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Structural Calculations
for
CBISC-03 Series

Prepared for:

PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

Date: August 22, 2018

Project Number: PV1805

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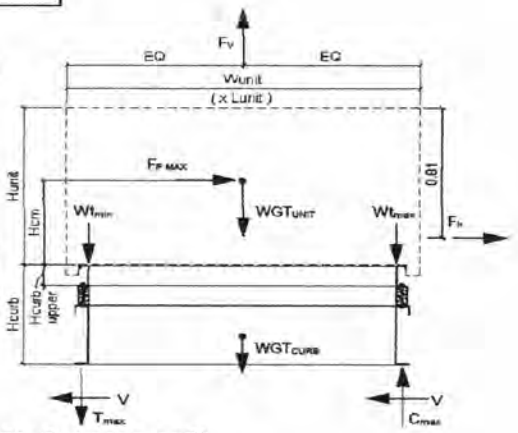
Client: ProVent PV1805
Project: CBISC-03 Iso Curb (CBISCSUN3672**Upper curb rail)
Unit: ZR 036-060, XP 036-060, ZF 036-072

Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	72	in	(Length of curb)
wcurb =	36.25	in	(Width of curb)
WGTcurb =	270	lbs	(Weight of curb)
# Clips long side =	2	# Clips short side =	1

Unit Information

WGTunit =	640	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 =	2.850		(Worst case for majority of CA - Design Category D)
Fa =	1.000		(Interpolated from Table 11.4-1 ASCE 7-10)
Sms =	2.850		(Fa*Ss)
Sds =	1.900		(2/3*Sms)
Ip =	1.25		(Importance Factor Category III Building)
Fpmax =	3.800	Wp	(1.6*Sds*Ip)*Wp
FpmaxASD =	1702	lbs	(0.7*Fpmax) FpmaxASD = 2421 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)
$F_{h\ ASD\ trans}$ =	807	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb upper) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	440	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb upper)
$F_{vert\ ASD}$ =	750	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	1359	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1145	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	269	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	635	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	978	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	764	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	6	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	372	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	1359	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1145	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	978	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	764	lbs	---> Along short edge of curb.

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

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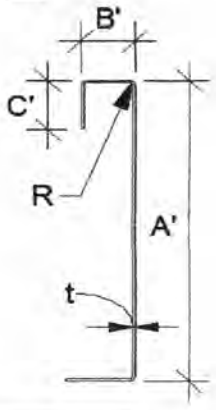
Curb Design

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



Calculate Section Properties of Curb

A' =	5.500 in	a =	5.144 in	= A'-(2r+t)
B' =	1.500 in	a' =	5.429 in	= A'-t
C' =	0.000 in (0 if no lips)	b =	1.322 in	= B'-[r+t/2+a(r+t/2)]
a =	0.000 (0 - no Lip; 1 w/ lip)	b' =	1.464 in	= B'-(t/2+at/2)
R =	0.1069 (Inside bend radius)	c =	0.000 in	= a[C'-(r+t/2)]
t =	0.0713 in	c' =	0.000 in	= a(C'-t/2)
r' =	0.143 in = R+t/2	u =	0.224 in	= πr/2

x = 0.261 in (Distance between centroid and web centerline)
Ix = 2.424 in (Moment of Inertia about X-Axis)
Iy = 0.109 in (Moment of Inertia about Y-Axis)
A = 0.59 in²
rx = 2.03 in
ry = 0.432 in
rmin = 0.432 in

Axial Compression

Pu = 0.851 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 4.309 k
Fe = 15.06 ksi
λc = 1.82
Fn = 13.21 ksi
Ly = 75.00 in Lateral unbraced length
k_yL_y/r_y = 139 (assume k=0.8)

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

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

Compression Check = O.K.

Check Web Crippling

h = 5.5 in
t = 0.0713 in
N = 7.00
Ωw = 1.75
Pn = 1.947 k
Pn/Ωw = 1.112 k
Long side: Pu_{Trans} = 0.679 k
Short side: Pu_{Long} = 0.978 k

-- Check limits:
h/t = 77.14 ≤ 200
N/t = 98.18 ≤ 210
N/h = 1.273 ≤ 2.0
R/t = 1.50 ≤ 12.0

C = 7.50
C_R = 0.08
C_N = 0.12
C_h = 0.048

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

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

O.K. # clips = 2
O.K. # clips = 1

Check Web Stiffener N/A

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 = 1.947 k Ae = 0.380 in²
Pn = 14.669 k
Pn/Ωc = 8.629 k **Not Req'd**

