MOUR GROUP
ENGINEERING + DESIGN

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

Structural Calculations
for
CBISC-03 Series

CBISCSUN3672** SERIES

Prepared for:

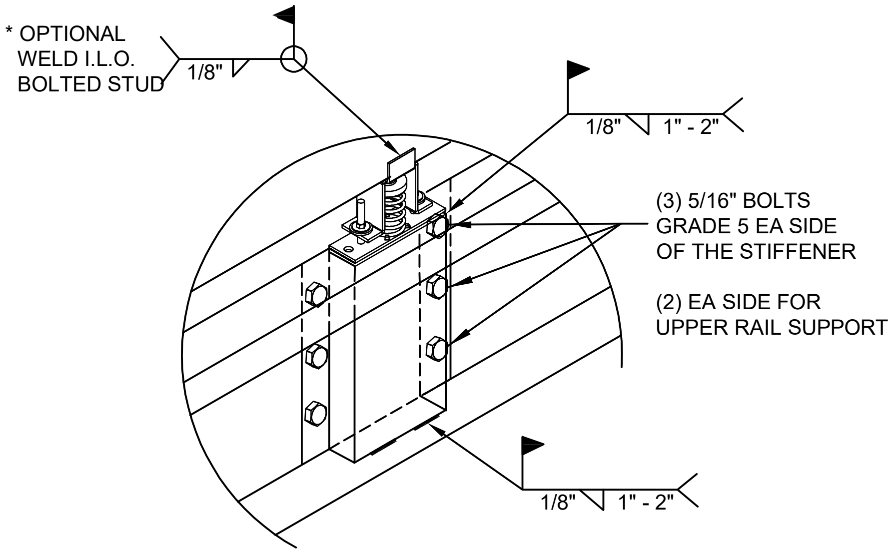
PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

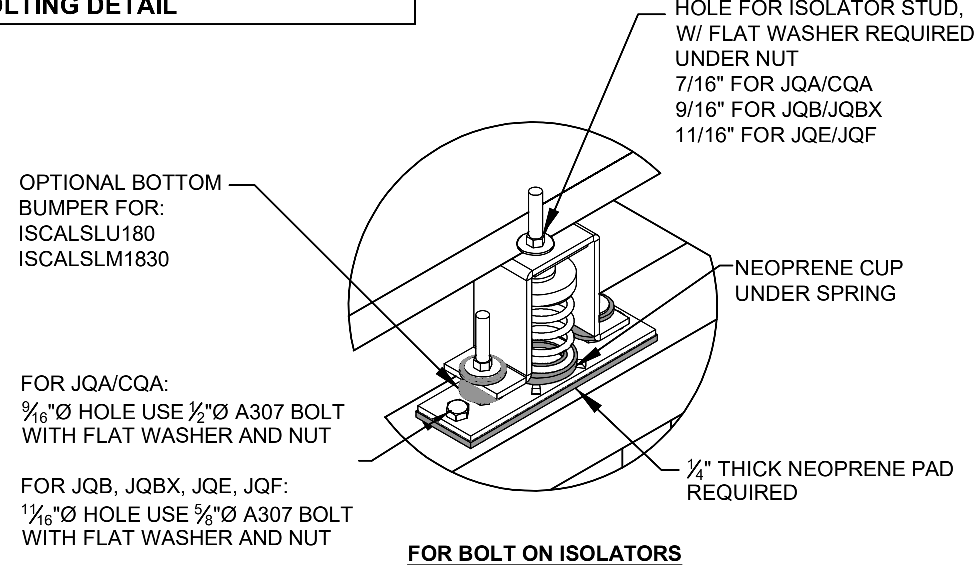
Date: August 23, 2023

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)

ProVent

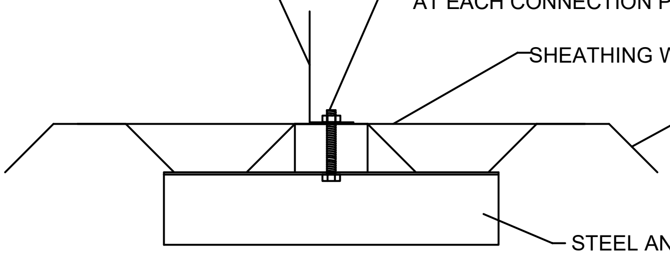
3847 WABASH DRIVE
MIRA LOMA, CA 91725

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

STEEL ATTACHMENT



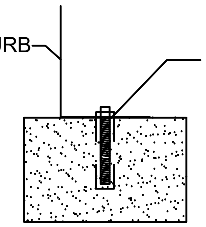
CURB	NO. OF ANCHORAGE BOLTS REQUIRED	
	LONG SIDE	SHORT SIDE
LXS	3 @ 19.25" O.C.	2 @ 23" O.C.
LXL	3 @ 19.25" O.C.	2 @ 33" O.C.
SUN3672	4 @ 21" O.C.	2 @ 27.25" O.C.
PRD3715	6 @ 14.28" O.C.	3 @ 20.75" O.C.
PRS	4 @ 20.46" O.C.	2 @ 31.13" O.C.
PRL	5 @ 17.44" O.C.	2 @ 41.5" O.C.
SAV1518	6 @ 22.43" O.C	3 @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

