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: July 13, 2022

Project Number: PV2203

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 YORK 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

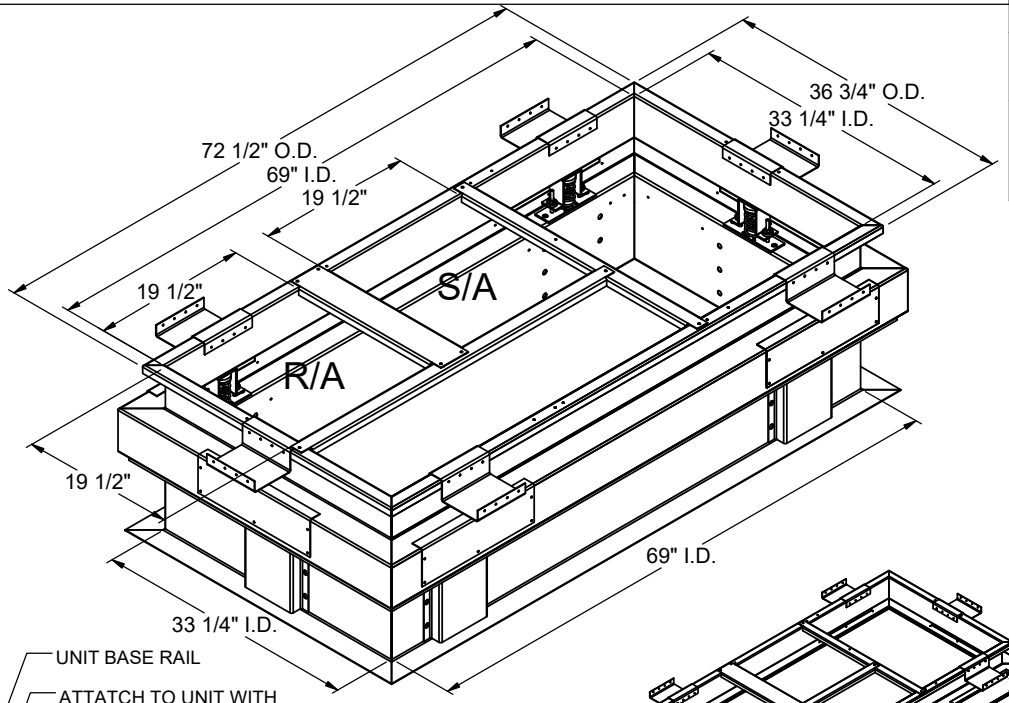
Meets seismic requirements for the following codes:
CBC 2019
IBC 2018

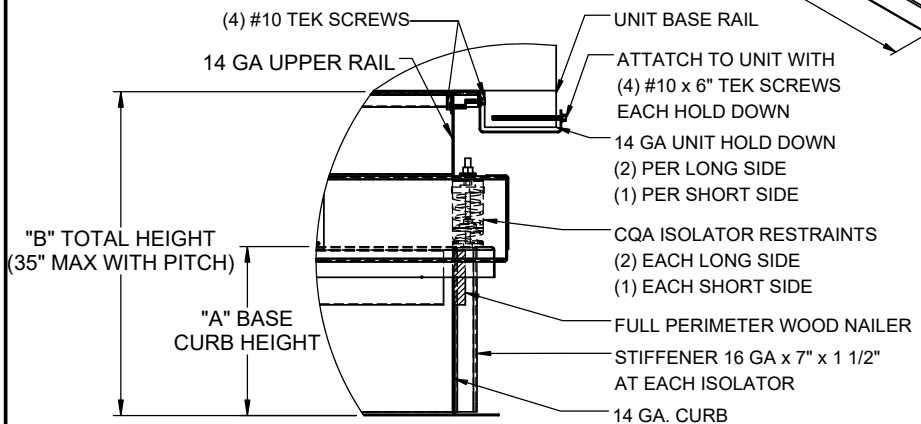
FEATURES

- 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).