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

Tcrnmax = 426 lbs Max[$F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections]
Vcrnmax = 572 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 = 0.2
# of Bolts required for Shear = 0.5 ***If combined fails:
# of Bolts Used = 1.0 USE --> 2.0
Check Combined Stress in Bolts & Inserts: 0.694 O.K. StressComb = 0.347 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 0.387 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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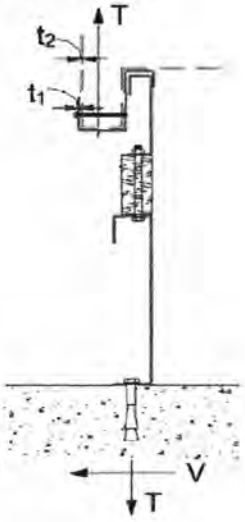
Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

t1 = 0.0713 in (clip thickness) | 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 #		
Tension:	Pnot =	540 # <- Controls	$P_{not} = 0.85t_c dF_{u2}$	
	Pnov =	1.068 k (screw pull-out strength)	$t_c = \min(t_1, t_2)$	
	Pts/Ω =	2.607 k (screw pull-over strength)	$P_{nov} = 1.5t_1 d_w F_{u1}$	
	Pts/Ω =	356 # <- Controls		
		820 # (full tensile screw capacity)		

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	1.702	2	0.85	540 #	4	2.00 in
Short side:	1.702	1	1.70	540 #	4	2.00 in

clip width (in) = 7.00 | clip height = 2.5 in
min spacing = 0.57 in | edge distance = 0.5 in (min. 1.5d)
Check Block shear rupture: O.K. | thinnest part = 0.0713 AISI BSR applies
Fy = 50 ksi | Ω = 2.22 bolt/screw connection
Agv = 0.463 in^2 | Anv = 0.416 in^2 | Ant = 0.082 in^2
Rn/Ω = 8.674 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.

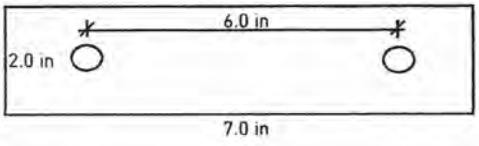
Curb Loads (copied from above)

Transverse: (on long edge)	$Comp_{MAX}$ =	1359	lbs
	$Tens_{MAX}$ =	1145	lbs
	$Shear_{MAX}$ =	851	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	978	lbs
	$Tens_{MAX}$ =	764	lbs
	$Shear_{MAX}$ =	851	lbs

Loads at each Isolator Type: **JQA**

Transverse loading: (on long edge) # isolators: 2	$Comp_{MAX}$ =	679.3	lbs
	$Tens_{MAX}$ =	572.4	lbs
	$Shear_{MAX}$ =	283.7	lbs
Longitudinal loading: (on short edge) # isolators: 1	$Comp_{MAX}$ =	978.2	lbs
	$Tens_{MAX}$ =	764.4	lbs
	$Shear_{MAX}$ =	283.7	lbs

Max compression force on isolator: 0.978 k ≤ 1.660 k **O.K.**
Max uplift on isolator: 0.764 k ≤ 1.660 k **O.K.**
Max shear on isolator: 0.284 k ≤ 0.800 k **O.K.**



Forces on top bolt:
d_b = 0.375 in
upper rail, t = 0.1017 in
Tension = 0.764 k
Shear = 0.284 k

Shear on curb rail: $P_n = teF_u$ | Ω = 2.00 (Appendix A, Section E3.1 AISI)
Pn/Ω = 6.611 k | e = 1.0 in
Shear O.K.

Net section rupture: $P_n = A_n F_t$ | Ω = 2.22 (Appendix A, Section E3.2 AISI)
Pn/Ω = 7.117 k | An = 0.165 in
N.S.R. O.K. | $F_t = (0.1 + 3d/s)F_u \le F_u$ = 43.063 ksi

Bolt Bearing Strength: $P_n = Cm_f dtF_u$ | Ω = 2.50 (Section E3.3.1 AISI)
Pn/Ω = 2.975 k | d/t = 3.69
Bearing O.K. | C = 3.00 | mf = 1.00

Shear and tension in bolt: (Appendix A, Section E3.4 AISI)

