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

Structural Calculations
for
CBISC-03 Series

Prepared for:

PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

Date: July 29, 2019

Project Number: PV1805

STRUCTURALLY CALCULATED VIBRATION ISOLATION ROOF CURBS FOR YORK UNITS

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

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

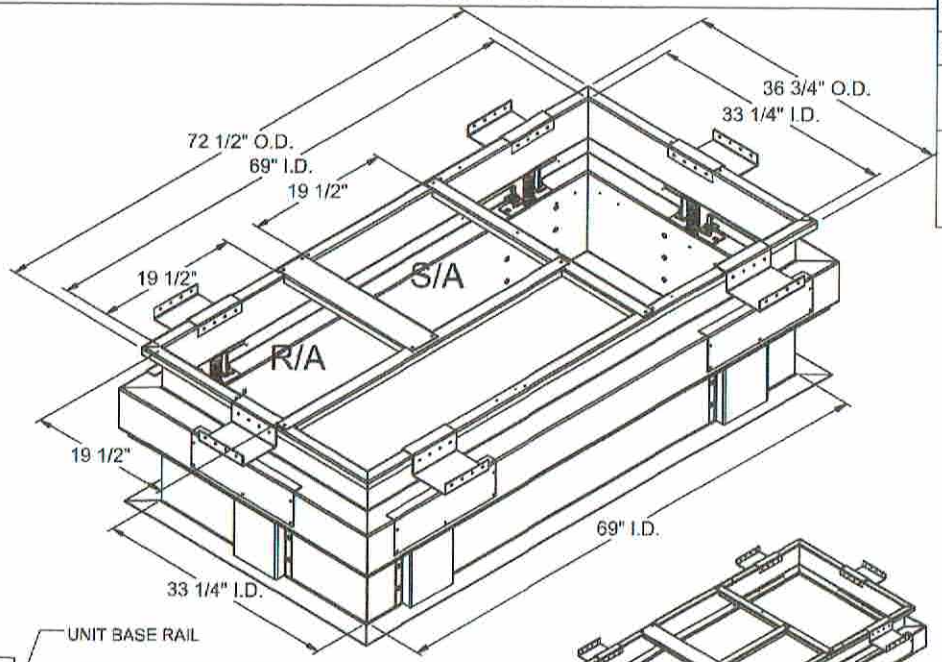
NOTES

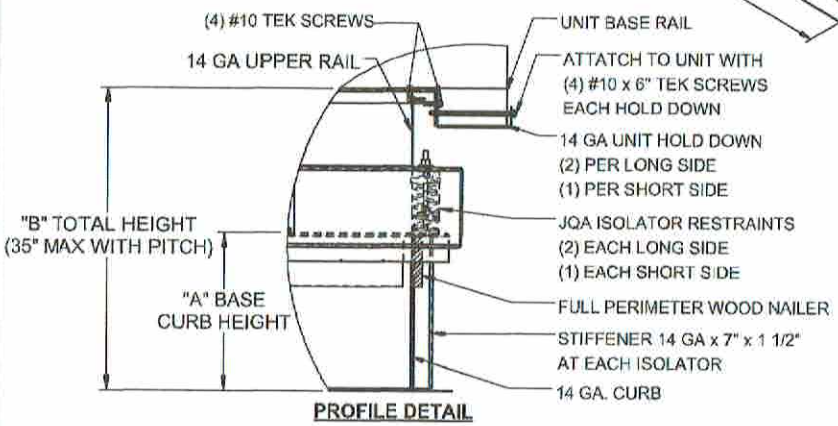
- Attach ductwork to roof curb. Flanges of duct rest on top of the curb, Support ductwork below the curb.
- Thru the curb utillities are available. Contact you York distributor or Provent directly.

