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

Structural Calculations
for
CBKD-141 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.)

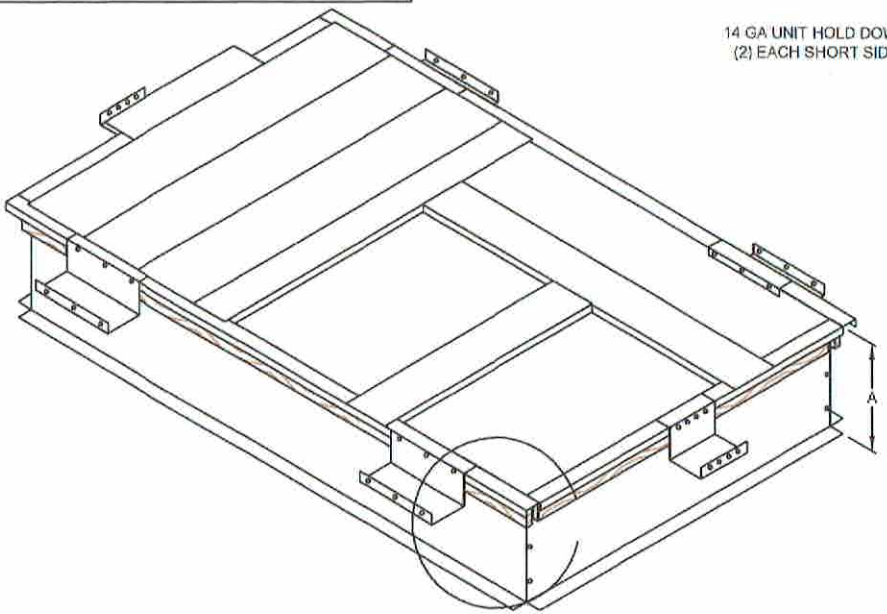
STRUCTURALLY CALCULATED KNOCK-DOWN ROOF CURBS FOR YORK UNITS

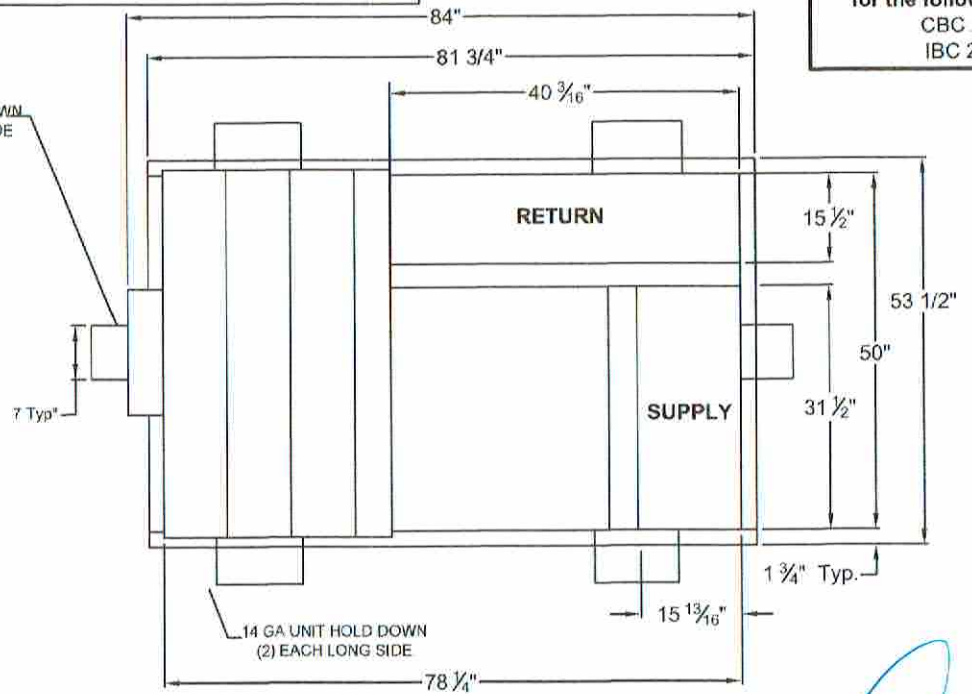
ZX, ZY 08-12; ZX 14; ZY 07

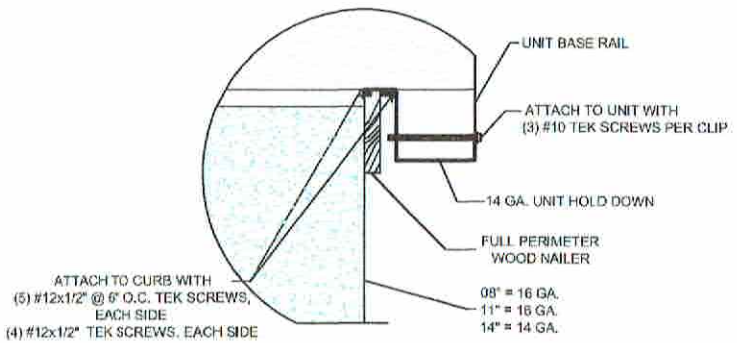
ProVent P/N	A	WEIGHT
CBKDPRL08	8"	115 Lbs
CBKDPRL11	11"	129 Lbs
CBKDPRL14	14"	144 Lbs

SEISMIC KIT P/N	WEIGHT
KDKITPRL	60 Lbs

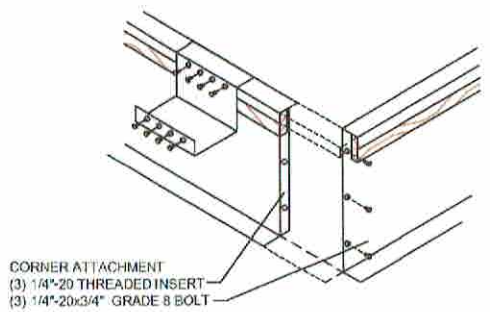
Meets seismic requirements for the following codes:
CBC 2016
IBC 2015







HOLD DOWN DETAIL



CORNER &
HOLD DOWN DETAIL

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

8/1/19

ProVent

3847 WABASH DRIVE
MIRA LOMA, CA 91725

PHONE (951) 685-1101
FAX (619) 872-9799

SUBMITTED TO: _____
COMPANY: _____
JOB NAME: _____
EQUIPMENT: _____
NOTES: _____

FORM NO:		PART NUMBER:
CBKD-141		KDKITPRL Series
DATE: 01/07/19	REV: 4	DRAWN BY: ALL

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Client: ProVent PV1806
Description: CBKD-141 14" KDKITPRL
Unit: ZX, ZY 08-12; ZX 14; ZY 07

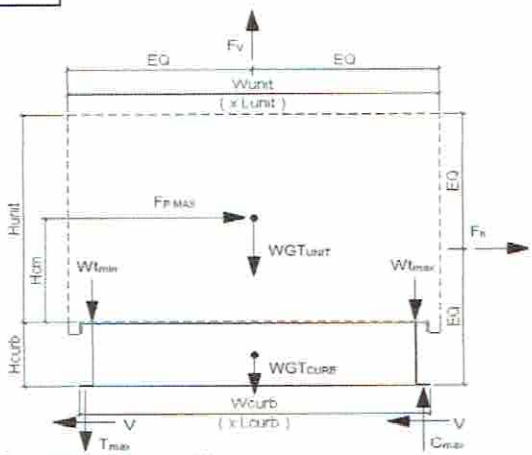
Curb Information

Hcurb =	14	in	(Height of curb)
Lcurb =	84	in	(Length of curb)
wcurb =	53.5	in	(Width of curb)
WGTcurb =	204	lbs	(Weight of curb)

Clips long side = 2 # Clips short side = 1

Unit Information

WGTunit =	653	lbs	(Weight of Unit)
Wtmax =	176	lbs	(Maximum corner weight)
Wtmin =	151	lbs	(Minimum corner weight)
Hunit =	40.56	in	(Height of unit above curb)
Hcm =	20.28	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 =	651	lbs	(0.7*Fpmax)
	(unit only)		

FpmaxASD = 855 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)
$F_{h\ ASD\ trans}$ =	1040	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	687	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:

$Compression_{SEISMIC}$ =	693	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	474	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	238	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	581	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	603	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	385	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	9	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	353	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	693	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	581	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	603	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	385	lbs	---> Along short edge of curb.

