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

Structural Calculations
for
CBKD-79 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.

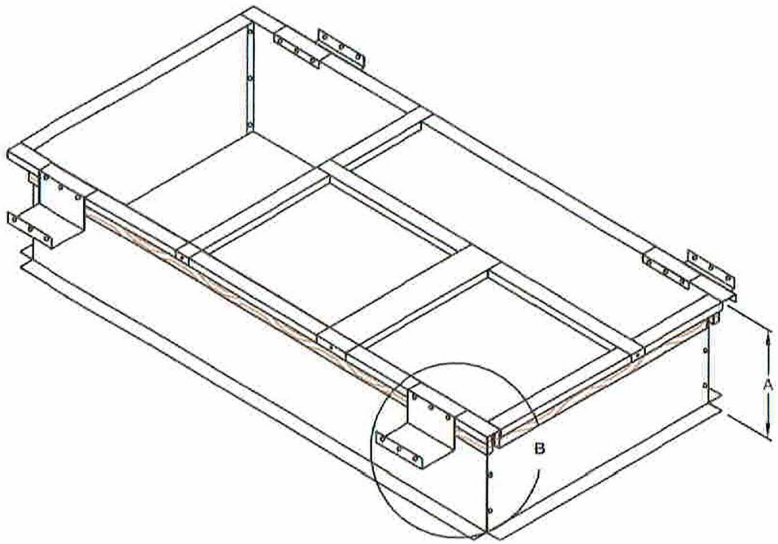
Will conform to seismic code requirements for knock-down or pre-assembled application. (Contact factory for assembled version.)

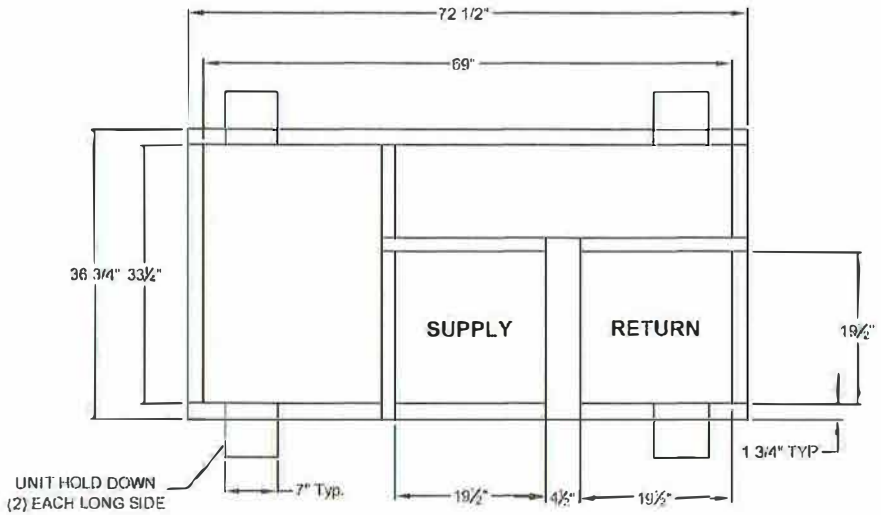
STRUCTURALLY CALCULATED KNOCK-DOWN ROOF CURBS FOR YORK UNITS

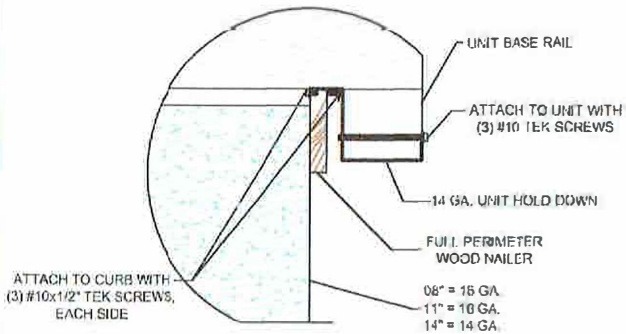
ZR 036-060, ZE 036-072, XP 036-060, ZF 036-072, XN 036-060

ProVent P/N	A	WEIGHT	SEISMIC KIT P/N	WEIGHT
CBKDSUN367208	8"	67 Lbs	KDKITSUN3672	6 Lbs
CBKDSUN367211	11"	79 Lbs		
CBKDSUN367214	14"	91 Lbs		

