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

Structural Calculations
for
CBKD-136 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

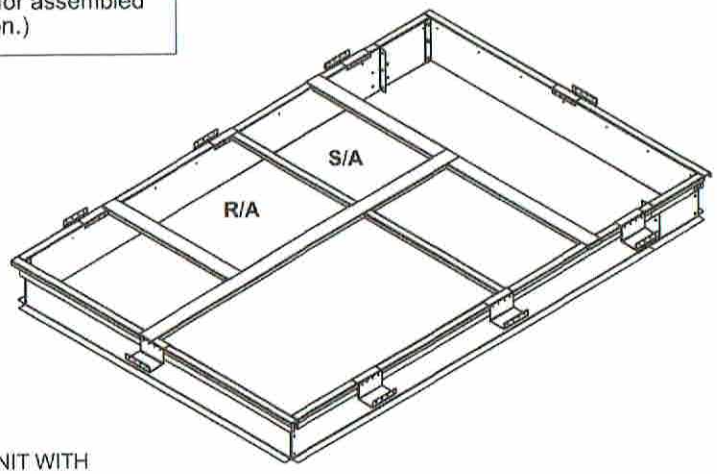
ZJ, ZR 180-300; XP 180-240
ZF 210-300

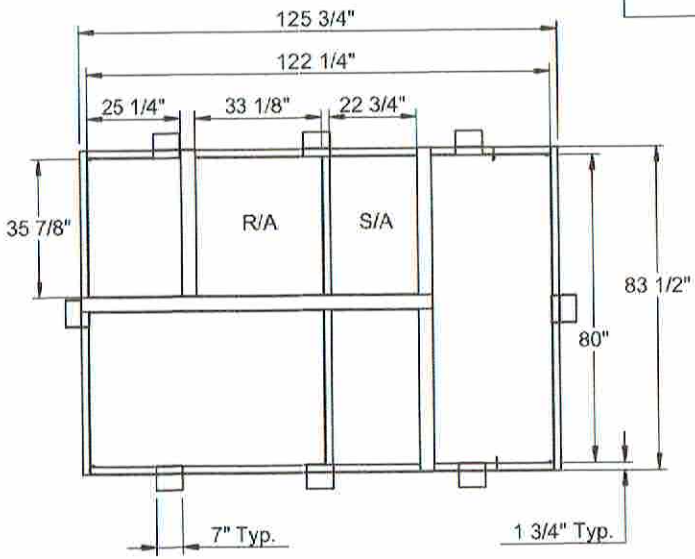
PROVENT P/N	A	EST. WEIGHT
CBKDSLM183008	8"	125 Lbs.
CBKDSLM183011	11"	139 Lbs.
CBKDSLM183014	14"	154 Lbs

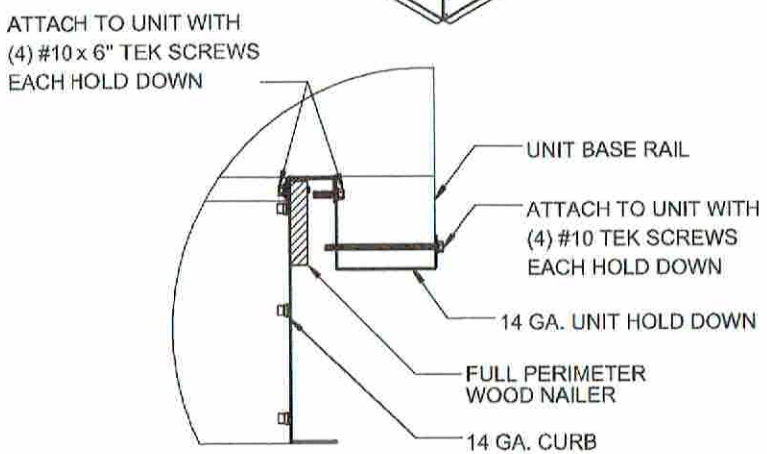
SEISMIC KIT P/N

KDKITSLM1830

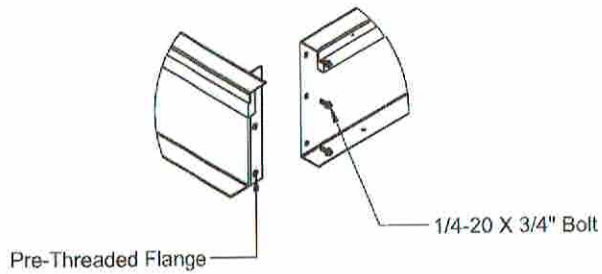
Meets seismic requirements for the following codes:
CBC 2016
IBC 2015