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

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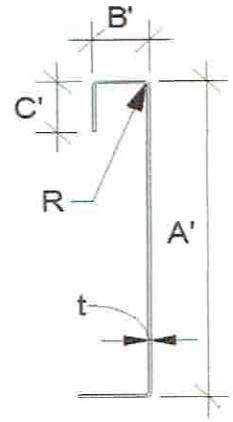
Curb Design

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



Calculate Section Properties of Curb

A'=	[14.000] in	a =	13.644 in	= A'-(2r+t)
B'=	[3.000] in	a'=	13.929 in	= A'-t
C'=	[1.000] in (0 if no lips)	b =	2.644 in	= B'-[r+t/2+α(r+t/2)]
α =	[1.000] (0 - no Lip; 1 w/ lip)	b'=	2.929 in	= B'-(t/2+αt/2)
R =	0.1069 (Inside bend radius)	c =	0.822 in	= α(C'-(r+t/2)]
t =	0.0713 in	c'=	0.964 in	= α(C'-t/2)
r'=	0.143 in = R+t/2	u =	0.224 in	= πr/2

x = 0.646 in (Distance between centroid and web centerline)
Ix = 41.261 in (Moment of Inertia about X-Axis)
Iy = 1.659 in (Moment of Inertia about Y-Axis)
A = 1.53 in^2
rx = 5.19 in
ry = 1.041 in
rmin = 1.041 in

Axial Compression

Pu = 0.520 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 = 4.00
N = 7.00 N/t = 98.18 ≤ 210 C_R = 0.14
Ω_w = 1.75 N/h = 0.5 ≤ 2.0 C_N = 0.35
P_n = 2.422 k R/t = 1.50 ≤ 9.0 C_h = 0.02
P_n/Ω_w = 1.384 k
Long side: Pu_{Trans} = 0.346 k **O.K.** # clips = 2
Short side: Pu_{Long} = 0.201 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 = 2.422 k Ae = 0.380 in^2
Pn = 15.002 k Pn/Ω = 8.825 k

Not Req'd

Corner Connections

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

Tcrnmax = 260 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 291 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: 0.370 O.K. StressComb = 0.185 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 0.197 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 #

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ = 3.86 k
$P_{ns} = 2.7t_1 dF_{u1}$ = 2.38 k
$P_{ns} = 2.7t_2 dF_{u2}$ = 3.39 k
Pns/Ω = 792 #
Pss/Ω = 540 # <- Controls

For t2/t1 ≥ 2.5: | Pns = 2377 #

$P_{ns} = 2.7t_1 dF_{u1}$ = 2.38 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 = 2.607 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:	1.040	2	0.52	540 #	2	6.00 in
Short side:	0.687	3	0.23	540 #	2	6.00 in

clip width (in) = 7.00 | clip height = 1.4 in
min spacing = 0.57 in | edge distance = 0.5 in (min. 1.5d)
Check Block shear rupture: O.K. | thinnest part = 0.0713 AISI BSR applies
Fy = 50 ksi | Ω = 2.22 bolt/screw connection
Agv = 0.463 in² | Anv = 0.443 in² | Ant = 0.042 in²
Rn/Ω = 7.500 k | $R_n = 0.6F_y A_{gv} + F_u A_{nt} \le 0.6F_u A_{nv} + F_u A_{nt}$
BSR O.K. (AISI Sect. E5.3)

Connection of Curb to Supporting Structure

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

Transverse:	$Uplift_{MAX}$ = 804 lbs		$Shear_{MAX}$ = 520 lbs
$Compression_{SEISMIC}$ =	1090 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2]*wcurb]/wcurb	
$Tension_{SEISMIC}$ =	804 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)	
$Compression_{WIND}$ =	556 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2]*wcurb-$F_{vertASD}$*wcurb/2]/wcurb	
$Tension_{WIND}$ =	777 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2]*wcurb+$F_{vertASD}$*wcurb/2]/wcurb	
Longitudinal:	$Uplift_{MAX}$ = 605 lbs		$Shear_{MAX}$ = 427 lbs
$Compression_{SEISMIC}$ =	891 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2]*Lcurb]/Lcurb	
$Tension_{SEISMIC}$ =	605 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)	
$Compression_{WIND}$ =	169 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2]*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb	
$Tension_{WIND}$ =	391 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 = 0.85 | COMBINED LOADING: 0.839 O.K.
# of Screws Req'd for Shear = 0.51 | Screw Spacing = #DIV/0! in o.c.
Total # of screws Required = 1

#DIV/0!