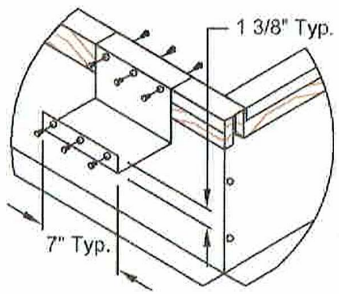
Meets seismic requirements for the following codes:
CBC 2016
IBC 2015



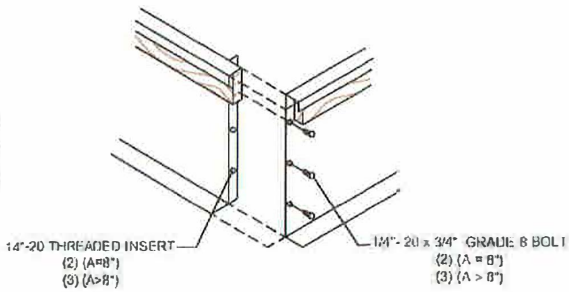




HOLD DOWN DETAIL



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-79		KDKITSUN3672
DATE:	REV:	DRAWN BY:
01/07/19	3	ALL

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Client: ProVent PV1806
Description: CBKD-79 14" KDKITSUN3672
Unit: ZR 036-060, XP 036-060, ZF 036-072

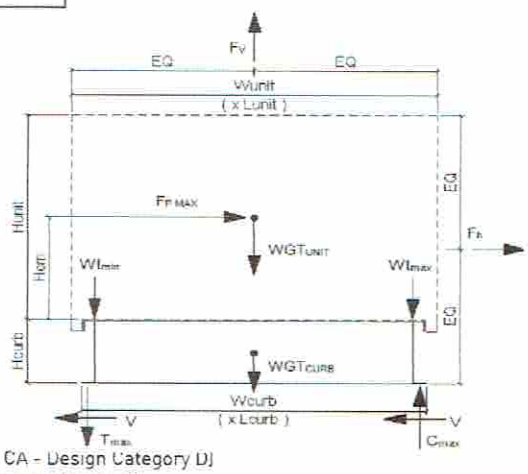
Curb Information

Hcurb =	14	in	(Height of curb)
Lcurb =	72.5	in	(Length of curb)
wcurb =	36.75	in	(Width of curb)
WGTcurb =	97	lbs	(Weight of curb)

Clips long side = 2 # Clips short side = 0

Unit Information

WGTunit =	704	lbs	(Weight of Unit)
Wtmax =	234	lbs	(Maximum corner weight)
Wtmin =	96	lbs	(Minimum corner weight)
Hunit =	32.625	in	(Height of unit above curb)
Hcm =	16.3125	in	(Height to center of mass)
Lunit =	82.25	in	(Length of unit)
Wunit =	44.875	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 =	702 lbs (unit only)	(0.7*Fpmax) FpmaxASD = 799 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)
$F_{h\ ASD\ trans}$ =	987 lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	539 lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	750 lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	904 lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	669 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	344 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	672 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	750 lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	515 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	27 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	355 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	904	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	672	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	750	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	515	lbs	---> Along short edge of curb.

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

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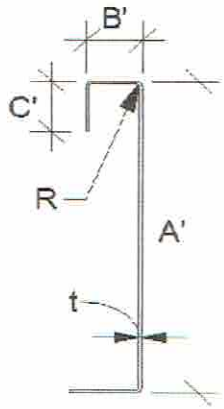
Curb Design

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'=	[2.000] in	a'=	13.929 in	= A'-t
C'=	[0.000] in (0 if no lips)	b =	1.822 in	= B'-[r+t/2+α(r+t/2)]
α =	[0.000] (0 - no Lip; 1 w/ lip)	b'=	1.964 in	= B'-(t/2+αt/2)
R =	0.1069 (Inside bend radius)	c =	0.000 in	= α[C'-(r+t/2)]
t =	0.0713 in	c'=	0.000 in	= α(C'-t/2)
r' =	0.143 in = R+t/2	u =	0.224 in	= πr/2
x =	0.218 in (Distance between centroid and web centerline)			
Ix =	29.228 in (Moment of Inertia about X-Axis)			
Iy =	0.300 in (Moment of Inertia about Y-Axis)			
A =	1.26 in^2			
rx =	4.81 in			
ry =	0.487 in			
rmin =	0.487 in			

Axial Compression

Pu = 0.494 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 21.644 k
Fe = 43.22 ksi
λc = 1.08
Fn = 30.81 ksi
Ly = 50 in Lateral unbraced length
k_yL_y/r_y = 82 (assume k=0.8)

$$\frac{P_n}{\Omega_c} = \frac{F_nA}{\Omega_c} \qquad If\ \lambda_c \le 1.5;\ F_n = \left(0.658^{\lambda_c^2}\right)F_y \qquad If\ \lambda_c > 1.5;\ F_n = \frac{0.877}{\lambda_c^2}F_y$$

$$\lambda_c = \sqrt{\frac{F_y}{F_e}} \qquad F_e = \frac{\pi^2E}{\left(kl/r\right)^2}$$

Compression Check = O.K.