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

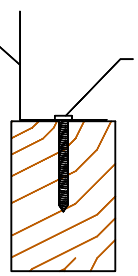
CONCRETE ATTACHMENT



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
3847 WABASH DRIVE
MIRA LOMA, CA 91752
PHONE (951) 685-1101
FAX (619) 872-9799

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

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

For wood, concrete and steel attachment see Roof Anchorage Detail, Form No. CB-62.
Welded Isolation springs housingare standard. For bolted spring housing, neoprene pads and spring cups see Weldment and Bolting Detail, Form No. CB-61

STRUCTURALLY CALCULATED VIBRATION ISOLATION ROOF CURBS FOR SMALL SUNLINE 3-6 TON UNITS

ZR, XN, XP 036-060,
ZE, ZF 036-072

PROVENT P/N	A	B	EST. WEIGHT
CBISCSUN367218**	8"	18"	260 Lbs.
CBISCSUN367221**	11"	21"	280 Lbs.
CBISCSUN367224**	14"	24"	300 Lbs.

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

Weight of upper portion supported by spring isolators= 144 Lbs.

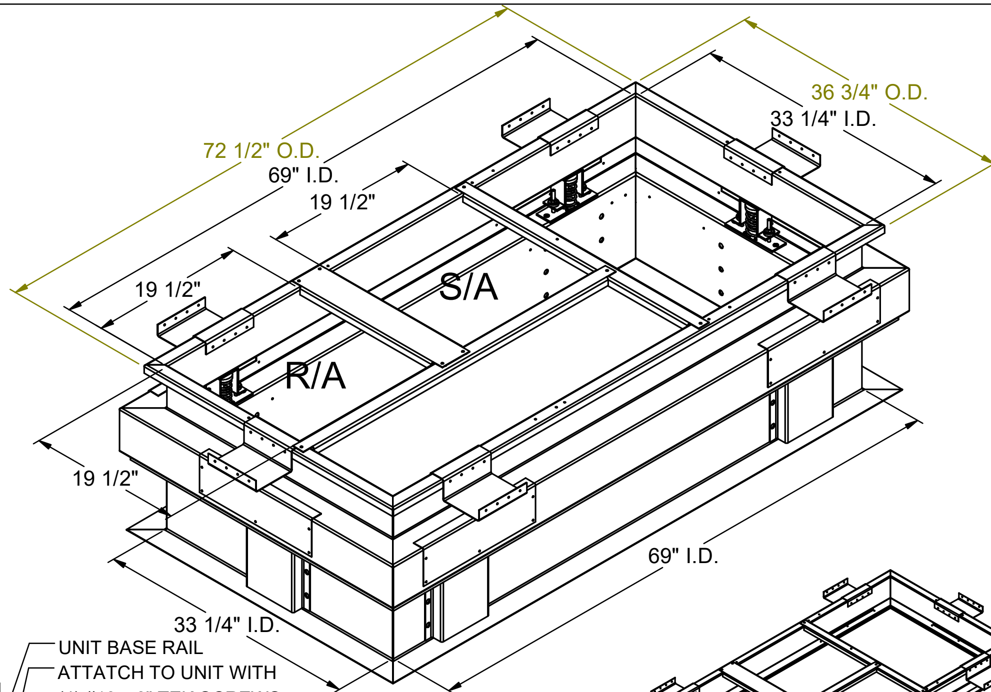
Meets seismic requirements for the following codes:
CBC 2022
IBC 2021

