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

Structural Calculations
for
CBKD-135 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 Nos. CB-60.

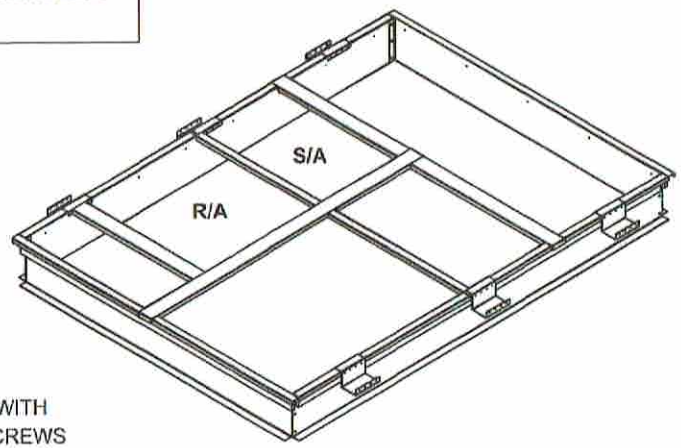
Will conform to seismic code requirements for knock-down or pre-assembled application. (Contact factory for assembled version.)

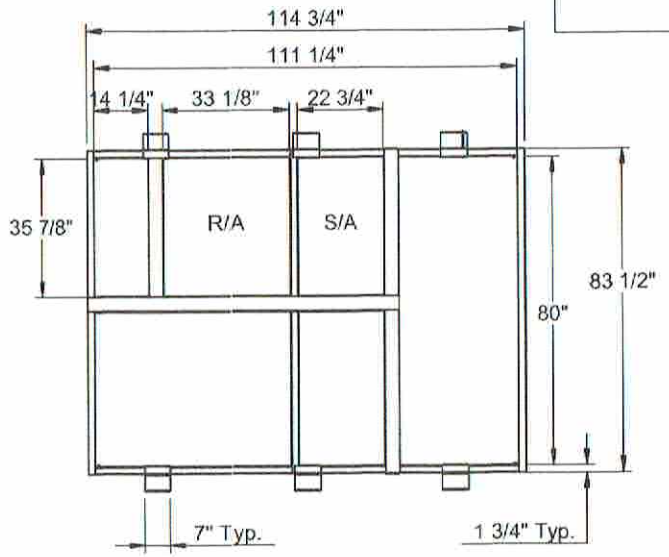
STRUCTURALLY CALCULATED KNOCK-DOWN ROOF CURBS FOR YORK UNITS

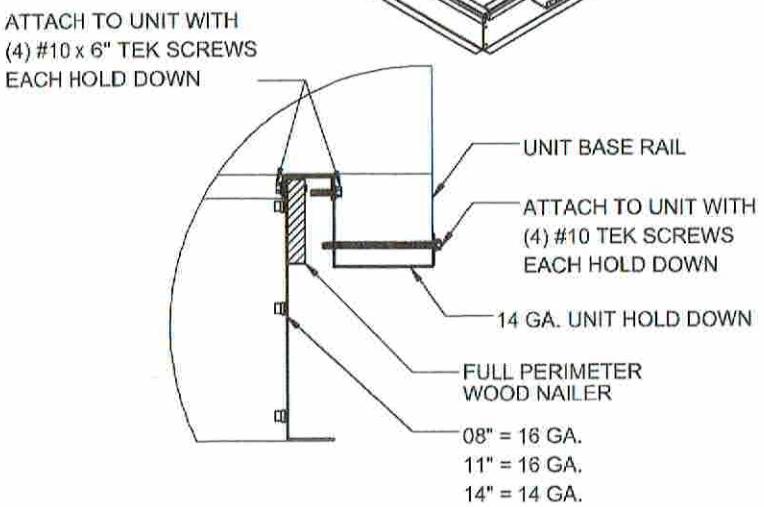
ZF 180

PROVENT P/N	A	EST. WEIGHT	SEISMIC KIT P/N
CBKDSLU18008	8"	115 Lbs.	KDKITSLU180
CBKDSLU18011	11"	129 Lbs.	
CBKDSLU18014	14"	144 Lbs	