Tension	$P_{nt} = A_b F_{nt}$	Fnt = 40.5 ksi	A_b =	0.1104	in^2	
	Pnt/Ω = 1.988 k **Bolt tension O.K.**		Ωt =	2.25		(Table E3.4-1, AISI)
Shear	$P_{nv} = A_b F_{nv}$	Fnv = 24.0 ksi	Ωv =	2.40		(Table E3.4-1, AISI)
	Pnv/Ω = 1.104 k **Bolt shear O.K.**					

$$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \le F_{nt}$$

fv = 2.57 ksi O.K.
F'nt = 40.50 ksi | Fnv/Ω = 10.00 ksi

Combined Not Applicable

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Client: ProVent PV1805
Project: CBISC-03 Iso Curb (CBISCSUN3672**) Base curb
Unit: ZR 036-060, XP 036-060, ZF 036-072

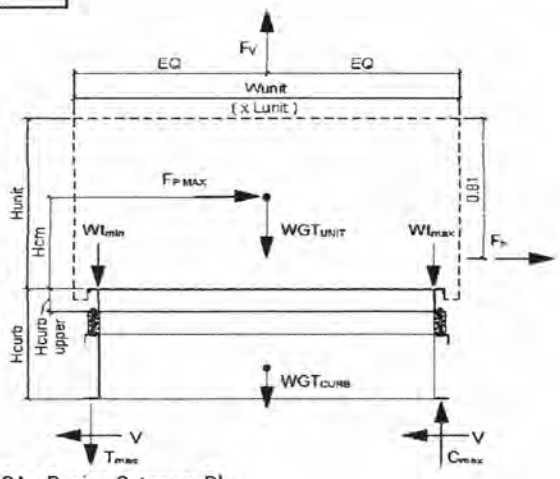
Curb Information

Hcurb =	25	in	(Height of curb)
Lcurb =	75	in	(Length of curb)
wcurb =	39.25	in	(Width of curb)
WGTcurb =	270	lbs	(Weight of curb)

Clips long side = 2 # Clips short side = 1

Unit Information

WGTunit =	640	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 =	2.850		(Worst case for majority of CA - Design Category D)
Fa =	1.000		(Interpolated from Table 11.4-1 ASCE 7-10)
Sms =	2.850		(Fa*Ss)
Sds =	1.900		(2/3*Sms)
Ip =	1.25		(Importance Factor Category III Building)
Fpmax =	3.800	Wp	(1.6*Sds*Ip)*Wp
FpmaxASD =	1702	lbs	(0.7*Fpmax)
	(unit only)		

FpmaxASD = 2421 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)
$F_{h\ ASD\ trans}$ =	1220	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	666	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:

$Compression_{SEISMIC}$ =	1300	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1086	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	413	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	779	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	963	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	749	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	51	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	417	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	1300	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1086	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	963	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	749	lbs	---> Along short edge of curb.

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

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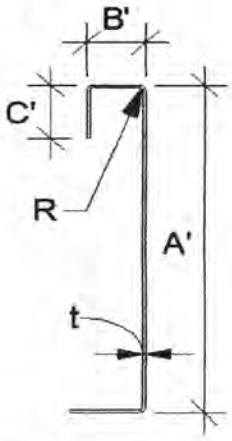
Curb Design

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

E = 29500 ksi



Calculate Section Properties of Curb

A' =	[25.000] in		a =	24.717 in	= A'-(2r+t)
B' =	[1.750] in		a' =	24.943 in	= A'-t
C' =	[0.000] in (0 if no lips)		b =	1.609 in	= B'-[r+t/2+α(r+t/2)]
α =	[0.000] (0 - no Lip; 1 w/ lip)		b' =	1.722 in	= B'-(t/2+αt/2)
R =	0.0849 (Inside bend radius)		c =	0.000 in	= α[C'-(r+t/2)]
t =	0.0566 in		c' =	0.000 in	= α[C'-t/2]
r' =	0.113 in	= R+t/2	u =	0.178 in	= πr/2

x = 0.105 in (Distance between centroid and web centerline)

Ix = 102.712 in (Moment of Inertia about X-Axis)

Iy = 0.175 in (Moment of Inertia about Y-Axis)

A = 1.60 in^2

rx = 8.01 in

ry = 0.331 in

rmin = 0.331 in

Axial Compression

Pu = 0.851 k (Max Axial Comp) Ω_c = 1.80

Pn/Ωc = 6.895 k

Fe = 8.84 ksi

λc = 2.38

Fn = 7.75 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 = 75.00 in Lateral unbraced length

k_yL_y/r_y = 182 (assume k=0.8)

Compression Check = O.K.