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-136	KDKITSLM1830

DATE:	REV:	DRAWN BY:
1/7/2019	1	ALL

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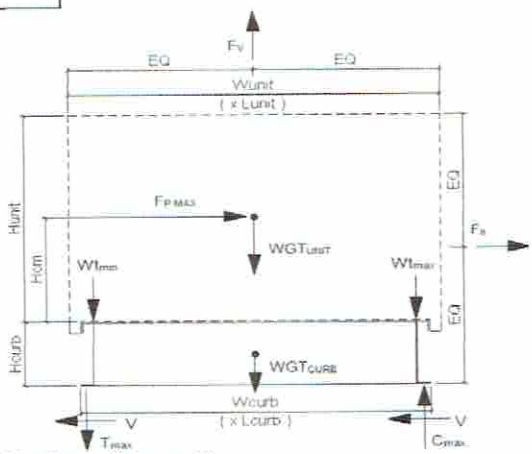
Client: ProVent PV1806
Description: CBKD-136 14" KDKITSLM1830
Unit: ZJ,ZR 180-300; ZF 210-300; XP 180-240

Curb Information

Hcurb =	14	in	(Height of curb)
Lcurb =	125.75	in	(Length of curb)
wcurb =	83.5	in	(Width of curb)
WGTcurb =	192	lbs	(Weight of curb)
# Clips long side =	3	# Clips short side =	1

Unit Information

WGTunit =	3061.3	lbs	(Weight of Unit)
Wtmax =	908	lbs	(Maximum corner weight)
Wtmin =	306	lbs	(Minimum corner weight)
Hunit =	52.625	in	(Height of unit above curb)
Hcm =	26.3125	in	(Height to center of mass)
Lunit =	136.25	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 =	3054	lbs	(0.7*Fpmax)
	(unit only)		FpmaxASD = 3245 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)
$F_{h\ ASD\ trans}$ =	2337	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	1578	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	2548	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	3261	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	2239	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	552	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1263	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	2938	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1916	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	146	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	857	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	3261	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	2239	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	2938	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1916	lbs	---> Along short edge of curb.

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

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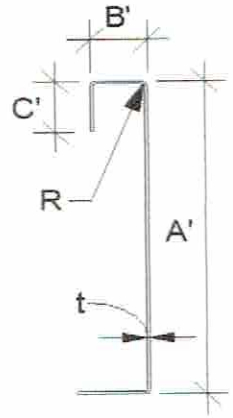
Curb Design

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

E = 29500 ksi



Calculate Section Properties of Curb

A' =	[14.000] in	a =	13.717 in	= A'-(2r+t)
B' =	[3.000] in	a' =	13.943 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 = 0.653 in (Distance between centroid and web centerline)

Ix = 33.089 in (Moment of Inertia about X-Axis)

Iy = 1.346 in (Moment of Inertia about Y-Axis)

A = 1.22 in²

rx = 5.20 in

ry = 1.050 in

rmin = 1.050 in

Axial Compression

Pu = 1.527 k (Max Axial Comp) Ωc = 1.80

Pn/Ωc = 25.270 k

Fe = 71.03 ksi

λc = 0.84

Fn = 37.24 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 = 84 in Lateral unbraced length

$k_y L_y/r_y$ = 64 (assume k=0.8)

Compression Check = O.K.