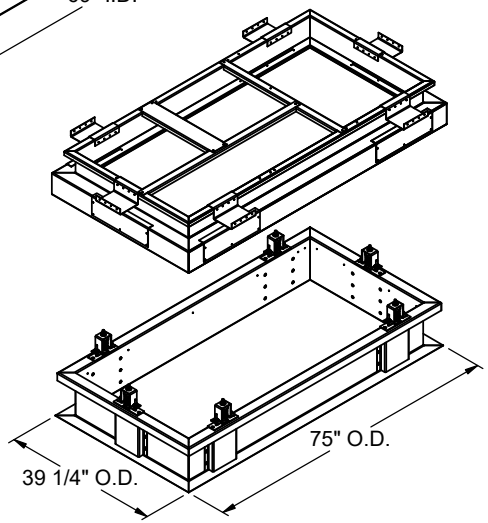
NOTES

- 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



REGISTERED PROFESSIONAL ENGINEER
GLENN A. MOURITZEN
SE 3578
Exp. 6/30/23
STRUCTURAL
STATE OF CALIFORNIA

3847 WABASH DRIVE
MIRA LOMA, CA 91752

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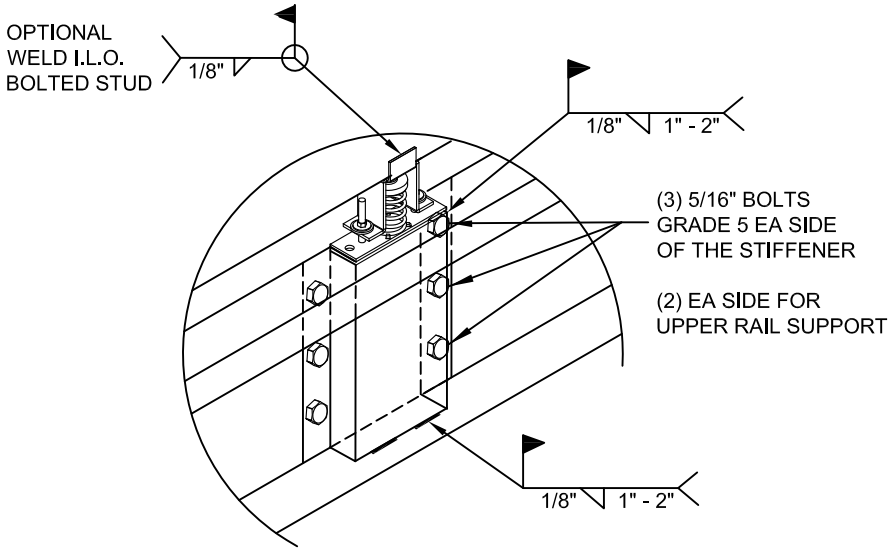
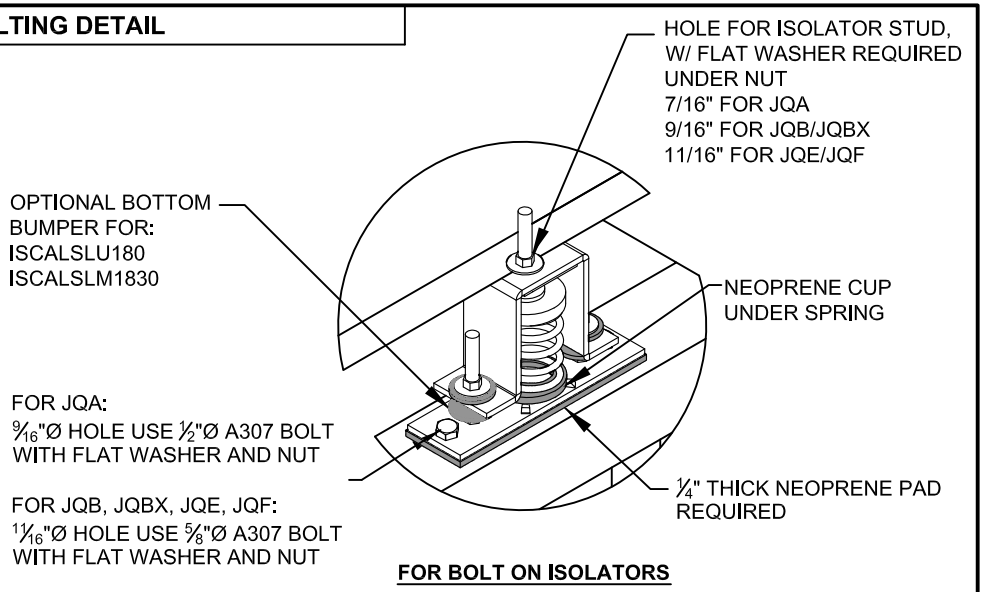
SUBMITED TO:
COMPANY:
JOB NAME:
EQUIPMENT:
NOTES:

FORM NO:	PART NUMBER:	
CBISC-03	-	
DATE:	**REV:**	**DRAWN BY:**
4/20/2022	4	FMM

WELDMENT AND BOLTING DETAIL



BASE CURB SUPPORT



FOR BOLT ON ISOLATORS

ProVent
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COMPANY:
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CB-61		
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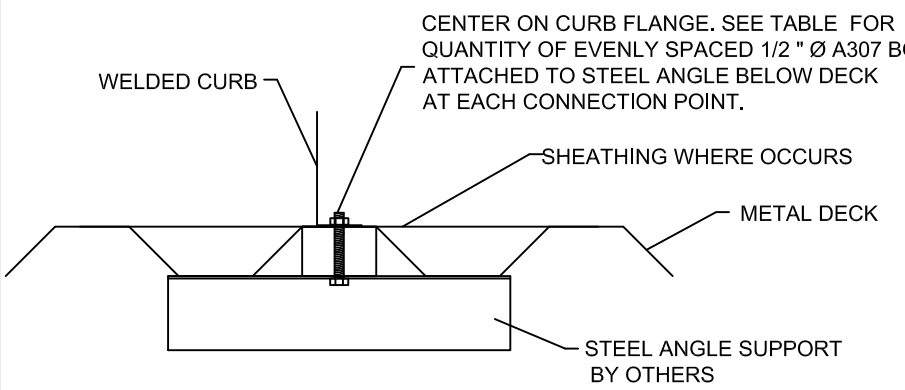
02/08/18	1	ALL

STEEL ATTACHMENT



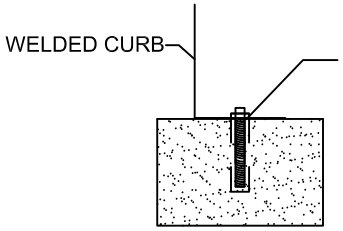
	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
LXS	3 @ 19.25" O.C.	2 @ 23" O.C.
LXL	3 @ 19.25" O.C.	2 @ 33" O.C.
SUN3672	4 @ 21" O.C.	2 @ 27.25" O.C.
PRD3715	6 @ 14.28" O.C.	3 @ 20.75" O.C.
PRS	4 @ 20.46" O.C.	2 @ 31.13" O.C.
PRL	3 @ 36.13" O.C.	2 @ 44" O.C.
SLU180	4 @ 35.08" O.C.	3 @ 37" O.C.
SLM1830	5 @ 29.06" O.C	4 @ 24.67" O.C.
SAV1518	4 @ 37.38" O.C	3 @ 35.56" O.C.
SAV2025	4 @ 42.04" O.C	3 @ 35.56" O.C.
SAV28	5 @ 35.63" O.C	3 @ 35.56" O.C.

