.
# of Screws Req'd for Shear = 10.04 Req'd Min Spacing = 7.71 in o.c.
Total # of screws required = 20

Use 20 - 1/4"ϕ x 4.5" Simpson SDS screws @ 7.7 in o.c. along long side of curb w/ 2.75" threaded embed

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Longitudinal:

# of Screws Req'd for Uplift =	6.62	COMBINED LOADING:	0.997 O.K.
# of Screws Req'd for Shear =	10.04	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
$T_{all_{metal}}$ =	2086 lbs	$V_{all_{metal}}$ =	2192 lbs

Transverse:

# of Bolts Req'd for Uplift =	4.70	COMBINED LOADING:	0.979 O.K.
# of Bolts Req'd for Shear =	3.08	Bolt Spacing =	23.75 in o.c.
Total # of bolts required =	7		

Use 7 - 1/2" ϕ A307 Bolts to steel angle below deck @ 23.8 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift =	2.41	COMBINED LOADING:	0.652 O.K.
# of Bolts Req'd for Shear =	3.08	Bolt Spacing =	35.56 in o.c.
Total # of bolts required =	3		

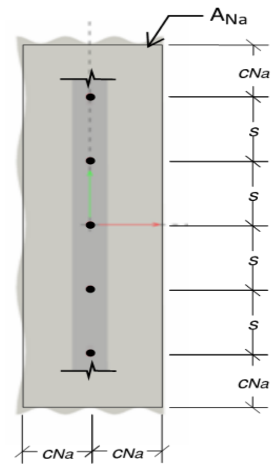
Use 3 - 1/2" ϕ A307 Bolts to steel angle below deck @ 35.6 in o.c. along short side of curb

For Concrete anchorage: SEISMIC $(0.6-0.14S_{DS})D + 0.7\Omega_o E$ 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 = 14.2 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); $c_{Na} = 10 d_a \sqrt{\frac{\tau_{uncr}}{1100}}$



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}= 1358.02 in²
A_{Nao}= 328.52 in²
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} = 39416 lbs (group) $\lambda_a = 1.0$
$øN_{ag}$ = 19215 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} =	825.6 in²	N_b = 8601	lbs	$ø_{conc}$ =	0.75
A_{Nco} =	144 in²	kc = 17		$ø_{bond}$ =	0.65
N_{cbg} =	49315 lbs (group)			$ø_{seis}$ =	0.75
$øN_{cbg}$ =	27739 lbs (group)			$ø_{steel}$ =	0.65

Shear: Vsa,eq = 7865 (from ESR4868, Table 11) $\alpha_{v,seismic}$ = 0.6
Steel strength øVsa,eq = 3067

$T_{all_{LRFD}}$ = 3843 lbs (anchor) $V_{all_{LRFD}}$ = 3067 lbs $\propto = (1 + 0.2SDS)D + 2.5E$ =1.421
$T_{all_{ASD}} = T_{all_{LRFD}}/\alpha$ = 2249 lbs $V_{all_{ASD}} = V_{all_{LRFD}}/\alpha$ = 1795 lbs D =0.758 E =0.242 $\propto$ =1.709

Transverse:	$Uplift_{MAX}$ = 13520 lbs	$Shear_{MAX}$ = 16869 lbs

$Compression_{SEISMIC}$ = 16702 lbs =[Ωo*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*$WGT_{unit+curb}$*wcurb/2]/wcurb
$Tension_{SEISMIC}$ = 13520 lbs =[Ωo*FpmaxASD*(Hcm+Hcurb)-(0.6-0.14S_{DS})*$WGT_{unit+curb}$*wcurb/2]/wcurb
$Shear_{SEISMIC}$ = 16869 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift = 6.01 spacing = 23.75 in o.c. Tapplied = 1352.0 lbs
Min Bolts Req'd Shear = 9.40 spacing = 15.83 in o.c. Vapplied = 1054.3 lbs

Try using	10	bolts
spaced at	15.83	in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.19 O.K.

Use 10 - 0.625in ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy @ 15.8 in o.c. max. along long side of curb w/ 4in embed

Longitudinal:	$Uplift_{MAX}$ = 7016 lbs	$Shear_{MAX}$ = 16869 lbs

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$Compression_{SEISMIC}$ =	10198 lbs	=[Ωo*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*$WGT_{unit+curb}$*Lcurb/2]/Lcurb
$Tension_{SEISMIC}$ =	7016 lbs	=[Ωo*FpmaxASD*(Hcm+Hcurb)-(0.6-0.14S_{DS})*$WGT_{unit+curb}$*Lcurb/2]/Lcurb
$Shear_{SEISMIC}$ =	16869 lbs	=Ωo*FpmaxASD/2

Min Bolts Req'd Uplift =	3.12	spacing =	23.71	in o.c.	Tapplied =	1169.4	lbs
Min Bolts Req'd Shear =	9.40	spacing =	7.90	in o.c.	Vapplied =	1054.3	lbs

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

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.11 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-14	CBISCSAV28	**Unit:** AV/AD 28; AE/AW 18-23; AH/AL 25; HV 25
UPPER CURB RAIL THICKNESS:	0.1017 in	12 Gauge	
UNIT CLIP THICKNESS:	0.0713 in	14 Gauge	
# OF CLIPS (LONG SIDE) -	3 clips with 4 - #10 SMS screws each clip		
WEB STIFFENER:	16Ga x 1 3/16in x 7in (C-channel) stiffener at each clip		
# OF CLIPS (SHORT SIDE) -	3 clips with 4 - #10 SMS screws each clip		
WEB STIFFENER:	16Ga x 1 3/16in x 7in (C-channel) stiffener at each clip		
VIBRATION ISOLATOR TYPE:	CQA	Top stud diameter: 3/8	(3) - CQA Isolators long side
Anchor bolt diameter:	1/2	Anchor hole diamter: 9/16	(3) - CQA Isolators short side
BASE CURB THICKNESS:	0.1017 in	12 Gauge	***Must weld top of CQA***
WEB STIFFENER:	NOT REQUIRED		
CORNER CONNECTION:	Use minimum 6 - 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	20 @ 7.71 in o.c.	7 @ 23.75 in o.c.	10 @ 15.83 in o.c.
SHORT DIRECTION	10 @ 8.35 in o.c.	3 @ 35.56 in o.c.	6 @ 14.23 in o.c.