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

Structural Calculations
for
CBKD-153 Series

Prepared for:

PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

Date: January 10, 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.)

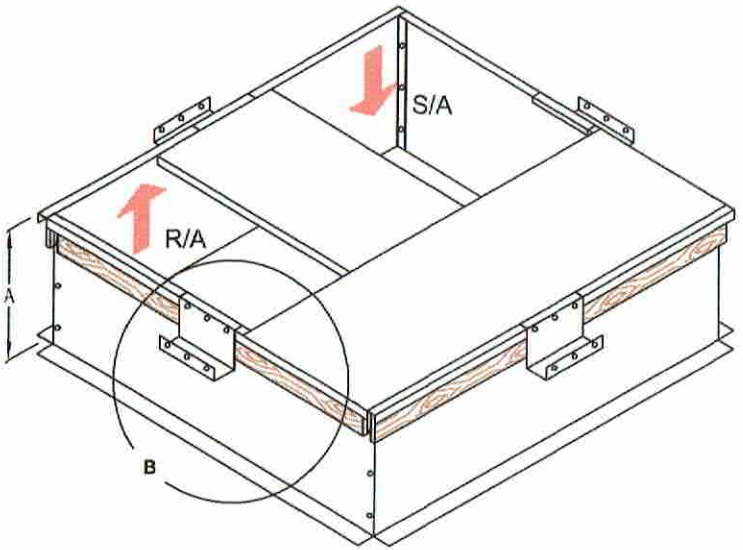
STRUCTURALLY CALCULATED KNOCK-DOWN ROOF CURBS FOR YORK UNITS

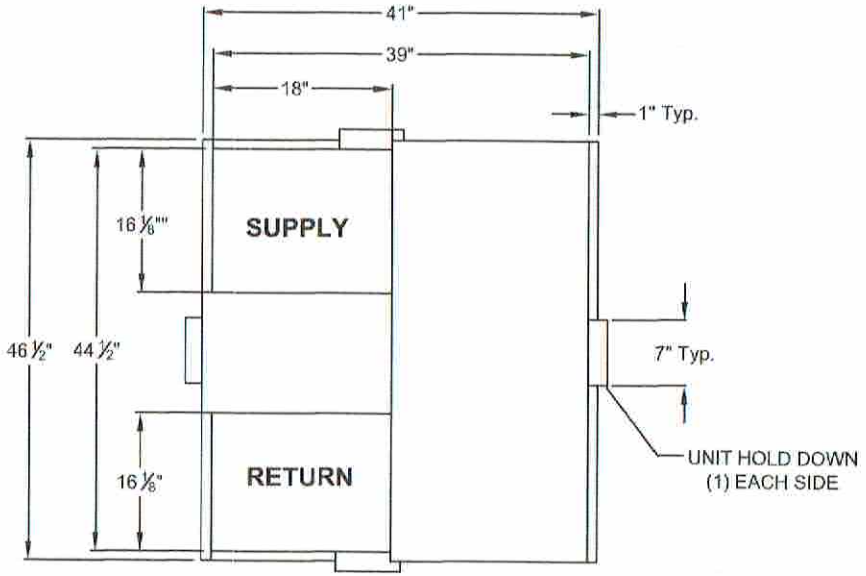
P***B ALL MODELS

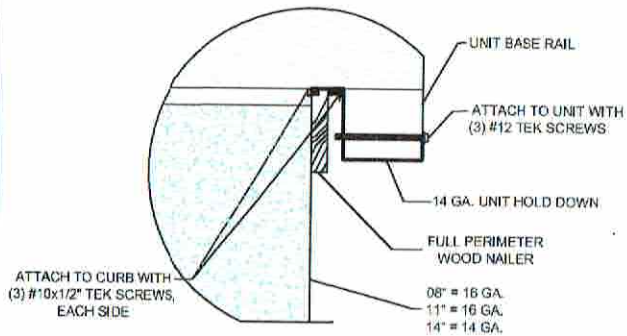
ProVent P/N	A	WEIGHT
CBKDLXL08	8"	53 Lbs
CBKDLXL11	11"	64 Lbs
CBKDLXL14	14"	75 Lbs

