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San Diego, CA 92120
619-727-4800

# Structural Calculations
# for
# CBKD-140 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.)

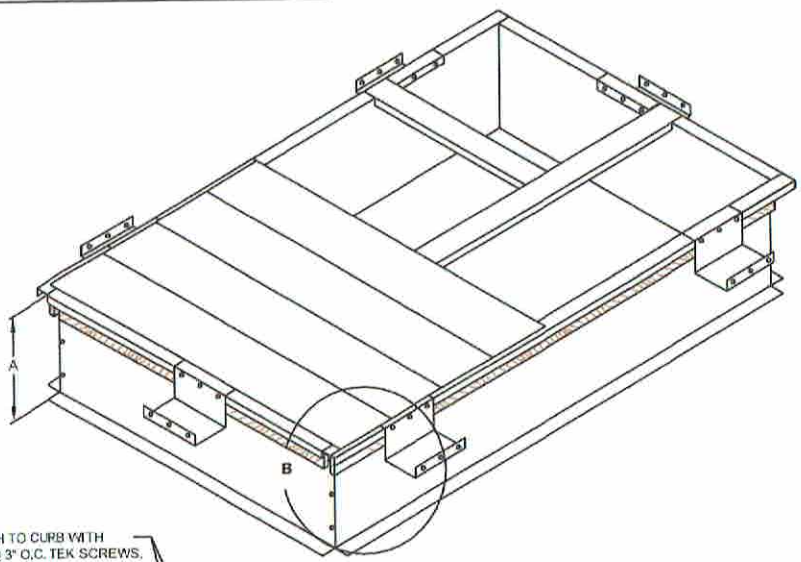
# STRUCTURALLY CALCULATED KNOCK-DOWN ROOF CURBS FOR YORK UNITS

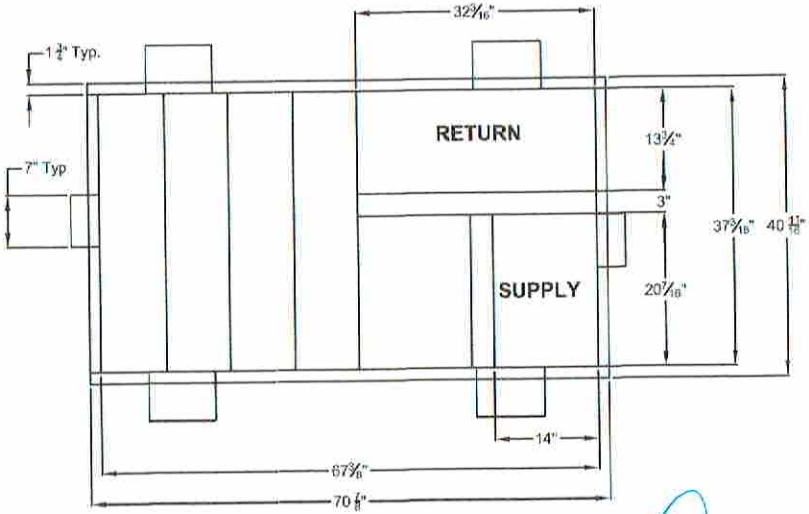
## ZX, ZY 04-06; ZX 07

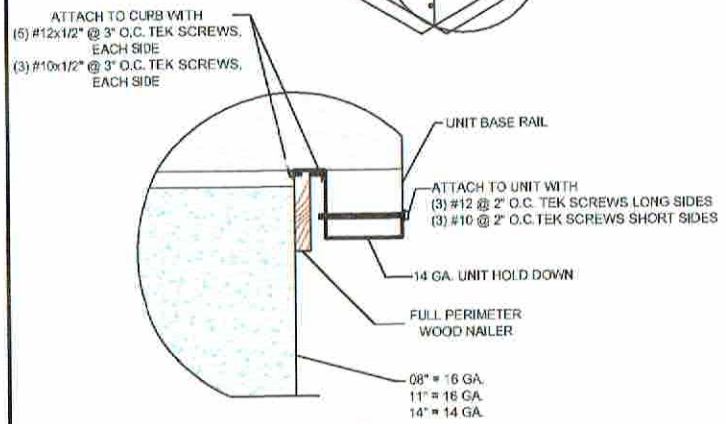
| ProVent P/N | A | WEIGHT |
|---|---|---|
| CBKDPRS08 | 8" | 67 Lbs |
| CBKDPRS11 | 11" | 79 Lbs |
| CBKDPRS14 | 14" | 91 Lbs |

| SEISMIC KIT P/N | WEIGHT |
|---|---|
| KDKITPRS | 43 Lbs |

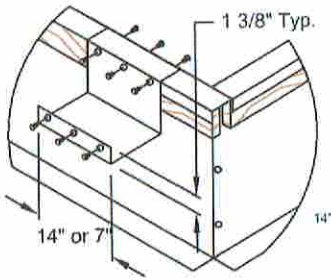
**Meets seismic requirements for the following codes:**
CBC 2016
IBC 2015