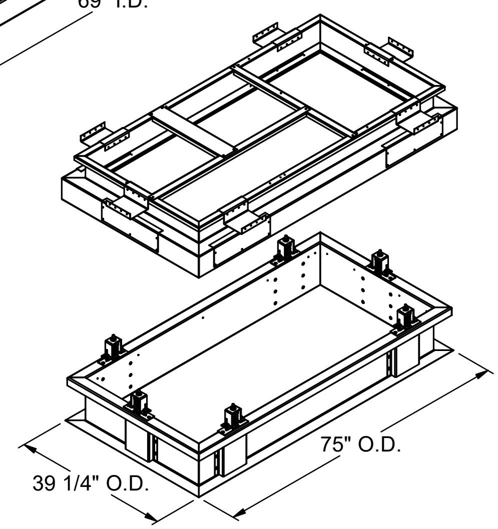
FEATURES

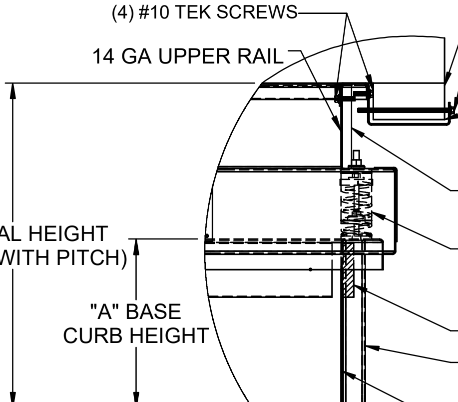
- Roof curbs sides and ends are 14 ga.
- Fully welded construction.
- Gasketing package provided.
- Heat treated wood nailer provided.
- insulated deck pans provided.
- Pitched curbs and taller curbs are available.
- CalDyn OSHPd pre-approved seismic restraints. (OPM-0401-13), (CQA).

NOTES

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







PROFILE DETAIL

ProVent

3847 WABASH DRIVE
MIRA LOMA, CA 91752

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

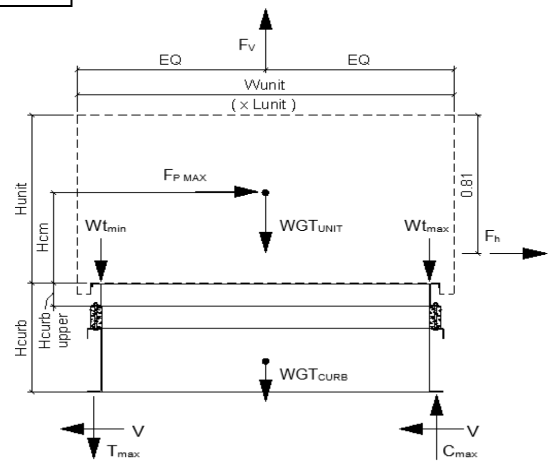
SUBMITED TO: ____
COMPANY: ____
JOB NAME: ____
EQUIPMENT: ____
NOTES: ____

FORM NO:	PART NUMBER:	
CBISC-03	-	
DATE:	REV:	DRAWN BY:
8/14/2023	5	FMM

MOUR GROUP
ENGINEERING + DESIGN

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

Client:	ProVent	PV2312	Upper curb rail
Project:	CBISC-03	Iso Curb	CBISCSUN3672
Unit:	ZR, XN, XP 036-060; ZE, ZF 036-072		



Upper Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	72.5	in	(Length of upper curb)
wcurb =	36.75	in	(Width of upper curb)
WGTupper =	144	lbs	(Weight of upper curb)
# Clips long side =	2		# Clips short side = 1

Unit Information

WGTunit =	845	lbs	(Weight of Unit)
Wtmax =	254	lbs	(Maximum corner weight)
Wtmin =	180	lbs	(Minimum corner weight)
Hunit =	32.625	in	(Height of unit above curb)
Hcm =	16.3125	in	(Height to center of mass)
Lunit =	82.25	in	(Length of unit)
Wunit =	44.875	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 =	3034	lbs	(0.7*Fpmax)	FpmaxASD =	3551 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)
$F_{h\ ASD\ trans}$ =	739	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	403	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	686	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Upper Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	2016	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1246	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*wcurb)]/wcurb
$Compression_{WIND}$ =	289	lbs	=[$F_{h\ ASD\ trans}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	456	lbs	=[$F_{h\ ASD\ trans}$*Hcm-2*0.6*Wtmin*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	1352	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	582	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*Lcurb)]/Lcurb
$Compression_{WIND}$ =	52	lbs	=[$F_{h\ ASD\ long}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	218	lbs	=[$F_{h\ ASD\ long}$*Hcm-2*0.6*Wtmin*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	2016	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1246	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1352	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	582	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

MOUR GROUP
ENGINEERING + DESIGN

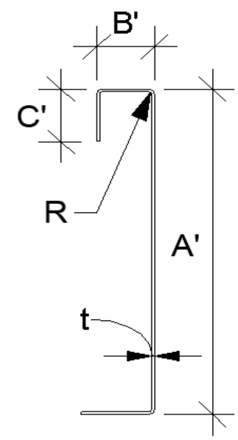
6593 Riverdale St.
San Diego, CA 92120
(619)727-4800