Check Web Crippling

h = 14 in -- Check limits:

t = 0.0566 in h/t = 247.35 ≤ 200 C = 4.00

N = 7.00 N/t = 123.67 ≤ 210 C_R = 0.14

Ω_w = 1.75 N/h = 0.5 ≤ 2.0 C_N = 0.35

P_n = 1.591 k R/t = 1.50 ≤ 9.0 C_h = 0.02

[See table C3.4.1-2, fastened to support, one flange, end loading]

P_n/Ω_w = 0.909 k

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

Long side: Pu_{Trans} = 1.087 k **web stiffener REQ'D** # clips = 3

Short side: Pu_{Long} = 0.979 k **web stiffener REQ'D** # clips = 3

*****h/t > 200; use web stiffeners**

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 = 1.591 k Ae = 0.380 in²

Pn = 14.420 k Pn/Ω = 8.483 k

O.K.

Corner Connections

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

Tcrnmax = 763 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)

Vcrnmax = 1119 lbs (Max Ten/2 corner connections per side)

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

# of Bolts required for Tension = 0.3

# of Bolts required for Shear = 1.0 ***If combined fails:

# of Bolts Used = [2.0] USE --> 3.0

Check Combined Stress in Bolts & Inserts: 0.665 O.K. StressComb = 0.443 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35

Assume L/t > 25: 25*t = 1.415 in

Lreq'd = 0.953 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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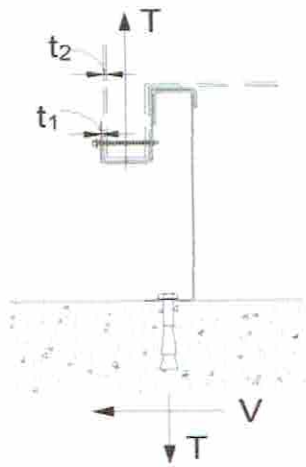
Connection Unit to Curb Clip — #10 SMS screw — Ω = 3.0

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:	3.054	3	1.02	540 #	2	6.00 in
Short side:	3.054	3	1.02	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: — $Uplift_{MAX}$ = 2539 lbs — $Shear_{MAX}$ = 1623 lbs

$Compression_{SEISMIC}$ = 3626 lbs — =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 2539 lbs — =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 830 lbs — =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb

$Tension_{WIND}$ = 1426 lbs — =[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: — $Uplift_{MAX}$ = 2013 lbs — $Shear_{MAX}$ = 1623 lbs

$Compression_{SEISMIC}$ = 3100 lbs — =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 2013 lbs — =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 208 lbs — =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb

$Tension_{WIND}$ = 804 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**

Transverse: — $Tall_{metal}$ = 946.67 lbs — $Vall_{metal}$ = 1043.33 lbs

$Tall_{wood}$ = 1195.95 lbs — $Vall_{wood}$ = 1024 lbs

# of Screws Req'd for Uplift = 2.68 — COMBINED LOADING: 0.927 O.K.

# of Screws Req'd for Shear = 1.58 — Screw Spacing = 39.3 in o.c.

Total # of screws Required = 4

Use 5/8" ϕ wood lag screws @ 39.3 in o.c. along long side of curb

Longitudinal:

# of Screws Req'd for Uplift = 2.1 — COMBINED LOADING: 0.817 O.K.

# of Screws Req'd for Shear = 1.6 — Screw Spacing = 25.2 in o.c.

Total # of screws Required = 4

Use 5/8" ϕ wood lag screws @ 25.2 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 = 0.37 — COMBINED LOADING: 0.140 O.K.

# of Bolts Req'd for Shear = 0.44 — Bolt Spacing = 113.8 in o.c.

Total # of Bolts Required = 2

Use 5/8" ϕ A307 Bolts attached to steel angle below deck @ 113.8 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.29 — COMBINED LOADING: 0.121 O.K.

