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

Structural Calculations

for

CBISCSEL4050 Curb

Prepared for:

PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

Date: November 26, 2024

Project Number: PV2403

For wood, concrete and steel attachment see Roof Anchorage Detail, Form No. CB-63.

Welded Isolation springs housing are standard. For bolted spring housing, neoprene pads and spring cups see Weldment and Bolting Detail, Form No. CB-61

VIBRATION ISOLATION ROOF CURBS
YORK UNITS

SUN SELECT 40-50 TON

PROVENT P/N	A	B	EST. WEIGHT
CBISCSEL405018**	8"	18"	810 Lbs
CBISCSEL405021**	11"	21"	863 Lbs
CBISCSEL405024**	14"	24"	913 Lbs
CBISCSEL405028**	18"	28"	1,038 Lbs

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

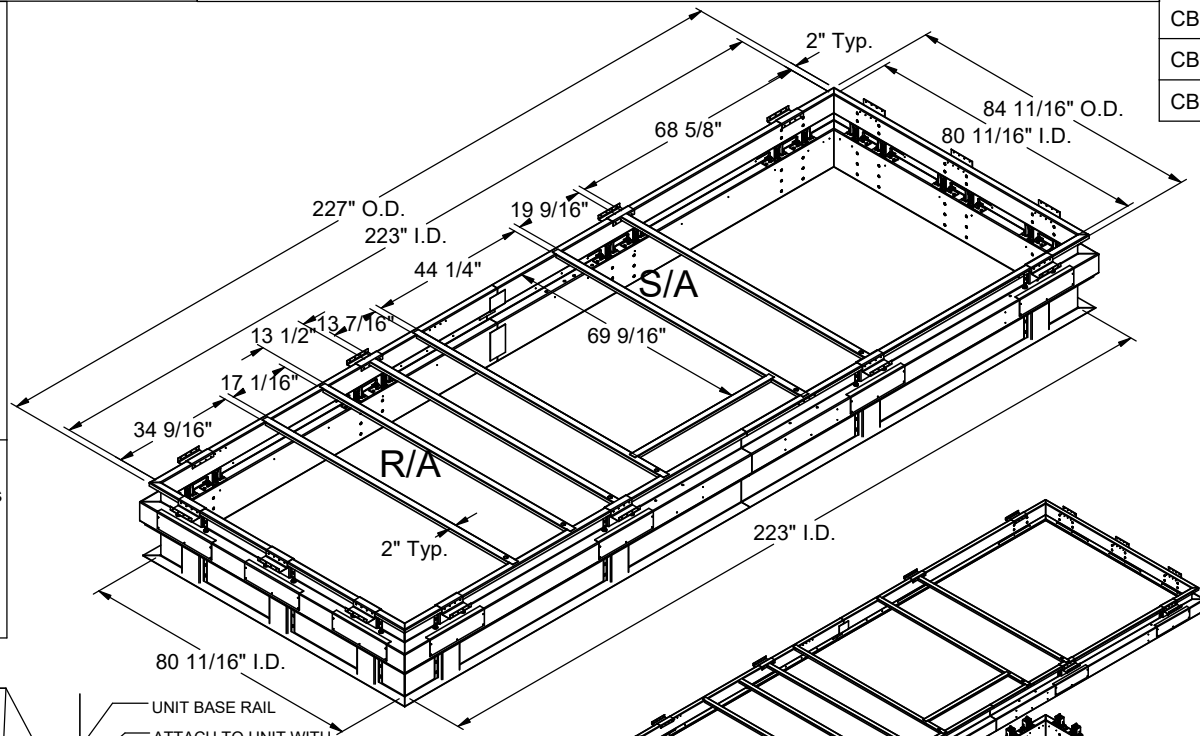
Meets seismic requirements for the following codes:
CBC 2022
IBC 2021