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

Meets seismic requirements for the following codes:
CBC 2019
IBC 2018

ROOF ANCHORAGE DETAIL
CBISC Series
LXS
LXL
SUN3672
PRD3715
PRS
PRL
SLU180
SLM1830
SAV1518
SAV2025
SAV28

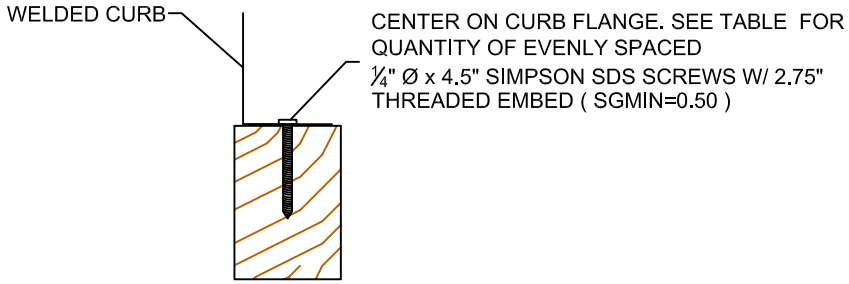
CONCRETE ATTACHMENT



	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
LXS	7 @ 6.42" O.C.	4 @ 7.67" O.C.
LXL	7 @ 6.42" O.C.	5 @ 8.25" O.C.
SUN3672	9 @ 7.88" O.C.	4 @ 9.08" O.C.
PRD3715	14 @ 5.49" O.C.	9 @ 5.19" O.C.
PRS	10 @ 6.82" O.C.	5 @ 7.78" O.C.
PRL	11 @ 7.23" O.C.	6 @ 8.8" O.C.
SLU180	12 @ 9.57" O.C.	8 @ 10.57" O.C.
SLM1830	18 @ 6.84" O.C.	11 @7.4" O.C.
SAV1518	12 @ 10.19" O.C.	6 @ 14.23" O.C.
SAV2025	14 @ 14.97" O.C.	6 @ 14.23" O.C.
SAV28	14 @ 10.96" 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	7 @ 7.08" 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 @ 6.93" O.C.	8 @ 6.86" O.C.
SLU180	14 @ 8.4" O.C.	10 @ 8.67" O.C.
SLM1830	19 @ 6.68" O.C.	13 @ 6.5" O.C.
SAV1518	13 @ 9.68" O.C.	9 @ 9.39" O.C.
SAV2025	15 @ 9.29" O.C.	9 @ 9.39" O.C.
SAV28	16 @ 9.77" O.C.	9 @ 9.39" O.C.

FOUR INCHES FROM EACH CORNER EVENLY SPACED

ProVent

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6/30/2022	2	FMM

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

Client:	ProVent	PV2203	Upper curb rail
Project:	CBISC-03	Iso Curb	CBISCSUN3672
Unit:	ZR 036-060, XP 036-060, ZF 036-072		

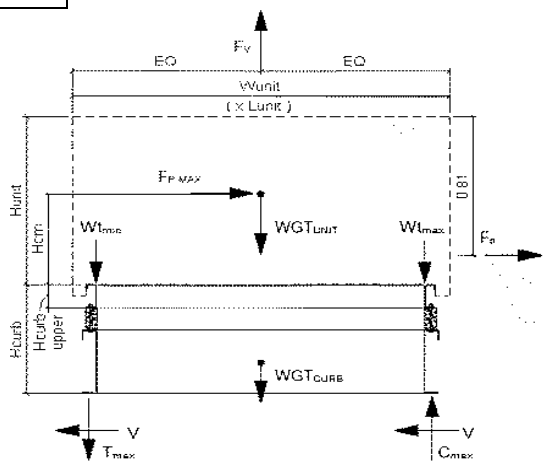
Upper Curb Information

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 =	55	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 =	169	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 - 2018 IBC/2019 CBC

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 =	3232 lbs
	(unit only)				(unit + upper rail)

Wind Loading - 2018 IBC/2019 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
$Tension_{SEISMIC}$ =	1252	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
$Tension_{WIND}$ =	468	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
$Tension_{SEISMIC}$ =	588	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
$Tension_{WIND}$ =	231	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)	$Tens_{MAX}$ =	1252	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1352	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	588	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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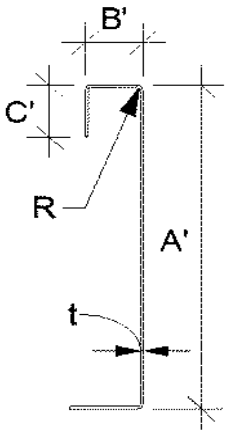
Curb Design

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



Calculate Section Properties of Curb

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

Axial Compression

Pa = 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)

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

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

Compression Check = **O.K.**

Check Web Crippling

h = 5.5 in -- Check limits: C = 7.50
t = 0.0713 in h/t = 77.14 ≤ 200 C_R = 0.08
N = 7.00 N/t = 98.18 ≤ 210 C_N = 0.12
Ω_w = 1.75 N/h = 1.273 ≤ 2.0 C_h = 0.048
P_n = 1.947 k R/t = 1.50 ≤ 12.0
P_n/Ω_w = 1.112 k
Long side: Pu_{Trans} = 1.008 k **O.K.** # clips = 2
Short side: Pu_{Long} = 0.901 k **O.K.** # clips = 1