# of Bolts Req'd for Shear = 0.44 — 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: $Uplift_{MAX}$ = 4890 lbs $Shear_{MAX}$ = 4056 lbs

$Compression_{SEISMIC}$ = 5976 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 4890 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 4056 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 5.31 spacing = 20.35 in o.c. Tapplied = 698.5 lbs

Min Bolts Req'd Shear = 3.73 spacing = 33.91667 in o.c. Vapplied = 579.5 lbs

Try using 7 bolts spaced at 18.96 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 1.29

Use 7 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 19 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 3574 lbs $Shear_{MAX}$ = 4056 lbs

$Compression_{SEISMIC}$ = 4660 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 3574 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 4056 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 3.88 spacing = 19.83333 in o.c. Tapplied = 714.7 lbs

Min Bolts Req'd Shear = 3.73 spacing = 19.83333 in o.c. Vapplied = 811.3 lbs

Try using 5 bolts spaced at 17.88 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 1.52

Use 5 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 17.9 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBKD-136			
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: 16Ga x 3/4" x 7" (C-channel) stiffener at each clip			
# OF CLIPS (SHORT SIDE) - 3 clips with 2 - #10 SMS screws each clip			
WEB STIFFENER: 16Ga x 3/4" x 7" (C-channel) stiffener at each clip			
CORNER CONNECTION: Use 3 - 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 @ 39.25 in o.c.	2 @ 113.75 in o.c.	7 @ 18.96 in o.c.
SHORT DIRECTION	4 @ 25.17 in o.c.	2 @ 71.5 in o.c.	5 @ 17.88 in o.c.

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Client: ProVent PV1806
Description: CBKD-136 11" KDKITSLM1830
Unit: ZJ,ZR 180-300; ZF 210-300; XP 180-240

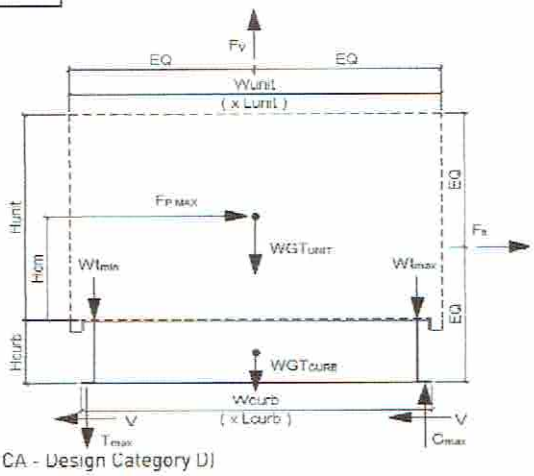
Curb Information

Hcurb =	11	in	(Height of curb)
Lcurb =	125.75	in	(Length of curb)
wcurb =	83.5	in	(Width of curb)
WGTcurb =	192	lbs	(Weight of curb)

Clips long side = 3 # Clips short side = 1

Unit Information

WGTunit =	3061.3	lbs	(Weight of Unit)
Wtmax =	908	lbs	(Maximum corner weight)
Wtmin =	306	lbs	(Minimum corner weight)
Hunit =	52.625	in	(Height of unit above curb)
Hcm =	26.3125	in	(Height to center of mass)
Lunit =	136.25	in	(Length of unit)
Wuhit =	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 =	3054	lbs	(0.7*Fpmax) FpmaxASD = 3245 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)
$F_{h\ ASD\ trans}$ =	2232	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	1507	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	2548	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	3261	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	2239	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	519	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1230	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	2938	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1916	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	131	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	842	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	3261	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	2239	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	2938	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1916	lbs	---> Along short edge of curb.

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

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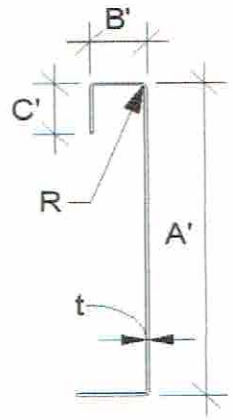
Curb Design