Check Web Crippling

h = 25 in -- Check limits: C = 4.00

t = 0.0566 in h/t = 441.70 ≤ 200 C_R = 0.14

N = 7.00 N/t = 123.67 ≤ 210 C_N = 0.35

Ω_w = 1.75 N/h = 0.28 ≤ 2.0 C_h = 0.02

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

P_n = 1.346 k R/t = 1.50 ≤ 9.0

P_n/Ω_w = 0.769 k **O.K.** # clips = 2

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

Long side: Pu_{Trans} = 0.650 k

Short side: Pu_{Long} = 0.963 k **web stiffener REQ'D** # clips = 1

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

Check Web Stiffener

16Ga x 1.5in x 7in (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 Ω_c = 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 = 1.346 k Ae = 0.380 in^2

Pn = 14.248 k

Pn/Ω_c = 8.381 k **O.K.**

Corner Connections

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

Tcrnmax = 426 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)

Vcrnmax = 543 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 = 0.2

# of Bolts required for Shear = 0.5

# of Bolts Used = [1.0]

***If combined fails: USE --> 4.0

Check Combined Stress in Bolts & Inserts: 0.667 O.K. StressComb = 0.167 **O.K.**

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Check 1/8" welded connection <--- USE WELD Ω = 2.35

Assume L/t > 25: 25*t = 1.415 in $P_n/\Omega = \frac{1}{\Omega}0.75tLF_u \geq V_{req}$ $L_{req'd} = \frac{V_{req}\Omega}{0.75tF_u}$

Lreq'd = 0.463 in

Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	1359	lbs
	$Tens_{MAX}$ =	1145	lbs
	$Shear_{MAX}$ =	851	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	978	lbs
	$Tens_{MAX}$ =	764	lbs
	$Shear_{MAX}$ =	851	lbs

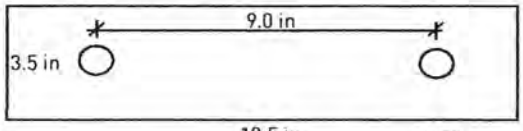
Loads at each Isolator Type: JQB

Transverse loading: (on long edge) # isolators: 2	$Comp_{MAX}$ =	679.3	lbs
	$Tens_{MAX}$ =	572.4	lbs
	$Shear_{MAX}$ =	283.7	lbs
Longitudinal loading: (on short edge) # isolators: 1	$Comp_{MAX}$ =	978.2	lbs
	$Tens_{MAX}$ =	764.4	lbs
	$Shear_{MAX}$ =	283.7	lbs

Max compression force on isolator: 0.978 k ≤ 1.600 k **O.K.**

Max uplift on isolator: 0.764 k ≤ 1.600 k **O.K.**

Max shear on isolator: 0.284 k ≤ 1.000 k **O.K.**



10.5 in

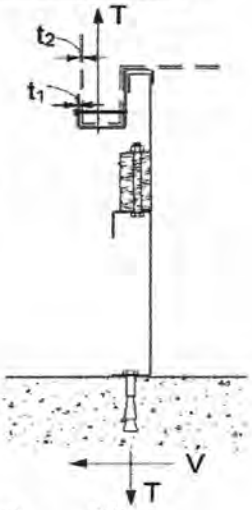
Forces on bottom bolts:

d_b = 0.625 in

base curb, t = 0.0566 in

Tension = 0.382 k / bolt

Shear = 0.142 k / bolt



Shear on base curb: $P_n = teF_u$ Ω = 2.00 (Appendix A, Section E3.1 AISI)

Pn/Ω = 3.679 k e = 1.0 in

Shear O.K.

Net section rupture: $P_n = A_nF_t$ Ω = 2.22 (Appendix A, Section E3.2 AISI)

Pn/Ω = 5.059 k An = 0.078 in

N.S.R. O.K. $F_t = (0.1 + 3d/s)F_u \leq F_u$ = 65.000 ksi

Bolt Bearing Strength: $P_n = Cm_fdtF_u$ Ω = 2.50 (Section E3.3.1 AISI)

Pn/Ω = 2.663 k d/t = 11.04

Bearing O.K. C = 2.90 mf = 1.00

Shear and tension in bolt: (Appendix A, Section E3.4 AISI)

Tension $P_{nt} = A_bF_{nt}$ Fnt = 45.0 ksi A_b = 0.3068 in^2

Pnt/Ω = 6.136 k **Bolt tension O.K.** Ωt = 2.25

Shear $P_{nv} = A_bF_{nv}$ Fnv = 27.0 ksi Ωv = 2.40

Pnv/Ω = 3.451 k **Bolt shear O.K.** ***(Table E3.4-1, AISI)***

$$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}}f_v \leq F_{nt}$$

fv = 0.46 ksi O.K.