Curb Design

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

Calculate Section Properties of Curb

A'=	5.500 in		a =	5.144 in	= A'-(2r+t)
B'=	1.750 in		a'=	5.429 in	= A'-t
C'=	0.000 in	(0 if no lips)	b =	1.572 in	= B'-[r+t/2+α(r+t/2)]
α =	0.000	(0 - no Lip; 1 w/ lip)	b'=	1.714 in	= B'-(t/2+αt/2)
R =	0.1069	(Inside bend radius)	c =	0.000 in	= α[C'-(r+t/2)]
t =	0.0713 in		c'=	0.000 in	= α(C'-t/2)
r'=	0.143 in	= R+t/2	u =	0.224 in	= πr/2
x =	0.337 in	(Distance between centroid and web centerline)			
Ix =	2.687 in^4		rx =	2.08 in	
Iy =	0.169 in^4		ry =	0.521 in	
A =	0.62 in^2		rmin =	0.521 in	



Axial Compression

Pa =	1.517 k	(Max Axial Comp)	Ω_c = 1.80
Pn/Ωc =	14.341 k		
Fe =	111.57 ksi		
λc =	0.67		
Fn =	41.45 ksi		
Ly =	33.25 in	Lateral unbraced length	
k_yL_y/r_y =	51	(assume k=0.8)	

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

Compression Check = O.K.

Check Web Crippling

h =	5.5 in	-- Check limits:		C = 7.50	(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				

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

Long side: Pu_{Trans} = 1.008 k **O.K.** # clips = 2
Short side: Pu_{Long} = 1.352 k **web stiffener REQ'D** # clips = 1

Check Web Stiffener 16Ga x 3/4in 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 = 888 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 1008 lbs Max(Tens/2 -OR- Comp/2 corner connections per side)

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

# of Bolts required for Tension = 0.4
# of Bolts required for Shear = 0.9
# of Bolts Used = 2.0
Check Combined Stress in Bolts & Inserts: 0.639 **O.K.**

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

Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 0.681 in

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

MOUR GROUP
ENGINEERING + DESIGN

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

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)

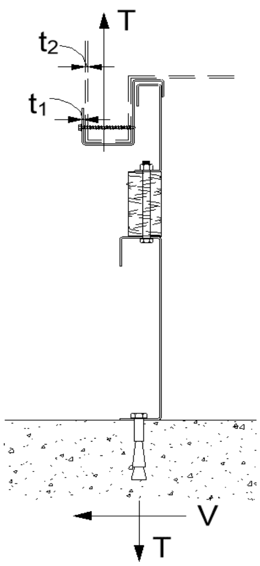
Pts/Ω = 249 # <- Controls

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:	1.517	2	0.76	540 #	4	2.00 in
Short side:	1.517	1	1.52	540 #	4	2.00 in

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

min spacing = 0.57 in | edge distance = 0.5 in (min. 1.5d)

Check Block shear rupture: O.K. | thinnest part = 0.0713 | AISI BSR applies

Fy = 50 ksi | Ω = 2.22 bolt/screw connection

Agv = 0.463 in^2 | Anv = 0.416 in^2 | Ant = 0.082 in^2

Rn/Ω = 8.674 k | $R_n = 0.6F_y A_{gv} + F_u A_{nt} \le 0.6F_u A_{nv} + F_u A_{nt}$

BSR O.K. (AISI Sect. E5.3)

Curb Loads (copied from above)

Transverse: (on long edge)	$Comp_{MAX}$ =	2760	lbs
	$Tens_{MAX}$ =	1969	lbs
	$Shear_{MAX}$ =	3551	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	1721	lbs
	$Tens_{MAX}$ =	930	lbs
	$Shear_{MAX}$ =	3551	lbs

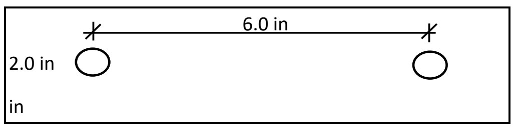
Loads at each Isolator Type: **CQA**

Transverse loading: (on long edge)	$Comp_{MAX}$ =	1380.1	lbs
	$Tens_{MAX}$ =	984.5	lbs
# isolators: 2	$Shear_{MAX}$ =	591.9	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	1720.9	lbs
	$Tens_{MAX}$ =	929.7	lbs
# isolators: 1	$Shear_{MAX}$ =	591.9	lbs