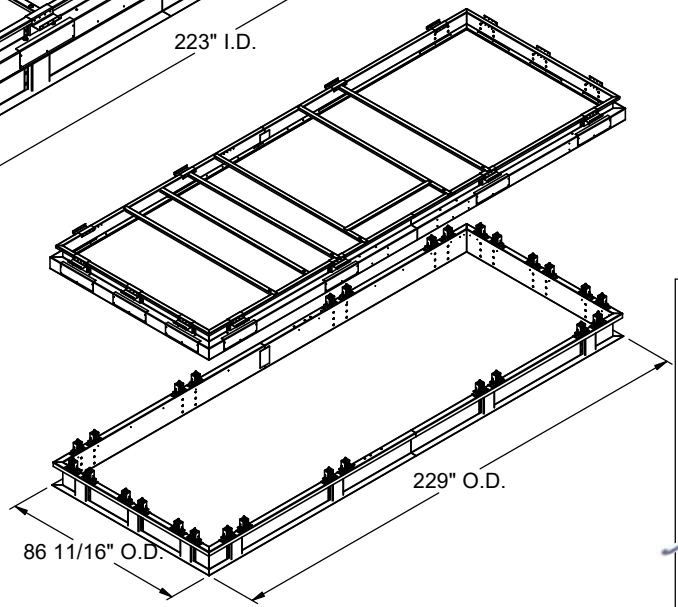
FEATURES

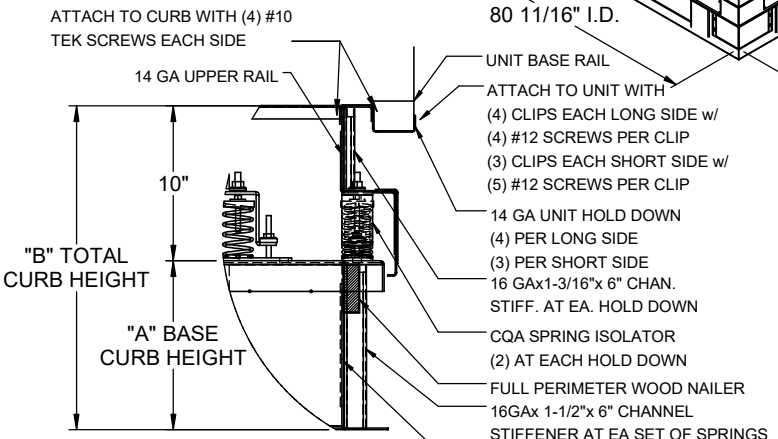
- Roof curb base 12 ga.
- Roof curb upper rail 14 ga.
- Fully welded construction.
- Gasketing package provided.
- Heat treated wood nailer provided.
- insulated deck pans provided.
- Pitched curbs and taller curbs are available.
- CalDyn OSHPd pre-approved seismic restraints. (OPM-0401-13), (CQA).

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

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

ProVent

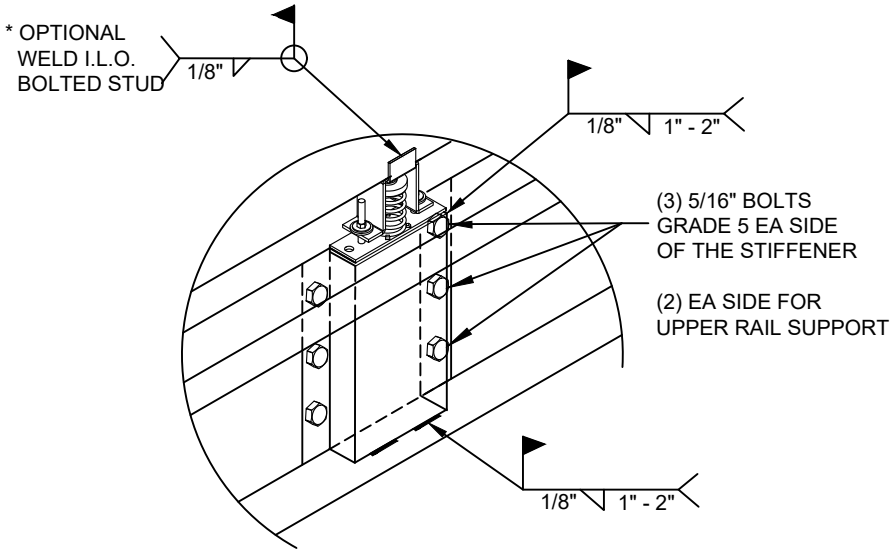
3847 WABASH DRIVE
MIRA LOMA, CA 91752

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

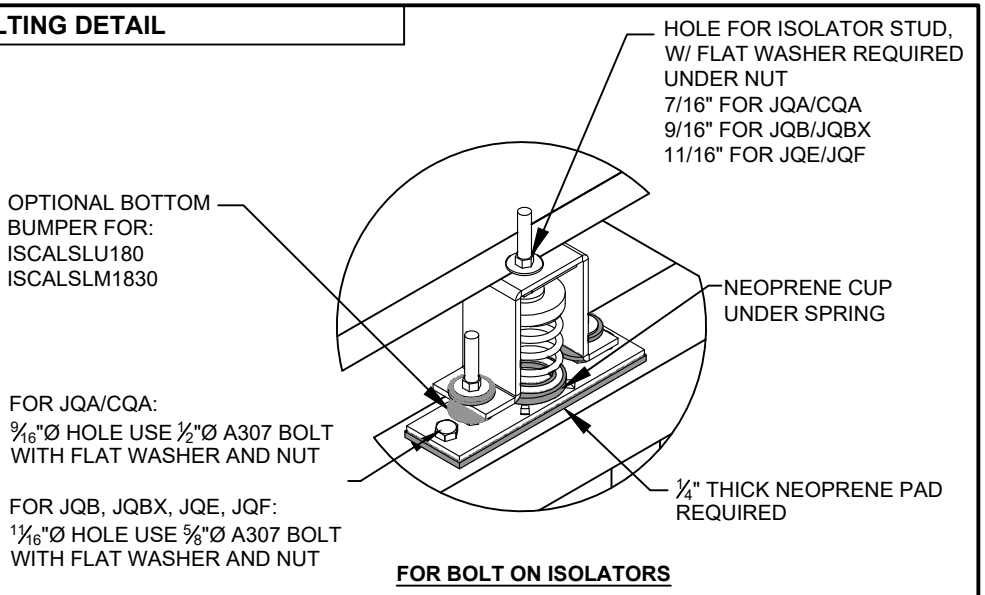
SUBMITED TO: _____
COMPANY: _____
JOB NAME: _____
EQUIPMENT: _____
NOTES: _____

