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

Structural Calculations
for
CBKD-80 Series

Prepared for:

PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

Date: August 1, 2019

Project Number: PV1806

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

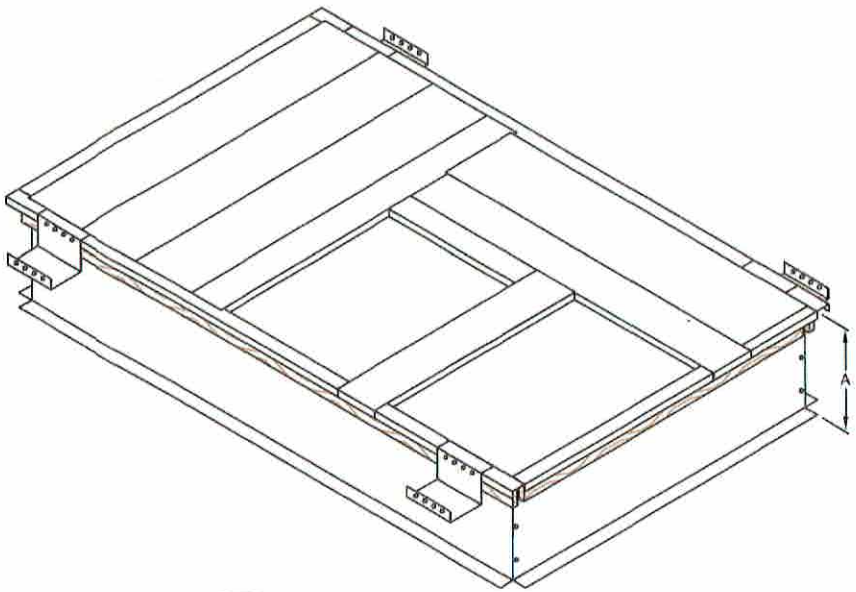
Will conform to seismic code requirements for knock-down or pre-assembled application. (Contact factory for assembled version.)

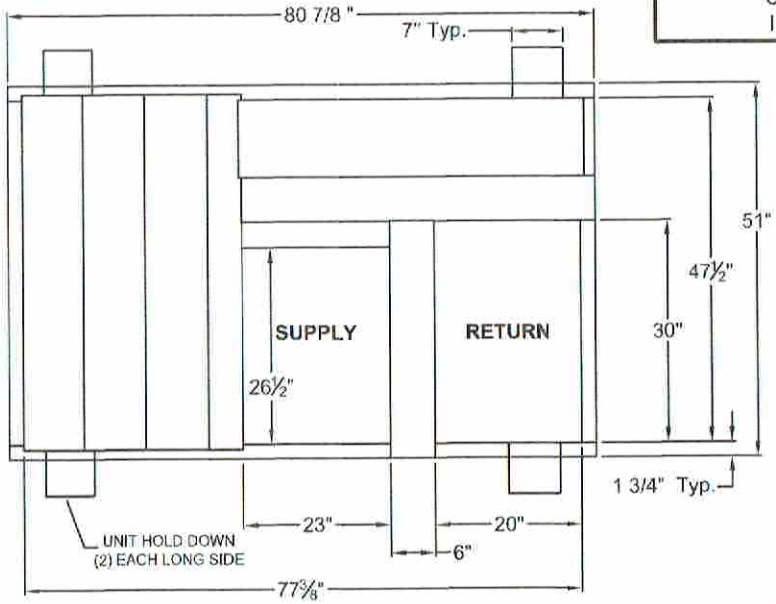
STRUCTURALLY CALCULATED KNOCK-DOWN ROOF CURBS FOR YORK UNITS

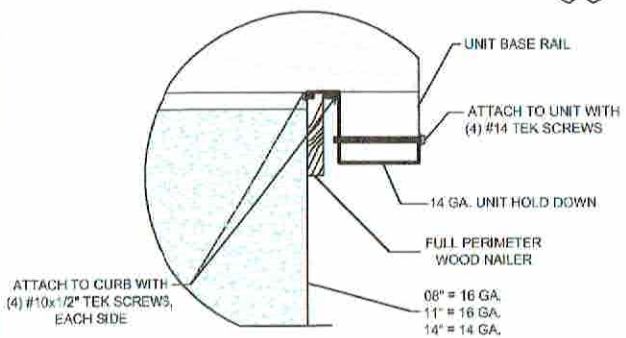
ZT, ZR, ZJ, ZH 037-150
ZF, ZH, ZJ, ZR, XP, DH, DM, DF, DR, BP 078-150

ProVent P/N	A	WEIGHT	SEISMIC KIT P/N	WEIGHT
CBKDPRD371508	8"	115 Lbs	KDKITPRD371508	8 Lbs
CBKDPRD371511	11"	129 Lbs	KDKITPRD371511	10 Lbs
CBKDPRD371514	14"	144 Lbs	KDKITPRD371514	11 Lbs

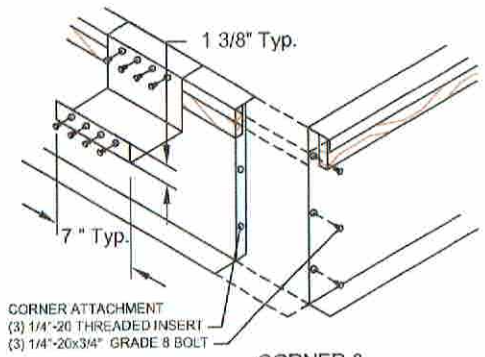
Meets seismic requirements for the following codes:
CBC 2016
IBC 2015