Longitudinal:
# of Screws Req'd for Uplift = 0.6 | COMBINED LOADING: 0.175 O.K.
# of Screws Req'd for Shear = 0.4 | Screw Spacing = 45.5 in o.c.
Total # of screws Required = 2

Use 5/8" φ wood lag screws @ 45.5 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: 0.021 O.K.
# of Bolts Req'd for Shear = 0.14 | Bolt Spacing = 72.0 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 72 in o.c. along long side of curb

Longitudinal:
# of Bolts Req'd for Uplift = 0.09 | COMBINED LOADING: 0.014 O.K.
# of Bolts Req'd for Shear = 0.12 | Req'd Min Spacing = 41.5 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 41.5 in o.c. along short side of curb

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

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

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

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

Transverse: $Uplift_{MAX}$ = 1626 lbs $Shear_{MAX}$ = 1069 lbs

$Compression_{SEISMIC}$ = 1912 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS}]*(WGT$_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 1626 lbs =Comp$_{SEISMIC}$-(0.6-0.14S_{DS}]*(WGTunit+curb)

$Shear_{SEISMIC}$ = 1069 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.77 spacing = 60.00 in o.c. Tapplied = 541.9 lbs

Min Bolts Req'd Shear = 2.00 spacing = 60 in o.c. Vapplied = 356.2 lbs

Try using 3 bolts spaced at 36.00 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 0.92

Use 3 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 36 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 1128 lbs $Shear_{MAX}$ = 1069 lbs

$Compression_{SEISMIC}$ = 1415 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS}]*(WGT$_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 1128 lbs =Comp$_{SEISMIC}$-(0.6-0.14S_{DS}]*(WGTunit+curb)

$Shear_{SEISMIC}$ = 1069 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.23 spacing = 29.5 in o.c. Tapplied = 282.1 lbs

Min Bolts Req'd Shear = 2.00 spacing = 29.5 in o.c. Vapplied = 267.1 lbs

Try using 4 bolts spaced at 13.83 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 0.55

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

CURB DESIGN SUMMARY: CBKD-141			
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 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	#DIV/0!	2 @ 72 in o.c.	3 @ 36 in o.c.
SHORT DIRECTION	2 @ 45.5 in o.c.	2 @ 41.5 in o.c.	4 @ 13.83 in o.c.

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Client: ProVent PV1806
Description: CBKD-141 11" KDKITPRL
Unit: ZX, ZY 08-12; ZX 14; ZY 07

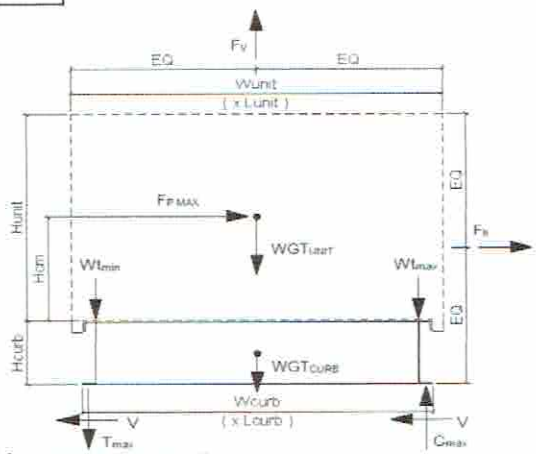
Curb Information

Hcurb =	11	in	(Height of curb)
Lcurb =	84	in	(Length of curb)
wcurb =	53.5	in	(Width of curb)
WGTcurb =	204	lbs	(Weight of curb)

Clips long side = 2 # Clips short side = 1

Unit Information

WGTunit =	653	lbs	(Weight of Unit)
Wtmax =	176	lbs	(Maximum corner weight)
Wtmin =	151	lbs	(Minimum corner weight)
Hunit =	40.56	in	(Height of unit above curb)
Hcm =	20.28	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 =	651	lbs	(0.7*Fpmax) FpmaxASD = 855 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)
$F_{h\ ASD\ trans}$ =	983	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	649	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:

$Compression_{SEISMIC}$ =	693	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	474	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	216	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	560	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	603	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	385	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	0	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	344	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	693	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	560	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	603	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	385	lbs	---> Along short edge of curb.