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



Calculate Section Properties of Curb

A'=	[11.000] in	a =	10.644 in	= A'-(2r+t)
B'=	[3.000] in	a'=	10.929 in	= A'-t
C'=	[1.000] in (0 if no lips)	b =	2.644 in	= B'-[r+t/2+a(r+t/2)]
a =	[1.000] (0 - no Lip; 1 w/ lip)	b'=	2.929 in	= B'-(t/2+at/2)
R =	0.1069 (Inside bend radius)	c =	0.822 in	= a[C'-(r+t/2)]
t =	0.0713 in	c'=	0.964 in	= a(C'-t/2)
r'=	0.143 in = R+t/2	u =	0.224 in	= πr/2

x = 0.751 in (Distance between centroid and web centerline)
Ix = 23.130 in (Moment of Inertia about X-Axis)
Iy = 1.555 in (Moment of Inertia about Y-Axis)
A = 1.32 in^2
rx = 4.19 in
ry = 1.087 in
rmin = 1.087 in

Axial Compression

Pu = 1.527 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 27.790 k
Fe = 76.14 ksi
λc = 0.81
Fn = 37.98 ksi
Ly = 84 in Lateral unbraced length
k_yL_y/r_y = 62 (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:
t = 0.0713 in h/t = 154.28 ≤ 200 C = 4.00
N = 7.00 N/t = 98.18 ≤ 210 C_R = 0.14
Ω = 1.75 N/h = 0.636364 ≤ 2.0 C_N = 0.35
P_n = 2.529 k R/t = 1.50 ≤ 9.0 C_h = 0.02
P_n/Ω_w = 1.445 k
Long side: Pu_{Trans} = 1.087 k **O.K.** # clips = 3
Short side: Pu_{Long} = 0.979 k **O.K.** # clips = 3

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

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

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 = 2.529 k Ae = 0.380 in^2
Pn = 15.077 k Pn/Ω = 8.869 k

Not Req'd

Corner Connections

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

Tcrnmax = 763 lbs Max[$F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections]
Vcrnmax = 1119 lbs (Max Ten/2 corner connections per side)

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

# of Bolts required for Tension = 0.3
# of Bolts required for Shear = 1.0 ***If combined fails:
# of Bolts Used = [2.0] USE --> 3.0
Check Combined Stress in Bolts & Inserts: 0.665 O.K. StressComb = 0.443 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 0.757 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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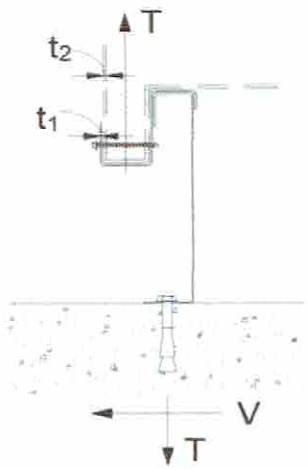
Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

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:
Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ Pns = 2377 # / 3.86 k
$P_{ns} = 2.7t_1dF_{u1}$ 2.38 k
$P_{ns} = 2.7t_2dF_{u2}$ 3.39 k
Pns/Ω = 792 #
Pss/Ω = 540 # <- Controls

For t2/t1 ≥ 2.5:
Pns = 2377 #
$P_{ns} = 2.7t_1dF_{u1}$ 2.38 k
$P_{ns} = 2.7t_2dF_{u2}$ 3.39 k

Tension: Pnot = 1.068 k (screw pull-out strength) $P_{not} = 0.85t_c dF_{u2}$, $t_c = \min(t_1, t_2)$
Pnov = 2.607 k (screw pull-over strength) $P_{nov} = 1.5t_1 d_w F_{u1}$
Pts/Ω = 356 # <- Controls
Pts/Ω = 820 # (full tensile screw capacity)

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	3.054	3	1.02	540 #	2	6.00 in
Short side:	3.054	3	1.02	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 | $R_n = 0.6F_yA_{gv} + F_uA_{nt} \le 0.6F_uA_{nv} + F_uA_{nt}$ (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: $Uplift_{MAX}$ = 2423 lbs | $Shear_{MAX}$ = 1623 lbs

$Compression_{SEISMIC}$ =	3509 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*wcurb]/wcurb
$Tension_{SEISMIC}$ =	2423 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ =	699 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*(WGT$_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1295 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*(WGT$_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: $Uplift_{MAX}$ = 1936 lbs | $Shear_{MAX}$ = 1623 lbs

$Compression_{SEISMIC}$ =	3022 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1936 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ =	149 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*(WGT$_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	745 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**