HOLD DOWN DETAIL



CORNER &
HOLD DOWN DETAIL

REGISTERED PROFESSIONAL ENGINEER
GLENN A. MOURITZEN
NO. 3578
EXP. 06/30/2021
STRUCTURAL
STATE OF CALIFORNIA
8/1/19

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:		PART NUMBER:
CBKD-80		KDKITPRD3715 Series
DATE: 01/07/19	REV: 3	DRAWN BY: ALL

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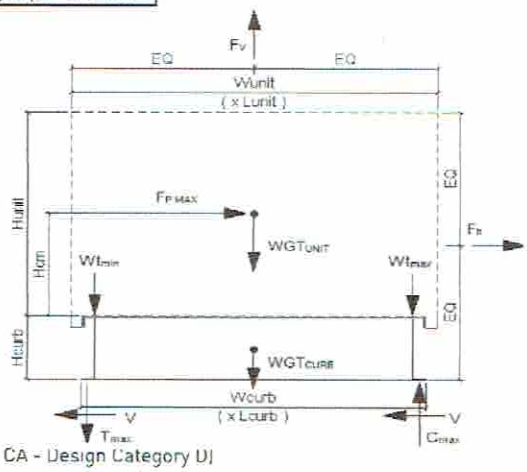
Client: ProVent PV1806
Description: CBKD-80 14" KDKITPRD3715**
Unit: ZT,ZR,ZJ,ZH 037-150; ZF,ZH,ZJ,ZR,XP,DH,DM,DF,DR,BP 078-150

Curb Information

Hcurb =	14	in	(Height of curb)
Lcurb =	80.875	in	(Length of curb)
wcurb =	51	in	(Width of curb)
WGTcurb =	155	lbs	(Weight of curb)
# Clips long side =	2	# Clips short side =	0



Unit Information

WGTunit =	1700	lbs	(Weight of Unit)
Wtmax =	329	lbs	(Maximum corner weight)
Wtmin =	191	lbs	(Minimum corner weight)
Hunit =	50.75	in	(Height of unit above curb)
Hcm =	25.375	in	(Height to center of mass)
Lunit =	89	in	(Length of unit)
Wunit =	59	in	(Width of unit)

Seismic Loading - 2015 IBC/2016 CBC

Ss =	2.85		(Worst case for majority of CA - Design Category D)
Fa =	1		(Interpolated from Table 11.4-1 ASCE 7-10)
Sms =	2.850		(Fa*Ss)
Sds =	1.900		(2/3*Sms)
Ip =	1.50		(Importance Factor Category III Building)
Fpmax =	1.425	Wp	(0.4*ap*Sds*Ip)*Wp*3/Rp
FpmaxASD =	1696	lbs	(0.7*Fpmax) FpmaxASD = 1850 lbs (unit and curb)
	(unit only)		

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)
$F_{h\ ASD\ trans}$ =	1484	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	983	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	1067	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	1677	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1109	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	599	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	647	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	1365	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	797	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	170	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	217	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	1677	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1109	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1365	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	797	lbs	---> Along short edge of curb.

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

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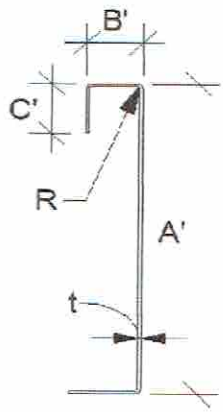
Curb Design

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



Calculate Section Properties of Curb

A'=	[14.000] in	a =	13.644 in	= A'-(2r+t)
B'=	[2.000] in	a'=	13.929 in	= A'-t
C'=	[0.000] in (0 if no lips)	b =	1.822 in	= B'-[r+t/2+a(r+t/2)]
a =	[0.000] (0 - no Lip; 1 w/ lip)	b'=	1.964 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 = 0.218 in (Distance between centroid and web centerline)
Ix = 29.228 in (Moment of Inertia about X-Axis)
Iy = 0.300 in (Moment of Inertia about Y-Axis)
A = 1.26 in²
rx = 4.81 in
ry = 0.487 in
rmin = 0.487 in

Axial Compression

Pu = 0.848 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 21.644 k
Fe = 43.22 ksi
λc = 1.08
Fn = 30.81 ksi
Ly = 50 in Lateral unbraced length
k_yL_y/r_y = 82 (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 = 14 in -- Check limits: C = 4.00
t = 0.0713 in h/t = 196.35 ≤ 200 C_R = 0.14
N = 7.00 N/t = 98.18 ≤ 210 C_N = 0.35
Ω_w = 1.75 N/h = 0.5 ≤ 2.0 C_h = 0.02
P_n = 2.422 k R/t = 1.50 ≤ 9.0 (See table C3.4.1-2, fastened to support, one flange, end loading)
P_n/Ω_w = 1.384 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} = 0.838 k **O.K.** # clips = 2
Short side: Pu_{Long} = 0.683 k **O.K.** # clips = 2

Check Web Stiffener

16Ga x 3/4" x 7" (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 Ωc = 1.70
w/ts = 118.675
1.28√(E/Fys) = 31.091 --> w/ts over limit Use C3.7.2