FORM NO:	PART NUMBER:	
CBISC-16	CBISCSEL4050 SERIES	
DATE: 11/20/2024	**REV:** 1	**DRAWN BY:** FMM

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)
- -SEL4050 (CBISC-16)

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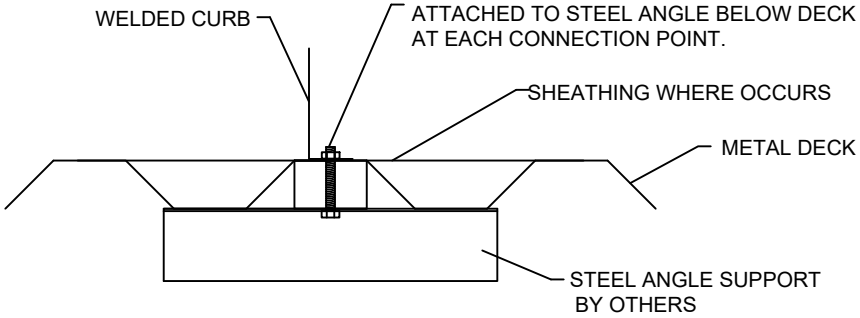
NOTES:

FORM NO:		
CB-61		
DATE:	**REV:**	**DRAWN BY:**
11/21/24	3	FMM

STEEL ATTACHMENT



	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
SEL2835	7 @ 27.57" O.C.	4 @ 24.23" O.C.
SEL4050	14 @ 16.23" O.C.	5 @ 17.17" O.C.

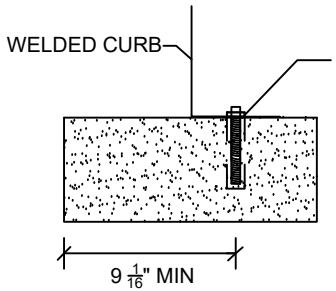
ASSUMES:
CONC SLAB
f'c= 4000PSI MINIMUM
6" MIN THICKNESS
NORMAL WEIGHT CONCRETE

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

ROOF ANCHORAGE DETAIL

CBISC Series
SEL2835
SEL4050

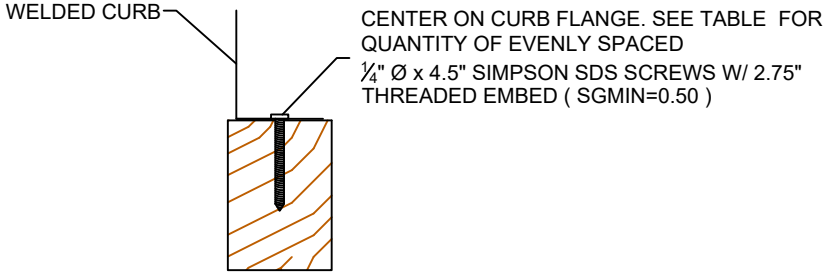
CONCRETE ATTACHMENT



	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
SEL2835	16 @ 11.03" O.C.	8 @ 10.38" O.C.
SEL4050	26 @ 8.44" O.C.	9 @ 8.59" O.C.

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

WOOD ATTACHMENT



	NO. OF ANCHORAGE SCREWS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
SEL2835	26 @ 6.78" O.C.	13 @ 6.39" O.C.
SEL4050	40 @ 5.51" O.C.	15 @ 5.19" O.C.

FOUR INCHES FROM EACH CORNER EVENLY SPACED

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FORM NO: CB-63

DATE:	REV:	DRAWN BY:
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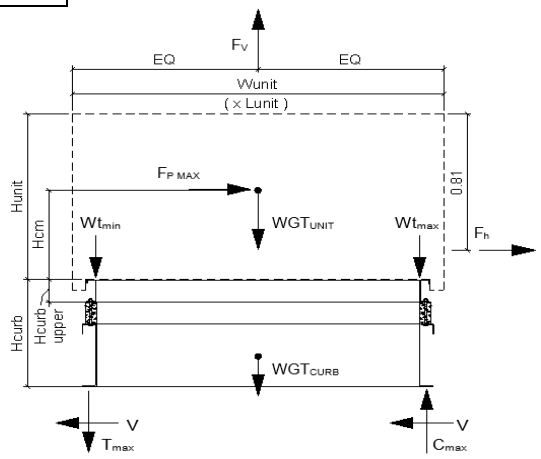
Client:	ProVent	PV2403	Upper curb rail
Project:	CBISC-16	Iso Curb	CBISCSEL4050
Unit:	SUN SELECT 40-50 TON		