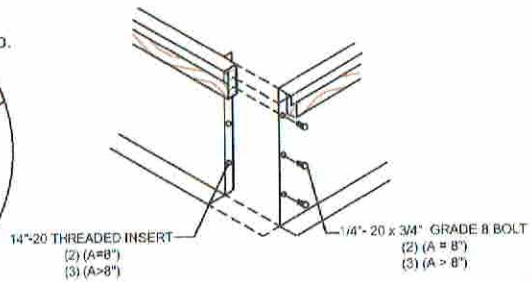




HOLD DOWN DETAIL




DETAIL B




CORNER 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-140 | | KDKITPRS |
| DATE: 01/07/19 | REV: 4 | DRAWN BY: ALL |

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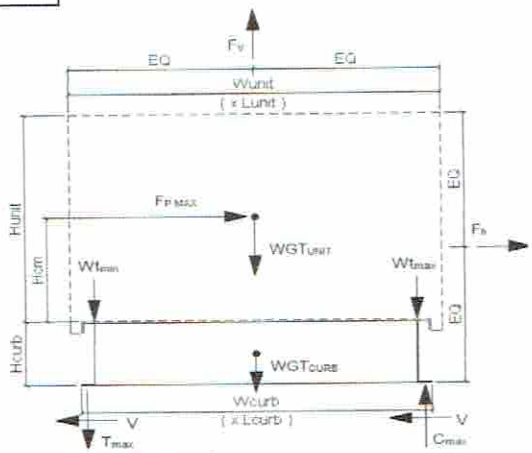
Client: ProVent PV1806
Description: CBKD-140 14" KDKITPRS
Unit: ZX, ZY 04-06; ZX 07

**Curb Information**

| | | | |
|---|---|---|---|
| Hcurb = | 14 | in | (Height of curb) |
| Lcurb = | 70.875 | in | (Length of curb) |
| wcurb = | 40.6875 | in | (Width of curb) |
| WGTcurb = | 134 | lbs | (Weight of curb) |
| # Clips long side = | 2 | # Clips short side = | 1 |

**Unit Information**

| | | | |
|---|---|---|---|
| WGTunit = | 1047 | lbs | (Weight of Unit) |
| Wtmax = | 284 | lbs | (Maximum corner weight) |
| Wtmin = | 203 | lbs | (Minimum corner weight) |
| Hunit = | 32.53 | in | (Height of unit above curb) |
| Hcm = | 16.265 | in | (Height to center of mass) |
| Lunit = | 74.05 | in | (Length of unit) |
| Wunit = | 48.88 | 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 = | 1044 | lbs (unit only) | (0.7*Fpmax) FpmaxASD = 1178 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) |
| $F_{h\ ASD\ trans}$ = | 887 | lbs | = 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2) |
| $F_{h\ ASD\ long}$ = | 586 | lbs | = 0.6*qz*GCr*Wunit*(Hunit+Hcurb) |
| $F_{vert\ ASD}$ = | 736 | lbs | = 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3) |

**Curb Loading**

Transverse:

| | | | |
|---|---|---|---|
| $Compression_{SEISMIC}$ = | 1137 | lbs | =[FpmaxASD*Hcm+2*(1+0.14$S_{DS}$)*Wtmax*wcurb]/wcurb |
| $Tension_{SEISMIC}$ = | 787 | lbs | = $Comp_{SEISMIC}$-(0.6-0.14$S_{DS}$)*WGTunit |
| $Compression_{WIND}$ = | 328 | lbs | =[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb |
| $Tension_{WIND}$ = | 435 | lbs | = $Comp_{WIND}$+Fvert-0.6*WGTunit |

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

Longitudinal:

| | | | |
|---|---|---|---|
| $Compression_{SEISMIC}$ = | 959 | lbs | =[FpmaxASD*Hcm+2*(1+0.14*$S_{DS}$)*Wtmax*Lcurb]/Lcurb |
| $Tension_{SEISMIC}$ = | 609 | lbs | = $Comp_{SEISMIC}$-(0.6-0.14$S_{DS}$)*WGTunit |
| $Compression_{WIND}$ = | 107 | lbs | =[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb |
| $Tension_{WIND}$ = | 215 | lbs | = $Comp_{WIND}$+Fvert-0.6*WGTunit |

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

Governing Reactions:

| | | | | |
|---|---|---|---|---|
| Transverse: | $Comp_{MAX}$ = | 1137 | lbs | ---> Along long edge of curb. |
| (on long edge) | $Tens_{MAX}$ = | 787 | lbs | ---> Along long edge of curb. |
| Longitudinal: | $Comp_{MAX}$ = | 959 | lbs | ---> Along short edge of curb. |
| (on short edge) | $Tens_{MAX}$ = | 609 | lbs | ---> Along short edge of curb. |