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

Pwc = 2.422 k Ae = 0.380 in²
Pn = 15.002 k Pn/Ω = 8.825 k

Not Req'd

Corner Connections

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

Tcrnmax = 424 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 554 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 ***If combined fails:
# of Bolts Used = [1.0] USE --> 2.0
Check Combined Stress in Bolts & Inserts: 0.677 O.K. StressComb = 0.338 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 0.375 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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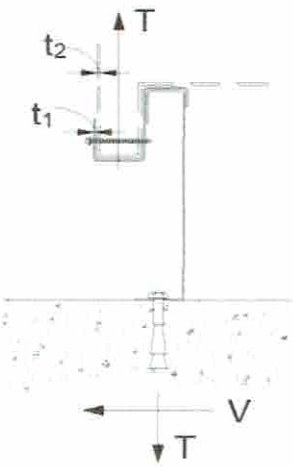
Connection Unit to Curb Clip | #14 | SMS screw | Ω = 3.0

t1 = 0.0713 in | Fu1 = 65 ksi
t2 = 0.1017 in (unit base rail thickness) | Fu2 = 65 ksi
d = 0.242 in (screw diameter) | dw = 0.500 in (nom. washer diameter)
t2/t1 = 1.4



For t2/t1 ≤ 1.0: | Pns = 3028 #
Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ = 4.36 k
$P_{ns} = 2.7t_1 dF_{u1}$ = 3.03 k
$P_{ns} = 2.7t_2 dF_{u2}$ = 4.32 k
Pns/Ω = 1009 # <- Controls
Pss/Ω = 1045 #

For t2/t1 ≥ 2.5: | Pns = 3028 #
$P_{ns} = 2.7t_1 dF_{u1}$ = 3.03 k
$P_{ns} = 2.7t_2 dF_{u2}$ = 4.32 k

Tension: Pnot = 1.360 k (screw pull-out strength) $P_{not} = 0.85t_c dF_{u2}$
$t_c = \min(t_1, t_2)$
Pnov = 3.476 k (screw pull-over strength) $P_{nov} = 1.5t_1 d_w F_{u1}$
Pts/Ω = 453 # <- Controls
Pts/Ω = 1220 # (full tensile screw capacity)

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	1.696	2	0.85	1009 #	2	6.00 in
Short side:	1.696	2	0.85	1009 #	2	6.00 in

clip width (in) = 7.00 | clip height = 1.4 in
min spacing = 0.73 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 = 0.438 in² | Ant = 0.040 in²
Rn/Ω = 7.445 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)

Connection of Curb to Supporting Structure

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

Transverse: | $Uplift_{MAX}$ = 1983 lbs | $Shear_{MAX}$ = 925 lbs

$Compression_{SEISMIC}$ =	2603 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1983 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ =	1168 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*(WGT$_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1123 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*(WGT$_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: | $Uplift_{MAX}$ = 1456 lbs | $Shear_{MAX}$ = 925 lbs

$Compression_{SEISMIC}$ =	2075 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1456 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ =	502 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*(WGT$_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	456 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*(WGT$_{unit+curb}$/2)*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

Wood Attachment: **Use 5/8" φ wood lag screws w/ 3.5" Min. Embed**

$Tall_{metal}$ = 946.67 lbs | $Vall_{metal}$ = 1043.33 lbs
Transverse: $Tall_{wood}$ = 1195.95 lbs | $Vall_{wood}$ = 1024 lbs
# of Screws Req'd for Uplift = 2.09 | COMBINED LOADING: 0.512 O.K.
# of Screws Req'd for Shear = 0.90 | Screw Spacing = 18.2 in o.c.
Total # of screws Required = 5

Use 5/8" φ wood lag screws @ 18.2 in o.c. along long side of curb w/ 3.5" Min. Embed

Longitudinal:
# of Screws Req'd for Uplift = 1.5 | COMBINED LOADING: 0.530 O.K.
# of Screws Req'd for Shear = 0.9 | Screw Spacing = 14.3 in o.c.
Total # of screws Required = 4

Use 5/8" φ wood lag screws @ 14.3 in o.c. along short side of curb w/ 3.5" Min. Embed

Steel Deck Attachment: **Use 5/8" φ A307 Bolts attached to steel angle below deck**

$Tall_{bolt}$ = 6903 lbs | $Vall_{bolt}$ = 3682 lbs
Transverse: 6903 lbs | 3682 lbs
# of Bolts Req'd for Uplift = 0.29 | COMBINED LOADING: 0.071 O.K.
# of Bolts Req'd for Shear = 0.25 | Bolt Spacing = 68.9 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 68.9 in o.c. along long side of curb

Longitudinal:
# of Bolts Req'd for Uplift = 0.21 | COMBINED LOADING: 0.055 O.K.
# of Bolts Req'd for Shear = 0.25 | Req'd Min Spacing = 39.0 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 39 in o.c. along short side of curb

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

Concrete Attachment: 3/4" φ Hilti Hit-HY 200 adhesive anchors w/ 4" embed

$Tall_{LRFD}$ = 1722 lbs $Vall_{LRFD}$ = 2032 lbs $\propto = (1 + 0.2SDS)D + 2.5E = 1.87$

$Tall_{ASD} = Tall_{LRFD}/\alpha$ = 920.9 lbs $Vall_{ASD} = Vall_{LRFD}/\alpha$ = 1086.6 lbs $(D = 0.465, E = 0.535)$

Transverse: $Uplift_{MAX}$ = 4126 lbs $Shear_{MAX}$ = 2313 lbs

$Compression_{SEISMIC}$ = 4746 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 4126 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*[WGTunit+curb]

$Shear_{SEISMIC}$ = 2313 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 4.48 spacing = 14.22 in o.c. Tapplied = 589.4 lbs

Min Bolts Req'd Shear = 2.13 spacing = 28.4375 in o.c. Vapplied = 330.4 lbs

Try using 7 bolts spaced at 11.48 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 0.94

Use 7 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 11.5 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 2807 lbs $Shear_{MAX}$ = 2313 lbs