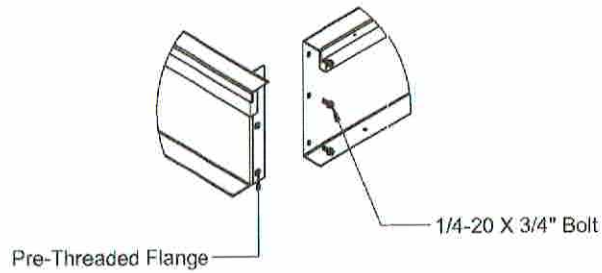
Meets seismic requirements for the following codes:
CBC 2016
IBC 2015







HOLD DOWN DETAIL



CROSS SECTION 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

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

FORM NO:	PART NUMBER:	
CBKD-135	KDKITSLU180	
DATE:	REV:	DRAWN BY:
1/7/2019	1	ALL

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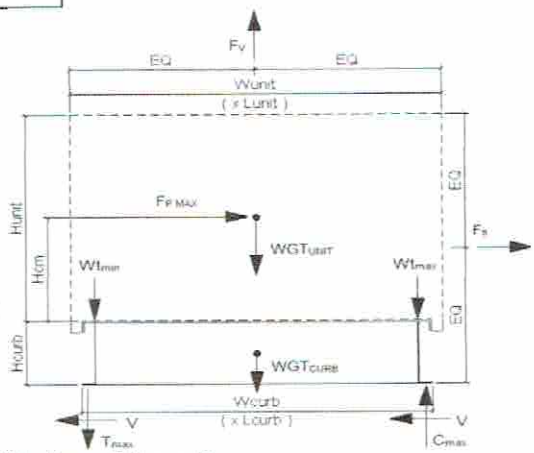
Client: ProVent PV1806
Description: CBKD-135 14" KDKITSLU180
Unit: ZF 180

Curb Information

Hcurb =	14	in	(Height of curb)
Lcurb =	114.75	in	(Length of curb)
wcurb =	83.5	in	(Width of curb)
WGTcurb =	192	lbs	(Weight of curb)
# Clips long side =	3	# Clips short side =	0

Unit Information

WGTunit =	2057	lbs	(Weight of Unit)
Wtmax =	498	lbs	(Maximum corner weight)
Wtmin =	438	lbs	(Minimum corner weight)
Hunit =	48.625	in	(Height of unit above curb)
Hcm =	24.3125	in	(Height to center of mass)
Lunit =	125.25	in	(Length of unit)
Wunit =	92	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 =	2052	lbs (unit only)	(0.7*Fpmax) FpmaxASD = 2243 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)
$F_{h\ ASD\ trans}$ =	2019	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	1483	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	2342	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	1858	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1171	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	15	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1122	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	1696	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS}]*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1009	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	-259	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	849	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	1858	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1171	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1696	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1009	lbs	---> Along short edge of curb.

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

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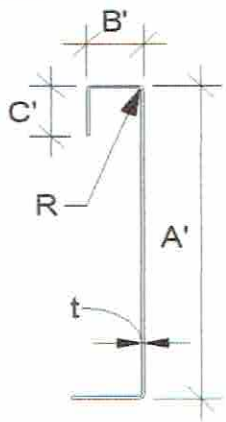
Curb Design

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'=	3.000 in	a'=	13.929 in	= A'-t	
C'=	1.000 in (0 if no lips)	b =	2.644 in	= B'-[r+t/2+α[r+t/2)]	
α =	1.000 (0 - no Lip; 1 w/ lip)	b'=	2.929 in	= B'-(t/2+αt/2)	
R =	0.1069 (Inside bend radius)	c =	0.822 in	= α[C'-(r+t/2)]	
t =	0.0713 in	c'=	0.964 in	= α(C'-t/2)	
r'=	0.143 in = R+t/2	u =	0.224 in	= πr/2	
x =	0.646 in (Distance between centroid and web centerline)				
Ix =	41.261 in (Moment of Inertia about X-Axis)				
Iy =	1.659 in (Moment of Inertia about Y-Axis)				
A =	1.53 in^2				
rx =	5.19 in				
ry =	1.041 in				
rmin =	1.041 in				