Upper Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	227	in	(Length of upper curb)
wcurb =	84.6875	in	(Width of upper curb)
WGTupper =	558	lbs	(Weight of upper curb)
# Clips long side =	4		# Clips short side = 3

Unit Information

WGTunit =	5984	lbs	(Weight of Unit)
Wtmax =	1646	lbs	(Maximum corner weight)
Wtmin =	1346	lbs	(Minimum corner weight)
Hunit =	77	in	(Height of unit above curb)
Hcm =	38.5	in	(Height to center of mass)
Lunit =	232	in	(Length of unit)
Wunit =	90	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 =	21489	lbs	(0.7*Fpmax)	FpmaxASD =	23492 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)
$F_{h\ ASD\ trans}$ =	4508	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	1749	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	3883	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Upper Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	14111	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	9013	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*wcurb)]/wcurb
$Compression_{WIND}$ =	2083	lbs	=[$F_{h\ ASD\ trans}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	2375	lbs	=[$F_{h\ ASD\ trans}$*Hcm-2*0.6*Wtmin*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	7986	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	2888	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*Lcurb)]/Lcurb
$Compression_{WIND}$ =	330	lbs	=[$F_{h\ ASD\ long}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	622	lbs	=[$F_{h\ ASD\ long}$*Hcm-2*0.6*Wtmin*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	14111	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	9013	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	7986	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2888	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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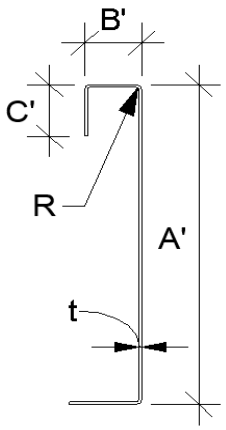
Curb Design

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'=	2.000	in		a'=	5.429 in	= A'-t
C'=	1.000	in	(0 if no lips)	b =	1.644 in	= B'-[r+t/2+α(r+t/2)]
α =	1.000		(0 - no Lip; 1 w/ lip)	b'=	1.929 in	= B'-(t/2+αt/2)
R =	0.1069		(Inside bend radius)	c =	0.822 in	= α[C'-(r+t/2)]
t =	0.0713	in		c'=	0.964 in	= α(C'-t/2)
r'=	0.143	in	= R+t/2	u =	0.224 in	= πr/2
x =	0.657	in	(Distance between centroid and web centerline)			
Ix =	3.543	in		rx =	2.13 in	
Iy =	0.482	in		ry =	0.785 in	
A =	0.782	in^2		rmin =	0.785 in	



Axial Compression

Pa =	10.744 k	(Max Axial Comp)	Ω_c =	1.80
Pn/Ωc =	13.366 k			
Fe =	43.07 ksi	$\frac{P_n}{\Omega_c} = \frac{F_n A}{\Omega_c}$	$If\ \lambda_c \le 1.5;\ F_n = \left(0.658^{\lambda_c{}^2}\right) F_y$	$\lambda_c = \sqrt{\frac{F_y}{F_e}}$
λc =	1.08		$If\ \lambda_c > 1.5;\ F_n = \frac{0.877}{\lambda_c{}^2} F_y$	$F_e = \frac{\pi^2 E}{\left(kl/r\right)^2}$
Fn =	30.76 ksi			
Ly =	80.68 in	Lateral unbraced length		
$k_y L_y/r_y$ =	82	(assume k=0.8)		

Compression Check = O.K.

Check Web Crippling

h =	5.5 in	-- Check limits:		C = 7.50	(See table C3.4.1-2, fastened to support, two flange, end loading)
t =	0.0713 in	h/t =	77.14 ≤ 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				

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

Long side: Pu_{Trans} = 3.528 k **web stiffener REQ'D** # clips = 4

Short side: Pu_{Long} = 2.662 k **web stiffener REQ'D** # clips = 3

Check Web Stiffener

16Ga x 1 3/16in x 6in (C-channel)

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

width of stiffener =	6.000	in	ts =	0.0566	16 Gauge	Pwc =	1.947 k
web of stiff. w =	5.717	in	Rs =	0.0849	in	Pn =	12.688 k
***Check w/ts ≤ 1.28√E/Fys			Ω_c =	1.70		Ae =	0.324 in^2
w/ts =	101.007						
1.28√(E/Fys) =	31.091	--> w/ts over limit	Use C3.7.2			Pn/Ω_c =	7.464 k **O.K.**

Corner Connections

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

Tcrnmax = 5873 lbs — Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)

Vcrnmax = 7055 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 = 2.4

# of Bolts required for Shear = 6.4

# of Bolts Used = 9.0

Check Combined Stress in Bolts & Inserts: 0.978 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35

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

Lreq'd = 4.770 in

$$P_n/\Omega = \frac{1}{\Omega} 0.75 t L F_u \ge V_{req} \qquad L_{req'd} = \frac{V_{req}\Omega}{0.75 t F_u}$$

