MOUR GROUP
ENGINEERING + DESIGN

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

Structural Calculations
for
CBISC-06 Series

Prepared for:

PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

Date: July 29, 2019

Project Number: PV1805

For wood, concrete and steel attachment see Roof Anchorage Detail, Form No. CB-60.

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

FEATURES

- Roof curbs sides and ends are 12 ga.
- Fully welded construction.
- Gasketing package provided.
- Heat treated wood nailer provided.
- insulated deck pans provided.
- Pitched curbs and taller curbs are available.

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.

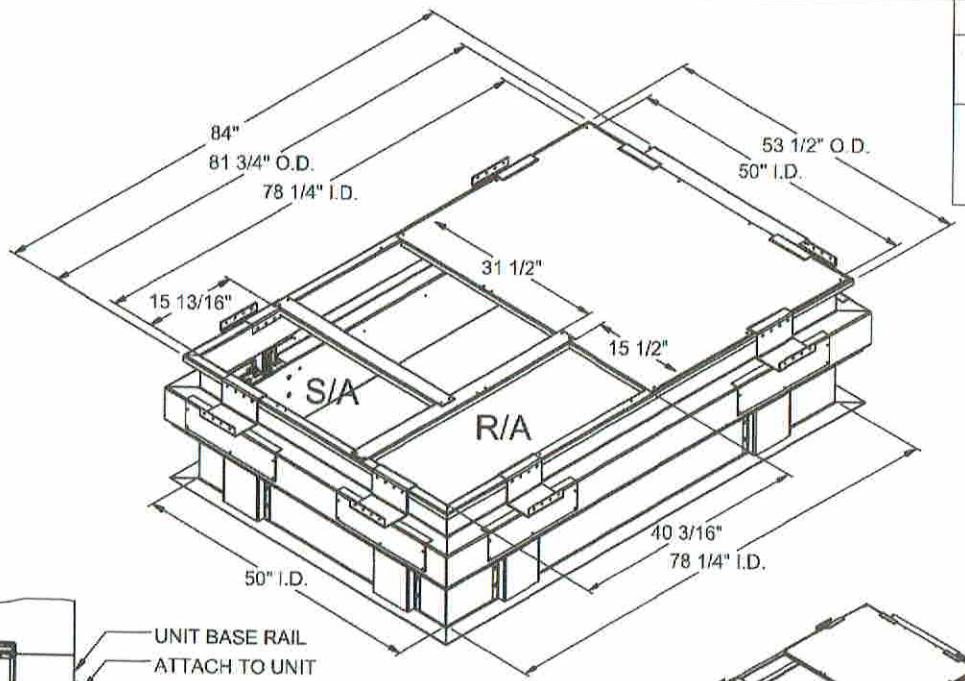
STRUCTURALY CALCULATED VIBRATION ISOLATION ROOF CURB FOR YORK UNITS

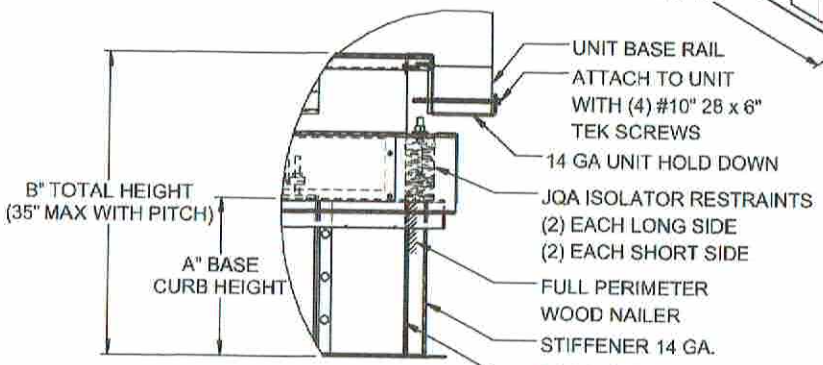
ZX08-14; XX08-12; ZY07-12; XY07-09

PROVENT P/N	A	B	EST. WEIGHT
CBISCPRL18**	8"	18"	380 Lbs.
CBISCPRL21**	11"	21"	405 Lbs.
CBISCPRL24**	14"	24"	425 Lbs.