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

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

Check Web Stiffener N/A

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 **Not Req'd**

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

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

Tcrnmax = 808 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 = 0.3
# of Bolts required for Shear = 0.9
# of Bolts Used = [2.0]
Check Combined Stress in Bolts & Inserts: 0.623 **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

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

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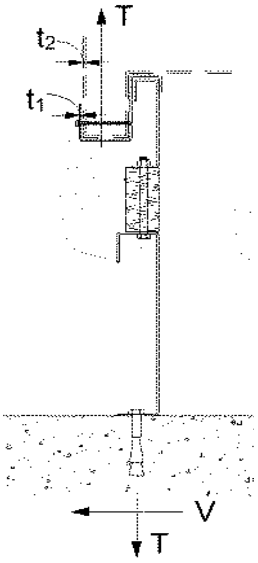
Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

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

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

d = 0.190 in (screw diameter) | dw = 0.375 in (nom. washer diameter)



For t2/t1 ≤ 1.0: | Pns = 2266 # | For t2/t1 ≥ 2.5: | Pns = 2377 #

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 | $P_{ns} = 2.7t_1 dF_{u1}$ | 2.38 k

$P_{ns} = 2.7t_2 dF_{u2}$ | 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) $P_{not} = 0.85t_c dF_{u2})$

$t_c = \min(t_1, t_2)$

Pnov = 2.607 k (screw pull-over strength) $P_{nov} = 1.5t_1 d_w F_{u1}$

Pts/Ω = 249 # <- Controls

Pts/Ω = 820 # (full tensile screw capacity)

	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 in² | Anv = 0.416 in² | Ant = 0.082 in²

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

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

Curb Loads (copied from above)

Transverse: (on long edge)	$Comp_{MAX}$ =	2512	lbs
	$Tens_{MAX}$ =	1792	lbs
	$Shear_{MAX}$ =	3232	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	1566	lbs
	$Tens_{MAX}$ =	846	lbs
	$Shear_{MAX}$ =	3232	lbs

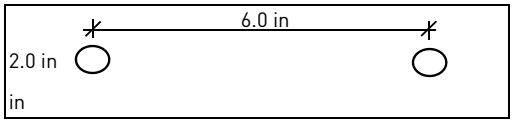
Loads at each Isolator Type: **CQA**

Transverse loading: (on long edge) # isolators: 2	$Comp_{MAX}$ =	1255.9	lbs
	$Tens_{MAX}$ =	895.9	lbs
	$Shear_{MAX}$ =	538.7	lbs
Longitudinal loading: (on short edge) # isolators: 1	$Comp_{MAX}$ =	1566.0	lbs
	$Tens_{MAX}$ =	846.0	lbs
	$Shear_{MAX}$ =	538.7	lbs

Max compression force on isolator: 1.566 k ≤ 3.176 k **O.K.**

Max uplift on isolator: 0.896 k ≤ 3.176 k **O.K.**

Max shear on isolator: 0.539 k ≤ 1.163 k **O.K.**



Forces on top bolt:

Tension = 0.896 k | d_b = 0.375 in

Shear = 0.539 k | per 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. $F_t = (0.1 + 3d/s)F_u \leq F_u$ = 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:

$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \leq F_{nt}$ | ft = 8.11 ksi | fv = 4.88 ksi | O.K.

F'nt = 32.90 ksi | Fnv/Ω = 10.00 ksi

$P'_{nt} = A_b F'_{nt}$ | P'nt/Ω = 1.615 k **Combined O.K.**

Longitudinal weld loading: | L = | $1.5P_n/\Omega = \frac{1}{\Omega}\left(1 - \frac{0.01L}{t_2}\right)Lt_2F_{u2} \geq V_{req}$ | 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 | $P_n/\Omega = \frac{1}{\Omega}tLF_u \geq T_{req}$ | Ω = 2.35