Check Web Crippling

h = 14 in -- Check limits: C = 4.00
t = 0.0713 in h/t = 196.35 ≤ 200 C_R = 0.14
N = 7.00 N/t = 98.18 ≤ 210 C_N = 0.35
Ω_w = 1.75 N/h = 0.5 ≤ 2.0 C_h = 0.02
P_n = 2.422 k R/t = 1.50 ≤ 9.0
P_n/Ω_w = 1.384 k
Long side: Pu_{Trans} = 0.452 k **O.K.** # clips = 2
Short side: Pu_{Long} = 0.375 k **O.K.** # clips = 2

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

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

Check Web Stiffener

16Ga x 3/4" x 7" (C-channel)

width of stiffener = 7.000 in ts = 0.0566 [16 Gauge]
web of stiff. w = 6.717 in Rs = 0.0849 in
***Check w/ts ≤ 1.28√E/Fys Ωc = 1.70
w/ts = 118.675
1.28√(E/Fys) = 31.091 --> w/ts over limit Use C3.7.2

$$P_n = 0.7\left(P_{wc} + A_eF_y\right) \ge P_{wc}$$

Pwc = 2.422 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 = 247 lbs Max($F_{gmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 336 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: 0.406 O.K. StressComb = 0.203 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 0.227 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 #		Pns = 2377 #
$P_{ns} = 2.7t_1 dF_{u1}$	3.86 k	$P_{ns} = 2.7t_1 dF_{u1}$	2.38 k
$P_{ns} = 2.7t_2 dF_{u2}$	2.38 k	$P_{ns} = 2.7t_2 dF_{u2}$	3.39 k
Pns/Ω =	3.39 k		
Pss/Ω =	792 #		
	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:	0.987	2	0.49	540 #	2	6.00 in
Short side:	0.702	2	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 | $R_n = 0.6F_y A_{gv} + F_u A_{nt} \le 0.6F_u A_{nv} + F_u A_{nt}$
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:	$Uplift_{MAX}$ =	949 lbs	$Shear_{MAX}$ =	494 lbs
$Compression_{SEISMIC}$ =	1166 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb		
$Tension_{SEISMIC}$ =	899 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)		
$Compression_{WIND}$ =	680 lbs	=[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb		
$Tension_{WIND}$ =	949 lbs	=[$F_{h\,transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb		
Longitudinal:	$Uplift_{MAX}$ =	574 lbs	$Shear_{MAX}$ =	399 lbs
$Compression_{SEISMIC}$ =	841 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb		
$Tension_{SEISMIC}$ =	574 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)		
$Compression_{WIND}$ =	90 lbs	=[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb		
$Tension_{WIND}$ =	360 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 = 1.00 | COMBINED LOADING: 0.638 O.K.
# of Screws Req'd for Shear = 0.48 | Screw Spacing = 64.5 in o.c.
Total # of screws Required = 2

Use 5/8" φ wood lag screws @ 64.5 in o.c. along long side of curb

Longitudinal:
# of Screws Req'd for Uplift = 0.6 | COMBINED LOADING: 0.435 O.K.
# of Screws Req'd for Shear = 0.4 | Screw Spacing = 28.8 in o.c.
Total # of screws Required = 2

Use 5/8" φ wood lag screws @ 28.8 in o.c. along short side of curb

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

	$Tall_{bolt}$ =	6903 lbs	$Vall_{bolt}$ =	3682 lbs
Transverse:		6903 lbs		3682 lbs

# of Bolts Req'd for Uplift = 0.14 | COMBINED LOADING: 0.023 O.K.
# of Bolts Req'd for Shear = 0.13 | Bolt Spacing = 60.5 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 60.5 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 = 0.11 | Req'd Min Spacing = 24.8 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 24.8 in o.c. along short side of curb

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

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: $Uplift_{MAX}$ = 1887 lbs $Shear_{MAX}$ = 999 lbs

$Compression_{SEISMIC}$ = 2155 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 1887 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 999 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 2.05 spacing = 24.25 in o.c. Tapplied = 471.8 lbs

Min Bolts Req'd Shear = 2.00 spacing = 48.5 in o.c. Vapplied = 249.7 lbs

Try using 4 bolts spaced at 20.17 in o.c.