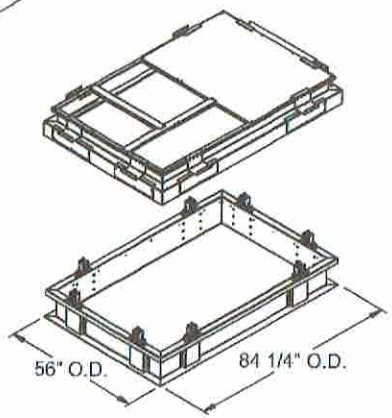
**Note: Spring configuration must be added to part number at time of order

Meets seismic requirements for the following codes:
CBC 2016
IBC 2015





PROFILE DETAIL

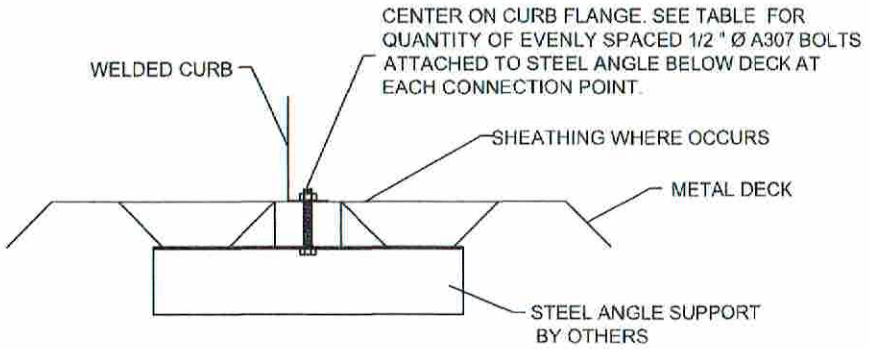


REGISTERED PROFESSIONAL ENGINEER
GLENN A. MOURITZEN
NO. 3578
EXP. 06/30/2021
STRUCTURAL
STATE OF CALIFORNIA
7/29/19

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

SUBMITED TO:	FORM NO: CBISC-06	PART NUMBER: -		
COMPANY:				
JOB NAME:				
EQUIPMENT:	DATE: 9/27/2018	REV: 1	DRAWN BY: ALL	
NOTES:				

STEEL ATTACHMENT



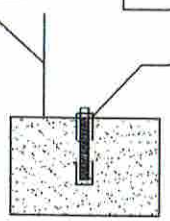
CURB	NO. OF ANCHORAGE BOLTS REQUIRED	
	LONG SIDE	SHORT SIDE
LXS	2 @ 34.5" O.C	XX @ 2 @ 19" O.C
LXL	2 @ 34.5" O.C.XX	2 @ 29" O.C
SUN3672	2 @ 60" O.C	2 @ 24.25" O.C
PRD3715	2 @ 68.38" O.C	2 @ 38.5" O.C
PRS	2 @ 58.38" O.C	2 @ 28.19" O.C.
PRL	2 @ 72" O.C	2 @ 41" O.C
SLU180	2 @ 102.25" O.C.	2 @ 71" O.C.
SLM1830	2 @ 113.25" O.C	2 @ 71" O.C.

Meets seismic requirements for the following codes:
CBC 2016
IBC 2015

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

ROOF ANCHORAGE DETAIL		
CBKD Series	CBWC Series	CBISC Series
LXS	LXS	LXS
LXL	LXL	LXL
SUN3672	SUN3672	SUN3672
PRD3715	PRD3715	PRD3715
PRS	PRS	PRS
PRL	PRL	PRL
	SLU180	SLU180
	SLM1830	SLM1830

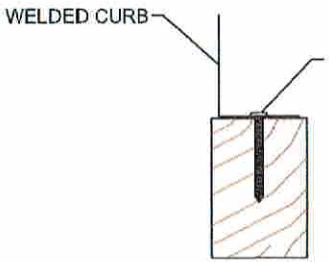
CONCRETE ATTACHMENT



CURB	NO. OF ANCHORAGE BOLTS REQUIRED	
	LONG SIDE	SHORT SIDE
LXS	10 @ 3.73" O.C.	9 @ 2.38" O.C.
LXL	8 @ 4.93" O.C.	7 @ 4.83" O.C.
SUN3672	9 @ 7.5" O.C.	6 @ 4.85" O.C.
PRD3715	17 @ 4.27" O.C.	13 @ 3.21" O.C.
PRS	9 @ 7.3" O.C.	7 @ 4.7" O.C.
PRL	11 @ 7.2" O.C.	9 @ 5.13" O.C.
SLU180	16 @ 6.82" O.C.	13 @ 5.92" O.C.
SLM1830	18 @ 6.66" O.C.	13 @ 5.92" O.C.

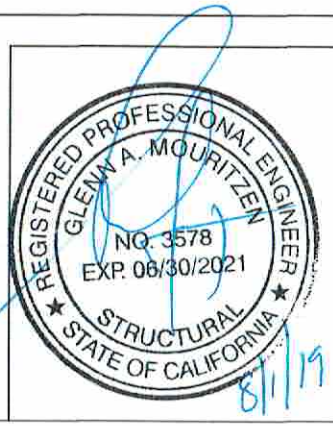
* SIX INCHES FROM EACH CORNER EVENLY SPACED.
** CENTERED.