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

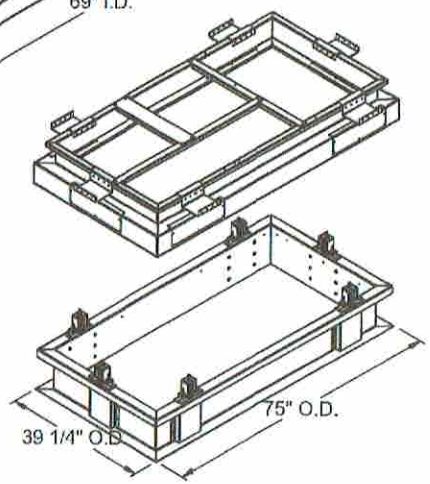
**Note: Spring configuration must be added to part number at time of order

Meets seismic requirements for the following codes:
CBC 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

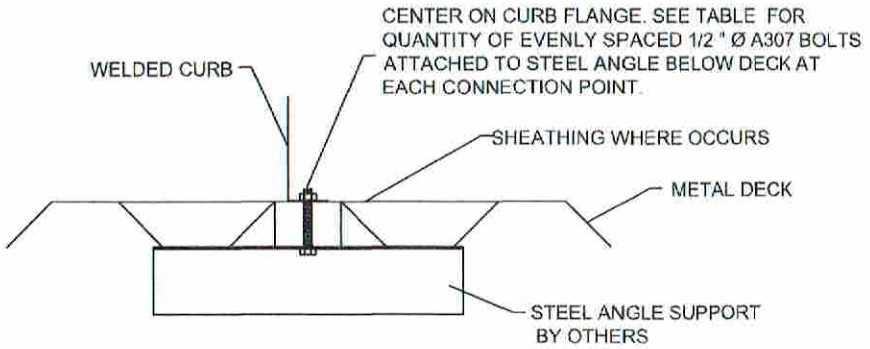
PHONE (951) 685-1101
FAX (619) 872-9799

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

FORM NO:	PART NUMBER:
CBISC-03	-

DATE:	REV:	DRAWN BY:
9/27/2018	1	ALL

STEEL ATTACHMENT



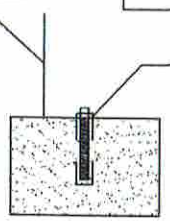
CURB	NO. OF ANCHORAGE BOLTS REQUIRED	
	LONG SIDE	SHORT SIDE
LXS	2 @ 34.5" O.C	XX @ 2 @ 19" O.C
LXL	2 @ 34.5" O.C.XX	2 @ 29" O.C
SUN3672	2 @ 60" O.C	2 @ 24.25" O.C
PRD3715	2 @ 68.38" O.C	2 @ 38.5" O.C
PRS	2 @ 58.38" O.C	2 @ 28.19" O.C.
PRL	2 @ 72" O.C	2 @ 41" O.C
SLU180	2 @ 102.25" O.C.	2 @ 71" O.C.
SLM1830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

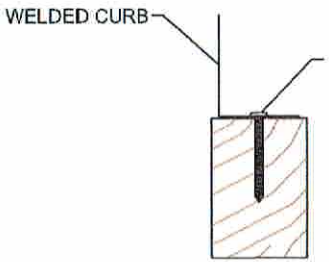
CONCRETE ATTACHMENT



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.

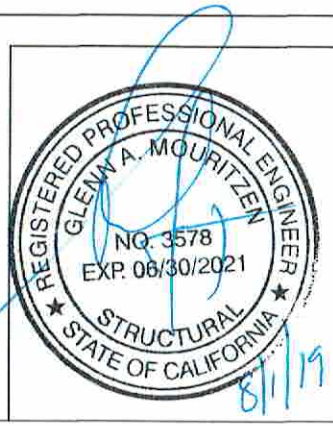
* SIX INCHES FROM EACH CORNER EVENLY SPACED.
** CENTERED.