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

Use 4 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 20.2 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 1075 lbs $Shear_{MAX}$ = 999 lbs

$Compression_{SEISMIC}$ = 1342 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 1075 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 999 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.17 spacing = 12.75 in o.c. Tapplied = 268.7 lbs

Min Bolts Req'd Shear = 2.00 spacing = 12.75 in o.c. Vapplied = 249.7 lbs

Try using 4 bolts spaced at 8.25 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 0.52

Use 4 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 8.3 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBKD-79			
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) - 2 clips with 2 - #10 SMS screws each clip			
WEB STIFFENER: NOT REQUIRED			
CORNER CONNECTION: Use 2 - 1/4" φ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts			
CURB ANCHORAGE	WOOD 5/8" φ lag screw w/ min. 3.5" embed (SGmin=0.43)	STEEL 5/8" φ A307 bolts	CONCRETE 3/4" φ thrd'd rod in Hilti HIT-HY 200 epoxy, min. 4" embed
LONG DIRECTION	2 @ 64.5 in o.c.	2 @ 60.5 in o.c.	4 @ 20.17 in o.c.
SHORT DIRECTION	2 @ 28.75 in o.c.	2 @ 24.75 in o.c.	4 @ 8.25 in o.c.

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Client: ProVent PV1806
Description: CBKD-79 11" KDKITSUN3672
Unit: ZR 036-060, XP 036-060, ZF 036-072

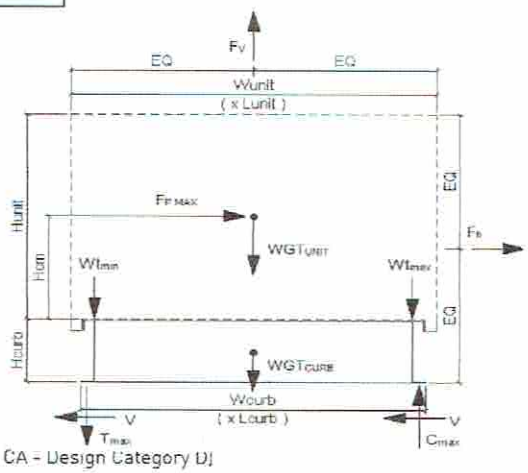
Curb Information

Hcurb =	11	in	(Height of curb)
Lcurb =	72.5	in	(Length of curb)
wcurb =	36.75	in	(Width of curb)
WGTcurb =	97	lbs	(Weight of curb)

Clips long side = 2 # Clips short side = 0

Unit Information

WGTunit =	704	lbs	(Weight of Unit)
Wtmax =	234	lbs	(Maximum corner weight)
Wtmin =	96	lbs	(Minimum corner weight)
Hunit =	32.625	in	(Height of unit above curb)
Hcm =	16.3125	in	(Height to center of mass)
Lunit =	82.25	in	(Length of unit)
Wunit =	44.875	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)
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Fpmax =	1.425 Wp	(0.4*ap*Sds*Ip)*Wp*3/Rp
FpmaxASD =	702 lbs (unit only)	(0.7*Fpmax) FpmaxASD = 799 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)
$F_{h\ ASD\ trans}$ =	924 lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	504 lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	750 lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	904 lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	669 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	316 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	644 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	750 lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS}]*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	515 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	19 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	347 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	904	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	669	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	750	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	515	lbs	---> Along short edge of curb.

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

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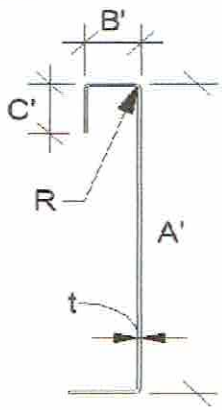
Curb Design

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'=	[2.000] in	a'=	10.943 in	= A'-t
C'=	[0.000] in (0 if no lips)	b =	1.859 in	= B'-[r+t/2+a(r+t/2)]
a =	[0.000] (0 - no Lip; 1 w/ lip)	b'=	1.972 in	= B'-(t/2+at/2)
R =	0.0849 (Inside bend radius)	c =	0.000 in	= a[C'-(r+t/2)]
t =	0.0566 in	c'=	0.000 in	= a(C'-t/2)
r'=	0.113 in = R+t/2	u =	0.178 in	= πr/2

x = 0.263 in (Distance between centroid and web centerline)
Ix = 12.703 in (Moment of Inertia about X-Axis)
Iy = 0.231 in (Moment of Inertia about Y-Axis)
A = 0.84 in²
rx = 3.90 in
ry = 0.526 in
rmin = 0.526 in

Axial Compression

Pu = 0.462 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 15.337 k
Fe = 50.29 ksi
λc = 1.00
Fn = 32.98 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 = 50 in Lateral unbraced length
$k_y L_y/r_y$ = 76 (assume k=0.8)

Compression Check = O.K.