WOOD ATTACHMENT



CURB	NO. OF ANCHORAGE SCREWS REQUIRED	
	LONG SIDE	SHORT SIDE
LXS	7 @ 6.42" O.C.	4 @ 7.67" O.C.
LXL	7 @ 6.42" O.C.	6 @ 6.6" O.C.
SUN3672	4 @ 21.33" O.C.	3 @ 14.13" O.C.
PRD3715	8 @ 10.34" O.C.	6 @ 8.5" O.C.
PRS	4 @ 20.79" O.C.	3 @ 16.09" O.C.
PRL	4 @ 25.33" O.C.	3 @ 22.5" O.C.
SLU180	7 @ 17.71" O.C.	7 @ 12.5" O.C.
SLM1830	8 @ 16.75" O.C.	6 @ 15" O.C.

FOUR INCHES FROM EACH CORNER EVENLY SPACED



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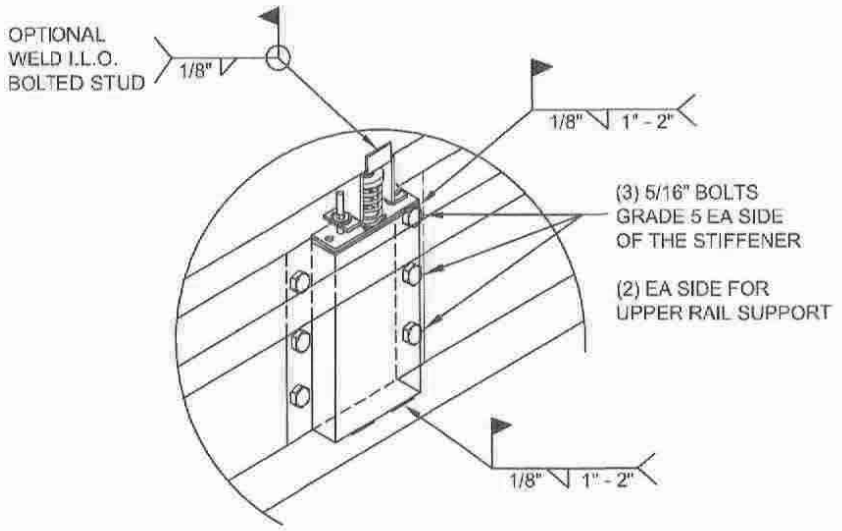
COMPANY: _____
JOB NAME: _____
EQUIPMENT: _____
NOTES: _____

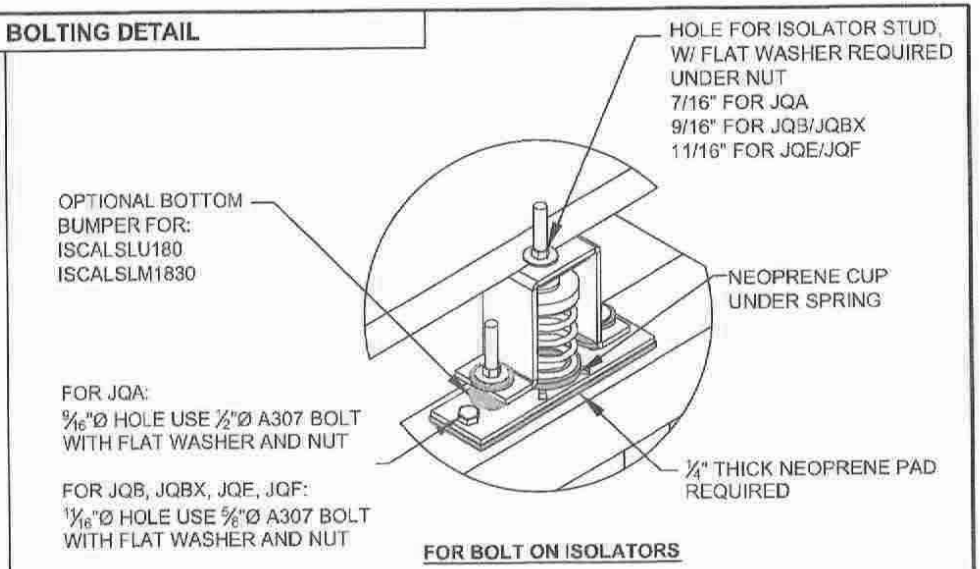
FORM NO: CB-60

DATE:	REV:	DRAWN BY:
07/31/18	3	ALL

WELDMENT AND BOLTING DETAIL



BASE CURB SUPPORT



FOR BOLT ON ISOLATORS

ProVent

3847 WABASH DRIVE
MIRA LOMA, CA 91725

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

FORM NO:		
CB-61		
DATE:	**REV:**	**DRAWN BY:**
02/08/18	1	ALL

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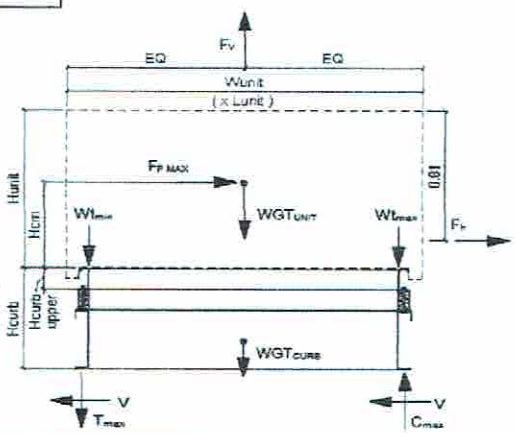
Client: ProVent PV1805
Project: CBISC-06 Iso Curb (CBISCPRL**) Upper curb rail
Unit: ZX 08-14; XX 08-12; ZY 07-12; XY 07-09

Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	84	in	(Length of curb)
wcurb =	53	in	(Width of curb)
WGTcurb =	425	lbs	(Weight of curb)
# Clips long side =	2		# Clips short side = 2

Unit Information

WGTunit =	1167	lbs	(Weight of Unit)
Wtmax =	359	lbs	(Maximum corner weight)
Wtmin =	211	lbs	(Minimum corner weight)
Hunit =	48.56	in	(Height of unit above curb)
Hcm =	24.28	in	(Height to center of mass)
Lunit =	87.18	in	(Length of unit)
Wunit =	61.69	in	(Width of unit)



Seismic Loading - 2015 IBC/2016 CBC

Ss =	2.850		(Worst case for majority of CA - Design Category D)
Fa =	1.000		(Interpolated from Table 11.4-1 ASCE 7-10)
Sms =	2.850		(Fa*Ss)
Sds =	1.900		(2/3*Sms)
Ip =	1.25		(Importance Factor Category III Building)
Fpmax =	3.800	Wp	(1.6*Sds*Ip)*Wp
FpmaxASD =	3104	lbs	(0.7*Fpmax) FpmaxASD = 4235 lbs
	(unit only)		(unit and curb)

Wind Loading - 2015 IBC/2016 CBC

*** Exposure Category C ***

Kz =	1.13		(For 60 ft roof height, Exposure C - Table 29.3-1 ACSE 7-10)
Kzt =	1.0		(No topographic effects assumed for rooftop mounted units)
Kd =	0.85		(Directionality factor Table 26.6-1 ASCE 7-10)
V =	115		(Max wind velocity, mph for Cat III & IV bldgs Exp. Cat C)
$GCr_{(horz)}$ =	1.9		(Refer Sect 29.5.1 ASCE 7-10)
$GCr_{(vert)}$ =	1.5		(Refer Sect 29.5.1 ASCE 7-10)
qz	32.5	psf	= 0.00256*Kz*Kzt*Kd*V^2 (Eq. 29.3-1 ASCE 7-10)
$F_{h\ ASD\ trans}$ =	1213	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb upper) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	859	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb upper)
$F_{vert\ ASD}$ =	1093	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	2330	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1940	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	440	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	832	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate Compression load rather than Tension.

Longitudinal:

$Compression_{SEISMIC}$ =	1805	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1415	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	132	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	525	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate Compression load rather than Tension.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	2330	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1940	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1805	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1415	lbs	---> Along short edge of curb.

---> Negative values indicate Compression load rather than Tension.

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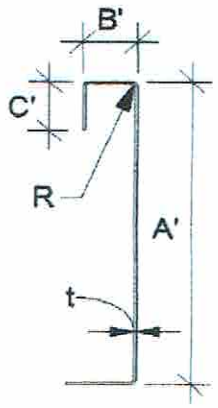
Curb Design

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



Calculate Section Properties of Curb

A'=	5.500	in	a =	4.992	in = A'-(2r+t)
B'=	1.500	in	a'=	5.398	in = A'-t
C'=	0.000	in (0 if no lips)	b =	1.246	in = B'-[r+t/2+a(r+t/2)]
a =	0.000	(0 - no Lip; 1 w/ lip)	b'=	1.449	in = B'-(t/2+at/2)
R =	0.1525	(Inside bend radius)	c =	0.000	in = a(C'-(r+t/2)]
t =	0.1017	in	c'=	0.000	in = a(C'-t/2)
r'=	0.203	in = R+t/2	u =	0.319	in = πr/2
x =	0.259	in (Distance between centroid and web centerline)			
Ix =	3.349	in (Moment of Inertia about X-Axis)			
Iy =	0.151	in (Moment of Inertia about Y-Axis)			
A =	0.83	in^2			
rx =	2.01	in			
ry =	0.427	in			
rmin =	0.427	in			

Axial Compression

Pu = 1.552 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 4.739 k
Fe = 11.77 ksi
λc = 2.06
Fn = 10.33 ksi
Ly = 84.00 in Lateral unbraced length
k_yL_y/r_y = 157 (assume k=0.8)

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

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

Compression Check = O.K.