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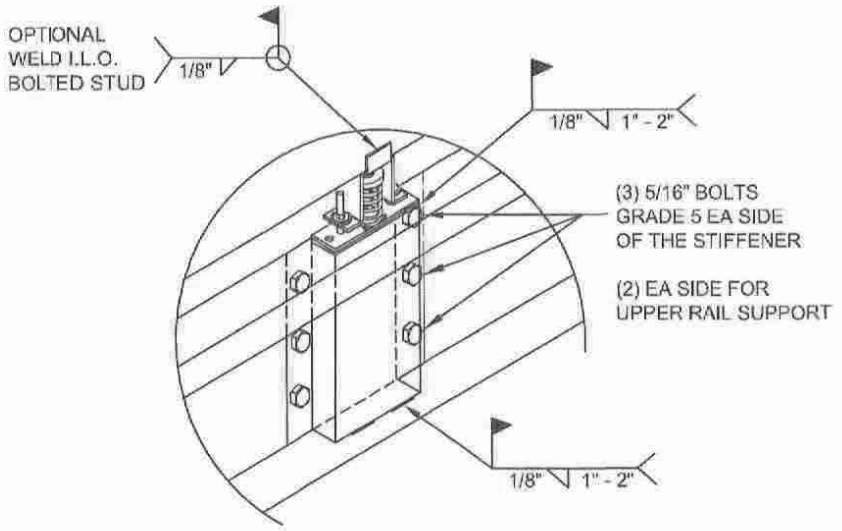
SUBMITTED TO: _____
COMPANY: _____
JOB NAME: _____
EQUIPMENT: _____
NOTES: _____