Check Web Crippling

h = 11 in -- Check limits: C = 4.00
t = 0.0566 in h/t = 194.35 ≤ 200 C_R = 0.14
N = 7.00 N/t = 123.67 ≤ 210 C_N = 0.35
Ω_w = 1.75 N/h = 0.636364 ≤ 2.0 C_h = 0.02
P_n = 1.674 k R/t = 1.50 ≤ 9.0
P_n/Ω_w = 0.957 k

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

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

Long side: Pu_{Trans} = 0.452 k **O.K.** # clips = 2
Short side: Pu_{Long} = 0.375 k **O.K.** # clips = 2

Check Web Stiffener

16Ga x 3/4" x 7" (C-channel)

width of stiffener = 7.000 in ts = 0.0566 [16 Gauge]
web of stiff. w = 6.717 in Rs = 0.0849 in
***Check w/ts ≤ 1.28√E/Fys Ωc = 1.70
w/ts = 118.675
1.28√(E/Fys) = 31.091 --> w/ts over limit Use C3.7.2

$$P_n = 0.7\left(P_{wc} + A_e F_y\right) \ge P_{wc}$$

Pwc = 1.674 k Ae = 0.380 in²
Pn = 14.478 k Pn/Ω = 8.517 k

Not Req'd

Corner Connections

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

Tcrnmax = 231 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 335 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: 0.398 O.K. StressComb = 0.199 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.415 in
Lreq'd = 0.285 in

$$P_n/\Omega = \frac{1}{\Omega} 0.75 t l F_u \ge V_{req} \qquad L_{req'd} = \frac{V_{req}\Omega}{0.75 t F_u}$$

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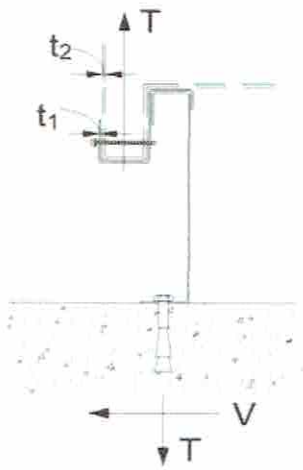
Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

t1 = 0.0566 in | Fu1 = 65 ksi
t2 = 0.1017 in (unit base rail thickness) | Fu2 = 65 ksi
d = 0.190 in (screw diameter) | dw = 0.375 in (nom. washer diameter)
t2/t1 = 1.8



For t2/t1 ≤ 1.0: | For t2/t1 ≥ 2.5:

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ → 3.86 k | Pns = 1887 #

$P_{ns} = 2.7t_1dF_{u1}$ → 1.89 k | $P_{ns} = 2.7t_1dF_{u1}$ → 1.89 k

$P_{ns} = 2.7t_2dF_{u2}$ → 3.39 k | $P_{ns} = 2.7t_2dF_{u2}$ → 3.39 k

Pns/Ω = 629 #
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 = 2.069 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:	0.924	2	0.46	540 #	2	6.00 in
Short side:	0.702	2	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

$R_n = 0.6F_yA_{gv} + F_uA_{nt} \le 0.6F_uA_{nv} + F_uA_{nt}$ (AISI Sect. E5.3)

BSR O.K.

Connection of Curb to Supporting Structure

Roof Loading | SEISMIC: [0.6-0.14SDS]D + 0.7E | WIND: 0.6D + W

Transverse: | $Uplift_{MAX}$ = 833 lbs | $Shear_{MAX}$ = 462 lbs

$Compression_{SEISMIC}$ = 1101 lbs =[FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*[$WGT_{unit+curb}$/2]*wcurb]/wcurb
$Tension_{SEISMIC}$ = 833 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*[WGTunit+curb]
$Compression_{WIND}$ = 552 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*[$WGT_{unit+curb}$/2]*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ = 821 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*[$WGT_{unit+curb}$/2]*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: | $Uplift_{MAX}$ = 541 lbs | $Shear_{MAX}$ = 399 lbs