$Compression_{SEISMIC}$ = 3426 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 2807 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*[WGTunit+curb]

$Shear_{SEISMIC}$ = 2313 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 3.05 spacing = 9 in o.c. Tapplied = 401.0 lbs

Min Bolts Req'd Shear = 2.13 spacing = 13.5 in o.c. Vapplied = 330.4 lbs

Try using 7 bolts spaced at 6.50 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 0.74

Use 7 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 6.5 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBKD-80			
CURB RAIL THICKNESS: 0.0713 in 14 Gauge			
UNIT CLIP THICKNESS: 0.0713 in 14 Gauge			
# OF CLIPS (LONG SIDE) - 2 clips with 2 - #14 SMS screws each clip			
WEB STIFFENER: NOT REQUIRED			
# OF CLIPS (SHORT SIDE) - 2 clips with 2 - #14 SMS screws each clip			
WEB STIFFENER: NOT REQUIRED			
CORNER CONNECTION: Use 2 - 1/4" φ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts			
CURB ANCHORAGE	WOOD 5/8" φ lag screw w/ min. 3.5" embed (SGmin=0.43)	STEEL 5/8" φ A307 bolts	CONCRETE 3/4" φ thrd'd rod in Hilti HIT-HY 200 epoxy, min. 4" embed
LONG DIRECTION	5 @ 18.22 in o.c.	2 @ 68.88 in o.c.	7 @ 11.48 in o.c.
SHORT DIRECTION	4 @ 14.33 in o.c.	2 @ 39 in o.c.	7 @ 6.5 in o.c.

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Client: ProVent PV1806
Description: CBKD-80 11PV1806 KDKITPRD3715**
Unit: ZT,ZR,ZJ,ZH 037-150; ZF,ZH,ZJ,ZR,XP,DH,DM,DF,DR,BP 078-150

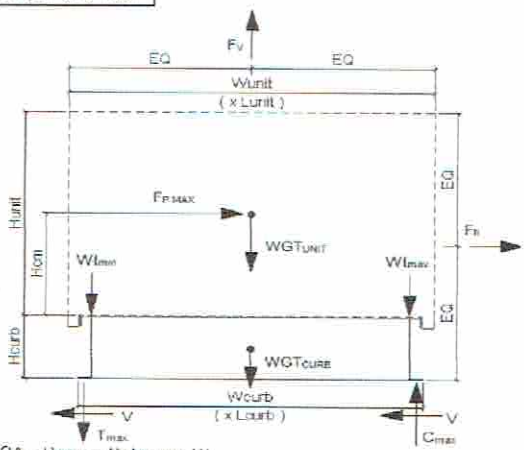
Curb Information

Hcurb =	11	in	(Height of curb)
Lcurb =	80.875	in	(Length of curb)
wcurb =	51	in	(Width of curb)
WGTcurb =	155	lbs	(Weight of curb)

Clips long side = 2 # Clips short side = 0

Unit Information

WGTunit =	1700	lbs	(Weight of Unit)
Wtmax =	329	lbs	(Maximum corner weight)
Wtmin =	191	lbs	(Minimum corner weight)
Hunit =	50.75	in	(Height of unit above curb)
Hcm =	25.375	in	(Height to center of mass)
Lunit =	89	in	(Length of unit)
Wunit =	59	in	(Width of unit)



Seismic Loading - 2015 IBC/2016 CBC

Ss =	2.85	(Worst case for majority of CA - Design Category D)
Fa =	1	(Interpolated from Table 11.4-1 ASCE 7-10)
Sms =	2.850	(Fa*Ss)
Sds =	1.900	(2/3*Sms)
Ip =	1.50	(Importance Factor Category III Building)
Fpmax =	1.425 Wp	(0.4*ap*Sds*Ip)*Wp*3/Rp
FpmaxASD =	1696 lbs (unit only)	(0.7*Fpmax) FpmaxASD = 1850 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)
$F_{h\ ASD\ trans}$ =	1415 lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	938 lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	1067 lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	1677 lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1109 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	565 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	612 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	1365 lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	797 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	155 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	203 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	1677	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1109	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1365	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	797	lbs	---> Along short edge of curb.

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

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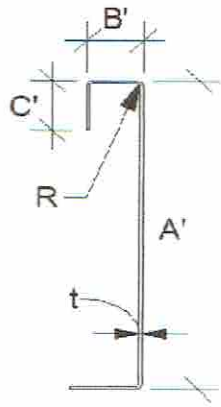
Curb Design

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



Calculate Section Properties of Curb

A'=	[11.000] in	a =	10.717 in	= A'-(2r+t)
B'=	[2.000] in	a'=	10.943 in	= A'-t
C'=	[0.000] in (0 if no lips)	b =	1.859 in	= B'-[r+t/2+a[r+t/2)]
a =	[0.000] (0 - no Lip; 1 w/ lip)	b'=	1.972 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 = 0.263 in (Distance between centroid and web centerline)
Ix = 12.703 in (Moment of Inertia about X-Axis)
Iy = 0.231 in (Moment of Inertia about Y-Axis)
A = 0.84 in²
rx = 3.90 in
ry = 0.526 in
rmin = 0.526 in

Axial Compression

Pu = 0.848 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 15.337 k
Fe = 50.29 ksi
λc = 1.00
Fn = 32.98 ksi

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

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

Ly = 50 in Lateral unbraced length
$k_y L_y/r_y$ = 76 (assume k=0.8)

Compression Check = O.K.