Check Web Crippling

h = 5.5 in -- Check limits:
t = 0.1017 in h/t = 54.08 ≤ 200 C = 7.50
N = 7.00 N/t = 68.83 ≤ 210 C_R = 0.08
Ωw = 1.75 N/h = 1.273 ≤ 2.0 C_N = 0.12
Pn = 4.038 k R/t = 1.50 ≤ 12.0 C_h = 0.048
Pn/Ωw = 2.308 k
Long side: Pu_{Trans} = 1.165 k **O.K.** # clips = 2
Short side: Pu_{Long} = 0.903 k **O.K.** # clips = 2

(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]
web of stiff. w = 6.717 in Rs = 0.0849 in
***Check w/ts ≤ 1.28√E/Fys Ωc = 1.70
w/ts = 118.675
1.28√[E/Fys] = 31.091 --> w/ts over limit Use C3.7.2

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

Pwc = 4.038 k Ae = 0.380 in^2
Pn = 16.133 k
Pn/Ω_c = 9.490 k **Not Req'd**

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

Tcrnmax = 776 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 970 lbs (Max Ten/2 corner connections per side)

Bolt:	Tall =	2480 lbs	Vall =	1096 lbs
Threaded Insert:	Tall =	2860 lbs	Vall =	1714 lbs

# of Bolts required for Tension = 0.3
# of Bolts required for Shear = 0.9 ***If combined fails:
# of Bolts Used = [1.0] USE --> 2.0
Check Combined Stress in Bolts & Inserts: 1.198 N.G. StressComb = 0.599 **O.K.**

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

Assume L/t > 25: 25*t = 2.543 in
Lreq'd = 0.460 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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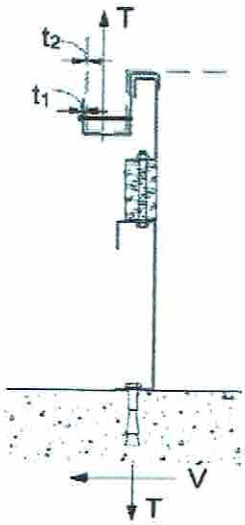
Page ___ of ___

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

t1 = 0.0713 in (clip thickness) | Fu1 = 65 ksi
t2 = 0.1017 in (unit base rail thickness) | Fu2 = 65 ksi
d = 0.190 in (screw diameter) | dw = 0.375 in (nom. washer diameter)
t2/t1 = 1.4



For t2/t1 ≤ 1.0:
Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ Pns = 2377 # | 3.86 k
$P_{ns} = 2.7t_1 dF_{u1}$ 2.38 k
$P_{ns} = 2.7t_2 dF_{u2}$ 3.39 k
Pns/Ω = 792 #
Pss/Ω = 540 # <- Controls

For t2/t1 ≥ 2.5:
Pns = 2377 #
$P_{ns} = 2.7t_1 dF_{u1}$ 2.38 k
$P_{ns} = 2.7t_2 dF_{u2}$ 3.39 k

Tension: Pnot = 1.068 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 = 356 # <- Controls
Pts/Ω = 820 # (full tensile screw capacity)

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	3.104	2	1.55	540 #	4	2.00 in
Short side:	3.104	2	1.55	540 #	4	2.00 in

clip width (in) = 7.00 | clip height = 2.5 in
min spacing = 0.57 in | edge distance = 0.5 in (min. 1.5d)
Check Block shear rupture: O.K. | thinnest part = 0.0713 AISI BSR applies
Fy = 50 ksi | Ω = 2.22 bolt/screw connection
Agv = 0.463 in² | Anv = 0.416 in² | Ant = 0.082 in²
Rn/Ω = 8.674 k
$R_n = 0.6F_y A_{gv} + F_u A_{nt} \le 0.6F_u A_{nv} + F_u A_{nt}$ (AISI Sect. E5.3)
BSR O.K.

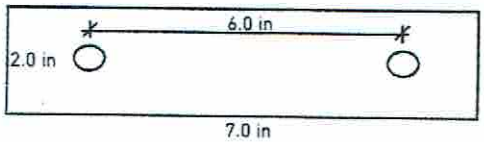
Curb Loads (copied from above)

Transverse: (on long edge)	$Comp_{MAX}$ =	2330	lbs
	$Tens_{MAX}$ =	1940	lbs
	$Shear_{MAX}$ =	1552	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	1805	lbs
	$Tens_{MAX}$ =	1415	lbs
	$Shear_{MAX}$ =	1552	lbs

Loads at each Isolator Type: JQA

Transverse loading: (on long edge) # isolators: 2	$Comp_{MAX}$ =	1165.0	lbs
	$Tens_{MAX}$ =	970.1	lbs
	$Shear_{MAX}$ =	776.1	lbs
Longitudinal loading: (on short edge) # isolators: 2	$Comp_{MAX}$ =	902.6	lbs
	$Tens_{MAX}$ =	707.7	lbs
	$Shear_{MAX}$ =	776.1	lbs

Max compression force on isolator: 1.165 k ≤ 1.660 k **O.K.**
Max uplift on isolator: 0.970 k ≤ 1.660 k **O.K.**
Max shear on isolator: 0.776 k ≤ 0.800 k **O.K.**