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

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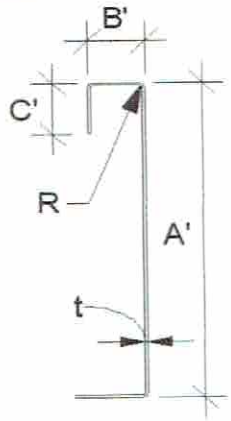
## Curb Design

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+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 = 0.646 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 in²
rx = 5.19 in
ry = 1.041 in
rmin = 1.041 in

### Axial Compression

Pu = 0.522 k (Max Axial Comp)  Ωc = 1.80
Pn/Ωc = 31.517 k
Fe = 69.87 ksi
λc = 0.85
Fn = 37.06 ksi
Ly = 84 in  Lateral unbraced length
$k_yL_y/r_y$ = 65  (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
t = 0.0713 in
N = 7.00
Ω_w = 1.75
P_n = 2.422 k
P_n/Ω_w = 1.384 k
Long side: Pu_Trans = 0.568 k
Short side: Pu_Long = 0.320 k

-- Check limits:
h/t = 196.35 ≤ 200
N/t = 98.18 ≤ 210
N/h = 0.5 ≤ 2.0
R/t = 1.50 ≤ 9.0

C = 4.00
$C_R$ = 0.14
$C_N$ = 0.35
$C_h$ = 0.02
(See table C3.4.1-2, fastened to support, one flange, end loading)

**O.K.** # clips = 2
**O.K.** # clips = 3

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

### 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 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 = 261 lbs  Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 393 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 = 0.1
# of Bolts required for Shear = 0.4
# of Bolts Used = [1.0]

***If combined fails: USE --> 2.0

Check Combined Stress in Bolts & Inserts: 0.464 O.K.  StressComb = 0.232 **O.K.**

### Check 1/8" welded connection

<--- USE WELD  Ω = 2.35

Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 0.266 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: | For t2/t1 ≥ 2.5:

***Shear:***
$P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ → Pns = 2377 # | 3.86 k
$P_{ns} = 2.7t_1 dF_{u1}$ | 2.38 k | $P_{ns} = 2.7t_1 dF_{u1}$ | 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: | 1.044 | 2 | 0.52 | 540 # | 2 | 6.00 in |
| Short side: | 1.044 | 3 | 0.35 | 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
$R_n = 0.6F_y A_{gv} + F_u A_{nt} \le 0.6F_u A_{nv} + F_u A_{nt}$ (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: | $Uplift_{MAX}$ = 1229 lbs | $Shear_{MAX}$ = 589 lbs

$Compression_{SEISMIC}$ = 1624 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14$S_{DS}$)*($WGT_{unit+curb}$/2)*wcurb]/wcurb
$Tension_{SEISMIC}$ = 1229 lbs =$Comp_{SEISMIC}$-(0.6-0.14$S_{DS}$)*(WGTunit+curb)
$Compression_{WIND}$ = 646 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ = 673 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: | $Uplift_{MAX}$ = 856 lbs | $Shear_{MAX}$ = 589 lbs

$Compression_{SEISMIC}$ = 1251 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14$S_{DS}$)*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb
$Tension_{SEISMIC}$ = 856 lbs =$Comp_{SEISMIC}$-(0.6-0.14$S_{DS}$)*(WGTunit+curb)
$Compression_{WIND}$ = 237 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ = 264 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 = 1.30 | COMBINED LOADING: 0.455 O.K.
# of Screws Req'd for Shear = 0.58 | Screw Spacing = 62.9 in o.c.
Total # of screws Required = 2

Use 5/8" φ wood lag screws @ 62.9 in o.c. along long side of curb w/ 3.5" Min. Embed

Longitudinal:
# of Screws Req'd for Uplift = 0.9 | COMBINED LOADING: 0.971 O.K.
# of Screws Req'd for Shear = 0.6 | Screw Spacing = #DIV/0! in o.c.
Total # of screws Required = 1

#DIV/0!

**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 = 0.18 | COMBINED LOADING: 0.033 O.K.
# of Bolts Req'd for Shear = 0.16 | Bolt Spacing = 58.9 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 58.9 in o.c. along long side of curb

Longitudinal:
# of Bolts Req'd for Uplift = 0.12 | COMBINED LOADING: 0.025 O.K.
# of Bolts Req'd for Shear = 0.16 | Req'd Min Spacing = 28.7 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 28.7 in o.c. along short side of curb

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**For Concrete anchorage:** SEISMIC (0.6-0.14SDSID + 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: $Uplift_{MAX}$ = 2544 lbs $Shear_{MAX}$ = 1473 lbs

$Compression_{SEISMIC}$ = 2938 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14$S_{DS}$)*(WGT$_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 2544 lbs =$Comp_{SEISMIC}$-(0.6-0.14$S_{DS}$)*(WGTunit+curb)