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Connection Unit to Curb Clip | #12 SMS screw | Ω = 3.0

t1 = 0.0713 in (clip thickness) | t2/t1 = 1.0 | Fu1 = 65 ksi

t2 = 0.0713 in (mech unit base rail thickness) | Fu2 = 65 ksi

d = 0.216 in (screw diameter) | dw = 0.375 in (nom. washer diameter)

	For t2/t1 ≤ 1.0:		For t2/t1 ≥ 2.5:	
		Pns = 2416 #		Pns = 2703 #
Shear:	$P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$	2.42 k		
Tension:	$P_{ns} = 2.7t_1 dF_{u1}$	2.70 k	$P_{ns} = 2.7t_1 dF_{u1}$	2.70 k
	$P_{ns} = 2.7t_2 dF_{u2}$	2.70 k	$P_{ns} = 2.7t_2 dF_{u2}$	2.70 k

Pns/Ω = 805 # <- Controls

Pss/Ω = 840 #

Pnot = 0.851 k (screw pull-out strength)

Pnov = 2.607 k (screw pull-over strength)

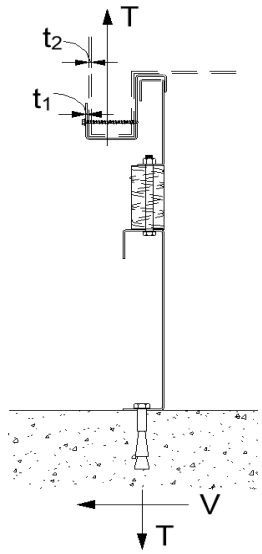
Pts/Ω = 284 # <- Controls

Pts/Ω = 845 # (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:	10.744	4	2.69	805 #	4	2.00 in
Short side:	10.744	3	3.58	805 #	5	1.50 in

clip width (in) = 7.00 | clip height = 2.5 in

min spacing = 0.65 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 = 0.394 in² | Ant = 0.081 in²

Rn/Ω = 8.647 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)	$Comp_{MAX}$ =	16521	lbs
	$Tens_{MAX}$ =	11287	lbs
	$Shear_{MAX}$ =	23492	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	8869	lbs
	$Tens_{MAX}$ =	3635	lbs
	$Shear_{MAX}$ =	23492	lbs

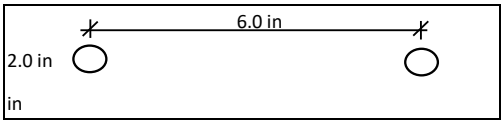
Loads at each Isolator Type: **CQA**

Transverse loading: (on long edge)	$Comp_{MAX}$ =	2065.1	lbs
	$Tens_{MAX}$ =	1410.9	lbs
# isolators: 8	$Shear_{MAX}$ =	839.0	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	1478.1	lbs
	$Tens_{MAX}$ =	605.8	lbs
# isolators: 6	$Shear_{MAX}$ =	839.0	lbs

Max compression force on isolator: 2.065 k ≤ 3.176 k **O.K.**

Max uplift on isolator: 1.411 k ≤ 3.176 k **O.K.**

Max shear on isolator: 0.839 k ≤ 1.163 k **O.K.**



Forces on top bolt:

Tension = 1.411 k | d_b = 0.375 in

Shear = 0.839 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 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 = 12.77 ksi | fv = 7.60 ksi | O.K.

F'nt = 21.88 ksi | Fnv/Ω = 10.00 ksi

$P'_{nt} = A_b F'_{nt}$ | P'nt/Ω = 1.074 k **No Good - Use Welds**

Longitudinal weld loading: L = 1.5 | $P_n/\Omega = \frac{1}{\Omega}\left(1 - \frac{0.01L}{t_2}\right) Lt_2 F_{u2} \ge V_{req}$ | Ω = 2.55

If L/t < 25: L/t = 21.04 | t = 0.0713 | Pn/Ω = 2.153 k

Transverse weld loading: t = 0.0713 | $P_n/\Omega = \frac{1}{\Omega} tLF_u \ge T_{req}$ | Ω = 2.35

L = 1 | Fu = 65 ksi | Pn/Ω = 1.972 k

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Client:	ProVent	PV2403	Base curb
Project:	CBISC-16	Iso Curb	CBISCSEL4050
Unit:	SUN SELECT 40-50 TON		

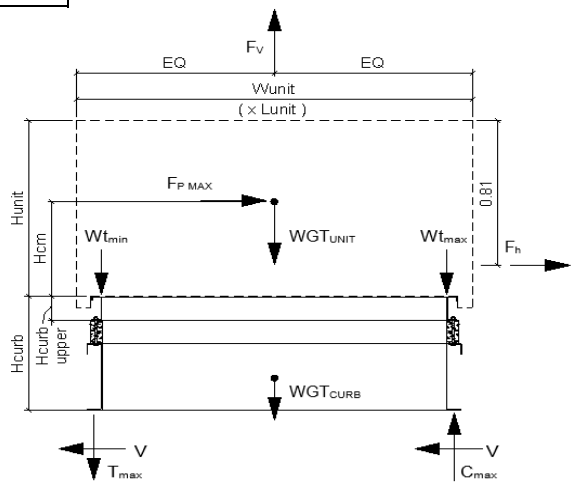
Base Curb Information

Hbase curb =	25	in	(Height of base curb)
Lcurb =	223	in	(Length of base curb)
wcurb =	80.6875	in	(Width of base curb)
WGTbase =	480	lbs	(Weight of base curb)