L = 1 | Fu = 65 ksi | Pn/Ω = 1.972 k

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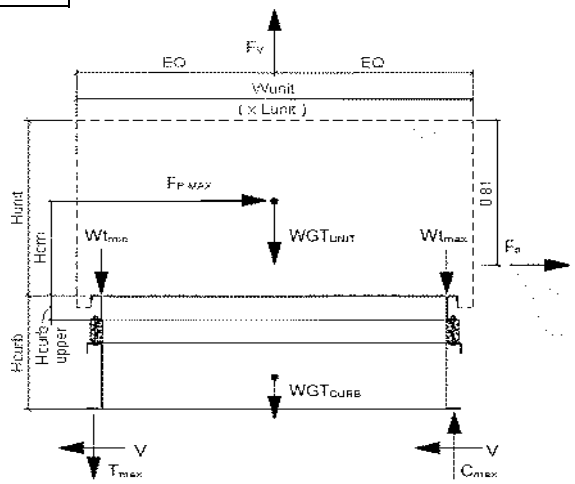
Client:	ProVent	PV2203	Base curb
Project:	CBISC-03	Iso Curb	CBISCSUN3672
Unit:	ZR 036-060, XP 036-060, ZF 036-072		

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 =	245	lbs	(Weight of base curb)
# Springs long side =	2		# Springs short side = 1



Unit Information

WGTunit =	845	lbs	(Weight of Unit)
Wt'max =	267	lbs	(Wtmax+1/4*WGTupper)
Wt'min =	183	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)
WGTunit+upper+base =	1145	lbs	(Total weight)

Seismic Loading - 2018 IBC/2019 CBC

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 =	3232	lbs	(0.7*Fpmax) FpmaxASD = 4112 lbs
	(unit + upper rail)		(unit + upper rail + base curb)

Wind Loading - 2018 IBC/2019 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:

$Compression_{SEISMIC}$ =	2872	lbs	$=[FpmaxASD*H'cm+2*(1+0.14S_{DS})*Wt'max*wcurb]/wcurb$
$Tension_{SEISMIC}$ =	2064	lbs	$=[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*wcurb)]/wcurb$
$Compression_{WIND}$ =	856	lbs	$=[F_{h\ ASD\ trans}*H'cm+2*0.6*Wt'max*wcurb-F_{vert\ ASD}*wcurb/2]/wcurb$
$Tension_{WIND}$ =	1002	lbs	$=[F_{h\ ASD\ trans}*H'cm-2*0.6*Wt'min*wcurb+F_{vertASD}*wcurb/2]/wcurb$

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	1839	lbs	$=[FpmaxASD*H'cm+2*(1+0.14*S_{DS})*Wt'max*Lcurb]/Lcurb$
$Tension_{SEISMIC}$ =	1031	lbs	$=[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*Lcurb)]/Lcurb$
$Compression_{WIND}$ =	228	lbs	$=[F_{h\ ASD\ long}*H'cm+2*0.6*Wt'max*Lcurb-F_{vertASD}*Lcurb/2]/Lcurb$
$Tension_{WIND}$ =	375	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:	$Comp_{MAX}$ =	2872	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	2064	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1839	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1031	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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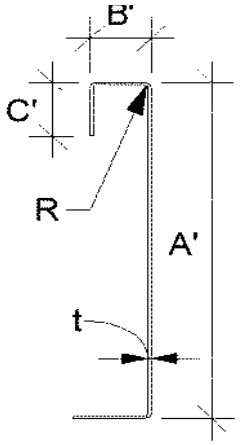
Curb Design

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



Calculate Section Properties of Curb

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

Axial Compression

Pu = 1.616 k (Max Axial Comp) Ω_c = 1.80
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)

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

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

Compression Check = **O.K.**

Check Web Crippling

h =	25 in	-- Check limits:		C =	4.00
t =	0.0713 in	h/t =	350.63 ≤ 200	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				

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

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

Long side: Pu_{Trans} = 1.436 k **web stiffener REQ'D** # clips = 2
Short side: Pu_{Long} = 1.839 k **web stiffener REQ'D** # clips = 1

***h/t > 200; 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 = 1436 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 = 1.3
# of Bolts Used = [3.0]
Check Combined Stress in Bolts & Inserts: 0.575 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 0.971 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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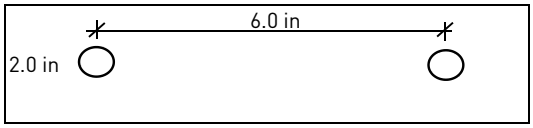
Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	2512	lbs
	$Tens_{MAX}$ =	1792	lbs
	$Shear_{MAX}$ =	3232	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	1566	lbs
	$Tens_{MAX}$ =	846	lbs
	$Shear_{MAX}$ =	3232	lbs