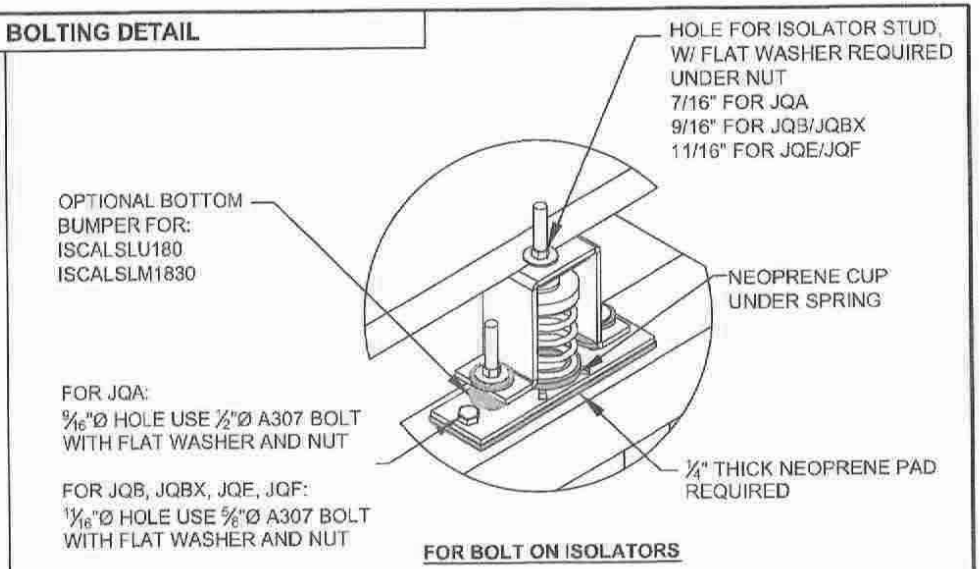
FORM NO: CB-60

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

WELDMENT AND BOLTING DETAIL



BASE CURB SUPPORT



FOR BOLT ON ISOLATORS

ProVent

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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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6593 Riverdale St.
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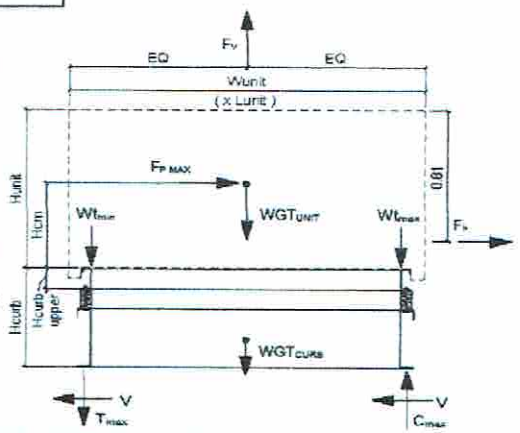
Client: ProVent PV1805
Project: CBISC-03 Iso Curb (CBISCSUN3672**Upper curb rail)
Unit: ZR 036-060, XP 036-060, ZF 036-072

Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	72	in	(Length of curb)
wcurb =	36.25	in	(Width of curb)
WGTcurb =	270	lbs	(Weight of curb)
# Clips long side =	2	# Clips short side =	1

Unit Information

WGTunit =	640	lbs	(Weight of Unit)
Wtmax =	234	lbs	(Maximum corner weight)
Wtmin =	96	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 - 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 =	1702	lbs (unit only)	(0.7*Fpmax) FpmaxASD = 2421 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)
$F_{h\ ASD\ trans}$ =	807	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb upper) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	440	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb upper)
$F_{vert\ ASD}$ =	750	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	1359	lbs	$=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb$
$Tension_{SEISMIC}$ =	1145	lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	269	lbs	$=[F_{h\ transASD}*Hcm+2*0.6*Wtmax*wcurb-F_{vertASD}*wcurb/2]/wcurb$
$Tension_{WIND}$ =	635	lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Longitudinal:

$Compression_{SEISMIC}$ =	978	lbs	$=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb$
$Tension_{SEISMIC}$ =	764	lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	6	lbs	$=[F_{h\ transASD}*Hcm+2*0.6*Wtmax*Lcurb-F_{vertASD}*Lcurb/2]/Lcurb$
$Tension_{WIND}$ =	372	lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	1359	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1145	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	978	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	764	lbs	---> Along short edge of curb.

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

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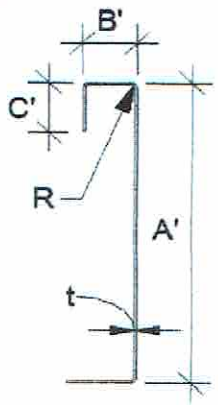
Curb Design

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



Calculate Section Properties of Curb

A'=	5.500 in		a =	5.144 in	= A'-(2r+t)
B'=	1.500 in		a'=	5.429 in	= A'-t
C'=	0.000 in	(0 if no lips)	b =	1.322 in	= B'-[r+t/2+a(r+t/2)]
a =	0.000	(0 - no Lip; 1 w/ lip)	b'=	1.464 in	= B'-(t/2+at/2)
R =	0.1069	(Inside bend radius)	c =	0.000 in	= a[C'-(r+t/2)]
t =	0.0713 in		c'=	0.000 in	= a[C'-t/2]
r'=	0.143 in	= R+t/2	u =	0.224 in	= πr/2

x = 0.261 in (Distance between centroid and web centerline)
Ix = 2.424 in (Moment of Inertia about X-Axis)
Iy = 0.109 in (Moment of Inertia about Y-Axis)
A = 0.59 in²
rx = 2.03 in
ry = 0.432 in
rmin = 0.432 in

Axial Compression

Pu = 0.851 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 4.309 k
Fe = 15.06 ksi
λc = 1.82
Fn = 13.21 ksi
Ly = 75.00 in Lateral unbraced length
k_yL_y/r_y = 139 (assume k=0.8)

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

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

Compression Check = O.K.