Springs long side = 4 # Springs short side = 3

Unit Information

WGTunit =	5984	lbs	(Weight of Unit)
Wt'max =	1785	lbs	(Wtmax+1/4*WGTupper)
Wt'min =	1486	lbs	(Wtmin+1/4*WGTupper))
Hunit =	77	in	(Height of unit above curb)
H'cm =	48.5	in	(Hcm+10"(upper+spring))
Lunit =	232	in	(Length of unit)
Wunit =	90	in	(Width of unit)
$WGT_{unit+upper+base}$ =	7022	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 =	23492	lbs	(0.7*Fpmax) FpmaxASD = 25216 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)
$F_{h\ ASD\ trans}$ =	6120	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hbase curb+10") (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	2374	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hbase curb+10")
$F_{vert\ ASD}$ =	3883	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Base Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	18831	lbs	=[FpmaxASD*H'cm+2*(1+0.14S_{DS})*Wt'max*wcurb]/wcurb
$Tension_{SEISMIC}$ =	13286	lbs	=[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*wcurb)]/wcurb
$Compression_{WIND}$ =	3880	lbs	=[$F_{h\ ASD\ trans}$*H'cm+2*0.6*Wt'max*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	3837	lbs	=[$F_{h\ ASD\ trans}$*H'cm-2*0.6*Wt'min*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	9819	lbs	=[FpmaxASD*H'cm+2*(1+0.14*S_{DS})*Wt'max*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	4275	lbs	=[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*Lcurb)]/Lcurb
$Compression_{WIND}$ =	717	lbs	=[$F_{h\ ASD\ long}$*H'cm+2*0.6*Wt'max*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	675	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:	$Comp_{MAX}$ =	18831	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	13286	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	9819	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	4275	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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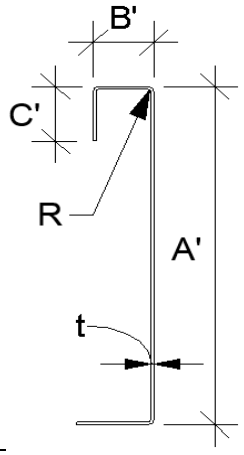
Curb Design

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 =	3.025 in^2		rmin =	0.471 in	

Axial Compression

Pu =	11.746 k	(Max Axial Comp)	Ω_c =	1.80
Pn/Ωc =	20.428 k			
Fe =	13.86 ksi	$\frac{P_n}{\Omega_c} = \frac{F_n A}{\Omega_c}$	$If\ \lambda_c \le 1.5;\ F_n = \left(0.658^{\lambda_c{}^2}\right) F_y$	$\lambda_c = \sqrt{\frac{F_y}{F_e}}$
λc =	1.90		$If\ \lambda_c > 1.5;\ F_n = \frac{0.877}{\lambda_c{}^2} F_y$	$F_e = \frac{\pi^2 E}{\left(kl/r\right)^2}$
Fn =	12.16 ksi			
Ly =	85.42 in	Lateral unbraced length		
k_yL_y/r_y =	145	(assume k=0.8)		

Compression Check = O.K.

Check Web Crippling

h =	25 in	-- Check limits:		C = 4.00		
t =	0.1017 in	h/t =	245.82 ≤ 260	C_R = 0.14	(See table C3.4.1-2, fastened to support, one flange, end loading)	
N =	7.00	N/t =	68.83 ≤ 210	C_N = 0.35		
Ω_w =	1.75	N/h =	0.28 ≤ 2.0	C_h = 0.02		
P_n =	4.106 k	R/t =	1.50 ≤ 9.0			
P_n/Ω_w =	2.346 k					
Long side: Pu_{Trans} =	4.708 k	**web stiffener REQ'D**	# clips = 4			
Short side: Pu_{Long} =	3.273 k	**web stiffener REQ'D**	# 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 6in (C-channel)

width of stiffener =	6.000 in		ts =	0.0566	16 Gauge
web of stiff. w =	5.717 in		Rs =	0.0849 in	
***Check w/ts ≤ 1.28√E/Fys			Ω_c =	1.70	
w/ts =	101.007				
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 =	0.324 in^2
Pn =	14.200 k			
Pn/Ω_c =	8.353 k	**O.K.**		

Corner Connections

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

Tcrnmax =	6304 lbs	Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)			
Vcrnmax =	9415 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 =	2.5
# of Bolts required for Shear =	8.6
# of Bolts Used =	11.0
Check Combined Stress in Bolts & Inserts:	1.012 **N.G.- USE WELDS**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35