$Compression_{SEISMIC}$ = 808 lbs =[FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*[$WGT_{unit+curb}$/2]*Lcurb]/Lcurb
$Tension_{SEISMIC}$ = 541 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*[WGTunit+curb]
$Compression_{WIND}$ = 55 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*[$WGT_{unit+curb}$/2]*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ = 325 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 = 0.88 | COMBINED LOADING: 1.148 NO GOOD
# 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: 0.421 O.K.
# of Screws Req'd for Shear = 0.4 | Screw Spacing = 28.8 in o.c.
Total # of screws Required = 2

Use 5/8" φ wood lag screws @ 28.8 in o.c. along short side of curb

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

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

# of Bolts Req'd for Uplift = 0.12 | COMBINED LOADING: 0.019 O.K.
# of Bolts Req'd for Shear = 0.13 | Bolt Spacing = 60.5 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 60.5 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.08 | COMBINED LOADING: 0.012 O.K.
# of Bolts Req'd for Shear = 0.11 | Req'd Min Spacing = 24.8 in o.c.
Total # of Bolts Required = 2

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 24.8 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: $Uplift_{MAX}$ = 1724 lbs $Shear_{MAX}$ = 999 lbs

$Compression_{SEISMIC}$ = 1992 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 1724 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 999 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.87 spacing = 48.50 in o.c. Tapplied = 574.7 lbs

Min Bolts Req'd Shear = 2.00 spacing = 48.5 in o.c. Vapplied = 332.9 lbs

Try using	3	bolts
spaced at	30.25	in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 0.93

Use 3 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 30.3 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 992 lbs $Shear_{MAX}$ = 999 lbs

$Compression_{SEISMIC}$ = 1260 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 992 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 999 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.08 spacing = 12.75 in o.c. Tapplied = 248.0 lbs

Min Bolts Req'd Shear = 2.00 spacing = 12.75 in o.c. Vapplied = 249.7 lbs

Try using	4	bolts
spaced at	8.25	in o.c.

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

Use 4 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 8.3 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBKD-79

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) - 2 clips with 2 - #10 SMS screws each clip

WEB STIFFENER: NOT REQUIRED

CORNER CONNECTION: Use 2 - 1/4" φ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts

CURB ANCHORAGE	WOOD	STEEL	CONCRETE
	5/8" φ lag screw w/ min. 3.5" embed (SGmin=0.43)	5/8" φ A307 bolts	3/4" φ thrd'd rod in Hilti HIT-HY 200 epoxy, min. 4" embed
LONG DIRECTION	#DIV/0!	2 @ 60.5 in o.c.	3 @ 30.25 in o.c.
SHORT DIRECTION	2 @ 28.75 in o.c.	2 @ 24.75 in o.c.	4 @ 8.25 in o.c.

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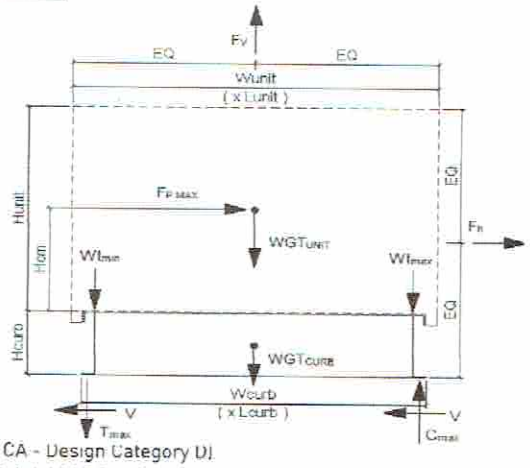
Client: ProVent PV1806
Description: CBKD-79 8" KDKITSUN3672
Unit: ZR 036-060, XP 036-060, ZF 036-072

Curb Information

Hcurb =	8	in	(Height of curb)
Lcurb =	72.5	in	(Length of curb)
wcurb =	36.75	in	(Width of curb)
WGTcurb =	97	lbs	(Weight of curb)
# Clips long side =	2	# Clips short side =	0

Unit Information

WGTunit =	704	lbs	(Weight of Unit)
Wtmax =	234	lbs	(Maximum corner weight)
Wtmin =	96	lbs	(Minimum corner weight)
Hunit =	32.625	in	(Height of unit above curb)
Hcm =	16.3125	in	(Height to center of mass)
Lunit =	82.25	in	(Length of unit)
Wunit =	44.875	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 =	702 lbs (unit only)	(0.7*Fpmax) FpmaxASD = 799 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)
$F_{h\ ASD\ trans}$ =	860 lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	469 lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	750 lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	904 lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	669 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	288 lbs	=($F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	615 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	750 lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	515 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	11 lbs	=($F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	339 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	904	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	669	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	750	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	515	lbs	---> Along short edge of curb.