$Shear_{SEISMIC}$ = 1473 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 2.76 spacing = 23.44 in o.c. Tapplied = 508.8 lbs

Min Bolts Req'd Shear = 2.00 spacing = 46.875 in o.c. Vapplied = 294.5 lbs

Try using 5 bolts spaced at 14.72 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 0.82

Use 5 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 14.7 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 1611 lbs $Shear_{MAX}$ = 1473 lbs

$Compression_{SEISMIC}$ = 2005 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14$S_{DS}$)*(WGT$_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 1611 lbs =$Comp_{SEISMIC}$-(0.6-0.14$S_{DS}$)*(WGTunit+curb)

$Shear_{SEISMIC}$ = 1473 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.75 spacing = 16.6875 in o.c. Tapplied = 322.1 lbs

Min Bolts Req'd Shear = 2.00 spacing = 16.6875 in o.c. Vapplied = 294.5 lbs

Try using 5 bolts spaced at 7.17 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 0.62

Use 5 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 7.2 in o.c. max. along short side of curb w/ 4" embed

**CURB DESIGN SUMMARY:** CBKD-140

**CURB RAIL THICKNESS:** 0.0713 in 14 Gauge

**UNIT CLIP THICKNESS:** 0.0713 in 14 Gauge

**# OF CLIPS (LONG SIDE)** - 2 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 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 | 2 @ 62.88 in o.c. | 2 @ 58.88 in o.c. | 5 @ 14.72 in o.c. |
| SHORT DIRECTION | #DIV/0! | 2 @ 28.69 in o.c. | 5 @ 7.17 in o.c. |

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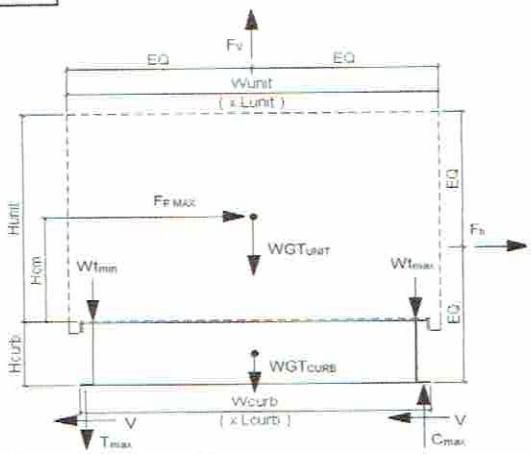
Client: ProVent PV1806
Description: CBKD-140 11" KDKITPRS
Unit: ZX, ZY 04-06; ZX 07

**Curb Information**

| | | | |
|---|---|---|---|
| Hcurb = | 11 | in | (Height of curb) |
| Lcurb = | 70.875 | in | (Length of curb) |
| wcurb = | 40.6875 | in | (Width of curb) |
| WGTcurb = | 134 | lbs | (Weight of curb) |
| # Clips long side = | 2 | # Clips short side = | 1 |

**Unit Information**

| | | | |
|---|---|---|---|
| WGTunit = | 1047 | lbs | (Weight of Unit) |
| Wtmax = | 284 | lbs | (Maximum corner weight) |
| Wtmin = | 203 | lbs | (Minimum corner weight) |
| Hunit = | 32.53 | in | (Height of unit above curb) |
| Hcm = | 16.265 | in | (Height to center of mass) |
| Lunit = | 74.05 | in | (Length of unit) |
| Wunit = | 48.88 | 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 = | 1044 | lbs | (0.7*Fpmax) FpmaxASD = 1178 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) |
| $F_{h\ ASD\ trans}$ = | 830 | lbs | = 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2) |
| $F_{h\ ASD\ long}$ = | 548 | lbs | = 0.6*qz*GCr*Wunit*(Hunit+Hcurb) |
| $F_{vert\ ASD}$ = | 736 | lbs | = 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3) |

**Curb Loading**

Transverse:

| | | | |
|---|---|---|---|
| $Compression_{SEISMIC}$ = | 1137 | lbs | =[FpmaxASD*Hcm+2*(1+0.14$S_{DS}$]*Wtmax*wcurb]/wcurb |
| $Tension_{SEISMIC}$ = | 787 | lbs | = $Comp_{SEISMIC}$-(0.6-0.14$S_{DS}$)*WGTunit |
| $Compression_{WIND}$ = | 305 | lbs | =[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb |
| $Tension_{WIND}$ = | 412 | lbs | = $Comp_{WIND}$+Fvert-0.6*WGTunit |