Axial Compression

Pu = 1.026 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 33.703 k
Fe = 90.03 ksi
λc = 0.75
Fn = 39.63 ksi
Ly = 74 in Lateral unbraced length
k_yL_y/r_y = 57 (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
Long side: Pu_{Trans} = 0.619 k **O.K.** # clips = 3
Short side: Pu_{Long} = 0.848 k **O.K.** # clips = 2

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

Check Web Stiffener

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 in^2
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 = 513 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 586 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: 0.741 O.K. StressComb = 0.371 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 0.396 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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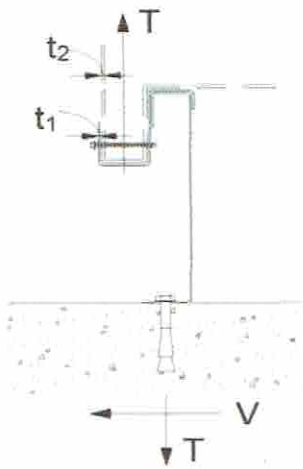
Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

t1 = 0.0713 in | 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: | Pns = 2377 # | For t2/t1 ≥ 2.5: | Pns = 2377 #

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ = 3.86 k | $P_{ns} = 2.7t_1 dF_{u1}$ = 2.38 k | $P_{ns} = 2.7t_1 dF_{u1}$ = 2.38 k
$P_{ns} = 2.7t_1 dF_{u1}$ = 2.38 k | $P_{ns} = 2.7t_2 dF_{u2}$ = 3.39 k | $P_{ns} = 2.7t_2 dF_{u2}$ = 3.39 k
$P_{ns} = 2.7t_2 dF_{u2}$ = 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:	2.052	3	0.68	540 #	2	6.00 in
Short side:	2.052	2	1.03	540 #	2	6.00 in

clip width (in) = 7.00 | clip height = 1.4 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 = 0.443 in² | Ant = 0.042 in²
Rn/Ω = 7.500 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: | $Uplift_{MAX}$ = 1702 lbs | $Shear_{MAX}$ = 1122 lbs

$Compression_{SEISMIC}$ = 2453 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb
$Tension_{SEISMIC}$ = 1702 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ = 430 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ = 1423 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: | $Uplift_{MAX}$ = 1421 lbs | $Shear_{MAX}$ = 1122 lbs

$Compression_{SEISMIC}$ = 2173 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb
$Tension_{SEISMIC}$ = 1421 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ = -1 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ = 991 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 = 1.80 | COMBINED LOADING: 0.630 O.K.
# of Screws Req'd for Shear = 1.10 | Screw Spacing = 35.6 in o.c.
Total # of screws Required = 4

Use 5/8" φ wood lag screws @ 35.6 in o.c. along long side of curb

Longitudinal:

# of Screws Req'd for Uplift = 1.5 | COMBINED LOADING: 0.457 O.K.
# of Screws Req'd for Shear = 1.1 | Screw Spacing = 18.9 in o.c.
Total # of screws Required = 5

Use 5/8" φ wood lag screws @ 18.9 in o.c. along short side of curb

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 = 0.25 | COMBINED LOADING: 0.074 O.K.
# of Bolts Req'd for Shear = 0.30 | Bolt Spacing = 102.8 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 102.8 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.21 | COMBINED LOADING: 0.066 O.K.
# of Bolts Req'd for Shear = 0.30 | Req'd Min Spacing = 71.5 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 71.5 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: $Uplift_{MAX}$ = 3246 lbs $Shear_{MAX}$ = 2804 lbs

$Compression_{SEISMIC}$ = 3997 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*[$WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 3246 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*(WGTunit+curb)

$Shear_{SEISMIC}$ = 2804 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 3.52 spacing = 30.25 in o.c. Tapplied = 360.6 lbs