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

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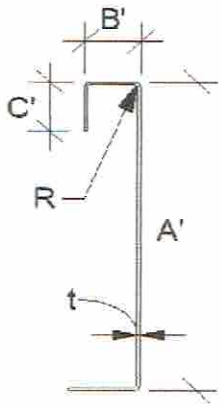
Curb Design

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' =	[2.000] in	a' =	7.943 in	= A'-t
C' =	[0.000] in (0 if no lips)	b =	1.859 in	= B'-[r+t/2+a[r+t/2)]
a =	[0.000] (0 - no Lip; 1 w/ lip)	b' =	1.972 in	= B'-(t/2+at/2)
R =	0.0849 (Inside bend radius)	c =	0.000 in	= a[C'-(r+t/2)]
t =	0.0566 in	c' =	0.000 in	= a(C'-t/2)
r' =	0.113 in = R+t/2	u =	0.178 in	= πr/2

x = 0.330 in (Distance between centroid and web centerline)
Ix = 5.799 in (Moment of Inertia about X-Axis)
Iy = 0.217 in (Moment of Inertia about Y-Axis)
A = 0.67 in²
rx = 2.95 in
ry = 0.570 in
rmin = 0.570 in

Axial Compression

Pu = 0.430 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 13.006 k
Fe = 59.07 ksi
λc = 0.92
Fn = 35.08 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 = 50 in Lateral unbraced length
$k_y L_y/r_y$ = 70 (assume k=0.8)

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
P_n/Ω_w = 1.011 k
Long side: Pu_{Trans} = 0.452 k **O.K.** # clips = 2
Short side: Pu_{Long} = 0.375 k **O.K.** # clips = 2

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

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

Check Web Stiffener 16Ga x 3/4" x 7" (C-channel)

width of stiffener = 7.000 in ts = 0.0566 [16 Gauge]
web of stiff. w = 6.717 in Rs = 0.0849 in
***Check w/ts ≤ 1.28√E/Fys Ωc = 1.70
w/ts = 118.675
1.28√(E/Fys) = 31.091 --> w/ts over limit Use C3.7.2

$$P_n = 0.7\left(P_{wc} + A_e F_y\right) \ge P_{wc}$$

Pwc = 1.770 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 = 215 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 335 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: 0.392 O.K. StressComb = 0.196 **O.K.**

Check 1/8" welded connection <--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.415 in
Lreq'd = 0.285 in

$$P_n/\Omega = \frac{1}{\Omega} 0.75 t L F_u \ge V_{req} \qquad L_{req'd} = \frac{V_{req}\Omega}{0.75 t F_u}$$

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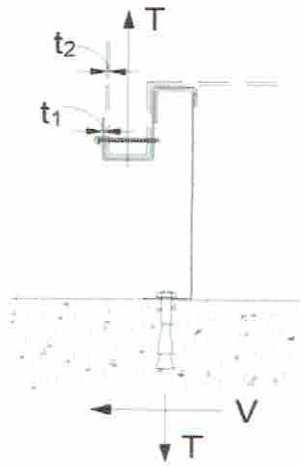
Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

t1 = 0.0566 in | Fu1 = 65 ksi
t2 = 0.1017 in (unit base rail thickness) | Fu2 = 65 ksi
d = 0.190 in (screw diameter) | dw = 0.375 in (nom. washer diameter)
t2/t1 = 1.8



For t2/t1 ≤ 1.0:			For t2/t1 ≥ 2.5:	
Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$	Pns = 1887 #	3.86 k	Pns =	1887 #
$P_{ns} = 2.7t_1 d F_{u1}$		1.89 k	$P_{ns} = 2.7t_1 d F_{u1}$	1.89 k
$P_{ns} = 2.7t_2 d F_{u2}$		3.39 k	$P_{ns} = 2.7t_2 d F_{u2}$	3.39 k

Pns/Ω = 629 #
Pss/Ω = 540 # <- Controls

Tension: Pnot = 1.068 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 = 356 # <- Controls
Pts/Ω = 820 # (full tensile screw capacity)