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

Longitudinal:

| | | | |
|---|---|---|---|
| $Compression_{SEISMIC}$ = | 959 | lbs | =[FpmaxASD*Hcm+2*(1+0.14*$S_{DS}$]*Wtmax*Lcurb]/Lcurb |
| $Tension_{SEISMIC}$ = | 609 | lbs | = $Comp_{SEISMIC}$-(0.6-0.14$S_{DS}$)*WGTunit |
| $Compression_{WIND}$ = | 99 | lbs | =[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb |
| $Tension_{WIND}$ = | 206 | lbs | = $Comp_{WIND}$+Fvert-0.6*WGTunit |

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

Governing Reactions:

| | | | | |
|---|---|---|---|---|
| Transverse: | $Comp_{MAX}$ = | 1137 | lbs | ---> Along long edge of curb. |
| (on long edge) | $Tens_{MAX}$ = | 787 | lbs | ---> Along long edge of curb. |
| Longitudinal: | $Comp_{MAX}$ = | 959 | lbs | ---> Along short edge of curb. |
| (on short edge) | $Tens_{MAX}$ = | 609 | lbs | ---> Along short edge of curb. |

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

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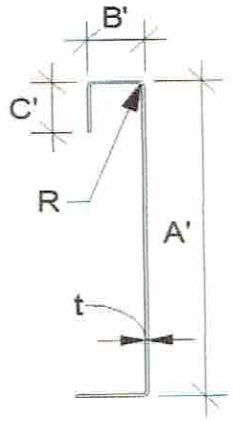
## Curb Design

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 in$^2$

rx = 4.20 in

ry = 1.095 in

rmin = 1.095 in

### Axial Compression

Pu = 0.522 k (Max Axial Comp)  Ωc = 1.80

Pn/Ωc = 22.286 k

Fe = 77.34 ksi

λc = 0.80

Fn = 38.15 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

$k_yL_y/r_y$ = 61  (assume k=0.8)

**Compression Check = O.K.**

### Check Web Crippling

h = 11 in

t = 0.0566 in

N = 7.00

$\Omega_w$ = 1.75

$P_n$ = 1.674 k

$P_n/\Omega_w$ = 0.957 k

Long side: $Pu_{Trans}$ = 0.568 k

Short side: $Pu_{Long}$ = 0.320 k

-- Check limits:

h/t = 194.35 ≤ 200

N/t = 123.67 ≤ 210

N/h = 0.636364 ≤ 2.0

R/t = 1.50 ≤ 9.0

C = 4.00

$C_R$ = 0.14

$C_N$ = 0.35

$C_h$ = 0.02

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

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

**O.K.** # clips = 2

**O.K.** # clips = 3

### 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 in$^2$

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 = 261 lbs  Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)

Vcrnmax = 393 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 = 0.1

# of Bolts required for Shear = 0.4  ***If combined fails:

# of Bolts Used = 1.0  USE --> 2.0

Check Combined Stress in Bolts & Inserts: 0.464 O.K.  StressComb = 0.232 **O.K.**

### Check 1/8" welded connection

<--- USE WELD  Ω = 2.35

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

Lreq'd = 0.335 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: | 1.044 | 2 | 0.52 | 540 # | 2 | 6.00 in |
| Short side: | 1.044 | 3 | 0.35 | 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: — $Uplift_{MAX}$ = 1143 lbs — $Shear_{MAX}$ = 589 lbs

$Compression_{SEISMIC}$ = 1537 lbs — =[FpmaxASD*(Hcm+Hcurb)+(1+0.14$S_{DS}$)*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 1143 lbs — =$Comp_{SEISMIC}$-(0.6-0.14$S_{DS}$)*(WGTunit+curb)

$Compression_{WIND}$ = 543 lbs — =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb

$Tension_{WIND}$ = 570 lbs — =[$F_{h\,transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: — $Uplift_{MAX}$ = 806 lbs — $Shear_{MAX}$ = 589 lbs

$Compression_{SEISMIC}$ = 1201 lbs — =[FpmaxASD*(Hcm+Hcurb)+(1+0.14$S_{DS}$)*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 806 lbs — =$Comp_{SEISMIC}$-(0.6-0.14$S_{DS}$)*(WGTunit+curb)

$Compression_{WIND}$ = 197 lbs — =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb

$Tension_{WIND}$ = 224 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 = 1.21 — COMBINED LOADING: 0.417 O.K.

# of Screws Req'd for Shear = 0.58 — Screw Spacing = 62.9 in o.c.

Total # of screws Required = 2

Use 5/8" φ wood lag screws @ 62.9 in o.c. along long side of curb w/ 3.5" Min. Embed

Longitudinal:

# of Screws Req'd for Uplift = 0.9 — COMBINED LOADING: 0.916 O.K.

# of Screws Req'd for Shear = 0.6 — Screw Spacing = #DIV/0! in o.c.

Total # of screws Required = 1

#DIV/0!

**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 = 0.17 — COMBINED LOADING: 0.031 O.K.

# of Bolts Req'd for Shear = 0.16 — Bolt Spacing = 58.9 in o.c.

Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 58.9 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.12 — COMBINED LOADING: 0.024 O.K.