Min Bolts Req'd Shear = 2.58 spacing = 45.375 in o.c. Vapplied = 311.6 lbs

Try using 9 bolts spaced at 12.84 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 0.68

Use 9 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 12.8 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 2545 lbs $Shear_{MAX}$ = 2804 lbs

$Compression_{SEISMIC}$ = 3296 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*[$WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 2545 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*(WGTunit+curb)

$Shear_{SEISMIC}$ = 2804 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 2.76 spacing = 29.75 in o.c. Tapplied = 363.6 lbs

Min Bolts Req'd Shear = 2.58 spacing = 29.75 in o.c. Vapplied = 400.6 lbs

Try using 7 bolts spaced at 11.92 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 0.76

Use 7 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 11.9 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY:	CBKD-135		
CURB RAIL THICKNESS:	0.0713 in 14 Gauge		
UNIT CLIP THICKNESS:	0.0713 in 14 Gauge		
# OF CLIPS (LONG SIDE) -	3 clips with 2 - #10 SMS screws each clip		
WEB STIFFENER:	NOT REQUIRED		
# OF CLIPS (SHORT SIDE) -	2 clips with 2 - #10 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 @ 35.58 in o.c.	2 @ 102.75 in o.c.	9 @ 12.84 in o.c.
SHORT DIRECTION	5 @ 18.88 in o.c.	2 @ 71.5 in o.c.	7 @ 11.92 in o.c.

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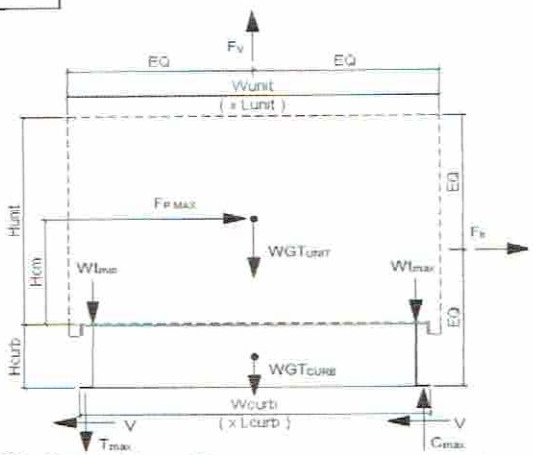
Client: ProVent PV1806
Description: CBKD-135 11" KDKITSLU180
Unit: ZF 180

Curb Information

Hcurb =	11	in	(Height of curb)
Lcurb =	114.75	in	(Length of curb)
wcurb =	83.5	in	(Width of curb)
WGTcurb =	192	lbs	(Weight of curb)
# Clips long side =	3	# Clips short side =	0

Unit Information

WGTunit =	2057	lbs	(Weight of Unit)
Wtmax =	498	lbs	(Maximum corner weight)
Wtmin =	438	lbs	(Minimum corner weight)
Hunit =	48.625	in	(Height of unit above curb)
Hcm =	24.3125	in	(Height to center of mass)
Lunit =	125.25	in	(Length of unit)
Wunit =	92	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 =	2052	lbs	(0.7*Fpmax) FpmaxASD = 2243 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)
$GCr_{(horiz)}$ =	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)
$F_{h\ ASD\ trans}$ =	1923	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	1412	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	2342	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	1858	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS}]*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1171	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	-14	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1094	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	1696	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS}]*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1009	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	-274	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	834	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	1858	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1171	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1696	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1009	lbs	---> Along short edge of curb.

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

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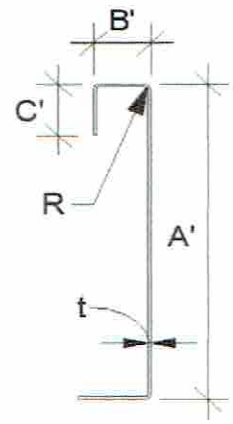
Curb Design