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

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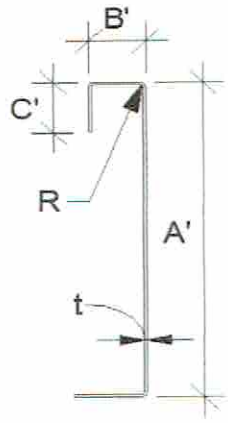
Curb Design

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 = 0.491 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
N = 7.00 N/t = 123.67 ≤ 210
Ω_w = 1.75 N/h = 0.636364 ≤ 2.0
P_n = 1.674 k R/t = 1.50 ≤ 9.0
P_n/Ω_w = 0.957 k
Long side: Pu_{Trans} = 0.346 k **O.K.** # clips = 2
Short side: Pu_{Long} = 0.201 k **O.K.** # clips = 3

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)

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

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 = 246 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 280 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: 0.354 O.K. StressComb = 0.177 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.415 in
Lreq'd = 0.238 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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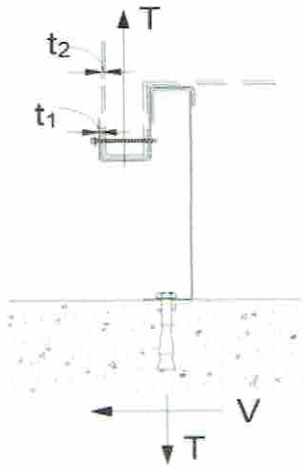
Connection Unit to Curb Clip — #10 SMS screw — Ω = 3.0

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:			For t2/t1 ≥ 2.5:	
Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$	Pns = 1887 #	3.86 k	Pns =	1887 #
$P_{ns} = 2.7t_1 dF_{u1}$		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:	0.983	2	0.49	540 #	2	6.00 in
Short side:	0.651	3	0.22	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 — $R_n = 0.6F_y A_{gv} + F_u A_{nt} \le 0.6F_u A_{nv} + F_u A_{nt}$ (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: $Uplift_{MAX}$ = 756 lbs — $Shear_{MAX}$ = 491 lbs

$Compression_{SEISMIC}$ = 1042 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

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

$Compression_{WIND}$ = 464 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb

$Tension_{WIND}$ = 685 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: $Uplift_{MAX}$ = 575 lbs — $Shear_{MAX}$ = 427 lbs

$Compression_{SEISMIC}$ = 861 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2]*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 575 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 131 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb

$Tension_{WIND}$ = 352 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 = 0.80 — COMBINED LOADING: 0.760 O.K.

# of Screws Req'd for Shear = 0.48 — Screw Spacing = #DIV/0! in o.c.

Total # of screws Required = 1

#DIV/0!

Longitudinal:

# of Screws Req'd for Uplift = 0.6 — COMBINED LOADING: 0.166 O.K.

# of Screws Req'd for Shear = 0.4 — Screw Spacing = 45.5 in o.c.

Total # of screws Required = 2

Use 5/8" φ wood lag screws @ 45.5 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 = 0.11 — COMBINED LOADING: 0.019 O.K.

# of Bolts Req'd for Shear = 0.13 — Bolt Spacing = 72.0 in o.c.

Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 72 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.08 — COMBINED LOADING: 0.014 O.K.

# of Bolts Req'd for Shear = 0.12 — Req'd Min Spacing = 41.5 in o.c.

Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 41.5 in o.c. along short side of curb

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For Concrete anchorage: SEISMIC (0.6-0.14SDSID + 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: $Uplift_{MAX}$ = 1506 lbs $Shear_{MAX}$ = 1069 lbs

$Compression_{SEISMIC}$ = 1792 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 1506 lbs =Comp$_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 1069 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.64 spacing = 60.00 in o.c. Tapplied = 501.9 lbs

Min Bolts Req'd Shear = 2.00 spacing = 60 in o.c. Vapplied = 356.2 lbs

Try using 3 bolts spaced at 36.00 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aptlied}}{V_{allow,ASD}} \leq 1.2$ = 0.87

Use 3 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 36 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 1052 lbs $Shear_{MAX}$ = 1069 lbs

$Compression_{SEISMIC}$ = 1338 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 1052 lbs =Comp$_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 1069 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.14 spacing = 29.5 in o.c. Tapplied = 263.0 lbs

Min Bolts Req'd Shear = 2.00 spacing = 29.5 in o.c. Vapplied = 267.1 lbs

Try using 4 bolts spaced at 13.83 in o.c.