Check Web Crippling

h = 5.5 in
t = 0.0713 in
N = 7.00
Ω_w = 1.75
P_n = 1.947 k
P_n/Ω_w = 1.112 k
Long side: Pu_{Trans} = 0.679 k
Short side: Pu_{Long} = 0.978 k

-- Check limits:
h/t = 77.14 ≤ 200
N/t = 98.18 ≤ 210
N/h = 1.273 ≤ 2.0
R/t = 1.50 ≤ 12.0

C = 7.50
C_R = 0.08
C_N = 0.12
C_h = 0.048

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

O.K. # clips = 2
O.K. # clips = 1

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

Check Web Stiffener N/A

width of stiffener = 7.000 in
web of stiff. w = 6.717 in
***Check w/ts ≤ 1.28√E/Fys
w/ts = 118.675
1.28√(E/Fys) = 31.091 --> w/ts over limit Use C3.7.2

ts = 0.0566 [16 Gauge]
Rs = 0.0849 in
Ω_c = 1.70

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

Pwc = 1.947 k Ae = 0.380 in²
Pn = 14.669 k
Pn/Ωc = 8.629 k **Not Req'd**

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

Tcrnmax = 426 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 572 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 = 0.2
# of Bolts required for Shear = 0.5
# of Bolts Used = 1.0
***If combined fails: USE --> 2.0

Check Combined Stress in Bolts & Inserts: 0.694 O.K. StressComb = 0.347 **O.K.**

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

Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 0.387 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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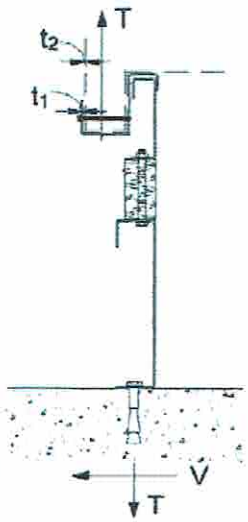
Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

t1 = 0.0713 in (clip thickness) | 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: | For t2/t1 ≥ 2.5:

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ Pns = 2377 # | Pns = 2377 #

$P_{ns} = 2.7t_1dF_{u1}$ 2.38 k | $P_{ns} = 2.7t_1dF_{u1}$ 2.38 k

$P_{ns} = 2.7t_2dF_{u2}$ 3.39 k | $P_{ns} = 2.7t_2dF_{u2}$ 3.39 k

Pns/Ω = 792 #

Pss/Ω = 540 # <- Controls

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:	1.702	2	0.85	540 #	4	2.00 in
Short side:	1.702	1	1.70	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 $R_n = 0.6F_yA_{gv} + F_uA_{nt} \le 0.6F_uA_{nv} + F_uA_{nt}$

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

Curb Loads (copied from above)

Transverse: (on long edge)	$Comp_{MAX}$ =	1359	lbs
	$Tens_{MAX}$ =	1145	lbs
	$Shear_{MAX}$ =	851	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	978	lbs
	$Tens_{MAX}$ =	764	lbs
	$Shear_{MAX}$ =	851	lbs

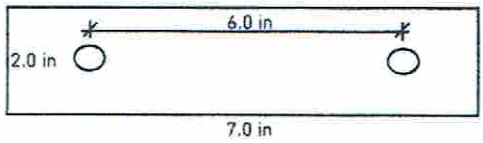
Loads at each isolator Type: JQA

Transverse loading: (on long edge) # isolators: 2	$Comp_{MAX}$ =	679.3	lbs
	$Tens_{MAX}$ =	572.4	lbs
	$Shear_{MAX}$ =	283.7	lbs
Longitudinal loading: (on short edge) # isolators: 1	$Comp_{MAX}$ =	978.2	lbs
	$Tens_{MAX}$ =	764.4	lbs
	$Shear_{MAX}$ =	283.7	lbs

Max compression force on isolator: 0.978 k ≤ 1.660 k **O.K.**

Max uplift on isolator: 0.764 k ≤ 1.660 k **O.K.**

Max shear on isolator: 0.284 k ≤ 0.800 k **O.K.**



Forces on top bolt:

d_b = 0.375 in

upper rail, t = 0.1017 in

Tension = 0.764 k

Shear = 0.284 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: $P_n = A_nF_t$ 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 $P_{nt} = A_bF_{nt}$ 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 $P_{nv} = A_bF_{nv}$ Fnv = 24.0 ksi Ωv = 2.40 (Table E3.4-1, AISI)

Pnv/Ω = 1.104 k **Bolt shear O.K.**

$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \le F_{nt}$ fv = 2.57 ksi O.K.