SEISMIC KIT P/N	WEIGHT
KDKITLX	5 Lbs

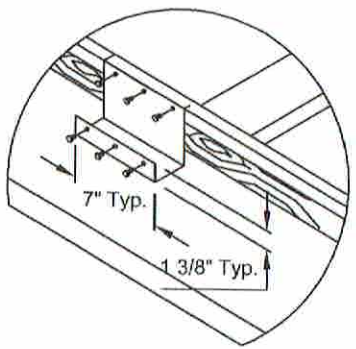
Meets seismic requirements for the following codes:
CBC 2016
IBC 2015



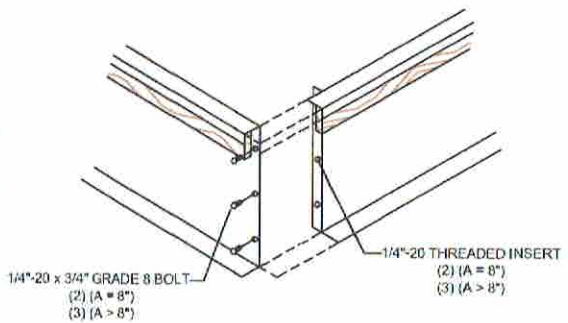




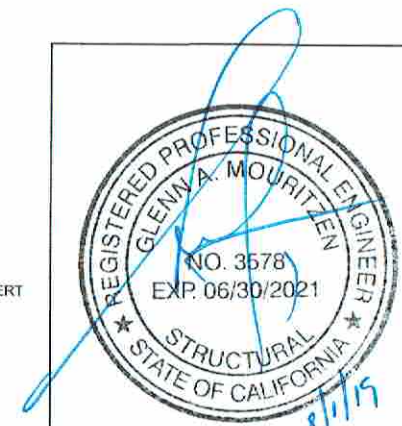
HOLD DOWN DETAIL



DETAIL B



CORNER DETAIL



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-153	KDKITLX
DATE: 01/07/19 / REV: 5	DRAWN BY: ALL

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Client: ProVent PV1806
Description: CBKD-153 14" KDKITLX
Unit: ALL YORK P***B MODELS

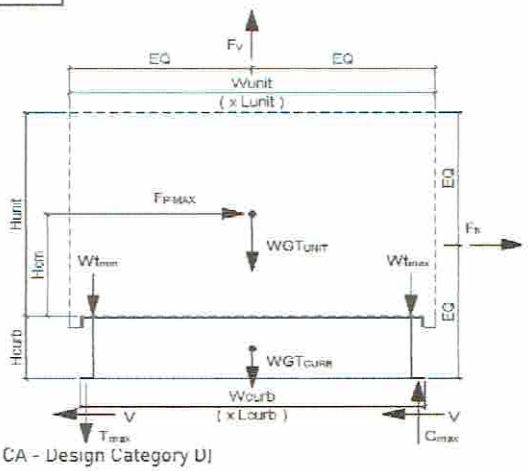
Curb Information

Hcurb =	14	in	(Height of curb)
Lcurb =	46.5	in	(Length of curb)
wcurb =	41	in	(Width of curb)
WGTcurb =	80	lbs	(Weight of curb)

Clips long side = 1 # Clips short side = 1

Unit Information

WGTunit =	420	lbs	(Weight of Unit)
Wtmax =	141	lbs	(Maximum corner weight)
Wtmin =	78	lbs	(Minimum corner weight)
Hunit =	55	in	(Height of unit above curb)
Hcm =	27.5	in	(Height to center of mass)
Lunit =	51.25	in	(Length of unit)
Wunit =	45.75	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 =	419	lbs (unit only)	(0.7*Fpmax) FpmaxASD = 499 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)
$F_{h\ ASD\ trans}$ =	910	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	813	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	477	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	638 lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	498 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	542 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	766 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	605 lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	464 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	412 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	636 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	638	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	766	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	605	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	636	lbs	---> Along short edge of curb.