Check Web Crippling

h = 11 in -- Check limits:
t = 0.0566 in h/t = 194.35 ≤ 200 C = 4.00
N = 7.00 N/t = 123.67 ≤ 210 C_R = 0.14
Ω_w = 1.75 N/h = 0.636364 ≤ 2.0 C_N = 0.35
P_n = 1.674 k R/t = 1.50 ≤ 9.0 C_h = 0.02
P_n/Ω_w = 0.957 k

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

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

Long side: Pu_{Trans} = 0.838 k **O.K.** # clips = 2
Short side: Pu_{Long} = 0.683 k **O.K.** # clips = 2

Check Web Stiffener

16Ga x 3/4" x 7" (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 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 = 1.674 k Ae = 0.380 in²
Pn = 14.478 k Pn/Ω = 8.517 k

Not Req'd

Corner Connections

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

Tcrnmax = 424 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 554 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: 0.677 O.K. StressComb = 0.338 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35

Assume L/t > 25: 25*t = 1.415 in
Lreq'd = 0.472 in

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

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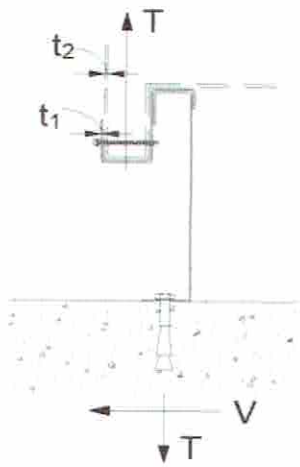
Connection Unit to Curb Clip | #14 | SMS screw | Ω = 3.0

t1 = 0.0566 in | Fu1 = 65 ksi
t2 = 0.1017 in (unit base rail thickness) | Fu2 = 65 ksi
d = 0.242 in (screw diameter) | dw = 0.500 in (nom. washer diameter)
t2/t1 = 1.8



For t2/t1 ≤ 1.0: | Pns = 2404 # | For t2/t1 ≥ 2.5: | Pns = 2404 #

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ = 4.36 k | $P_{ns} = 2.7t_1 dF_{u1}$ = 2.40 k | $P_{ns} = 2.7t_1 dF_{u1}$ = 2.40 k
$P_{ns} = 2.7t_1 dF_{u1}$ = 2.40 k | $P_{ns} = 2.7t_2 dF_{u2}$ = 4.32 k | $P_{ns} = 2.7t_2 dF_{u2}$ = 4.32 k
$P_{ns} = 2.7t_2 dF_{u2}$ = 4.32 k

Pns/Ω = 801 # <- Controls
Pss/Ω = 1045 #

Tension: Pnot = 1.360 k (screw pull-out strength) $P_{not} = 0.85t_c dF_{u2}$; $t_c = \min(t_1, t_2)$
Pnov = 2.759 k (screw pull-over strength) $P_{nov} = 1.5t_1 d_w F_{u1}$
Pts/Ω = 453 # <- Controls
Pts/Ω = 1220 # (full tensile screw capacity)

	Shear [k]	# clips	V_{clip} [k]	V_{allow} [lb]	# screws	spacing
Long side:	1.696	2	0.85	801 #	2	6.00 in
Short side:	1.696	2	0.85	801 #	2	6.00 in

clip width (in) = 7.00 | clip height = 1.4 in
min spacing = 0.73 in | edge distance = 0.5 in (min. 1.5d)
Check Block shear rupture: O.K. | thinnest part = 0.0566 AISI BSR applies
Fy = 50 ksi | Ω = 2.22 bolt/screw connection
Agv = 0.368 in² | Anv = 0.347 in² | Ant = 0.032 in²
Rn/Ω = 5.910 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.

Connection of Curb to Supporting Structure

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

Transverse: | $Uplift_{MAX}$ = 1874 lbs | $Shear_{MAX}$ = 925 lbs

$Compression_{SEISMIC}$ = 2494 lbs =(FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*wcurb)/wcurb
$Tension_{SEISMIC}$ = 1874 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ = 1032 lbs =(F$_{h\ transASD}$*(Hcm+Hcurb)+0.6*(WGT$_{unit+curb}$/2)*wcurb-F$_{vertASD}$*wcurb/2)/wcurb
$Tension_{WIND}$ = 986 lbs =(F$_{h\ transASD}$*(Hcm+Hcurb)-0.6*(WGT$_{unit+curb}$/2)*wcurb+F$_{vertASD}$*wcurb/2)/wcurb

Longitudinal: | $Uplift_{MAX}$ = 1387 lbs | $Shear_{MAX}$ = 925 lbs

$Compression_{SEISMIC}$ = 2006 lbs =(FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*Lcurb)/Lcurb
$Tension_{SEISMIC}$ = 1387 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ = 445 lbs =(F$_{h\ transASD}$*(Hcm+Hcurb)+0.6*(WGT$_{unit+curb}$/2)*Lcurb-F$_{vertASD}$*Lcurb/2)/Lcurb
$Tension_{WIND}$ = 399 lbs =(F$_{h\ transASD}$*(Hcm+Hcurb)-0.6*(WGT$_{unit+curb}$/2)*Lcurb+F$_{vertASD}$*Lcurb/2)/Lcurb

Wood Attachment: **Use 5/8" φ wood lag screws w/ 3.5" Min. Embed**

$Tall_{metal}$ = 946.67 lbs | $Vall_{metal}$ = 1043.33 lbs
Transverse: $Tall_{wood}$ = 1195.95 lbs | $Vall_{wood}$ = 1024 lbs
# of Screws Req'd for Uplift = 1.98 | COMBINED LOADING: 0.618 O.K.
# of Screws Req'd for Shear = 0.90 | Screw Spacing = 24.3 in o.c.
Total # of screws Required = 4