Combined Not Applicable F'nt = 40.50 ksi Fnv/Ω = 10.00 ksi

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6593 Riverdale St.
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Client: ProVent PV1805
Project: CBISC-03 Iso Curb (CBISCSUN3672**) Base curb
Unit: ZR 036-060, XP 036-060, ZF 036-072

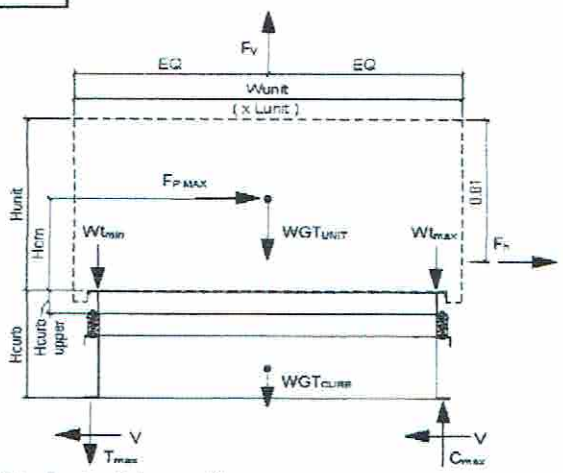
Curb Information

Hcurb =	25	in	(Height of curb)
Lcurb =	75	in	(Length of curb)
wcurb =	39.25	in	(Width of curb)
WGTcurb =	270	lbs	(Weight of curb)

Clips long side = 2 # Clips short side = 1

Unit Information

WGTunit =	640	lbs	(Weight of Unit)
Wtmax =	234	lbs	(Maximum corner weight)
Wtmin =	96	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 - 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 =	1702 lbs (unit only)	(0.7*Fpmax) FpmaxASD = 2421 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)
$F_{h\ ASD\ trans}$ =	1220 lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	666 lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	750 lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	1300 lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1086 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	413 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	779 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	963 lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	749 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	51 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	417 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	1300	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1086	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	963	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	749	lbs	---> Along short edge of curb.

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

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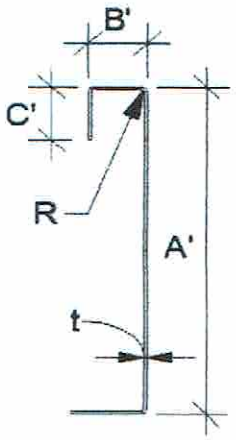
Curb Design

Fy = 50 ksi Fu = 65 ksi t = 0.0566 [16 Gauge]
E = 29500 ksi



Calculate Section Properties of Curb

A' =	[25.000] in		a =	24.717 in	= A'-(2r+t)
B' =	[1.750] in		a' =	24.943 in	= A'-t
C' =	[0.000] in (0 if no lips)		b =	1.609 in	= B'-[r+t/2+a(r+t/2)]
a =	[0.000] (0 - no Lip; 1 w/ lip)		b' =	1.722 in	= B'-(t/2+at/2)
R =	0.0849 (Inside bend radius)		c =	0.000 in	= a[C'-(r+t/2)]
t =	0.0566 in		c' =	0.000 in	= a(C'-t/2)
r' =	0.113 in	= R+t/2	u =	0.178 in	= πr/2

x = 0.105 in (Distance between centroid and web centerline)
Ix = 102.712 in (Moment of Inertia about X-Axis)
Iy = 0.175 in (Moment of Inertia about Y-Axis)
A = 1.60 in²
rx = 8.01 in
ry = 0.331 in
rmin = 0.331 in