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

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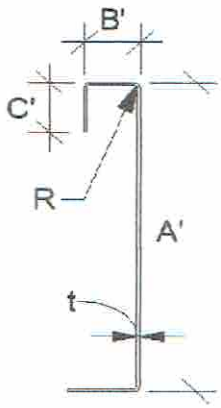
Curb Design

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 = 0.455 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 -- Check limits:
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 C = 4.00
P_n/Ω_w = 1.384 k
Long side: Pu_{Trans} = 0.638 k **O.K.** # clips = 1
Short side: Pu_{Long} = 0.605 k **O.K.** # clips = 1

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

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

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 = 228 lbs Max($F_{pm:axASD}$/4 -OR- $Fh_{ASD:trans}$/4 corner connections)
Vcrnmax = 383 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 = 0.3 ***If combined fails:
# of Bolts Used = [1.0] USE --> 2.0
Check Combined Stress in Bolts & Inserts: 0.441 O.K. StressComb = 0.221 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 0.259 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 | #12 | SMS screw | Ω = 3.0

t1 = 0.0713 in | Fu1 = 65 ksi
t2 = 0.1017 in (unit base rail thickness) | Fu2 = 65 ksi
d = 0.216 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 = 2703 # | 4.12 k | Pns = 2703 #

$P_{ns} = 2.7t_1dF_{u1}$ 2.70 k | $P_{ns} = 2.7t_1dF_{u1}$ 2.70 k

$P_{ns} = 2.7t_2dF_{u2}$ 3.86 k | $P_{ns} = 2.7t_2dF_{u2}$ 3.86 k

Pns/Ω = 901 #

Pss/Ω = 840 # <- 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 = 1.214 k (screw pull-out strength)

Pnov = 2.607 k (screw pull-over strength)

Pts/Ω = 405 # <- Controls

Pts/Ω = 845 # (full tensile screw capacity)

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	0.910	1	0.91	840 #	2	6.00 in
Short side:	0.813	1	0.81	840 #	2	6.00 in

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

min spacing = 0.65 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 = 0.440 in^2 | Ant = 0.041 in^2

Rn/Ω = 7.473 k $R_n = 0.6F_yA_{gv} + F_uA_{nt} \le 0.6F_uA_{nv} + F_uA_{nt}$

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

Connection of Curb to Supporting Structure

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

Transverse: $Uplift_{MAX}$ = 1010 lbs | $Shear_{MAX}$ = 455 lbs

$Compression_{SEISMIC}$ = 821 lbs =(FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*wcurb)/wcurb

$Tension_{SEISMIC}$ = 654 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 833 lbs =($F_{h\ transASD}$*(Hcm+Hcurb)+0.6*(WGT$_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2)/wcurb

$Tension_{WIND}$ = 1010 lbs =($F_{h\ transASD}$*(Hcm+Hcurb)-0.6*(WGT$_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2)/wcurb

Longitudinal: $Uplift_{MAX}$ = 814 lbs | $Shear_{MAX}$ = 406 lbs

$Compression_{SEISMIC}$ = 762 lbs =(FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*Lcurb)/Lcurb

$Tension_{SEISMIC}$ = 595 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 637 lbs =($F_{h\ transASD}$*(Hcm+Hcurb)+0.6*(WGT$_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2)/Lcurb

$Tension_{WIND}$ = 814 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**

$Tall_{screw}$ = 6133 lbs | $Vall_{metal}$ = 2744 lbs

Transverse: $Tall_{wood}$ = 1196 lbs | $Vall_{wood}$ = 1024 lbs

# of Screws Req'd for Uplift = 0.84 | COMBINED LOADING: 0.215 O.K.

# of Screws Req'd for Shear = 0.44 | Screw Spacing = 7.7 in o.c.

Total # of screws Required = 6

Use 5/8" φ wood lag screws @ 7.7 in o.c. along long side of curb w/ 3.5" Min. Embed

Longitudinal:

# of Screws Req'd for Uplift = 0.7 | COMBINED LOADING: 0.215 O.K.

# of Screws Req'd for Shear = 0.4 | Screw Spacing = 8.3 in o.c.

Total # of screws Required = 5

Use 5/8" φ wood lag screws @ 8.3 in o.c. along short side of curb w/ 3.5" Min. Embed

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

$Tall_{bolt}$ = 6903 lbs | $Vall_{bolt}$ = 3682 lbs

Transverse: 6903 lbs | 3682 lbs

# of Bolts Req'd for Uplift = 0.15 | COMBINED LOADING: 0.022 O.K.

# of Bolts Req'd for Shear = 0.12 | Bolt Spacing = 34.5 in o.c.

Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 34.5 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.12 | COMBINED LOADING: 0.017 O.K.