Assume L/t > 25: 25*t =	2.543 in	$P_n/\Omega = \frac{1}{\Omega}0.75tLF_u \ge V_{req}$	$L_{req'd} = \frac{V_{req}\Omega}{0.75tF_u}$
Lreq'd =	4.463 in		

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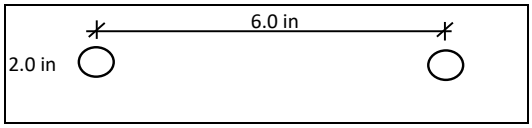
Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	16521	lbs
	$Tens_{MAX}$ =	11287	lbs
	$Shear_{MAX}$ =	23492	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	8869	lbs
	$Tens_{MAX}$ =	3635	lbs
	$Shear_{MAX}$ =	23492	lbs

Loads at each Isolator Type: **CQA**

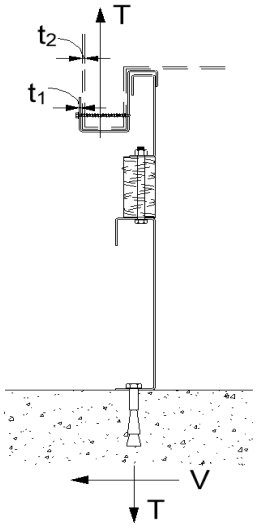
Transverse loading: (on long edge)	$Comp_{MAX}$ =	2065.1	lbs
	$Tens_{MAX}$ =	1410.9	lbs
# isolators: 8	$Shear_{MAX}$ =	839.0	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	1478.1	lbs
	$Tens_{MAX}$ =	605.8	lbs
# isolators: 6	$Shear_{MAX}$ =	839.0	lbs

Max compression force on isolator: 2.065 k ≤ 3.176 k **O.K.**
Max uplift on isolator: 1.411 k ≤ 3.176 k **O.K.**
Max shear on isolator: 0.839 k ≤ 1.163 k **O.K.**



Forces on bottom bolts:

d_b = 0.5 in
base curb, t = 0.1017 in
Tension = 0.705 k / bolt
Shear = 0.420 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 = 7.19 ksi fv = 2.14 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: $Uplift_{MAX}$ = 21984 lbs $Shear_{MAX}$ = 12608 lbs

$Compression_{SEISMIC}$ = 27602 lbs =[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb
$Tension_{SEISMIC}$ = 21984 lbs =[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb
$Compression_{WIND}$ = 5740 lbs =[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*wcurb/2-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ = 5410 lbs =[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)-0.6*$WGT_{unit+upper+base}$*wcurb/2+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: $Uplift_{MAX}$ = 7325 lbs $Shear_{MAX}$ = 12608 lbs

$Compression_{SEISMIC}$ = 12943 lbs =[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb
$Tension_{SEISMIC}$ = 7325 lbs =[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb
$Compression_{WIND}$ = 948 lbs =[$F_{h\ ASD\ long}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*Lcurb/2-$F_{vert\ ASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ = 617 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 = 28.93 COMBINED LOADING: 0.999 O.K.
# of Screws Req'd for Shear = 18.76 Req'd Min Spacing = 5.51 in o.c.
Total # of screws required = 40

Use 40 - 1/4"ϕ x 4.5" Simpson SDS screws @ 5.5 in o.c. along long side of curb w/ 2.75" threaded embed

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Longitudinal:

# of Screws Req'd for Uplift =	9.64	COMBINED LOADING:	0.848 O.K.
# of Screws Req'd for Shear =	18.76	Screw Spacing =	5.19 in o.c.
Total # of screws required =	15		

Use 15 - 1/4"ϕ x 4.5" Simpson SDS screws @ 5.2 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 =	10.54	COMBINED LOADING:	0.961 O.K.
# of Bolts Req'd for Shear =	5.75	Bolt Spacing =	16.23 in o.c.
Total # of bolts required =	14		

Use 14 - 1/2" ϕ A307 Bolts to steel angle below deck @ 16.2 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift =	3.51	COMBINED LOADING:	0.804 O.K.
# of Bolts Req'd for Shear =	5.75	Bolt Spacing =	17.17 in o.c.
Total # of bolts required =	5		

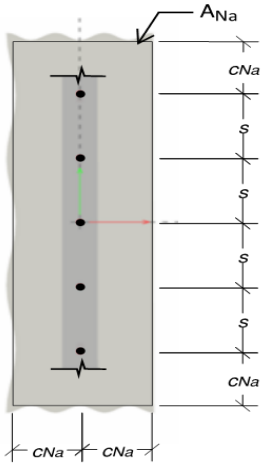
Use 5 - 1/2" ϕ A307 Bolts to steel angle below deck @ 17.2 in o.c. along short side of curb

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/ 4.5in 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 =	4.5	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