# of Bolts Req'd for Shear = 0.16 — Req'd Min Spacing = 28.7 in o.c.

Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 28.7 in o.c. along short side of curb

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**For Concrete anchorage:** SEISMIC $(0.6-0.14S_{DS})D + 0.7\Omega_o E$ $(\Omega_o = 2.5)$

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

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

$T_{all_{ASD}} = T_{all_{LRFD}}/\alpha$ = 920.9 lbs $V_{all_{ASD}} = V_{all_{LRFD}}/\alpha$ = 1086.6 lbs $(D = 0.465, E = 0.535)$

Transverse: $Uplift_{MAX}$ = 2327 lbs | $Shear_{MAX}$ = 1473 lbs

$Compression_{SEISMIC}$ = 2721 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14$S_{DS}$)*(WGT$_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 2327 lbs =Comp$_{SEISMIC}$-(0.6-0.14$S_{DS}$)*(WGTunit+curb)

$Shear_{SEISMIC}$ = 1473 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 2.53 spacing = 23.44 in o.c. Tapplied = 465.3 lbs

Min Bolts Req'd Shear = 2.00 spacing = 46.875 in o.c. Vapplied = 294.5 lbs

Try using 5 bolts spaced at 14.72 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 0.78

Use 5 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 14.7 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 1486 lbs | $Shear_{MAX}$ = 1473 lbs

$Compression_{SEISMIC}$ = 1881 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14$S_{DS}$)*(WGT$_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 1486 lbs =Comp$_{SEISMIC}$-(0.6-0.14$S_{DS}$)*(WGTunit+curb)

$Shear_{SEISMIC}$ = 1473 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.61 spacing = 16.6875 in o.c. Tapplied = 297.2 lbs

Min Bolts Req'd Shear = 2.00 spacing = 16.6875 in o.c. Vapplied = 294.5 lbs

Try using 5 bolts spaced at 7.17 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 0.59

Use 5 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 7.2 in o.c. max. along short side of curb w/ 4" embed

| **CURB DESIGN SUMMARY:** | CBKD-140 | | |
|---|---|---|---|
| **CURB RAIL THICKNESS:** | 0.0566 in 16 Gauge | | |
| **UNIT CLIP THICKNESS:** | 0.0566 in 16 Gauge | | |
| **# OF CLIPS (LONG SIDE) -** | 2 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 2 - 1/4" φ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts | | |

| **CURB ANCHORAGE** | WOOD<br>5/8" φ lag screw w/ min. 3.5" embed (SGmin=0.43) | STEEL<br>5/8" φ A307 bolts | CONCRETE<br>3/4" φ thrd'd rod in Hilti HIT-HY 200 epoxy, min. 4" embed |
|---|---|---|---|
| LONG DIRECTION | 2 @ 62.88 in o.c. | 2 @ 58.88 in o.c. | 5 @ 14.72 in o.c. |
| SHORT DIRECTION | #DIV/0! | 2 @ 28.69 in o.c. | 5 @ 7.17 in o.c. |

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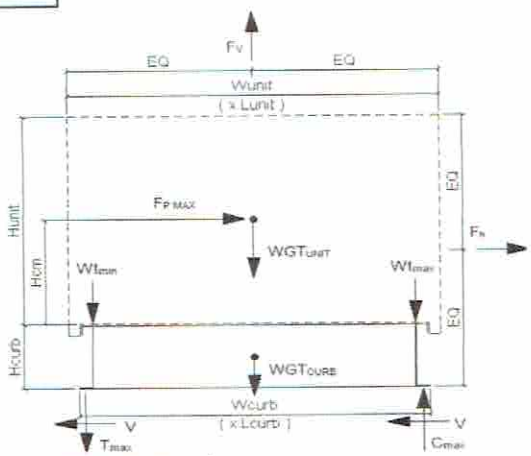
Client: ProVent PV1806
Description: CBKD-140 8" KDKITPRS
Unit: ZX, ZY 04-06; ZX 07

**Curb Information**

| | | | |
|---|---|---|---|
| Hcurb = | 8 | in | (Height of curb) |
| Lcurb = | 70.875 | in | (Length of curb) |
| wcurb = | 40.6875 | in | (Width of curb) |
| WGTcurb = | 134 | lbs | (Weight of curb) |
| # Clips long side = | 2 | # Clips short side = | 1 |

**Unit Information**

| | | | |
|---|---|---|---|
| WGTunit = | 1047 | lbs | (Weight of Unit) |
| Wtmax = | 284 | lbs | (Maximum corner weight) |
| Wtmin = | 203 | lbs | (Minimum corner weight) |
| Hunit = | 32.53 | in | (Height of unit above curb) |
| Hcm = | 16.265 | in | (Height to center of mass) |
| Lunit = | 74.05 | in | (Length of unit) |
| Wunit = | 48.88 | 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 = | 1044 | lbs (unit only) | (0.7*Fpmax) FpmaxASD = 1178 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) |
| $F_{h\ ASD\ trans}$ = | 773 | lbs | = 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2) |
| $F_{h\ ASD\ long}$ = | 510 | lbs | = 0.6*qz*GCr*Wunit*(Hunit+Hcurb) |
| $F_{vert\ ASD}$ = | 736 | lbs | = 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3) |