Forces on top bolt:
d_b = 0.375 in
upper rail, t = 0.1017 in
Tension = 0.970 k
Shear = 0.776 k

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

Net section rupture: $P_n = A_n F_t$ Ω = 2.22 (Appendix A, Section E3.2 AISI)
Pn/Ω = 7.117 k An = 0.165 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 = 2.975 k d/t = 3.69
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.**

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

Combined Not Applicable F'nt = 24.19 ksi fv = 7.03 ksi O.K. Fnv/Ω = 10.00 ksi

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Client: ProVent PV1805
Project: CBISC-06 Iso Curb (CBISCPRL**) Base curb
Unit: ZX 08-14; XX 08-12; ZY 07-12; XY 07-09

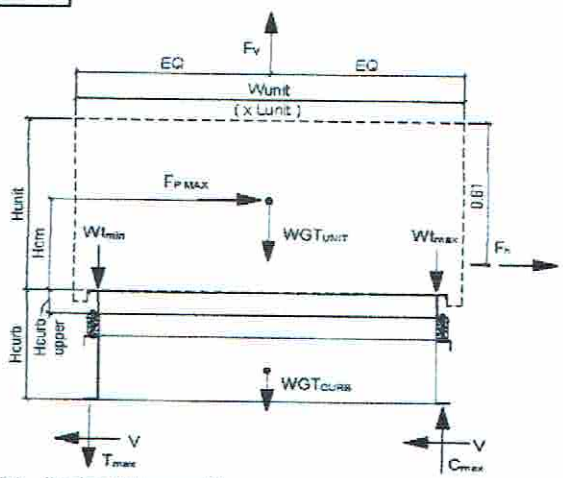
Curb Information

Hcurb =	25	in	(Height of curb)
Lcurb =	84.25	in	(Length of curb)
wcurb =	56	in	(Width of curb)
WGTcurb =	425	lbs	(Weight of curb)

Clips long side = 2 # Clips short side = 2

Unit Information

WGTunit =	1167	lbs	(Weight of Unit)
Wtmax =	359	lbs	(Maximum corner weight)
Wtmin =	211	lbs	(Minimum corner weight)
Hunit =	48.56	in	(Height of unit above curb)
Hcm =	24.28	in	(Height to center of mass)
Lunit =	87.18	in	(Length of unit)
Wunit =	61.69	in	(Width of unit)



Seismic Loading - 2015 IBC/2016 CBC

Ss =	2.850	(Worst case for majority of CA - Design Category D)
Fa =	1.000	(Interpolated from Table 11.4-1 ASCE 7-10)
Sms =	2.850	(Fa*Ss)
Sds =	1.900	(2/3*Sms)
Ip =	1.25	(Importance Factor Category III Building)
Fpmax =	3.800 Wp	(1.6*Sds*Ip)*Wp
FpmaxASD =	3104 lbs (unit only)	(0.7*Fpmax) FpmaxASD = 4235 lbs (unit and curb)

Wind Loading - 2015 IBC/2016 CBC

*** Exposure Category C ***

Kz =	1.13	(For 60 ft roof height, Exposure C - Table 29.3-1 ACSE 7-10)
Kzt =	1.0	(No topographic effects assumed for rooftop mounted units)
Kd =	0.85	(Directionality factor Table 26.6-1 ASCE 7-10)
V =	115	(Max wind velocity, mph for Cat III & IV bldgs Exp. Cat C)
$GCr_{(horiz)}$ =	1.9	(Refer Sect 29.5.1 ASCE 7-10)
$GCr_{(vert)}$ =	1.5	(Refer Sect 29.5.1 ASCE 7-10)
qz	32.5 psf	$= 0.00256*Kz*Kzt*Kd*V^2$ (Eq. 29.3-1 ASCE 7-10)
$F_{h\ ASD\ trans}$ =	1651 lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	1168 lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	1093 lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	2254 lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1864 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	600 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	992 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate Compression load rather than Tension.

Longitudinal:

$Compression_{SEISMIC}$ =	1803 lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1413 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	220 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	613 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

---> Negative values indicate Compression load rather than Tension.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	2254	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1864	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1803	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1413	lbs	---> Along short edge of curb.

---> Negative values indicate Compression load rather than Tension.