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'=	3.000 in	a'=	10.943 in	= A'-t
C'=	1.000 in (0 if no lips)	b =	2.717 in	= B'-[r+t/2+a(r+t/2)]
a =	1.000 (0 - no Lip; 1 w/ lip)	b'=	2.943 in	= B'-(t/2+at/2)
R =	0.0849 (Inside bend radius)	c =	0.859 in	= a[C'-(r+t/2)]
t =	0.0566 in	c'=	0.972 in	= a(C'-t/2)
r'=	0.113 in = R+t/2	u =	0.178 in	= πr/2

x = 0.759 in (Distance between centroid and web centerline)
Ix = 18.573 in (Moment of Inertia about X-Axis)
Iy = 1.261 in (Moment of Inertia about Y-Axis)
A = 1.05 in²
rx = 4.20 in
ry = 1.095 in
rmin = 1.095 in

Axial Compression

Pu = 1.026 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 23.678 k
Fe = 99.66 ksi
λc = 0.71
Fn = 40.53 ksi
Ly = 74 in Lateral unbraced length
k_yL_y/r_y = 54 (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 = 11 in -- Check limits: C = 4.00
t = 0.0566 in h/t = 194.35 ≤ 200 C_R = 0.14
N = 7.00 N/t = 123.67 ≤ 210 C_N = 0.35
Ω_w = 1.75 N/h = 0.636364 ≤ 2.0 C_h = 0.02
P_n = 1.674 k R/t = 1.50 ≤ 9.0 (See table C3.4.1-2, fastened to support, one flange, end loading)
P_n/Ω_w = 0.957 k
Long side: Pu_{Trans} = 0.619 k **O.K.** # clips = 3
Short side: Pu_{Long} = 0.848 k **O.K.** # clips = 2

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

Check Web Stiffener

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 = 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 = 513 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 586 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: 0.741 O.K. StressComb = 0.371 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.415 in
Lreq'd = 0.499 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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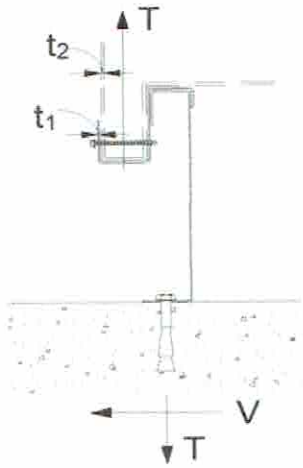
Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

t1 = 0.0566 in | 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 = 1.8



For t2/t1 ≤ 1.0: | Pns = 1887 #

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ = 3.86 k
$P_{ns} = 2.7t_1 dF_{u1}$ = 1.89 k
$P_{ns} = 2.7t_2 dF_{u2}$ = 3.39 k
Pns/Ω = 629 #
Pss/Ω = 540 # <- Controls

For t2/t1 ≥ 2.5: | Pns = 1887 #
$P_{ns} = 2.7t_1 dF_{u1}$ = 1.89 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 = 2.069 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:	2.052	3	0.68	540 #	2	6.00 in
Short side:	2.052	2	1.03	540 #	2	6.00 in

clip width (in) = 7.00 | clip height = 1.4 in
min spacing = 0.57 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 = 0.352 in² | Ant = 0.034 in²
Rn/Ω = 5.954 k | $R_n = 0.6F_yA_{gv} + F_uA_{nt} \le 0.6F_uA_{nv} + F_uA_{nt}$ (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: | $Uplift_{MAX}$ = 1621 lbs | $Shear_{MAX}$ = 1122 lbs

$Compression_{SEISMIC}$ = 2372 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb
$Tension_{SEISMIC}$ = 1621 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ = 317 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ = 1309 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: | $Uplift_{MAX}$ = 1363 lbs | $Shear_{MAX}$ = 1122 lbs

$Compression_{SEISMIC}$ = 2114 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb
$Tension_{SEISMIC}$ = 1363 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ = -62 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ = 931 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 = 1.71 | COMBINED LOADING: 0.613 O.K.
# of Screws Req'd for Shear = 1.10 | Screw Spacing = 35.6 in o.c.
Total # of screws Required = 4
Use 5/8" φ wood lag screws @ 35.6 in o.c. along long side of curb
Longitudinal:
# of Screws Req'd for Uplift = 1.4 | COMBINED LOADING: 0.447 O.K.
# of Screws Req'd for Shear = 1.1 | Screw Spacing = 18.9 in o.c.
Total # of screws Required = 5
Use 5/8" φ wood lag screws @ 18.9 in o.c. along short side of curb