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	0.860	2	0.43	540 #	2	6.00 in
Short side:	0.702	2	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:	$Uplift_{MAX}$ = 768 lbs	$Shear_{MAX}$ = 430 lbs	
$Compression_{SEISMIC}$ =	1036 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*wcurb]/wcurb	
$Tension_{SEISMIC}$ =	768 lbs	=Comp$_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)	
$Compression_{WIND}$ =	434 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*(WGT$_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb	
$Tension_{WIND}$ =	704 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*(WGT$_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb	
Longitudinal:	$Uplift_{MAX}$ = 507 lbs	$Shear_{MAX}$ = 399 lbs	
$Compression_{SEISMIC}$ =	775 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*Lcurb]/Lcurb	
$Tension_{SEISMIC}$ =	507 lbs	=Comp$_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)	
$Compression_{WIND}$ =	23 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*(WGT$_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb	
$Tension_{WIND}$ =	292 lbs	=[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*(WGT$_{unit+curb}$/2)*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb	

Wood Attachment: **Use 5/8" φ wood lag screws** **w/ 3.5" Min. Embed**

Transverse: $Tall_{metal}$ = 946.67 lbs | $Vall_{metal}$ = 1043.33 lbs
$Tall_{wood}$ = 1195.95 lbs | $Vall_{wood}$ = 1024 lbs
# of Screws Req'd for Uplift = 0.81 | COMBINED LOADING: 1.062 NO GOOD
# of Screws Req'd for Shear = 0.42 | Screw Spacing = #DIV/0! in o.c.
Total # of screws Required = 1
#DIV/0!

Longitudinal:
# of Screws Req'd for Uplift = 0.5 | COMBINED LOADING: 0.407 O.K.
# of Screws Req'd for Shear = 0.4 | Screw Spacing = 28.8 in o.c.
Total # of screws Required = 2
Use 5/8" φ wood lag screws @ 28.8 in o.c. along short side of curb

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

$Tall_{bolt}$ = 6903 lbs | $Vall_{bolt}$ = 3682 lbs
Transverse: 6903 lbs | 3682 lbs
# of Bolts Req'd for Uplift = 0.11 | COMBINED LOADING: 0.017 O.K.
# of Bolts Req'd for Shear = 0.12 | Bolt Spacing = 60.5 in o.c.
Total # of Bolts Required = 2
Use 5/8" φ A307 Bolts attached to steel angle below deck @ 60.5 in o.c. along long side of curb

Longitudinal:
# of Bolts Req'd for Uplift = 0.07 | COMBINED LOADING: 0.012 O.K.
# of Bolts Req'd for Shear = 0.11 | Req'd Min Spacing = 24.8 in o.c.
Total # of Bolts Required = 2
Use 5/8" φ A307 Bolts attached to steel angle below deck @ 24.8 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: $Uplift_{MAX}$ = 1561 lbs $Shear_{MAX}$ = 999 lbs

$Compression_{SEISMIC}$ = 1829 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 1561 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*(WGTunit+curb)

$Shear_{SEISMIC}$ = 999 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 1.70 spacing = 48.50 in o.c. Tapplied = 520.3 lbs

Min Bolts Req'd Shear = 2.00 spacing = 48.5 in o.c. Vapplied = 332.9 lbs

Try using 3 bolts spaced at 30.25 in o.c.

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

Use 3 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 30.3 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 909 lbs $Shear_{MAX}$ = 999 lbs

$Compression_{SEISMIC}$ = 1177 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+[1+0.14S_{DS}]*($WGT_{unit+curb}$/2]*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 909 lbs =$Comp_{SEISMIC}$-[0.6-0.14S_{DS}]*(WGTunit+curb)

$Shear_{SEISMIC}$ = 999 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 0.99 spacing = #DIV/0! in o.c. Tapplied = 227.3 lbs

Min Bolts Req'd Shear = 2.00 spacing = 12.75 in o.c. Vapplied = 249.7 lbs

Try using 4 bolts spaced at 8.25 in o.c.

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

Use 4 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 8.3 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBKD-79			
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) - 2 clips with 2 - #10 SMS screws each clip **WEB STIFFENER:** NOT REQUIRED			
CORNER CONNECTION: Use 2 - 1/4" φ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts			
CURB ANCHORAGE	WOOD 5/8" φ lag screw w/ min. 3.5" embed (SGmin=0.43)	STEEL 5/8" φ A307 bolts	CONCRETE 3/4" φ thrd'd rod in Hilti HIT-HY 200 epoxy, min. 4" embed
LONG DIRECTION	#DIV/0!	2 @ 60.5 in o.c.	3 @ 30.25 in o.c.
SHORT DIRECTION	2 @ 28.75 in o.c.	2 @ 24.75 in o.c.	4 @ 8.25 in o.c.