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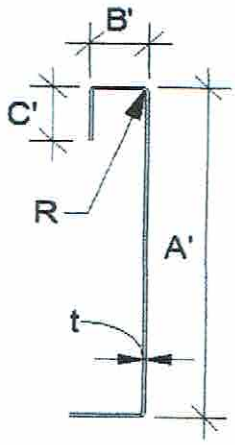
Curb Design

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



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 (Moment of Inertia about X-Axis)
Iy = 0.218 in (Moment of Inertia about Y-Axis)
A = 2.01 in²
rx = 8.00 in
ry = 0.329 in
rmin = 0.329 in

Axial Compression

Pu = 1.552 k (Max Axial Comp) Ω_c = 1.80
Pn/Ωc = 8.960 k
Fe = 9.14 ksi
λc = 2.34
Fn = 8.01 ksi
Ly = 73.38 in Lateral unbraced length
k_yL_y/r_y = 179 (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:
t = 0.0713 in h/t = 350.63 ≤ 200 C = 4.00
N = 7.00 N/t = 98.18 ≤ 210 C_R = 0.14
Ω_w = 1.75 N/h = 0.28 ≤ 2.0 C_N = 0.35
P_n = 2.105 k R/t = 1.50 ≤ 9.0 C_h = 0.02
P_n/Ω_w = 1.203 k
Long side: Pu_{Trans} = 1.127 k **O.K.** # clips = 2
Short side: Pu_{Long} = 0.901 k **O.K.** # clips = 2

(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 > 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 in²
Pn = 14.780 k
P_n/Ω_c = 8.694 k **O.K.**

Corner Connections

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

Tcrnmax = 776 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 932 lbs (Max Ten/2 corner connections per side)

Bolt:	Tall = [2480] lbs		Vall = [1096] lbs	
Threaded Insert:	Tall = [2860] lbs		Vall = [1714] lbs	

# of Bolts required for Tension = 0.3
# of Bolts required for Shear = 0.9
# of Bolts Used = [1.0]

***If combined fails: USE --> 4.0

Check Combined Stress in Bolts & Inserts: 1.163 N.G. StressComb = 0.291 **O.K.**

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

Assume L/t > 25: 25*t = 1.783 in $P_n/\Omega = \frac{1}{\Omega} 0.75tLF_u \geq V_{req}$ $L_{req'd} = \frac{V_{req}\Omega}{0.75tF_u}$

Lreq'd = 0.630 in

Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	2330	lbs
	$Tens_{MAX}$ =	1940	lbs
	$Shear_{MAX}$ =	1552	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	1805	lbs
	$Tens_{MAX}$ =	1415	lbs
	$Shear_{MAX}$ =	1552	lbs

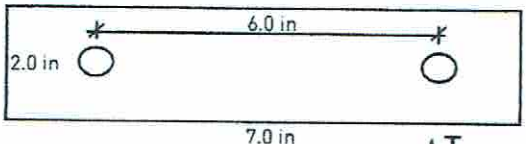
Loads at each Isolator Type: JQA

Transverse loading: (on long edge) # isolators: 2	$Comp_{MAX}$ =	1165.0	lbs
	$Tens_{MAX}$ =	970.1	lbs
	$Shear_{MAX}$ =	776.1	lbs
Longitudinal loading: (on short edge) # isolators: 2	$Comp_{MAX}$ =	902.6	lbs
	$Tens_{MAX}$ =	707.7	lbs
	$Shear_{MAX}$ =	776.1	lbs

Max compression force on isolator: 1.165 k ≤ 1.660 k **O.K.**

Max uplift on isolator: 0.970 k ≤ 1.660 k **O.K.**

Max shear on isolator: 0.776 k ≤ 0.800 k **O.K.**



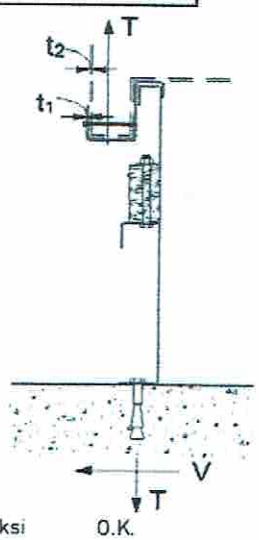
Forces on bottom bolts:

d_b = 0.5 in

base curb, t = 0.0713 in

Tension = 0.485 k / bolt

Shear = 0.388 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: $P_n = A_n F_t$ 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 $P_{nt} = A_b F_{nt}$ Fnt = 45.0 ksi A_b = 0.1963 in^2

Pnt/Ω = 3.927 k **Bolt tension O.K.** Ωt = 2.25

Shear $P_{nv} = A_b F_{nv}$ Fnv = 27.0 ksi Ωv = 2.40

Pnv/Ω = 2.209 k **Bolt shear O.K.** ***(Table E3.4-1, AISI)***

$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \leq F_{nt}$ fv = 1.98 ksi O.K.