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 = 0.23 | COMBINED LOADING: 0.072 O.K.
# of Bolts Req'd for Shear = 0.30 | Bolt Spacing = 102.8 in o.c.
Total # of Bolts Required = 2
Use 5/8" φ A307 Bolts attached to steel angle below deck @ 102.8 in o.c. along long side of curb
Longitudinal:
# of Bolts Req'd for Uplift = 0.20 | COMBINED LOADING: 0.065 O.K.
# of Bolts Req'd for Shear = 0.30 | Req'd Min Spacing = 71.5 in o.c.
Total # of Bolts Required = 2
Use 5/8" φ A307 Bolts attached to steel angle below deck @ 71.5 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: $Uplift_{MAX}$ = 3044 lbs $Shear_{MAX}$ = 2804 lbs

$Compression_{SEISMIC}$ = 3795 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 3044 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 2804 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 3.31 spacing = 30.25 in o.c. Tapplied = 338.3 lbs

Min Bolts Req'd Shear = 2.58 spacing = 45.375 in o.c. Vapplied = 311.6 lbs

Try using 9 bolts spaced at 12.84 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 0.65

Use 9 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 12.8 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 2398 lbs $Shear_{MAX}$ = 2804 lbs

$Compression_{SEISMIC}$ = 3150 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 2398 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 2804 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 2.60 spacing = 29.75 in o.c. Tapplied = 342.6 lbs

Min Bolts Req'd Shear = 2.58 spacing = 29.75 in o.c. Vapplied = 400.6 lbs

Try using 7 bolts spaced at 11.92 in o.c.

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

Use 7 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 11.9 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBKD-135			
CURB RAIL THICKNESS: 0.0566 in 16 Gauge			
UNIT CLIP THICKNESS: 0.0566 in 16 Gauge			
# OF CLIPS (LONG SIDE) - 3 clips with 2 - #10 SMS screws each clip **WEB STIFFENER:** NOT REQUIRED			
# OF CLIPS (SHORT SIDE) - 2 clips with 2 - #10 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 @ 35.58 in o.c.	2 @ 102.75 in o.c.	9 @ 12.84 in o.c.
SHORT DIRECTION	5 @ 18.88 in o.c.	2 @ 71.5 in o.c.	7 @ 11.92 in o.c.

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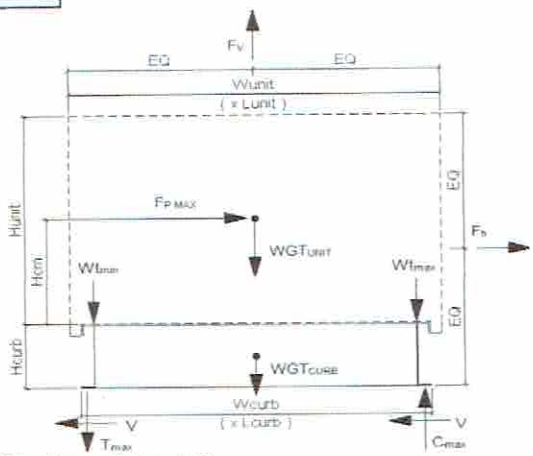
Client: ProVent PV1806
Description: CBKD-135 8" KDKITSLU180
Unit: ZF 180

Curb Information

Hcurb =	8	in	(Height of curb)
Lcurb =	114.75	in	(Length of curb)
wcurb =	83.5	in	(Width of curb)
WGTcurb =	192	lbs	(Weight of curb)
# Clips long side =	3	# Clips short side =	0

Unit Information

WGTunit =	2057	lbs	(Weight of Unit)
Wtmax =	498	lbs	(Maximum corner weight)
Wtmin =	438	lbs	(Minimum corner weight)
Hunit =	48.625	in	(Height of unit above curb)
Hcm =	24.3125	in	(Height to center of mass)
Lunit =	125.25	in	(Length of unit)
Wunit =	92	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 =	2052	lbs (unit only)	(0.7*Fpmax) FpmaxASD = 2243 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)
$F_{h\ ASD\ trans}$ =	1826	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	1341	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	2342	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	1858	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS}]*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1171	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	-42	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1066	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	1696	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS}]*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1009	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	-289	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	819	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	1858	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1171	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1696	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1009	lbs	---> Along short edge of curb.