# of Bolts Req'd for Shear = 0.11 | Req'd Min Spacing = 29.0 in o.c.

Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 29 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

$Tall_{LRFD}$ = 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: $Uplift_{MAX}$ = 1412 lbs $Shear_{MAX}$ = 623 lbs

$Compression_{SEISMIC}$ = 1579 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 1412 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*(WGTunit+curb)

$Shear_{SEISMIC}$ = 623 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.53 spacing = 22.50 in o.c. Tapplied = 352.9 lbs

Min Bolts Req'd Shear = 2.00 spacing = 22.5 in o.c. Vapplied = 155.9 lbs

Try using 4 bolts
spaced at 11.50 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 0.53

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

Longitudinal: $Uplift_{MAX}$ = 1262 lbs $Shear_{MAX}$ = 623 lbs

$Compression_{SEISMIC}$ = 1429 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 1262 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*(WGTunit+curb)

$Shear_{SEISMIC}$ = 623 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.37 spacing = 17 in o.c. Tapplied = 315.6 lbs

Min Bolts Req'd Shear = 2.00 spacing = 17 in o.c. Vapplied = 155.9 lbs

Try using 4 bolts
spaced at 9.67 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 0.49

Use 4 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 9.7 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBKD-153

CURB RAIL THICKNESS: 0.0713 in 14 Gauge

UNIT CLIP THICKNESS: 0.0713 in 14 Gauge

 # OF CLIPS (LONG SIDE) - 1 clips with 2 - #12 SMS screws each clip

WEB STIFFENER: NOT REQUIRED

 # OF CLIPS (SHORT SIDE) - 1 clips with 2 - #12 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	6 @ 7.7 in o.c.	2 @ 34.5 in o.c.	4 @ 11.5 in o.c.
SHORT DIRECTION	5 @ 8.25 in o.c.	2 @ 29 in o.c.	4 @ 9.67 in o.c.

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Client: ProVent PV1806
Description: CBKD-153 11" KDKITLX
Unit: ALL YORK P***B MODELS

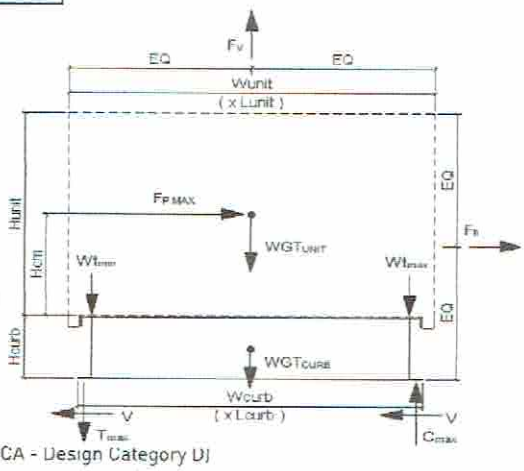
Curb Information

Hcurb =	11	in	(Height of curb)
Lcurb =	46.5	in	(Length of curb)
wcurb =	41	in	(Width of curb)
WGTcurb =	80	lbs	(Weight of curb)

Clips long side = 1 # Clips short side = 1

Unit Information

WGTunit =	420	lbs	(Weight of Unit)
Wtmax =	141	lbs	(Maximum corner weight)
Wtmin =	78	lbs	(Minimum corner weight)
Hunit =	55	in	(Height of unit above curb)
Hcm =	27.5	in	(Height to center of mass)
Lunit =	51.25	in	(Length of unit)
Wunit =	45.75	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 =	419	lbs (unit only)	(0.7*Fpmax) FpmaxASD = 499 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)
$F_{h\ ASD\ trans}$ =	871	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	777	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	477	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	638 lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	498 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	515 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	740 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	605 lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	464 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	391 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	615 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	638	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	740	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	605	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	615	lbs	---> Along short edge of curb.