Max compression force on isolator: 1.721 k ≤ 3.176 k **O.K.**

Max uplift on isolator: 0.985 k ≤ 3.176 k **O.K.**

Max shear on isolator: 0.592 k ≤ 1.163 k **O.K.**



Forces on top bolt:

Tension = 0.985 k | d_b = 0.375

Shear = 0.592 k | ıpper rail, t = 0.0713 in

Shear on curb rail: $P_n = teF_u$ | Ω = 2.00 (Appendix A, Section E3.1 AISI)

Shear O.K. Pn/Ω = 4.635 k | e = 1.0 in

Net section rupture: $P_n = A_n F_t$ | Ω = 2.22 (Appendix A, Section E3.2 AISI)

Pn/Ω = 4.989 k | An = 0.116 in

N.S.R. O.K. | $F_t = (0.1 + 3d/s)F_u \le F_u =$ 43.063 ksi

Bolt Bearing Strength: $P_n = Cm_f dtF_u$ | Ω = 2.50 (Section E3.3.1 AISI)

Pn/Ω = 2.086 k | d/t = 5.26

Bearing O.K. | C = 3.00 | mf = 1.00

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

Tension: $P_{nt} = A_b F_{nt}$ | Fnt = 40.5 ksi | A_b = 0.1104 in^2

Pnt/Ω = 1.988 k **Bolt tension O.K.** | Ωt = 2.25 (Table E3.4-1, AISI)

Shear: $P_{nv} = A_b F_{nv}$ | Fnv = 24.0 ksi | Ωv = 2.40 (Table E3.4-1, AISI)

Pnv/Ω = 1.104 k **Bolt shear O.K.**

Combined Shear and tension in bolt:

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

ft = 8.91 ksi | fv = 5.36 ksi | O.K.

F'nt = 30.94 ksi | Fnv/Ω = 10.00 ksi

$P'_{nt} = A_b F'_{nt}$ | P'nt/Ω = 1.519 k **Combined O.K.**

Longitudinal weld loading: L = 1.5 | Ω = 2.55

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

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

Transverse weld loading: t = 0.0713 | Ω = 2.35

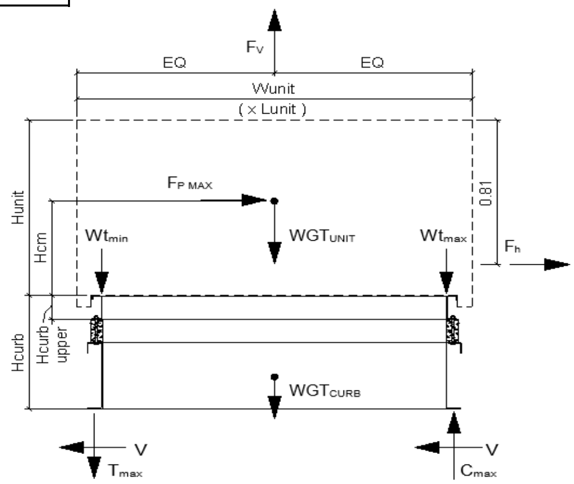
L = 1 | Fu = 65 ksi | Pn/Ω = 1.972 k

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

MOUR GROUP
ENGINEERING + DESIGN

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

Client:	ProVent	PV2312	Base curb
Project:	CBISC-03	Iso Curb	CBISCSUN3672
Unit:	ZR, XN, XP 036-060; ZE, ZF 036-072		



Base Curb Information

Hbase curb =	25	in	(Height of base curb)
Lcurb =	75	in	(Length of base curb)
wcurb =	39.25	in	(Width of base curb)
WGTbase =	156	lbs	(Weight of base curb)
# Springs long side =	2		# Springs short side = 1

Unit Information

WGTunit =	845	lbs	(Weight of Unit)
Wt'max =	290	lbs	(Wtmax+1/4*WGTupper)
Wt'min =	216	lbs	(Wtmin+1/4*WGTupper))
Hunit =	32.625	in	(Height of unit above curb)
H'cm =	26.3125	in	(Hcm+10"(upper+spring))
Lunit =	82.25	in	(Length of unit)
Wunit =	44.875	in	(Width of unit)
$WGT_{unit+upper+base}$ =	1145	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 =	3551	lbs	(0.7*Fpmax)	FpmaxASD =	4112 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)
$F_{h\ ASD\ trans}$ =	1310	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hbase curb+10") (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	715	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hbase curb+10")
$F_{vert\ ASD}$ =	686	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Base Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	3145	lbs	$=[FpmaxASD*H'cm+2*(1+0.14S_{DS})*Wt'max*wcurb]/wcurb$
$Tension_{SEISMIC}$ =	2260	lbs	$=[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*wcurb)]/wcurb$
$Compression_{WIND}$ =	883	lbs	$=[F_{h\ ASD\ trans}*H'cm+2*0.6*Wt'max*wcurb-F_{vert\ ASD}*wcurb/2]/wcurb$
$Tension_{WIND}$ =	963	lbs	$=[F_{h\ ASD\ trans}*H'cm-2*0.6*Wt'min*wcurb+F_{vertASD}*wcurb/2]/wcurb$