Transverse: $Tall_{metal}$ = 946.67 lbs | $Vall_{metal}$ = 1043.33 lbs
$Tall_{wood}$ = 1195.95 lbs | $Vall_{wood}$ = 1024 lbs
# of Screws Req'd for Uplift = 2.56 | COMBINED LOADING: 0.903 O.K.
# of Screws Req'd for Shear = 1.58 | Screw Spacing = 39.3 in o.c.
Total # of screws Required = 4

Use 5/8" ϕ wood lag screws @ 39.3 in o.c. along long side of curb

Longitudinal:
# of Screws Req'd for Uplift = 2.0 | COMBINED LOADING: 0.801 O.K.
# of Screws Req'd for Shear = 1.6 | Screw Spacing = 25.2 in o.c.
Total # of screws Required = 4

Use 5/8" ϕ wood lag screws @ 25.2 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 = 0.35 | COMBINED LOADING: 0.135 O.K.
# of Bolts Req'd for Shear = 0.44 | Bolt Spacing = 113.8 in o.c.
Total # of Bolts Required = 2

Use 5/8" ϕ A307 Bolts attached to steel angle below deck @ 113.8 in o.c. along long side of curb

Longitudinal:
# of Bolts Req'd for Uplift = 0.28 | COMBINED LOADING: 0.118 O.K.
# of Bolts Req'd for Shear = 0.44 | 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: $Uplift_{MAX}$ = 4598 lbs $Shear_{MAX}$ = 4056 lbs

$Compression_{SEISMIC}$ = 5685 lbs =[2.5*FpmaxASD*(Hcm+Hcurb]+[1+0.14S_{DS}]*[$WGT_{unit+curb}$/2]*wcurb]/wcurb

$Tension_{SEISMIC}$ = 4598 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*[WGTunit+curb]

$Shear_{SEISMIC}$ = 4056 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 4.99 spacing = 25.44 in o.c. Tapplied = 766.3 lbs

Min Bolts Req'd Shear = 3.73 spacing = 33.91667 in o.c. Vapplied = 676.1 lbs

Try using 6 bolts spaced at 22.75 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 1.45

Use 6 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 22.8 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 3380 lbs $Shear_{MAX}$ = 4056 lbs

$Compression_{SEISMIC}$ = 4467 lbs =[2.5*FpmaxASD*(Hcm+Hcurb]+[1+0.14S_{DS}]*[$WGT_{unit+curb}$/2]*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 3380 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*[WGTunit+curb]

$Shear_{SEISMIC}$ = 4056 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 3.67 spacing = 19.83333 in o.c. Tapplied = 676.0 lbs

Min Bolts Req'd Shear = 3.73 spacing = 19.83333 in o.c. Vapplied = 811.3 lbs

Try using 5 bolts spaced at 17.88 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 1.48

Use 5 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 17.9 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBKD-136			
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) - 3 clips with 2 - #10 SMS screws each clip			
WEB STIFFENER: NOT REQUIRED			
CORNER CONNECTION: Use 3 - 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 @ 39.25 in o.c.	2 @ 113.75 in o.c.	6 @ 22.75 in o.c.
SHORT DIRECTION	4 @ 25.17 in o.c.	2 @ 71.5 in o.c.	5 @ 17.88 in o.c.

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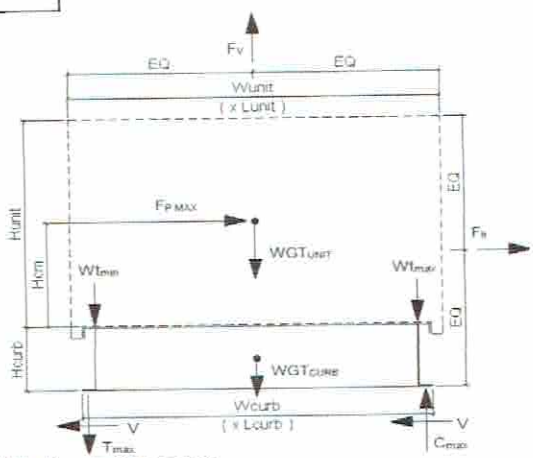
Client: ProVent PV1806
Description: CBKD-136 8" KDKITSLM1830
Unit: ZJ,ZR 180-300; ZF 210-300; XP 180-240