Use 5/8" φ wood lag screws @ 24.3 in o.c. along long side of curb w/ 3.5" Min. Embed

Longitudinal:
# of Screws Req'd for Uplift = 1.5 | COMBINED LOADING: 0.516 O.K.
# of Screws Req'd for Shear = 0.9 | Screw Spacing = 14.3 in o.c.
Total # of screws Required = 4

Use 5/8" φ wood lag screws @ 14.3 in o.c. along short side of curb w/ 3.5" Min. Embed

Steel Deck Attachment: **Use 5/8" φ A307 Bolts attached to steel angle below deck**

$Tall_{bolt}$ = 6903 lbs | $Vall_{bolt}$ = 3682 lbs
Transverse: 6903 lbs | 3682 lbs
# of Bolts Req'd for Uplift = 0.27 | COMBINED LOADING: 0.067 O.K.
# of Bolts Req'd for Shear = 0.25 | Bolt Spacing = 68.9 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 68.9 in o.c. along long side of curb

Longitudinal:
# of Bolts Req'd for Uplift = 0.20 | COMBINED LOADING: 0.053 O.K.
# of Bolts Req'd for Shear = 0.25 | Req'd Min Spacing = 39.0 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 39 in o.c. along short side of curb

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

Concrete Attachment: 3/4" φ Hilti Hit-HY 200 adhesive anchors w/ 4" embed

$Tall_{LRFD}$ = 1722 lbs $Vall_{LRFD}$ = 2032 lbs $\alpha = (1 + 0.2SDS)D + 2.5E = 1.87$

$Tall_{ASD} = Tall_{LRFD}/\alpha$ = 920.9 lbs $Vall_{ASD} = Vall_{LRFD}/\alpha$ = 1086.6 lbs $(D = 0.465, E = 0.535)$

Transverse: $Uplift_{MAX}$ = 3854 lbs $Shear_{MAX}$ = 2313 lbs

$Compression_{SEISMIC}$ = 4474 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*(WGT$_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 3854 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*(WGTunit+curb)

$Shear_{SEISMIC}$ = 2313 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 4.19 spacing = 14.22 in o.c. Tapplied = 550.6 lbs

Min Bolts Req'd Shear = 2.13 spacing = 28.4375 in o.c. Vapplied = 330.4 lbs

Try using 7 bolts
spaced at 11.48 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 0.90

Use 7 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 11.5 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 2635 lbs $Shear_{MAX}$ = 2313 lbs

$Compression_{SEISMIC}$ = 3255 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*(WGT$_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 2635 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*(WGTunit+curb)

$Shear_{SEISMIC}$ = 2313 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 2.86 spacing = 13.5 in o.c. Tapplied = 439.2 lbs

Min Bolts Req'd Shear = 2.13 spacing = 13.5 in o.c. Vapplied = 385.5 lbs

Try using 6 bolts
spaced at 7.80 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 0.83

Use 6 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 7.8 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBKD-80			
CURB RAIL THICKNESS: 0.0566 in 16 Gauge			
UNIT CLIP THICKNESS: 0.0566 in 16 Gauge			
# OF CLIPS (LONG SIDE) - 2 clips with 2 - #14 SMS screws each clip			
WEB STIFFENER: NOT REQUIRED			
# OF CLIPS (SHORT SIDE) - 2 clips with 2 - #14 SMS screws each clip			
WEB STIFFENER: NOT REQUIRED			
CORNER CONNECTION: Use 2 - 1/4" φ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts			
CURB ANCHORAGE	WOOD 5/8" φ lag screw w/ min. 3.5" embed (SGmin=0.43)	STEEL 5/8" φ A307 bolts	CONCRETE 3/4" φ thrd'd rod in Hilti HIT-HY 200 epoxy, min. 4" embed
LONG DIRECTION	4 @ 24.29 in o.c.	2 @ 68.88 in o.c.	7 @ 11.48 in o.c.
SHORT DIRECTION	4 @ 14.33 in o.c.	2 @ 39 in o.c.	6 @ 7.8 in o.c.

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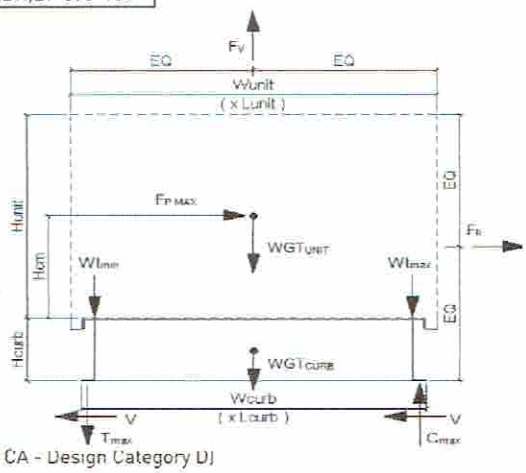
Client: ProVent PV1806
Description: CBKD-80 8" KDKITPRD3715**
Unit: ZT,ZR,ZJ,ZH 037-150; ZF,ZH,ZJ,ZR,XP,DH,DM,DF,DR,BP 078-150

Curb Information

Hcurb =	8	in	(Height of curb)
Lcurb =	80.875	in	(Length of curb)
wcurb =	51	in	(Width of curb)
WGTcurb =	155	lbs	(Weight of curb)
# Clips long side =	2	# Clips short side =	0