Axial Compression

Pu = 0.851 k (Max Axial Comp) Ω_c = 1.80
Pn/Ωc = 6.895 k
Fe = 8.84 ksi
λc = 2.38
Fn = 7.75 ksi
Ly = 75.00 in Lateral unbraced length
k_yL_y/r_y = 182 (assume k=0.8)

$$\frac{P_n}{\Omega_c} = \frac{F_nA}{\Omega_c}$$

If $\lambda_c \le 1.5$; $F_n = \left(0.658^{\lambda_c^2}\right)F_y$

If $\lambda_c > 1.5$; $F_n = \frac{0.877}{\lambda_c^2}F_y$

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

Compression Check = O.K.

Check Web Crippling

h = 25 in -- Check limits: C = 4.00
t = 0.0566 in h/t = 441.70 ≤ 200 C_R = 0.14
N = 7.00 N/t = 123.67 ≤ 210 C_N = 0.35
Ω_w = 1.75 N/h = 0.28 ≤ 2.0 C_h = 0.02
P_n = 1.346 k R/t = 1.50 ≤ 9.0
P_n/Ω_w = 0.769 k
Long side: Pu_{Trans} = 0.650 k **O.K.** # clips = 2
Short side: Pu_{Long} = 0.963 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 > 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 = 1.346 k Ae = 0.380 in²
Pn = 14.248 k
Pn/Ω_c = 8.381 k **O.K.**

Corner Connections

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

Tcrnmax = 426 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 543 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 = 0.2
# of Bolts required for Shear = 0.5
# of Bolts Used = [1.0]

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

Check Combined Stress in Bolts & Inserts: 0.667 O.K. StressComb = 0.167 **O.K.**

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

Assume L/t > 25: 25*t = 1.415 in
Lreq'd = 0.463 in

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

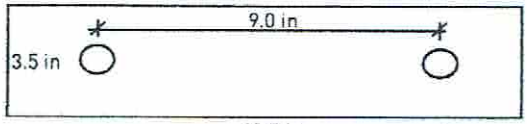
Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	1359	lbs
	$Tens_{MAX}$ =	1145	lbs
	$Shear_{MAX}$ =	851	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	978	lbs
	$Tens_{MAX}$ =	764	lbs
	$Shear_{MAX}$ =	851	lbs

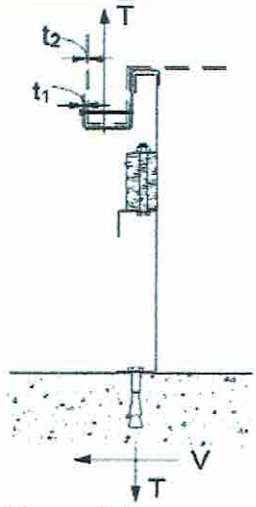
Loads at each Isolator Type: JQB

Transverse loading: (on long edge) # isolators: 2	$Comp_{MAX}$ =	679.3	lbs
	$Tens_{MAX}$ =	572.4	lbs
	$Shear_{MAX}$ =	283.7	lbs
Longitudinal loading: (on short edge) # isolators: 1	$Comp_{MAX}$ =	978.2	lbs
	$Tens_{MAX}$ =	764.4	lbs
	$Shear_{MAX}$ =	283.7	lbs

Max compression force on isolator: 0.978 k ≤ 1.600 k **O.K.**
Max uplift on isolator: 0.764 k ≤ 1.600 k **O.K.**
Max shear on isolator: 0.284 k ≤ 1.000 k **O.K.**



10.5 in



Forces on bottom bolts:
d_b = 0.625 in
base curb, t = 0.0566 in
Tension = 0.382 k / bolt
Shear = 0.142 k / bolt

Shear on base curb: $P_n = teF_u$ Ω = 2.00 (Appendix A, Section E3.1 AISI)
Pn/Ω = 3.679 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 = 5.059 k An = 0.078 in
N.S.R. O.K. $F_t = (0.1 + 3d/s)F_u \leq F_u$ = 65.000 ksi