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	2010	lbs	$=[FpmaxASD*H'cm+2*(1+0.14*S_{DS})*Wt'max*Lcurb]/Lcurb$
$Tension_{SEISMIC}$ =	1125	lbs	$=[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*Lcurb)]/Lcurb$
$Compression_{WIND}$ =	255	lbs	$=[F_{h\ ASD\ long}*H'cm+2*0.6*Wt'max*Lcurb-F_{vertASD}*Lcurb/2]/Lcurb$
$Tension_{WIND}$ =	335	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:	$Comp_{MAX}$ =	3145	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	2260	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	2010	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1125	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

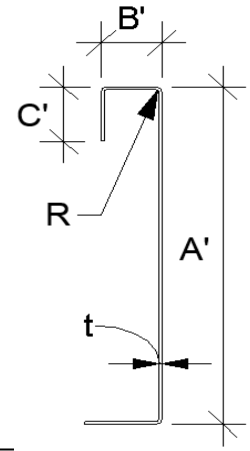
MOUR GROUP
ENGINEERING + DESIGN

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

Curb Design

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

Calculate Section Properties of Curb



A'=	25.000	in	a =	24.644	in	= A'-(2r+t)
B'=	1.750	in	a'=	24.929	in	= A'-t
C'=	0.000	in (0 if no lips)	b =	1.572	in	= B'-[r+t/2+α(r+t/2)]
α =	0.000	(0 - no Lip; 1 w/ lip)	b'=	1.714	in	= B'-(t/2+αt/2)
R =	0.1069	(Inside bend radius)	c =	0.000	in	= α[C'-(r+t/2)]
t =	0.0713	in	c'=	0.000	in	= α(C'-t/2)
r'=	0.143	in = R+t/2	u =	0.224	in	= πr/2
x =	0.104	in (Distance between centroid and web centerline)				
Ix =	128.737	in	rx =	8.00	in	
Iy =	0.218	in	ry =	0.329	in	
A =	2.01	in^2	rmin =	0.329	in	

Axial Compression

Pu =	1.776	k	(Max Axial Comp)
Pn/Ωc =	8.576	k	
Fe =	8.74	ksi	
λc =	2.39		
Fn =	7.67	ksi	
Ly =	75.00	in	Lateral unbraced length
k_yL_y/r_y =	182		(assume k=0.8)

Ω_c = 1.80

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

Compression Check = O.K.

Check Web Crippling

h =	25	in	-- Check limits:			C = 4.00
t =	0.0713	in	h/t =	350.63	≤ 260	C_R = 0.14
N =	7.00		N/t =	98.18	≤ 210	C_N = 0.35
Ω_w =	1.75		N/h =	0.28	≤ 2.0	C_h = 0.02
P_n =	2.105	k	R/t =	1.50	≤ 9.0	
P_n/Ω_w =	1.203	k				
Long side: Pu_{Trans} =	1.572	k	**web stiffener REQ'D**	# clips = 2		
Short side: Pu_{Long} =	2.010	k	**web stiffener REQ'D**	# clips = 1		

(See table C3.4.1-2, fastened to support, one flange, end loading)

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

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

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

width of stiffener =	7.000	in	ts =	0.0566	16 Gauge
web of stiff. w =	6.717	in	Rs =	0.0849	in
***Check w/ts ≤ 1.28√E/Fys			Ω_c =	1.70	

w/ts =	118.675		
1.28√(E/Fys) =	31.091	--> w/ts over limit	Use C3.7.2

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

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

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

Tcrnmax =	1028	lbs	Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax =	1572	lbs	Max(Tens/2 -OR- Comp/2 corner connections per side)

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

# of Bolts required for Tension =	0.4	
# of Bolts required for Shear =	1.4	
# of Bolts Used =	3.0	
Check Combined Stress in Bolts & Inserts:	0.616	**O.K.**

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

Assume L/t > 25: 25*t =	1.783	in
Lreq'd =	1.063	in

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

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

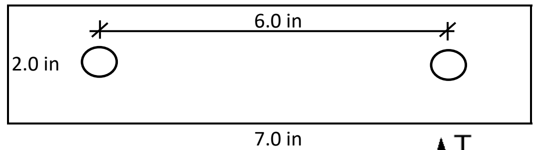
Curb Loads (copied from upper rail calcs)