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

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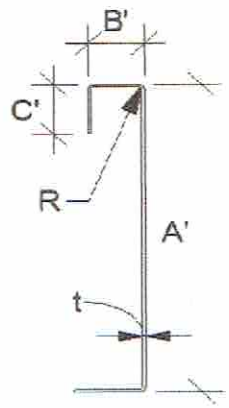
Curb Design

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 = 0.435 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 22.286 k
Fe = 77.34 ksi
λc = 0.80
Fn = 38.15 ksi
Ly = 84 in Lateral unbraced length
k_yL_y/r_y = 61 (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 = 0.0566 in h/t = 194.35 ≤ 200 C = 4.00
N = 7.00 N/t = 123.67 ≤ 210 C_R = 0.14
Ω_w = 1.75 N/h = 0.636364 ≤ 2.0 C_N = 0.35
P_n = 1.674 k R/t = 1.50 ≤ 9.0 C_h = 0.02
P_n/Ω_w = 0.957 k
Long side: Pu_{Trans} = 0.638 k **O.K.** # clips = 1
Short side: Pu_{Long} = 0.605 k **O.K.** # clips = 1

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

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

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 = 218 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 370 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 = 0.3 ***If combined fails:
# of Bolts Used = [1.0] USE --> 2.0
Check Combined Stress in Bolts & Inserts: 0.425 **O.K.** StressComb = 0.213 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.415 in
Lreq'd = 0.315 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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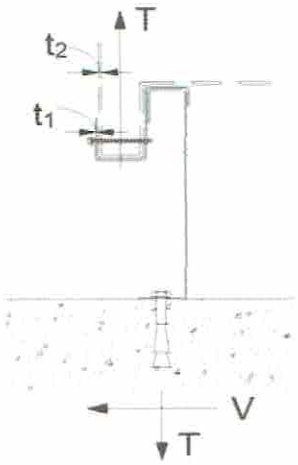
Connection Unit to Curb Clip | #12 SMS screw | Ω = 3.0

t1 = 0.0566 in | Fu1 = 65 ksi
t2 = 0.1017 in (unit base rail thickness) | Fu2 = 65 ksi
d = 0.216 in (screw diameter) | dw = 0.375 in (nom. washer diameter)
t2/t1 = 1.8



For t2/t1 ≤ 1.0: | Pns = 2146 # | For t2/t1 ≥ 2.5: | Pns = 2146 #

Shear:

$P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ = 4.12 k

$P_{ns} = 2.7t_1 dF_{u1}$ = 2.15 k | $P_{ns} = 2.7t_1 dF_{u1}$ = 2.15 k

$P_{ns} = 2.7t_2 dF_{u2}$ = 3.86 k | $P_{ns} = 2.7t_2 dF_{u2}$ = 3.86 k

Pns/Ω = 715 # <- Controls
Pss/Ω = 840 #

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 = 1.214 k (screw pull-out strength)
Pnov = 2.069 k (screw pull-over strength)
Pts/Ω = 405 # <- Controls
Pts/Ω = 845 # (full tensile screw capacity)

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	0.871	1	0.87	715 #	2	6.00 in
Short side:	0.777	1	0.78	715 #	2	6.00 in

clip width (in) = 7.00 | clip height = 1.4 in
min spacing = 0.65 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 = 0.350 in² | Ant = 0.033 in²
Rn/Ω = 5.932 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:	$Uplift_{MAX}$ = 906 lbs		$Shear_{MAX}$ = 435 lbs
$Compression_{SEISMIC}$ =	785 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb	
$Tension_{SEISMIC}$ =	618 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)	
$Compression_{WIND}$ =	729 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb	
$Tension_{WIND}$ =	906 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb	
Longitudinal:	$Uplift_{MAX}$ = 732 lbs		$Shear_{MAX}$ = 389 lbs
$Compression_{SEISMIC}$ =	729 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb	
$Tension_{SEISMIC}$ =	562 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)	
$Compression_{WIND}$ =	555 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb	
$Tension_{WIND}$ =	732 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**

$Tall_{screw}$ = 6133 lbs | $Vall_{metal}$ = 2744 lbs
Transverse: $Tall_{wood}$ = 1196 lbs | $Vall_{wood}$ = 1024 lbs
# of Screws Req'd for Uplift = 0.76 | COMBINED LOADING: 0.197 O.K.
# of Screws Req'd for Shear = 0.43 | Screw Spacing = 7.7 in o.c.
Total # of screws Required = 6