**Curb Loading**

Transverse:

| | | | |
|---|---|---|---|
| $Compression_{SEISMIC}$ = | 1137 | lbs | =[FpmaxASD*Hcm+2*(1+0.14$S_{DS}$)*Wtmax*wcurb]/wcurb |
| $Tension_{SEISMIC}$ = | 787 | lbs | = $Comp_{SEISMIC}$-(0.6-0.14$S_{DS}$)*WGTunit |
| $Compression_{WIND}$ = | 282 | lbs | =[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb |
| $Tension_{WIND}$ = | 389 | lbs | = $Comp_{WIND}$+Fvert-0.6*WGTunit |

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

Longitudinal:

| | | | |
|---|---|---|---|
| $Compression_{SEISMIC}$ = | 959 | lbs | =[FpmaxASD*Hcm+2*(1+0.14*$S_{DS}$)*Wtmax*Lcurb]/Lcurb |
| $Tension_{SEISMIC}$ = | 609 | lbs | = $Comp_{SEISMIC}$-(0.6-0.14$S_{DS}$)*WGTunit |
| $Compression_{WIND}$ = | 90 | lbs | =[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb |
| $Tension_{WIND}$ = | 197 | lbs | = $Comp_{WIND}$+Fvert-0.6*WGTunit |

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

Governing Reactions:

| | | | | |
|---|---|---|---|---|
| Transverse: | $Comp_{MAX}$ = | 1137 | lbs | ---> Along long edge of curb. |
| (on long edge) | $Tens_{MAX}$ = | 787 | lbs | ---> Along long edge of curb. |
| Longitudinal: | $Comp_{MAX}$ = | 959 | lbs | ---> Along short edge of curb. |
| (on short edge) | $Tens_{MAX}$ = | 609 | lbs | ---> Along short edge of curb. |

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

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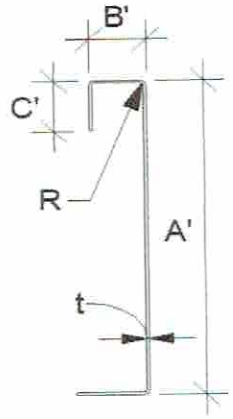
## Curb Design

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 = 0.522 k (Max Axial Comp)  Ωc = 1.80
Pn/Ωc = 19.076 k
Fe = 83.71 ksi
λc = 0.77
Fn = 38.94 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
t = 0.0566 in
N = 7.00
Ω_w = 1.75
P_n = 1.770 k
P_n/Ω_w = 1.011 k
Long side: $Pu_{Trans}$ = 0.568 k
Short side: $Pu_{Long}$ = 0.320 k

-- Check limits:
h/t = 141.34 ≤ 200
N/t = 123.67 ≤ 210
N/h = 0.875 ≤ 2.0
R/t = 1.50 ≤ 9.0

C = 4.00
$C_R$ = 0.14
$C_N$ = 0.35
$C_h$ = 0.02
[See table C3.4.1-2, fastened to support, one flange, end loading]

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

**O.K.** # clips = 2
**O.K.** # clips = 3

### 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 = 261 lbs  Max[$F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections]
Vcrnmax = 393 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 = 0.1
# of Bolts required for Shear = 0.4
# of Bolts Used = [1.0]

***If combined fails: USE --> 2.0

Check Combined Stress in Bolts & Inserts: 0.464 O.K.  StressComb = 0.232 **O.K.**

### Check 1/8" welded connection

<--- USE WELD  Ω = 2.35
Assume L/t > 25: 25*t = 1.415 in
Lreq'd = 0.335 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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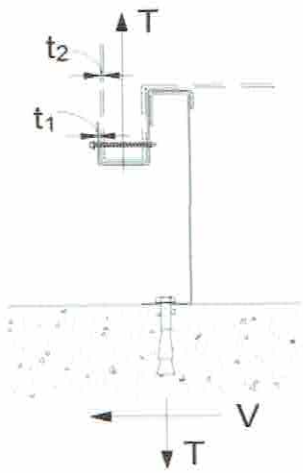
**Connection Unit to Curb Clip** — #10 SMS screw — Ω = 3.0

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:

***Shear***: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ — Pns = 1887 #

$P_{ns} = 2.7t_1 dF_{u1}$ = 3.86 k

$P_{ns} = 2.7t_2 dF_{u2}$ = 1.89 k

Pns/Ω = 3.39 k

Pss/Ω = 629 #

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)