Unit Information

WGTunit =	1700	lbs	(Weight of Unit)
Wtmax =	329	lbs	(Maximum corner weight)
Wtmin =	191	lbs	(Minimum corner weight)
Hunit =	50.75	in	(Height of unit above curb)
Hcm =	25.375	in	(Height to center of mass)
Lunit =	89	in	(Length of unit)
Wunit =	59	in	(Width of unit)



Seismic Loading - 2015 IBC/2016 CBC

Ss =	2.85		(Worst case for majority of CA - Design Category D)
Fa =	1		(Interpolated from Table 11.4-1 ASCE 7-10)
Sms =	2.850		(Fa*Ss)
Sds =	1.900		(2/3*Sms)
Ip =	1.50		(Importance Factor Category III Building)
Fpmax =	1.425	Wp	(0.4*ap*Sds*Ip)*Wp*3/Rp
FpmaxASD =	1696	lbs	(0.7*Fpmax) FpmaxASD = 1850 lbs (unit and curb)
	(unit only)		

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)
$F_{h\ ASD\ trans}$ =	1346	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	892	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	1067	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	1677 lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1109 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	531 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	578 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	1365 lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS}]*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	797 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	141 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	188 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	1677	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1109	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1365	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	797	lbs	---> Along short edge of curb.

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

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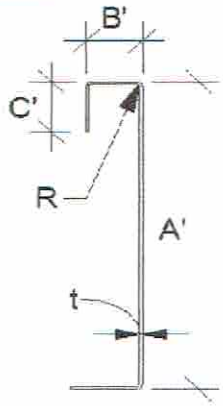
Curb Design

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



Calculate Section Properties of Curb

A'=	8.000 in	a =	7.717 in	= A'-(2r+t)
B'=	2.000 in	a'=	7.943 in	= A'-t
C'=	0.000 in (0 if no lips)	b =	1.859 in	= B'-[r+t/2+a(r+t/2)]
a =	0.000 (0 - no Lip; 1 w/ lip)	b'=	1.972 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 = 0.330 in (Distance between centroid and web centerline)
Ix = 5.799 in (Moment of Inertia about X-Axis)
Iy = 0.217 in (Moment of Inertia about Y-Axis)
A = 0.67 in²
rx = 2.95 in
ry = 0.570 in
rmin = 0.570 in

Axial Compression

Pu = 0.848 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 13.006 k
Fe = 59.07 ksi
λc = 0.92
Fn = 35.08 ksi

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

Ly = 50 in Lateral unbraced length
$k_y L_y/r_y$ = 70 (assume k=0.8)

Compression Check = O.K.

Check Web Crippling

h = 8 in -- Check limits: C = 4.00
t = 0.0566 in h/t = 141.34 ≤ 200 C_R = 0.14
N = 7.00 N/t = 123.67 ≤ 210 C_N = 0.35
Ω_w = 1.75 N/h = 0.875 ≤ 2.0 C_h = 0.02
P_n = 1.770 k R/t = 1.50 ≤ 9.0
P_n/Ω_w = 1.011 k

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

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

Long side: Pu_{Trans} = 0.838 k **O.K.** # clips = 2
Short side: Pu_{Long} = 0.683 k **O.K.** # clips = 2

Check Web Stiffener

16Ga x 3/4" x 7" (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 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 = 1.770 k Ae = 0.380 in²
Pn = 14.545 k Pn/Ω = 8.556 k

Not Req'd

Corner Connections

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

Tcrnmax = 424 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 554 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: 0.677 O.K. StressComb = 0.338 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.415 in
Lreq'd = 0.472 in

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

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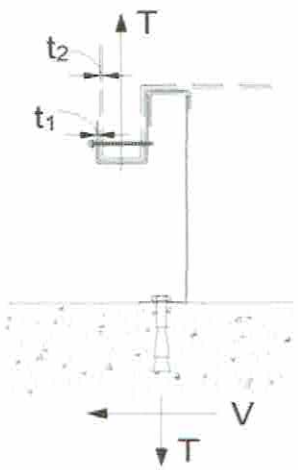
Connection Unit to Curb Clip | #14 SMS screw | Ω = 3.0

t1 = 0.0566 in | Fu1 = 65 ksi
t2 = 0.1017 in (unit base rail thickness) | Fu2 = 65 ksi
d = 0.242 in (screw diameter) | dw = 0.500 in (nom. washer diameter)
t2/t1 = 1.8



For t2/t1 ≤ 1.0: | Pns = 2404 # | For t2/t1 ≥ 2.5: | Pns = 2404 #

Shear:
$P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ = 4.36 k
$P_{ns} = 2.7t_1 dF_{u1}$ = 2.40 k | $P_{ns} = 2.7t_1 dF_{u1}$ = 2.40 k
$P_{ns} = 2.7t_2 dF_{u2}$ = 4.32 k | $P_{ns} = 2.7t_2 dF_{u2}$ = 4.32 k

Pns/Ω = 801 # <- Controls
Pss/Ω = 1045 #

Tension:
$P_{not} = 0.85t_c dF_{u2}$
$t_c = \min(t_1, t_2)$
$P_{nov} = 1.5t_1 d_w F_{u1}$

Pnot = 1.360 k (screw pull-out strength)
Pnov = 2.759 k (screw pull-over strength)
Pts/Ω = 453 # <- Controls
Pts/Ω = 1220 # (full tensile screw capacity)

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	1.696	2	0.85	801 #	2	6.00 in
Short side:	1.696	2	0.85	801 #	2	6.00 in

clip width (in) = 7.00 | clip height = 1.4 in
min spacing = 0.73 in | edge distance = 0.5 in (min. 1.5d)
Check Block shear rupture: O.K. | thinnest part = 0.0566 AISI BSR applies
Fy = 50 ksi | Ω = 2.22 bolt/screw connection
Agv = 0.368 in² | Anv = 0.347 in² | Ant = 0.032 in²
Rn/Ω = 5.910 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.