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

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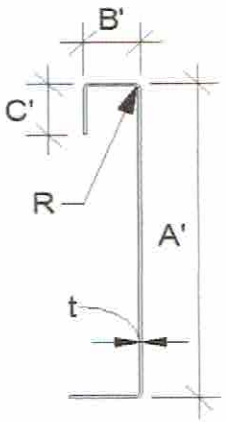
Curb Design

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' =	3.000 in	a' =	7.943 in	= A'-t
C' =	1.000 in (0 if no lips)	b =	2.717 in	= B'-(r+t/2+a(r+t/2)]
a =	1.000 (0 - no Lip; 1 w/ lip)	b' =	2.943 in	= B'-(t/2+at/2)
R =	0.0849 (Inside bend radius)	c =	0.859 in	= a[C'-(r+t/2)]
t =	0.0566 in	c' =	0.972 in	= a(C'-t/2)
r' =	0.113 in = R+t/2	u =	0.178 in	= πr/2

x = 0.905 in (Distance between centroid and web centerline)
Ix = 8.792 in (Moment of Inertia about X-Axis)
Iy = 1.145 in (Moment of Inertia about Y-Axis)
A = 0.88 in²
rx = 3.16 in
ry = 1.139 in
rmin = 1.139 in

Axial Compression

Pu = 1.026 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 20.174 k
Fe = 107.86 ksi
λc = 0.68
Fn = 41.18 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 = 74 in Lateral unbraced length
k_yL_y/r_y = 52 (assume k=0.8)

Compression Check = O.K.

Check Web Crippling

h = 8 in -- Check limits:
t = 0.0566 in h/t = 141.34 ≤ 200 C = 4.00
N = 7.00 N/t = 123.67 ≤ 210 C_R = 0.14
Ω_w = 1.75 N/h = 0.875 ≤ 2.0 C_N = 0.35
P_n = 1.770 k R/t = 1.50 ≤ 9.0 C_h = 0.02
P_n/Ω_w = 1.011 k (See table C3.4.1-2, fastened to support, one flange, end loading)
Long side: Pu_{Trans} = 0.619 k **O.K.** # clips = 3
Short side: Pu_{Long} = 0.848 k **O.K.** # clips = 2

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

Check Web Stiffener

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 = 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 = 513 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 586 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: 0.741 O.K. StressComb = 0.371 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.415 in
Lreq'd = 0.499 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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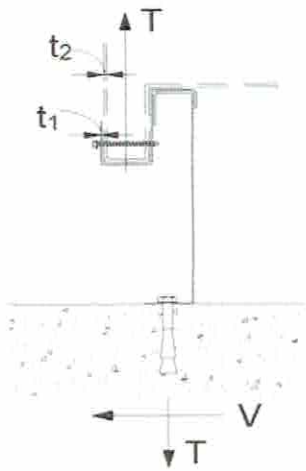
Connection Unit to Curb Clip — #10 SMS screw — Ω = 3.0

t1 = 0.0566 in — 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 = 1.8



For t2/t1 ≤ 1.0: — Pns = 1887 # — For t2/t1 ≥ 2.5: — Pns = 1887 #

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ = 3.86 k

$P_{ns} = 2.7t_1 dF_{u1}$ = 1.89 k — $P_{ns} = 2.7t_1 dF_{u1}$ = 1.89 k

$P_{ns} = 2.7t_2 dF_{u2}$ = 3.39 k — $P_{ns} = 2.7t_2 dF_{u2}$ = 3.39 k

Pns/Ω = 629 #

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 = 2.069 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:	2.052	3	0.68	540 #	2	6.00 in
Short side:	2.052	2	1.03	540 #	2	6.00 in

clip width (in) = 7.00 — clip height = 1.4 in

min spacing = 0.57 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 = 0.352 in² — Ant = 0.034 in²