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

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

CURB DESIGN SUMMARY: CBKD-141			
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 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	#DIV/0!	2 @ 72 in o.c.	3 @ 36 in o.c.
SHORT DIRECTION	2 @ 45.5 in o.c.	2 @ 41.5 in o.c.	4 @ 13.83 in o.c.

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Client: ProVent PV1806
Description: CBKD-141 8" KDKITPRL
Unit: ZX, ZY 08-12; ZX 14; ZY 07

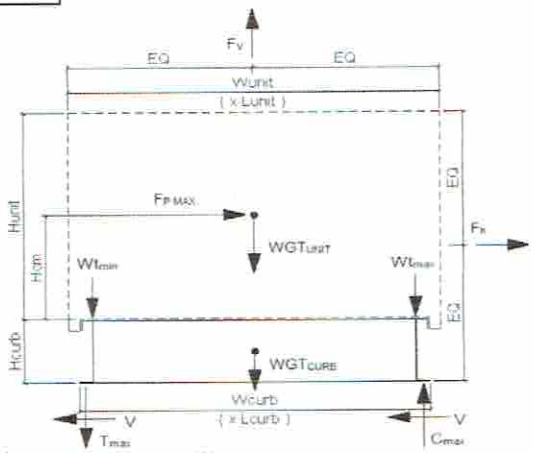
Curb Information

Hcurb =	8	in	(Height of curb)
Lcurb =	84	in	(Length of curb)
wcurb =	53.5	in	(Width of curb)
WGTcurb =	204	lbs	(Weight of curb)

Clips long side = 2 # Clips short side = 1

Unit Information

WGTunit =	653	lbs	(Weight of Unit)
Wtmax =	176	lbs	(Maximum corner weight)
Wtmin =	151	lbs	(Minimum corner weight)
Hunit =	40.56	in	(Height of unit above curb)
Hcm =	20.28	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 =	651	lbs	(0.7*Fpmax) FpmaxASD = 855 lbs (unit and curb)
	(unit only)		

Wind Loading - 2015 IBC/2016 CBC

*** Exposure Category C ***

Kz =	1.13		(For 60 ft roof height, Exposure C - Table 29.3-1 ACSE 7-10)
Kzt =	1.0		(No topographic effects assumed for rooftop mounted units)
Kd =	0.85		(Directionality factor Table 26.6-1 ASCE 7-10)
V =	115		(Max wind velocity, mph for Cat III & IV bldgs Exp. Cat C)
$GCr_{(horiz)}$ =	1.9		(Refer Sect 29.5.1 ASCE 7-10)
$GCr_{(vert)}$ =	1.5		(Refer Sect 29.5.1 ASCE 7-10)
qz	32.5	psf	$= 0.00256*Kz*Kzt*Kd*V^2$ (Eq. 29.3-1 ASCE 7-10)
$F_{h\ ASD\ trans}$ =	926	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	611	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:

$Compression_{SEISMIC}$ =	693	lbs	$=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb$
$Tension_{SEISMIC}$ =	474	lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	194	lbs	$=[F_{h\ transASD}*Hcm+2*0.6*Wtmax*wcurb-F_{vertASD}*wcurb/2]/wcurb$
$Tension_{WIND}$ =	538	lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Longitudinal:

$Compression_{SEISMIC}$ =	603	lbs	$=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb$
$Tension_{SEISMIC}$ =	385	lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	-9	lbs	$=[F_{h\ transASD}*Hcm+2*0.6*Wtmax*Lcurb-F_{vertASD}*Lcurb/2]/Lcurb$
$Tension_{WIND}$ =	335	lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	693	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	538	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	603	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	385	lbs	---> Along short edge of curb.