Curb Information

Hcurb =	8	in	(Height of curb)
Lcurb =	125.75	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 =	3061.3	lbs	(Weight of Unit)
Wtmax =	908	lbs	(Maximum corner weight)
Wtmin =	306	lbs	(Minimum corner weight)
Hunit =	52.625	in	(Height of unit above curb)
Hcm =	26.3125	in	(Height to center of mass)
Lunit =	136.25	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 =	3054 lbs (unit only)	(0.7*Fpmax) FpmaxASD = 3245 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)
$F_{h\ ASD\ trans}$ =	2126 lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	1436 lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	2548 lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	3261 lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	2239 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	486 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1197 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	2938 lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1916 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	116 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	827 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse: (on long edge)	$Comp_{MAX}$ =	3261	lbs	---> Along long edge of curb.
	$Tens_{MAX}$ =	2239	lbs	---> Along long edge of curb.
Longitudinal: (on short edge)	$Comp_{MAX}$ =	2938	lbs	---> Along short edge of curb.
	$Tens_{MAX}$ =	1916	lbs	---> Along short edge of curb.

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

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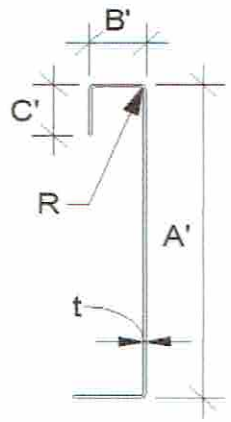
Curb Design

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



Calculate Section Properties of Curb

A'=	8.000 in	a =	7.644 in	= A'-(2r+t)
B'=	3.000 in	a'=	7.929 in	= A'-t
C'=	1.000 in (0 if no lips)	b =	2.644 in	= B'-[r+t/2+a(r+t/2)]
a =	1.000 (0 - no Lip; 1 w/ lip)	b'=	2.929 in	= B'-(t/2+at/2)
R =	0.1069 (Inside bend radius)	c =	0.822 in	= a[C'-(r+t/2)]
t =	0.0713 in	c'=	0.964 in	= a(C'-t/2)
r'=	0.143 in = R+t/2	u =	0.224 in	= πr/2
x =	0.896 in (Distance between centroid and web centerline)			
Ix =	10.928 in (Moment of Inertia about X-Axis)			
Iy =	1.411 in (Moment of Inertia about Y-Axis)			
A =	1.10 in^2			
rx =	3.15 in			
ry =	1.131 in			
rmin =	1.131 in			

Axial Compression

Pu = 1.527 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 23.774 k
Fe = 82.49 ksi
λc = 0.78
Fn = 38.80 ksi
Ly = 84 in Lateral unbraced length
k_yL_y/r_y = 59 (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 = 8 in -- Check limits: C = 4.00
t = 0.0713 in h/t = 112.20 ≤ 200 C_R = 0.14
N = 7.00 N/t = 98.18 ≤ 210 C_N = 0.35
Ω_w = 1.75 N/h = 0.875 ≤ 2.0 C_h = 0.02
P_n = 2.652 k R/t = 1.50 ≤ 9.0
P_n/Ω_w = 1.515 k
Long side: Pu_{Trans} = 1.087 k **O.K.** # clips = 3
Short side: Pu_{Long} = 1.469 k **O.K.** # clips = 2

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

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

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 = 2.652 k Ae = 0.380 in^2
Pn = 15.163 k Pn/Ω = 8.919 k

Not Req'd

Corner Connections

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

Tcrnmax = 763 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 1119 lbs (Max Ten/2 corner connections per side)

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

# of Bolts required for Tension = 0.3
# of Bolts required for Shear = 1.0 ***If combined fails:
# of Bolts Used = 2.0 USE --> 3.0
Check Combined Stress in Bolts & Inserts: 0.665 O.K. StressComb = 0.443 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 0.757 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