Rn/Ω = 5.954 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: — $Uplift_{MAX}$ = 1541 lbs — $Shear_{MAX}$ = 1122 lbs

$Compression_{SEISMIC}$ = 2292 lbs — =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 1541 lbs — =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 210 lbs — =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb

$Tension_{WIND}$ = 1203 lbs — =[$F_{h\,transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: — $Uplift_{MAX}$ = 1304 lbs — $Shear_{MAX}$ = 1122 lbs

$Compression_{SEISMIC}$ = 2055 lbs — =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 1304 lbs — =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = -119 lbs — =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb

$Tension_{WIND}$ = 874 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 = 1.63 — COMBINED LOADING: 0.596 O.K.

# of Screws Req'd for Shear = 1.10 — Screw Spacing = 35.6 in o.c.

Total # of screws Required = 4

Use 5/8" φ wood lag screws @ 35.6 in o.c. along long side of curb

Longitudinal:

# of Screws Req'd for Uplift = 1.4 — COMBINED LOADING: 0.437 O.K.

# of Screws Req'd for Shear = 1.1 — Screw Spacing = 18.9 in o.c.

Total # of screws Required = 5

Use 5/8" φ wood lag screws @ 18.9 in o.c. along short side of curb

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 = 0.22 — COMBINED LOADING: 0.069 O.K.

# of Bolts Req'd for Shear = 0.30 — Bolt Spacing = 102.8 in o.c.

Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 102.8 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.19 — COMBINED LOADING: 0.063 O.K.

# of Bolts Req'd for Shear = 0.30 — Req'd Min Spacing = 71.5 in o.c.

Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 71.5 in o.c. along short side of curb

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For Concrete anchorage: SEISMIC (0.6-0.14SDS)D + 0.7Ω_oE (Ω_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: $Uplift_{MAX}$ = 2843 lbs $Shear_{MAX}$ = 2804 lbs

$Compression_{SEISMIC}$ = 3594 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 2843 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 2804 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 3.09 spacing = 30.25 in o.c. Tapplied = 315.9 lbs

Min Bolts Req'd Shear = 2.58 spacing = 45.375 in o.c. Vapplied = 311.6 lbs

Try using 9 bolts spaced at 12.84 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aptlied}}{V_{allow,ASD}} \leq 1.2$ = 0.63

Use 9 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 12.8 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 2252 lbs $Shear_{MAX}$ = 2804 lbs

$Compression_{SEISMIC}$ = 3003 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 2252 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 2804 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 2.45 spacing = 29.75 in o.c. Tapplied = 321.7 lbs

Min Bolts Req'd Shear = 2.58 spacing = 29.75 in o.c. Vapplied = 400.6 lbs

Try using 7 bolts spaced at 11.92 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aptlied}}{V_{allow,ASD}} \leq 1.2$ = 0.72

Use 7 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 11.9 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBKD-135

CURB RAIL THICKNESS: 0.0566 in 16 Gauge

UNIT CLIP THICKNESS: 0.0566 in 16 Gauge

 # OF CLIPS (LONG SIDE) - 3 clips with 2 - #10 SMS screws each clip

WEB STIFFENER: NOT REQUIRED

 # OF CLIPS (SHORT SIDE) - 2 clips with 2 - #10 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	STEEL	CONCRETE
	5/8" ϕ lag screw w/ min. 3.5" embed (SGmin=0.43)	5/8" ϕ A307 bolts	3/4" ϕ thrd'd rod in Hilti HIT-HY 200 epoxy, min. 4" embed
LONG DIRECTION	4 @ 35.58 in o.c.	2 @ 102.75 in o.c.	9 @ 12.84 in o.c.
SHORT DIRECTION	5 @ 18.88 in o.c.	2 @ 71.5 in o.c.	7 @ 11.92 in o.c.