Transverse:	$Comp_{MAX}$ =	2760	lbs
(on long edge)	$Tens_{MAX}$ =	1969	lbs
	$Shear_{MAX}$ =	3551	lbs
Longitudinal:	$Comp_{MAX}$ =	1721	lbs
(on short edge)	$Tens_{MAX}$ =	930	lbs
	$Shear_{MAX}$ =	3551	lbs

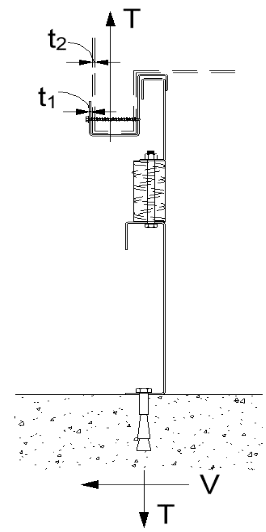
Loads at each Isolator Type: **CQA**

Transverse loading:	$Comp_{MAX}$ =	1380.1	lbs
(on long edge)	$Tens_{MAX}$ =	984.5	lbs
# isolators: 2	$Shear_{MAX}$ =	591.9	lbs
Longitudinal loading:	$Comp_{MAX}$ =	1720.9	lbs
(on short edge)	$Tens_{MAX}$ =	929.7	lbs
# isolators: 1	$Shear_{MAX}$ =	591.9	lbs

Max compression force on isolator: 1.721 k ≤ 3.176 k **O.K.**
Max uplift on isolator: 0.985 k ≤ 3.176 k **O.K.**
Max shear on isolator: 0.592 k ≤ 1.163 k **O.K.**



Forces on bottom bolts:
d_b = 0.5 in
base curb, t = 0.0713 in
Tension = 0.492 k / bolt
Shear = 0.296 k / bolt



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

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

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

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

Combined Shear and tension in bolt:

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

ft = 5.01 ksi fv = 1.51 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: $Uplift_{MAX}$ = 5215 lbs $Shear_{MAX}$ = 2056 lbs

$Compression_{SEISMIC}$ = 6131 lbs =[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb
$Tension_{SEISMIC}$ = 5215 lbs =[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb
$Compression_{WIND}$ = 1713 lbs =[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*wcurb/2-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ = 1712 lbs =[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)-0.6*$WGT_{unit+upper+base}$*wcurb/2+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: $Uplift_{MAX}$ = 2652 lbs $Shear_{MAX}$ = 2056 lbs

$Compression_{SEISMIC}$ = 3568 lbs =[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb
$Tension_{SEISMIC}$ = 2652 lbs =[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb
$Compression_{WIND}$ = 489 lbs =[$F_{h\ ASD\ long}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*Lcurb/2-$F_{vert\ ASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ = 489 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)

$T_{all\,metal}$ = 997 lbs $V_{all\,metal}$ = 1097 lbs
Transverse: $T_{all\,wood}$ = 760 lbs $V_{all\,wood}$ = 672 lbs

# of Screws Req'd for Uplift = 6.86 COMBINED LOADING: 0.981 O.K.
# of Screws Req'd for Shear = 3.06 Req'd Min Spacing = 8.38 in o.c.
Total # of screws required = 9

Use 9 - 1/4"ϕ x 4.5" Simpson SDS screws @ 8.4 in o.c. along long side of curb w/ 2.75" threaded embed

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

Longitudinal:

# of Screws Req'd for Uplift = 3.49 COMBINED LOADING: 0.917 O.K.
# of Screws Req'd for Shear = 3.06 Screw Spacing = 7.81 in o.c.
Total # of screws required = 5

Use 5 - 1/4"ϕ x 4.5" Simpson SDS screws @ 7.8 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 = 2.50 COMBINED LOADING: 0.781 O.K.
# of Bolts Req'd for Shear = 0.94 Bolt Spacing = 21.00 in o.c.
Total # of bolts required = 4

Use 4 - 1/2" ϕ A307 Bolts to steel angle below deck @ 21 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 1.27 COMBINED LOADING: 0.474 O.K.
# of Bolts Req'd for Shear = 0.94 Bolt Spacing = 27.25 in o.c.
Total # of bolts required = 2

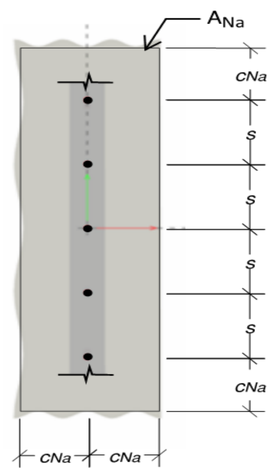
Use 2 - 1/2" ϕ A307 Bolts to steel angle below deck @ 27.3 in o.c. along short side of curb