Combined Not Applicable F'nt = 45.0 ksi Fnv/Ω = 11.25 ksi

Connection of Curb to Supporting Structure

Roof Loading SEISMIC: (0.6-0.14SDS)D + 0.7E WIND: 0.6D + W

Transverse: $Uplift_{MAX}$ = 4203 lbs $Shear_{MAX}$ = 2117 lbs

$Compression_{SEISMIC}$ = 4734 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 4203 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 1384 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb

$Tension_{WIND}$ = 1522 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: $Uplift_{MAX}$ = 2953 lbs $Shear_{MAX}$ = 2117 lbs

$Compression_{SEISMIC}$ = 3485 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 2953 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 614 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb

$Tension_{WIND}$ = 752 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

Wood Attachment: **1/4" φ wood lag screws** **w/ 3.5" Min. Embed** (SGmin = 0.43)

Transverse:

$Tall_{metal}$ = 946.67 lbs $Vall_{metal}$ = 1043.33 lbs

$Tall_{wood}$ = 671.25 lbs $Vall_{wood}$ = 224 lbs

# of Screws Req'd for Uplift = 6.26 COMBINED LOADING: 1.048 NO GOOD

# of Screws Req'd for Shear = 9.45 Req'd Min Spacing = 5.4 in o.c.

Total # of screws required = 15

Use 15 - 1/4" φ wood lag screws @ 5.4 in o.c. along long side of curb w/ 3.5" Min. Embed

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Longitudinal:

# of Screws Req'd for Uplift = 4.40 COMBINED LOADING: 1.066 NO GOOD

# of Screws Req'd for Shear = 9.45 Screw Spacing = 4.0 in o.c.

Total # of screws required = 13

Use 13 - 1/4" ϕ wood lag screws @ 4 in o.c. along short side of curb w/ 3.5" Min. Embed

Steel Deck Attachment: 1/2" φ A307 Bolts to steel angle below deck

$Tall_{bolt}$ = 6903 lbs $Vall_{bolt}$ = 3682 lbs

Transverse: 6903 lbs 3682 lbs

# of Bolts Req'd for Uplift = 0.61 COMBINED LOADING: 0.592 O.K.

# of Bolts Req'd for Shear = 0.58 Bolt Spacing = 72.3 in o.c.

Total # of bolts required = 2

Use 2 - 1/2" ϕ A307 Bolts to steel angle below deck @ 72.3 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.43 COMBINED LOADING: 0.501 O.K.

# of Bolts Req'd for Shear = 0.58 Bolt Spacing = 44.0 in o.c.

Total # of bolts required = 2

Use 2 - 1/2" ϕ A307 Bolts to steel angle below deck @ 44 in o.c. along short side of curb

For Concrete anchorage: SEISMIC $(0.6-0.14SDS)D + 0.7\Omega_o E$ $(\Omega_o = 2.5)$

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

$Tall_{LRFD}$ = 1919 lbs $Vall_{LRFD}$ = 3188 lbs $\alpha = (1 + 0.2SDS)D + 2.5E = 1.87$

$Tall_{ASD} = Tall_{LRFD}/\alpha$ = 1026.2 lbs $Vall_{ASD} = Vall_{LRFD}/\alpha$ = 1704.8 lbs $(D = 0.465, E = 0.535)$

Transverse: $Uplift_{MAX}$ = 9792 lbs $Shear_{MAX}$ = 5293 lbs

$Compression_{SEISMIC}$ = 10324 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 9792 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 5293 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 9.54 spacing = 6.69 in o.c. Tapplied = 890.2 lbs

Min Bolts Req'd Shear = 3.10 spacing = 20.08333 in o.c. Vapplied = 481.2 lbs

Try using 11 bolts spaced at 7.23 in o.c.

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

Use 11 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 7.2 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 6669 lbs $Shear_{MAX}$ = 5293 lbs

$Compression_{SEISMIC}$ = 7200 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 6669 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 5293 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 6.50 spacing = 5.333333 in o.c. Tapplied = 833.6 lbs

Min Bolts Req'd Shear = 3.10 spacing = 10.66667 in o.c. Vapplied = 661.7 lbs

Try using 8 bolts spaced at 6.29 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 1.20

Use 8 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 6.3 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: (CBISCPRL* (CBISCPRL** Unit: ZX 08-14; XX 08-12; ZY 07-12; XY 07-09			
UPPER CURB RAIL THICKNESS: 0.1017 in 12 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) - 2 clips with 4 - #10 SMS screws each clip			
WEB STIFFENER: NOT REQUIRED			
VIBRATION ISOLATOR TYPE: JQA Top stud diameter: 3/8 Anchor bolt diameter: 1/2 Anchor hole diamter: 9/16			
BASE CURB THICKNESS: 0.0713 in 14 Gauge			
WEB STIFFENER: 16Ga x 1.5in x 7in (C-channel) stiffener at each clip on base curb			
CORNER CONNECTION: Use minimum 4 - 1/4" ϕ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts			
CURB ANCHORAGE	WOOD 1/4" ϕ wood lag screws w/ 3.5" Min. Embed (SGmin = 0.43)	STEEL 1/2" ϕ A307 Bolts to steel angle below deck	CONCRETE 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy w/ 4" embed
LONG DIRECTION	15 @ 5.45 in o.c.	2 @ 72.25 in o.c.	11 @ 7.23 in o.c.
SHORT DIRECTION	13 @ 4 in o.c.	2 @ 44 in o.c.	8 @ 6.29 in o.c.