Bolt Bearing Strength: $P_n = Cm_f dtF_u$ Ω = 2.50 (Section E3.3.1 AISI)
Pn/Ω = 2.663 k d/t = 11.04
Bearing O.K. C = 2.90 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 = 0.3068 in^2
Pnt/Ω = 6.136 k **Bolt tension O.K.** Ωt = 2.25

Shear: $P_{nv} = A_b F_{nv}$ Fnv = 27.0 ksi Ωv = 2.40
Pnv/Ω = 3.451 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 = 0.46 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: $Uplift_{MAX}$ = 2820 lbs $Shear_{MAX}$ = 1210 lbs

$Compression_{SEISMIC}$ = 3124 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb
$Tension_{SEISMIC}$ = 2820 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ = 1182 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ = 1386 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: $Uplift_{MAX}$ = 1605 lbs $Shear_{MAX}$ = 1210 lbs

$Compression_{SEISMIC}$ = 1909 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb
$Tension_{SEISMIC}$ = 1605 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ = 265 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ = 469 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 = 4.20 COMBINED LOADING: 0.873 O.K.
# of Screws Req'd for Shear = 5.40 Req'd Min Spacing = 6.7 in o.c.
Total # of screws required = 11

Use 11 - 1/4" φ wood lag screws @ 6.7 in o.c. along long side of curb w/ 3.5" Min. Embed

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Longitudinal:

# of Screws Req'd for Uplift = 2.39 COMBINED LOADING: 0.866 O.K.
# of Screws Req'd for Shear = 5.40 Screw Spacing = 3.9 in o.c.
Total # of screws required = 9

Use 9 - 1/4" ϕ wood lag screws @ 3.9 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 = 0.41 COMBINED LOADING: 0.369 O.K.
# of Bolts Req'd for Shear = 0.33 Bolt Spacing = 63.0 in o.c.
Total # of bolts required = 2

Use 2 - 1/2" ϕ A307 Bolts to steel angle below deck @ 63 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.23 COMBINED LOADING: 0.281 O.K.
# of Bolts Req'd for Shear = 0.33 Bolt Spacing = 27.3 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 (0.6-0.14SDS)D + $0.7\Omega_o$ E (Ω_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: $Uplift_{MAX}$ = 6642 lbs $Shear_{MAX}$ = 3026 lbs

$Compression_{SEISMIC}$ = 6946 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 6642 lbs =Comp$_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 3026 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 6.47 spacing = 8.50 in o.c. Tapplied = 830.2 lbs
Min Bolts Req'd Shear = 1.77 spacing = 51 in o.c. Vapplied = 378.2 lbs

Try using 8 bolts spaced at 9.00 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 1.03

Use 8 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 9 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 3605 lbs $Shear_{MAX}$ = 3026 lbs

$Compression_{SEISMIC}$ = 3909 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 3605 lbs =Comp$_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 3026 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 3.51 spacing = 5.083333 in o.c. Tapplied = 721.1 lbs
Min Bolts Req'd Shear = 1.77 spacing = 15.25 in o.c. Vapplied = 605.2 lbs

Try using 5 bolts spaced at 6.81 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 1.06

Use 5 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 6.8 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: (CBISCSUN{ (CBISCSUN3(Unit: ZR 036-060, XP 036-060, ZF 036-072			
UPPER CURB RAIL THICKNESS: 0.0566 in 16 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: JQB Top stud diameter: 3/8			
Anchor bolt diameter: 5/8 Anchor hole diamter: 11/16			
BASE CURB THICKNESS: 0.0566 in 16 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	11 @ 6.7 in o.c.	2 @ 63 in o.c.	8 @ 9 in o.c.
SHORT DIRECTION	9 @ 3.91 in o.c.	2 @ 27.25 in o.c.	5 @ 6.81 in o.c.