Connection of Curb to Supporting Structure

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

Transverse: | $Uplift_{MAX}$ = 1766 lbs | $Shear_{MAX}$ = 925 lbs

$Compression_{SEISMIC}$ = 2385 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb
$Tension_{SEISMIC}$ = 1766 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ = 904 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ = 858 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: | $Uplift_{MAX}$ = 1318 lbs | $Shear_{MAX}$ = 925 lbs

$Compression_{SEISMIC}$ = 1938 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb
$Tension_{SEISMIC}$ = 1318 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ = 391 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ = 345 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

Wood Attachment: **Use 5/8" φ wood lag screws w/ 3.5" Min. Embed**

$Tall_{metal}$ = 946.67 lbs | $Vall_{metal}$ = 1043.33 lbs
Transverse: $Tall_{wood}$ = 1195.95 lbs | $Vall_{wood}$ = 1024 lbs
# of Screws Req'd for Uplift = 1.87 | COMBINED LOADING: 0.595 O.K.
# of Screws Req'd for Shear = 0.90 | Screw Spacing = 24.3 in o.c.
Total # of screws Required = 4

Use 5/8" ϕ wood lag screws @ 24.3 in o.c. along long side of curb w/ 3.5" Min. Embed

Longitudinal:
# of Screws Req'd for Uplift = 1.4 | COMBINED LOADING: 0.501 O.K.
# of Screws Req'd for Shear = 0.9 | Screw Spacing = 14.3 in o.c.
Total # of screws Required = 4

Use 5/8" ϕ wood lag screws @ 14.3 in o.c. along short side of curb w/ 3.5" Min. Embed

Steel Deck Attachment: **Use 5/8" φ A307 Bolts attached to steel angle below deck**

$Tall_{bolt}$ = 6903 lbs | $Vall_{bolt}$ = 3682 lbs
Transverse: 6903 lbs | 3682 lbs
# of Bolts Req'd for Uplift = 0.26 | COMBINED LOADING: 0.064 O.K.
# of Bolts Req'd for Shear = 0.25 | Bolt Spacing = 68.9 in o.c.
Total # of Bolts Required = 2

Use 5/8" ϕ A307 Bolts attached to steel angle below deck @ 68.9 in o.c. along long side of curb

Longitudinal:
# of Bolts Req'd for Uplift = 0.19 | COMBINED LOADING: 0.051 O.K.
# of Bolts Req'd for Shear = 0.25 | Req'd Min Spacing = 39.0 in o.c.
Total # of Bolts Required = 2

Use 5/8" ϕ A307 Bolts attached to steel angle below deck @ 39 in o.c. along short side of curb

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

Concrete Attachment: 3/4" φ Hilti Hit-HY 200 adhesive anchors w/ 4" embed

$Tall_{LRFD}$ = 1722 lbs $Vall_{LRFD}$ = 2032 lbs $\alpha = (1 + 0.2SDS)D + 2.5E = 1.87$

$Tall_{ASD} = Tall_{LRFD}/\alpha$ = 920.9 lbs $Vall_{ASD} = Vall_{LRFD}/\alpha$ = 1086.6 lbs $(D = 0.465, E = 0.535)$

Transverse: $Uplift_{MAX}$ = 3582 lbs $Shear_{MAX}$ = 2313 lbs

$Compression_{SEISMIC}$ = 4201 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*[$WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 3582 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*[WGTunit+curb]

$Shear_{SEISMIC}$ = 2313 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 3.89 spacing = 18.96 in o.c. Tapplied = 597.0 lbs

Min Bolts Req'd Shear = 2.13 spacing = 28.4375 in o.c. Vapplied = 385.5 lbs

Try using 6 bolts spaced at 13.78 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 1.00

Use 6 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 13.8 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 2464 lbs $Shear_{MAX}$ = 2313 lbs

$Compression_{SEISMIC}$ = 3083 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 2464 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*[WGTunit+curb]

$Shear_{SEISMIC}$ = 2313 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 2.68 spacing = 13.5 in o.c. Tapplied = 410.6 lbs

Min Bolts Req'd Shear = 2.13 spacing = 13.5 in o.c. Vapplied = 385.5 lbs

Try using 6 bolts spaced at 7.80 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 0.80

Use 6 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 7.8 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBKD-80			
CURB RAIL THICKNESS: 0.0566 in 16 Gauge			
UNIT CLIP THICKNESS: 0.0566 in 16 Gauge			
# OF CLIPS (LONG SIDE) - 2 clips with 2 - #14 SMS screws each clip			
WEB STIFFENER: NOT REQUIRED			
# OF CLIPS (SHORT SIDE) - 2 clips with 2 - #14 SMS screws each clip			
WEB STIFFENER: NOT REQUIRED			
CORNER CONNECTION: Use 2 - 1/4" φ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts			
CURB ANCHORAGE	WOOD 5/8" φ lag screw w/ min. 3.5" embed (SGmin=0.43)	STEEL 5/8" φ A307 bolts	CONCRETE 3/4" φ thrd'd rod in Hilti HIT-HY 200 epoxy, min. 4" embed
LONG DIRECTION	4 @ 24.29 in o.c.	2 @ 68.88 in o.c.	6 @ 13.78 in o.c.
SHORT DIRECTION	4 @ 14.33 in o.c.	2 @ 39 in o.c.	6 @ 7.8 in o.c.