Loads at each Isolator Type: **CQA**

Transverse loading: (on long edge) # isolators: 2	$Comp_{MAX}$ =	1255.9	lbs
	$Tens_{MAX}$ =	895.9	lbs
	$Shear_{MAX}$ =	538.7	lbs
Longitudinal loading: (on short edge) # isolators: 1	$Comp_{MAX}$ =	1566.0	lbs
	$Tens_{MAX}$ =	846.0	lbs
	$Shear_{MAX}$ =	538.7	lbs

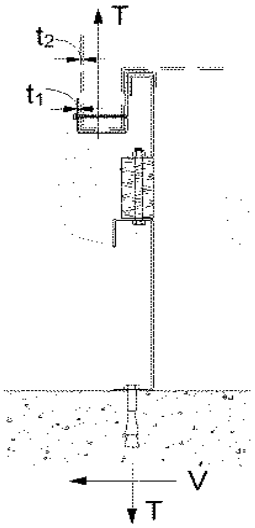
Max compression force on isolator: 1.566 k ⩽ 3.176 k **O.K.**
Max uplift on isolator: 0.896 k ⩽ 3.176 k **O.K.**
Max shear on isolator: 0.539 k ⩽ 1.163 k **O.K.**



Forces on bottom bolts:

d_b = 0.5 in
base curb, t = 0.0713 in
Tension = 0.448 k / bolt
Shear = 0.269 k / bolt

7.0 in



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 = 4.56 ksi fv = 1.37 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: (0.6-0.14S_{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 embt** (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 = 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

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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 $(0.6\text{-}0.14S_{DS})D + 0.7\Omega_o E$ Ωo = 2.0

Concrete Attachment: 3/4" φ thrd'd rods in Hilti Hit-HY 200 epoxy w/ 4" embed

$Tall_{LRFD}$ = 1957 lbs $Vall_{LRFD}$ = 4540 lbs $\propto = (1 + 0.2SDS)D + 2.5E = 1.708$

$Tall_{ASD} = Tall_{LRFD}/\alpha$ = 1146 lbs $Vall_{ASD} = Vall_{LRFD}/\alpha$ = 2658 lbs $(D = 0.758, E = 0.242)$

Transverse: $Uplift_{MAX}$ = 10590 lbs $Shear_{MAX}$ = 4112 lbs

$Compression_{SEISMIC}$ = 11506 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+curb+base}$*wcurb/2]/wcurb

$Tension_{SEISMIC}$ = 10590 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+curb+base}$*wcurb/2]/wcurb

$Shear_{SEISMIC}$ = 4112 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift = 9.24 spacing = 7.00 in o.c. Tapplied = 1176.7 lbs

Min Bolts Req'd Shear = 1.55 spacing = 63.00 in o.c. Vapplied = 316.3 lbs

Try using 9 bolts
spaced at 7.88 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.15

Use 9 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 7.9 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 5465 lbs $Shear_{MAX}$ = 4112 lbs

$Compression_{SEISMIC}$ = 6381 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+curb+base}$*Lcurb/2]/Lcurb

$Tension_{SEISMIC}$ = 5465 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+curb+base}$*Lcurb/2]/Lcurb

$Shear_{SEISMIC}$ = 4112 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift = 4.77 spacing = 6.81 in o.c. Tapplied = 910.9 lbs

Min Bolts Req'd Shear = 1.55 spacing = 27.25 in o.c. Vapplied = 316.3 lbs

Try using 4 bolts
spaced at 9.08 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 0.91

Use 4 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 9.1 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY:	CBISC-03	CBISCSUN3672	Unit:	ZR 036-060, XP 036-060, 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:	NOT REQUIRED			
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	STEEL	CONCRETE
	1/4"ϕ x 4.5" Simpson SDS screws w/ 2.75" threaded embed (SGmin =	1/2" ϕ A307 Bolts to steel angle below deck	3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy w/ 4" embed
LONG DIRECTION	9 @ 8.38 in o.c.	4 @ 21 in o.c.	9 @ 7.88 in o.c.
SHORT DIRECTION	5 @ 7.81 in o.c.	2 @ 27.25 in o.c.	4 @ 9.08 in o.c.