Use 5/8" ϕ wood lag screws @ 7.7 in o.c. along long side of curb w/ 3.5" Min. Embed

Longitudinal:
# of Screws Req'd for Uplift = 0.6 | COMBINED LOADING: 0.198 O.K.
# of Screws Req'd for Shear = 0.4 | Screw Spacing = 8.3 in o.c.
Total # of screws Required = 5

Use 5/8" ϕ wood lag screws @ 8.3 in o.c. along short side of curb w/ 3.5" Min. Embed

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

$Tall_{bolt}$ = 6903 lbs | $Vall_{bolt}$ = 3682 lbs
Transverse: 6903 lbs | 3682 lbs
# of Bolts Req'd for Uplift = 0.13 | COMBINED LOADING: 0.020 O.K.
# of Bolts Req'd for Shear = 0.12 | Bolt Spacing = 34.5 in o.c.
Total # of Bolts Required = 2

Use 5/8" ϕ A307 Bolts attached to steel angle below deck @ 34.5 in o.c. along long side of curb

Longitudinal:
# of Bolts Req'd for Uplift = 0.11 | COMBINED LOADING: 0.015 O.K.
# of Bolts Req'd for Shear = 0.11 | Req'd Min Spacing = 29.0 in o.c.
Total # of Bolts Required = 2

Use 5/8" ϕ A307 Bolts attached to steel angle below deck @ 29 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 $\propto = (1 + 0.2SDS)D + 2.5E = 1.87$

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

Transverse: $Uplift_{MAX}$ = 1320 lbs $Shear_{MAX}$ = 623 lbs

$Compression_{SEISMIC}$ = 1487 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*(WGT$_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 1320 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*[WGTunit+curb)

$Shear_{SEISMIC}$ = 623 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.43 spacing = 22.50 in o.c. Tapplied = 330.1 lbs

Min Bolts Req'd Shear = 2.00 spacing = 22.5 in o.c. Vapplied = 155.9 lbs

Try using 4 bolts
spaced at 11.50 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 0.50

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

Longitudinal: $Uplift_{MAX}$ = 1182 lbs $Shear_{MAX}$ = 623 lbs

$Compression_{SEISMIC}$ = 1349 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*(WGT$_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 1182 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*[WGTunit+curb]

$Shear_{SEISMIC}$ = 623 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.28 spacing = 17 in o.c. Tapplied = 295.5 lbs

Min Bolts Req'd Shear = 2.00 spacing = 17 in o.c. Vapplied = 155.9 lbs

Try using 4 bolts
spaced at 9.67 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 0.46

Use 4 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 9.7 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBKD-153

CURB RAIL THICKNESS: 0.0566 in 16 Gauge

UNIT CLIP THICKNESS: 0.0566 in 16 Gauge

 # OF CLIPS (LONG SIDE) - 1 clips with 2 - #12 SMS screws each clip

WEB STIFFENER: NOT REQUIRED

 # OF CLIPS (SHORT SIDE) - 1 clips with 2 - #12 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	6 @ 7.7 in o.c.	2 @ 34.5 in o.c.	4 @ 11.5 in o.c.
SHORT DIRECTION	5 @ 8.25 in o.c.	2 @ 29 in o.c.	4 @ 9.67 in o.c.

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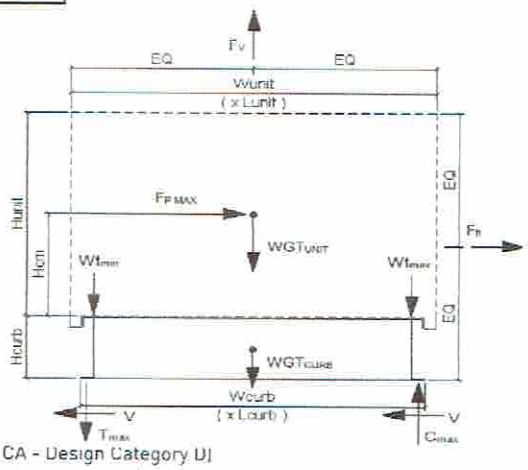
Client: ProVent PV1806
Description: CBKD-153 8" KDKITLX
Unit: ALL YORK P***B MODELS