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 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} = 38995 lbs (group) $\lambda_a = 1.0$
ϕN_{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 in² N_b = 8601 lbs ϕ_{conc} = 0.75
A_{Nco} = 144 in² kc = 17 ϕ_{bond} = 0.65
N_{cbg} = 48741 lbs (group) ϕ_{seis} = 0.75
ϕN_{cbg} = 27417 lbs (group) ϕ_{steel} = 0.65

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

$Tall_{LRFD}$ = 3802 lbs (anchor) $Vall_{LRFD}$ = 3067 lbs $\alpha = (1+0.2SDS)D + 2.5E$ = 1.421
$Tall_{ASD} = Tall_{LRFD}/\alpha$ = 2225 lbs $Vall_{ASD} = Vall_{LRFD}/\alpha$ = 1795 lbs D = 0.758 E = 0.242 α = 1.709

Transverse:	$Uplift_{MAX}$ = 5790 lbs	$Shear_{MAX}$ = 5140 lbs

$Compression_{SEISMIC}$ = 6716 lbs =[Ωo*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*$WGT_{unit+curb}$*wcurb/2]/wcurb
$Tension_{SEISMIC}$ = 5790 lbs =[Ωo*FpmaxASD*(Hcm+Hcurb)-(0.6-0.14S_{DS})*$WGT_{unit+curb}$*wcurb/2]/wcurb
$Shear_{SEISMIC}$ = 5140 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift = 2.60 spacing = 31.50 in o.c. Tapplied = 1447.4 lbs
Min Bolts Req'd Shear = 2.86 spacing = 31.50 in o.c. Vapplied = 856.6 lbs

Try using	4	bolts
spaced at	21.00	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 4 - 0.625in ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy @ 21 in o.c. max. along long side of curb w/ 4in embed

Longitudinal:	$Uplift_{MAX}$ = 2952 lbs	$Shear_{MAX}$ = 5140 lbs

MOUR GROUP
ENGINEERING + DESIGN

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

$Compression_{SEISMIC}$ =	3879	lbs	=[Ωo*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*$WGT_{unit+curb}$*Lcurb/2]/Lcurb
$Tension_{SEISMIC}$ =	2952	lbs	=[Ωo*FpmaxASD*(Hcm+Hcurb)-(0.6-0.14S_{DS})*$WGT_{unit+curb}$*Lcurb/2]/Lcurb
$Shear_{SEISMIC}$ =	5140	lbs	=Ωo*FpmaxASD/2

Min Bolts Req'd Uplift =	1.33	spacing =	13.63	in o.c.	Tapplied =	1476.2	lbs
Min Bolts Req'd Shear =	2.86	spacing =	13.63	in o.c.	Vapplied =	856.6	lbs

Try using	2	bolts
spaced at	27.25	in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.14 O.K.

Use 2 - 0.625in ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy @ 27.3 in o.c. max. along short side of curb w/ 4in embed

CURB DESIGN SUMMARY:	CBISC-03 CBISCSUN3672	**Unit:**	ZR, XN, XP 036-060; ZE, ZF 036-072
UPPER CURB RAIL THICKNESS:	0.0713 in 14 Gauge		
UNIT CLIP THICKNESS:	0.0713 in 14 Gauge		
# OF CLIPS (LONG SIDE) -	2 clips with 4 - #10 SMS screws each clip		
WEB STIFFENER:	NOT REQUIRED		
# OF CLIPS (SHORT SIDE) -	1 clips with 4 - #10 SMS screws each clip		
WEB STIFFENER:	16Ga x 3/4in x 7in (C-channel) stiffener at each clip		
VIBRATION ISOLATOR TYPE:	CQA	Top stud diameter: 3/8	(2) - CQA Isolators long side
Anchor bolt diameter:	1/2	Anchor hole diamter: 9/16	(1) - CQA Isolators short side
BASE CURB THICKNESS:	0.0713 in 14 Gauge		---Bolt or Weld O.K.---
WEB STIFFENER:	16Ga x 1.5in x 7in (C-channel) stiffener at each clip on base curb		
CORNER CONNECTION:	Use minimum 3 - 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	9 @ 8.38 in o.c.	4 @ 21 in o.c.	4 @ 21 in o.c.
SHORT DIRECTION	5 @ 7.81 in o.c.	2 @ 27.25 in o.c.	2 @ 27.25 in o.c.