Pnov = 2.069 k (screw pull-over strength)

Pts/Ω = 356 # <- Controls

Pts/Ω = 820 # (full tensile screw capacity)

$P_{not} = 0.85t_c dF_{u2}$

$t_c = \min(t_1, t_2)$

$P_{nov} = 1.5t_1 d_w F_{u1}$

| | Shear (k) | # clips | $V_{clip}$ (k) | $V_{allow}$ (lb) | # screws | spacing |
|---|---|---|---|---|---|---|
| Long side: | 1.044 | 2 | 0.52 | 540 # | 2 | 6.00 in |
| Short side: | 1.044 | 3 | 0.35 | 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 $in^2$ — Anv = 0.352 $in^2$ — Ant = 0.034 $in^2$

Rn/Ω = 5.954 k

$R_n = 0.6F_y A_{gv} + F_u A_{nt} \leq 0.6F_u A_{nv} + F_u A_{nt}$ (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: $Uplift_{MAX}$ = 1056 lbs — $Shear_{MAX}$ = 589 lbs

$Compression_{SEISMIC}$ = 1450 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14$S_{DS}$)*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 1056 lbs =$Comp_{SEISMIC}$-(0.6-0.14$S_{DS}$)*(WGTunit+curb)

$Compression_{WIND}$ = 447 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb

$Tension_{WIND}$ = 474 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: $Uplift_{MAX}$ = 756 lbs — $Shear_{MAX}$ = 589 lbs

$Compression_{SEISMIC}$ = 1151 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14$S_{DS}$)*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 756 lbs =$Comp_{SEISMIC}$-(0.6-0.14$S_{DS}$)*(WGTunit+curb)

$Compression_{WIND}$ = 161 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb

$Tension_{WIND}$ = 188 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 = 1.12 — COMBINED LOADING: 0.381 O.K.

# of Screws Req'd for Shear = 0.58 — Screw Spacing = 62.9 in o.c.

Total # of screws Required = 2

Use 5/8" φ wood lag screws @ 62.9 in o.c. along long side of curb w/ 3.5" Min. Embed

Longitudinal:

# of Screws Req'd for Uplift = 0.8 — COMBINED LOADING: 0.864 O.K.

# of Screws Req'd for Shear = 0.6 — Screw Spacing = #DIV/0! in o.c.

Total # of screws Required = 1

#DIV/0!

**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 = 0.15 — COMBINED LOADING: 0.029 O.K.

# of Bolts Req'd for Shear = 0.16 — Bolt Spacing = 58.9 in o.c.

Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 58.9 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.11 — COMBINED LOADING: 0.023 O.K.

# of Bolts Req'd for Shear = 0.16 — Req'd Min Spacing = 28.7 in o.c.

Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 28.7 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: $Uplift_{MAX}$ = 2110 lbs  $Shear_{MAX}$ = 1473 lbs

$Compression_{SEISMIC}$ = 2504 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14$S_{DS}$)*(WGT$_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 2110 lbs =Comp$_{SEISMIC}$-(0.6-0.14$S_{DS}$)*(WGTunit+curb)

$Shear_{SEISMIC}$ = 1473 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 2.29 spacing = 23.44 in o.c.  Tapplied = 421.9 lbs

Min Bolts Req'd Shear = 2.00 spacing = 46.875 in o.c.  Vapplied = 294.5 lbs

Try using 5 bolts spaced at 14.72 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aptlied}}{V_{allow,ASD}} \leq 1.2$ = 0.73

Use 5 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 14.7 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 1361 lbs  $Shear_{MAX}$ = 1473 lbs

$Compression_{SEISMIC}$ = 1756 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14$S_{DS}$)*(WGT$_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 1361 lbs =Comp$_{SEISMIC}$-(0.6-0.14$S_{DS}$)*(WGTunit+curb)

$Shear_{SEISMIC}$ = 1473 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.48 spacing = 16.6875 in o.c.  Tapplied = 272.3 lbs

Min Bolts Req'd Shear = 2.00 spacing = 16.6875 in o.c.  Vapplied = 294.5 lbs

Try using 5 bolts spaced at 7.17 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aptlied}}{V_{allow,ASD}} \leq 1.2$ = 0.57

Use 5 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 7.2 in o.c. max. along short side of curb w/ 4" embed

**CURB DESIGN SUMMARY:** CBKD-140

**CURB RAIL THICKNESS:** 0.0566 in 16 Gauge

**UNIT CLIP THICKNESS:** 0.0566 in 16 Gauge

**# OF CLIPS (LONG SIDE) -** 2 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 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 | 2 @ 62.88 in o.c. | 2 @ 58.88 in o.c. | 5 @ 14.72 in o.c. |
| SHORT DIRECTION | #DIV/0! | 2 @ 28.69 in o.c. | 5 @ 7.17 in o.c. |