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

Pns/Ω = 792 #
Pss/Ω = 540 # <- Controls

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 = 1.068 k (screw pull-out strength)
Pnov = 2.607 k (screw pull-over strength)
Pts/Ω = 356 # <- Controls
Pts/Ω = 820 # (full tensile screw capacity)

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	3.054	3	1.02	540 #	2	6.00 in
Short side:	3.054	2	1.53	540 #	3	3.00 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 in^2 | Anv = 0.430 in^2 | Ant = 0.042 in^2
Rn/Ω = 7.500 k

$R_n = 0.6F_y A_{gv} + F_u A_{nt} \leq 0.6F_u A_{nv} + F_u A_{nt}$

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

Connection of Curb to Supporting Structure

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

Transverse: | $Uplift_{MAX}$ = 2306 lbs | $Shear_{MAX}$ = 1623 lbs

$Compression_{SEISMIC}$ = 3393 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb
$Tension_{SEISMIC}$ = 2306 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ = 576 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ = 1172 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: | $Uplift_{MAX}$ = 1858 lbs | $Shear_{MAX}$ = 1623 lbs

$Compression_{SEISMIC}$ = 2945 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb
$Tension_{SEISMIC}$ = 1858 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)
$Compression_{WIND}$ = 94 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ = 690 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 = 2.44 | COMBINED LOADING: 0.878 O.K.
# of Screws Req'd for Shear = 1.58 | Screw Spacing = 39.3 in o.c.
Total # of screws Required = 4

Use 5/8" φ wood lag screws @ 39.3 in o.c. along long side of curb

Longitudinal:

# of Screws Req'd for Uplift = 2.0 | COMBINED LOADING: 1.046 NO GOOD
# of Screws Req'd for Shear = 1.6 | Screw Spacing = 37.8 in o.c.
Total # of screws Required = 3

Use 5/8" φ wood lag screws @ 37.8 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 = 0.33 | COMBINED LOADING: 0.131 O.K.
# of Bolts Req'd for Shear = 0.44 | Bolt Spacing = 113.8 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 113.8 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.27 | COMBINED LOADING: 0.116 O.K.
# of Bolts Req'd for Shear = 0.44 | 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: $Uplift_{MAX}$ = 4307 lbs $Shear_{MAX}$ = 4056 lbs

$Compression_{SEISMIC}$ = 5393 lbs =[2.5*FpmaxASD*(Hcm+Hcurb]+[1+0.14S_{DS}]*[$WGT_{unit+curb}$/2]*wcurb]/wcurb

$Tension_{SEISMIC}$ = 4307 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*(WGTunit+curb)

$Shear_{SEISMIC}$ = 4056 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 4.68 spacing = 25.44 in o.c. Tapplied = 717.8 lbs

Min Bolts Req'd Shear = 3.73 spacing = 33.91667 in o.c. Vapplied = 676.1 lbs

Try using 6 bolts spaced at 22.75 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 1.40

Use 6 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 22.8 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 3186 lbs $Shear_{MAX}$ = 4056 lbs

$Compression_{SEISMIC}$ = 4273 lbs =[2.5*FpmaxASD*(Hcm+Hcurb]+[1+0.14S_{DS}]*[$WGT_{unit+curb}$/2]*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 3186 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*(WGTunit+curb)

$Shear_{SEISMIC}$ = 4056 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 3.46 spacing = 19.83333 in o.c. Tapplied = 637.3 lbs

Min Bolts Req'd Shear = 3.73 spacing = 19.83333 in o.c. Vapplied = 811.3 lbs

Try using 5 bolts spaced at 17.88 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 1.44

Use 5 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 17.9 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBKD-136			
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 3 - #10 SMS screws each clip			
WEB STIFFENER: NOT REQUIRED			
CORNER CONNECTION: Use 3 - 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 @ 39.25 in o.c.	2 @ 113.75 in o.c.	6 @ 22.75 in o.c.
SHORT DIRECTION	3 @ 37.75 in o.c.	2 @ 71.5 in o.c.	5 @ 17.88 in o.c.