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

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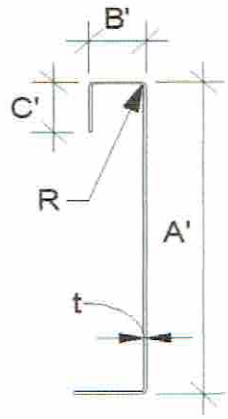
Curb Design

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	in^2			
rx =	3.16	in			
ry =	1.139	in			
rmin =	1.139	in			

Axial Compression

Pu = 0.463 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:
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 C = 4.00
P_n/Ω_w = 1.011 k
Long side: Pu_{Trans} = 0.346 k **O.K.** # clips = 2
Short side: Pu_{Long} = 0.201 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 = 1.770 k Ae = 0.380 in^2
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 = 231 lbs Max[$F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections]
Vcrnmax = 269 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 = 0.2 ***If combined fails:
# of Bolts Used = 1.0 USE --> 2.0
Check Combined Stress in Bolts & Inserts: 0.339 O.K. StressComb = 0.169 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.415 in
Lreq'd = 0.229 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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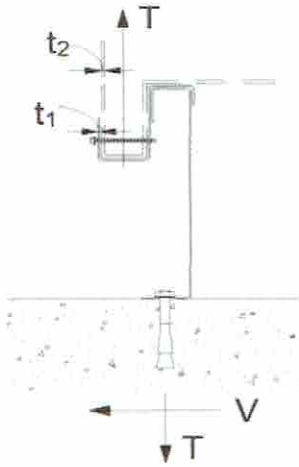
Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

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

Pnov = 2.069 k (screw pull-over strength) $t_c = \min(t_1, t_2)$ $P_{nov} = 1.5t_1 d_w F_{u1}$

Pts/Ω = 356 # <- Controls

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

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	0.926	2	0.46	540 #	2	6.00 in
Short side:	0.651	3	0.22	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 B5R 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: $Uplift_{MAX}$ = 708 lbs | $Shear_{MAX}$ = 463 lbs

$Compression_{SEISMIC}$ = 994 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 708 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 379 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb

$Tension_{WIND}$ = 600 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: $Uplift_{MAX}$ = 544 lbs | $Shear_{MAX}$ = 427 lbs

$Compression_{SEISMIC}$ = 830 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 544 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 95 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb

$Tension_{WIND}$ = 316 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 = 0.75 | COMBINED LOADING: 0.684 O.K.

# of Screws Req'd for Shear = 0.45 | Screw Spacing = #DIV/0! in o.c.

Total # of screws Required = 1

#DIV/0!

Longitudinal:

# of Screws Req'd for Uplift = 0.6 | COMBINED LOADING: 0.158 O.K.

# of Screws Req'd for Shear = 0.4 | Screw Spacing = 45.5 in o.c.

Total # of screws Required = 2

Use 5/8" φ wood lag screws @ 45.5 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 = 0.10 | COMBINED LOADING: 0.017 O.K.

# of Bolts Req'd for Shear = 0.13 | Bolt Spacing = 72.0 in o.c.

Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 72 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.08 | COMBINED LOADING: 0.013 O.K.

# of Bolts Req'd for Shear = 0.12 | Req'd Min Spacing = 41.5 in o.c.

Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 41.5 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: $Uplift_{MAX}$ = 1386 lbs $Shear_{MAX}$ = 1069 lbs

$Compression_{SEISMIC}$ = 1672 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 1386 lbs =Comp$_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 1069 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.51 spacing = 60.00 in o.c. Tapplied = 462.0 lbs

Min Bolts Req'd Shear = 2.00 spacing = 60 in o.c. Vapplied = 356.2 lbs

Try using 3 bolts spaced at 36.00 in o.c.

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

Use 3 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 36 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 976 lbs $Shear_{MAX}$ = 1069 lbs

$Compression_{SEISMIC}$ = 1262 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 976 lbs =Comp$_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 1069 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.06 spacing = 29.5 in o.c. Tapplied = 243.9 lbs

Min Bolts Req'd Shear = 2.00 spacing = 29.5 in o.c. Vapplied = 267.1 lbs

Try using 4 bolts spaced at 13.83 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 0.51

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

CURB DESIGN SUMMARY: CBKD-141			
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 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	#DIV/0!	2 @ 72 in o.c.	3 @ 36 in o.c.
SHORT DIRECTION	2 @ 45.5 in o.c.	2 @ 41.5 in o.c.	4 @ 13.83 in o.c.