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

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

A_{Na} =	908.52 in^2		
A_{Nao} =	328.52 in^2		
N_{ba} =	10727 lbs	$N_{ba} = \lambda_a\tau_{cr}\pi d_a h_{ef}\alpha_{n,seismic}$	$\alpha_{n,seismic} = 0.99$
N_{ag} =	29666 lbs (group)		λ_a = 1.0
øN_{ag} =	14462 lbs (group)	CONTROLS	λ_a = 1.0 for normal weight conc; 0.6 for lightw

Breakout strength

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

A_{Nc} =	614.25 in^2	N_b = 10264	lbs	ø$_{conc}$ =	0.75
A_{Nco} =	182.25 in^2	kc = 17		ø$_{bond}$ =	0.65
N_{cbg} =	34592 lbs (group)			ø$_{seis}$ =	0.75
øN_{cbg} =	19458 lbs (group)			ø$_{steel}$ =	0.65

Shear:

Steel strength

Vsa,eq =	7865	(from ESR4868, Table 11)		$\alpha_{v,seismic}$ =	0.6
øVsa,eq =	3067				
$Tall_{LRFD}$ =	2892 lbs (anchor)	$Vall_{LRFD}$ =	3067 lbs	$\propto = (1 + 0.2SDS)D + 2.5E$ =	1.421
$Tall_{ASD} = Tall_{LRFD}/\alpha$ =	1693 lbs	$Vall_{ASD} = Vall_{LRFD}/\alpha$ =	1795 lbs	D = 0.758 E = 0.242 $\propto$ =	1.709

Transverse:	$Uplift_{MAX}$ = 34300 lbs	$Shear_{MAX}$ =	31520 lbs
$Compression_{SEISMIC}$ =	40012 lbs	=[Ωo*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*$WGT_{unit+curb}$*wcurb/2]/wcurb	
$Tension_{SEISMIC}$ =	34300 lbs	=[Ωo*FpmaxASD*(Hcm+Hcurb)-(0.6-0.14S_{DS})*$WGT_{unit+curb}$*wcurb/2]/wcurb	
$Shear_{SEISMIC}$ =	31520 lbs	=Ωo*FpmaxASD/2	

Min Bolts Req'd Uplift =	20.26	spacing =	10.55 in o.c.	Tapplied =	1143.3 lbs
Min Bolts Req'd Shear =	17.56	spacing =	12.41 in o.c.	Vapplied =	900.6 lbs

Try using	26	bolts	
spaced at	8.44	in o.c.	

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \le 1.2$ = 1.18 O.K.

Use 26 - 0.625in ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy @ 8.4 in o.c. max. along long side of curb w/ 4.5in embed

Longitudinal:	$Uplift_{MAX}$ = 11771 lbs	$Shear_{MAX}$ =	31520 lbs

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$Compression_{SEISMIC}$ = 17483 lbs =[Ωo*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*$WGT_{unit+curb}$*Lcurb/2]/Lcurb

$Tension_{SEISMIC}$ = 11771 lbs =[Ωo*FpmaxASD*(Hcm+Hcurb)-(0.6-0.14S_{DS})*$WGT_{unit+curb}$*Lcurb/2]/Lcurb

$Shear_{SEISMIC}$ = 31520 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift = 6.95 spacing = 11.45 in o.c. Tapplied = 1070.1 lbs

Min Bolts Req'd Shear = 17.56 spacing = 4.04 in o.c. Vapplied = 900.6 lbs

Try using	9	bolts
spaced at	8.59	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 9 - 0.625in ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy @ 8.6 in o.c. max. along short side of curb w/ 4.5in embed

CURB DESIGN SUMMARY:	CBISC-16	CBISCSEL4050	**Unit:**	SUN SELECT 40-50 TON
UPPER CURB RAIL THICKNESS:	0.1017 in	12 Gauge		
UNIT CLIP THICKNESS:	0.0713 in	14 Gauge		
# OF CLIPS (LONG SIDE) -	4 clips with 4 - #12 SMS screws each clip			
WEB STIFFENER:	16Ga x 1 3/16in x 6in (C-channel) stiffener at each clip			
# OF CLIPS (SHORT SIDE) -	3 clips with 5 - #12 SMS screws each clip			
WEB STIFFENER:	16Ga x 1 3/16in x 6in (C-channel) stiffener at each clip			
VIBRATION ISOLATOR TYPE:	CQA	Top stud diameter:	3/8	(8) - CQA Isolators long side
Anchor bolt diameter:	1/2	Anchor hole diamter:	9/16	(6) - CQA Isolators short side
BASE CURB THICKNESS:	0.1017 in	12 Gauge		***Must weld top of CQA***
WEB STIFFENER:	16Ga x 1.5in x 6in (C-channel) stiffener at each clip on base curb			
CORNER CONNECTION:	Use minimum 11 - 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/ 4.5in embed
LONG DIRECTION	40 @ 5.51 in o.c.	14 @ 16.23 in o.c.	26 @ 8.44 in o.c.
SHORT DIRECTION	15 @ 5.19 in o.c.	5 @ 17.17 in o.c.	9 @ 8.59 in o.c.