Curb Information

Hcurb =	8	in	(Height of curb)
Lcurb =	46.5	in	(Length of curb)
wcurb =	41	in	(Width of curb)
WGTcurb =	80	lbs	(Weight of curb)
# Clips long side =	1	# Clips short side =	1

Unit Information

WGTunit =	420	lbs	(Weight of Unit)
Wtmax =	141	lbs	(Maximum corner weight)
Wtmin =	78	lbs	(Minimum corner weight)
Hunit =	55	in	(Height of unit above curb)
Hcm =	27.5	in	(Height to center of mass)
Lunit =	51.25	in	(Length of unit)
Wunit =	45.75	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 =	419 lbs (unit only)	(0.7*Fpmax) FpmaxASD = 499 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)
$F_{h\ ASD\ trans}$ =	831 lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	742 lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	477 lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	638 lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	498 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	488 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	713 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	605 lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	464 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	370 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	594 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	638	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	713	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	605	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	594	lbs	---> Along short edge of curb.

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

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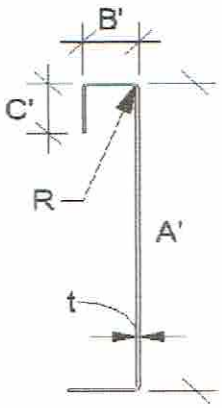
Curb Design

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 = 0.416 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 -- Check limits: C = 4.00
t = 0.0566 in h/t = 141.34 ≤ 200 C_R = 0.14
N = 7.00 N/t = 123.67 ≤ 210 C_N = 0.35
Ω_w = 1.75 N/h = 0.875 ≤ 2.0 C_h = 0.02
P_n = 1.770 k R/t = 1.50 ≤ 9.0 (See table C3.4.1-2, fastened to support, one flange, end loading)
P_n/Ω_w = 1.011 k
Long side: Pu_{trans} = 0.638 k **O.K.** # clips = 1
Short side: Pu_{Long} = 0.605 k **O.K.** # clips = 1

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

Check Web Stiffener 16Ga x 3/4" x 7" IC-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 = 208 lbs Max[$F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections]
Vcrnmax = 356 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 = 0.3 ***If combined fails:
# of Bolts Used = [1.0] USE --> 2.0
Check Combined Stress in Bolts & Inserts: 0.409 O.K. StressComb = 0.205 **O.K.**

Check 1/8" welded connection <--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.415 in
Lreq'd = 0.304 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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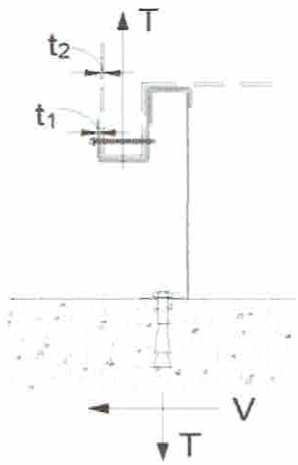
Connection Unit to Curb Clip | #12 SMS screw | Ω = 3.0

t1 = 0.0566 in | Fu1 = 65 ksi
t2 = 0.1017 in (unit base rail thickness) | Fu2 = 65 ksi
d = 0.216 in (screw diameter) | dw = 0.375 in (nom. washer diameter)
t2/t1 = 1.8



For t2/t1 ≤ 1.0:		For t2/t1 ≥ 2.5:	
Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$	Pns = 2146 # / 4.12 k		Pns = 2146 #
$P_{ns} = 2.7t_1 d F_{u1}$	2.15 k	$P_{ns} = 2.7t_1 d F_{u1}$	2.15 k
$P_{ns} = 2.7t_2 d F_{u2}$	3.86 k	$P_{ns} = 2.7t_2 d F_{u2}$	3.86 k

Pns/Ω = 715 # <- Controls
Pss/Ω = 840 #

Tension: Pnot = 1.214 k (screw pull-out strength) — $P_{not} = 0.85 t_c d F_{u2}$, $t_c = \min(t_1, t_2)$
Pnov = 2.069 k (screw pull-over strength) — $P_{nov} = 1.5 t_1 d_w F_{u1}$
Pts/Ω = 405 # <- Controls
Pts/Ω = 845 # (full tensile screw capacity)

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	0.831	1	0.83	715 #	2	6.00 in
Short side:	0.742	1	0.74	715 #	2	6.00 in

clip width (in) = 7.00 | clip height = 1.4 in
min spacing = 0.65 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 = 0.350 in² | Ant = 0.033 in²
Rn/Ω = 5.932 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:	$Uplift_{MAX}$ = 808 lbs	$Shear_{MAX}$ = 416 lbs
$Compression_{SEISMIC}$ = 748 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb	
$Tension_{SEISMIC}$ = 581 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)	
$Compression_{WIND}$ = 631 lbs	=[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb	
$Tension_{WIND}$ = 808 lbs	=[$F_{h\,transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb	
Longitudinal:	$Uplift_{MAX}$ = 655 lbs	$Shear_{MAX}$ = 371 lbs
$Compression_{SEISMIC}$ = 697 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb	
$Tension_{SEISMIC}$ = 530 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)	
$Compression_{WIND}$ = 478 lbs	=[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb	
$Tension_{WIND}$ = 655 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**

$Tall_{screw}$ = 6133 lbs | $Vall_{metal}$ = 2744 lbs
Transverse: $Tall_{wood}$ = 1196 lbs | $Vall_{wood}$ = 1024 lbs
# of Screws Req'd for Uplift = 0.68 | COMBINED LOADING: 0.180 O.K.
# of Screws Req'd for Shear = 0.41 | Screw Spacing = 7.7 in o.c.
Total # of screws Required = 6

Use 5/8" φ wood lag screws @ 7.7 in o.c. along long side of curb w/ 3.5" Min. Embed

Longitudinal:
# of Screws Req'd for Uplift = 0.5 | COMBINED LOADING: 0.182 O.K.
# of Screws Req'd for Shear = 0.4 | Screw Spacing = 8.3 in o.c.
Total # of screws Required = 5

Use 5/8" φ wood lag screws @ 8.3 in o.c. along short side of curb w/ 3.5" Min. Embed

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

$Tall_{bolt}$ = 6903 lbs | $Vall_{bolt}$ = 3682 lbs
Transverse: 6903 lbs | 3682 lbs
# of Bolts Req'd for Uplift = 0.12 | COMBINED LOADING: 0.017 O.K.
# of Bolts Req'd for Shear = 0.11 | Bolt Spacing = 34.5 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 34.5 in o.c. along long side of curb

Longitudinal:
# of Bolts Req'd for Uplift = 0.09 | COMBINED LOADING: 0.013 O.K.
# of Bolts Req'd for Shear = 0.10 | Req'd Min Spacing = 29.0 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 29 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: $Uplift_{MAX}$ = 1229 lbs $Shear_{MAX}$ = 623 lbs

$Compression_{SEISMIC}$ = 1396 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 1229 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 623 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.33 spacing = 22.50 in o.c. Tapplied = 307.3 lbs

Min Bolts Req'd Shear = 2.00 spacing = 22.5 in o.c. Vapplied = 155.9 lbs

Try using 4 bolts
spaced at 11.50 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 0.48

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

Longitudinal: $Uplift_{MAX}$ = 1101 lbs $Shear_{MAX}$ = 623 lbs

$Compression_{SEISMIC}$ = 1268 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 1101 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 623 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.20 spacing = 17 in o.c. Tapplied = 275.4 lbs

Min Bolts Req'd Shear = 2.00 spacing = 17 in o.c. Vapplied = 155.9 lbs

Try using 4 bolts
spaced at 9.67 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 0.44

Use 4 - 3/4" ϕ Hilti Hit-HY 200 adhesive anchors @ 9.7 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBKD-153

CURB RAIL THICKNESS: 0.0566 in 16 Gauge

UNIT CLIP THICKNESS: 0.0566 in 16 Gauge

 # OF CLIPS (LONG SIDE) - 1 clips with 2 - #12 SMS screws each clip

WEB STIFFENER: NOT REQUIRED

 # OF CLIPS (SHORT SIDE) - 1 clips with 2 - #12 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	6 @ 7.7 in o.c.	2 @ 34.5 in o.c.	4 @ 11.5 in o.c.
SHORT DIRECTION	5 @ 8.25 in o.c.	2 @ 29 in o.c.	4 @ 9.67 in o.c.