Combined Not Applicable F'nt = 45.0 ksi Fnv/Ω = 11.25 ksi

Connection of Curb to Supporting Structure

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

Transverse: $Uplift_{MAX}$ = 2820 lbs $Shear_{MAX}$ = 1210 lbs

$Compression_{SEISMIC}$ = 3124 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 2820 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 1182 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb

$Tension_{WIND}$ = 1386 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: $Uplift_{MAX}$ = 1605 lbs $Shear_{MAX}$ = 1210 lbs

$Compression_{SEISMIC}$ = 1909 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 1605 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 265 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb

$Tension_{WIND}$ = 469 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

Wood Attachment: **1/4" φ wood lag screws** **w/ 3.5" Min. Embed** (SGmin = 0.43)

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

$Tall_{wood}$ = 671.25 lbs $Vall_{wood}$ = 224 lbs

# of Screws Req'd for Uplift = 4.20 COMBINED LOADING: 0.873 O.K.

# of Screws Req'd for Shear = 5.40 Req'd Min Spacing = 6.7 in o.c.

Total # of screws required = 11

Use 11 - 1/4" φ wood lag screws @ 6.7 in o.c. along long side of curb w/ 3.5" Min. Embed

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Longitudinal:

# of Screws Req'd for Uplift = 2.39 COMBINED LOADING: 0.866 O.K.

# of Screws Req'd for Shear = 5.40 Screw Spacing = 3.9 in o.c.

Total # of screws required = 9

Use 9 - 1/4" ϕ wood lag screws @ 3.9 in o.c. along short side of curb w/ 3.5" Min. Embed

Steel Deck Attachment: 1/2" φ A307 Bolts to steel angle below deck

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

Transverse: 6903 lbs 3682 lbs

# of Bolts Req'd for Uplift = 0.41 COMBINED LOADING: 0.369 O.K.

# of Bolts Req'd for Shear = 0.33 Bolt Spacing = 63.0 in o.c.

Total # of bolts required = 2

Use 2 - 1/2" ϕ A307 Bolts to steel angle below deck @ 63 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.23 COMBINED LOADING: 0.281 O.K.

# of Bolts Req'd for Shear = 0.33 Bolt Spacing = 27.3 in o.c.

Total # of bolts required = 2

Use 2 - 1/2" ϕ A307 Bolts to steel angle below deck @ 27.3 in o.c. along short side of curb

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

Concrete Attachment: 3/4" φ thrd'd rods in Hilti Hit-HY 200 epoxy w/ 4" embed

$Tall_{LRFD}$ = 1919 lbs $Vall_{LRFD}$ = 3188 lbs $\alpha = (1 + 0.2SDS)D + 2.5E = 1.87$

$Tall_{ASD} = Tall_{LRFD}/\alpha$ = 1026.2 lbs $Vall_{ASD} = Vall_{LRFD}/\alpha$ = 1704.8 lbs $(D = 0.465, E = 0.535)$

Transverse: $Uplift_{MAX}$ = 6642 lbs $Shear_{MAX}$ = 3026 lbs

$Compression_{SEISMIC}$ = 6946 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 6642 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 3026 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 6.47 spacing = 8.50 in o.c. Tapplied = 830.2 lbs

Min Bolts Req'd Shear = 1.77 spacing = 51 in o.c. Vapplied = 378.2 lbs

Try using 8 bolts spaced at 9.00 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 1.03

Use 8 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 9 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 3605 lbs $Shear_{MAX}$ = 3026 lbs

$Compression_{SEISMIC}$ = 3909 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 3605 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 3026 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 3.51 spacing = 5.083333 in o.c. Tapplied = 721.1 lbs

Min Bolts Req'd Shear = 1.77 spacing = 15.25 in o.c. Vapplied = 605.2 lbs

Try using 5 bolts spaced at 6.81 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 1.06

Use 5 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 6.8 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: (CBISCSUN (CBISCSUN3	Unit: ZR 036-060, XP 036-060, ZF 036-072
UPPER CURB RAIL THICKNESS: 0.0566 in 16 Gauge	
UNIT CLIP THICKNESS: 0.0713 in 14 Gauge	
# OF CLIPS (LONG SIDE) - 2 clips with 4 - #10 SMS screws each clip	
WEB STIFFENER: NOT REQUIRED	
# OF CLIPS (SHORT SIDE) - 1 clips with 4 - #10 SMS screws each clip	
WEB STIFFENER: NOT REQUIRED	
VIBRATION ISOLATOR TYPE: JQB Top stud diameter: 3/8	
Anchor bolt diameter: 5/8 Anchor hole diamter: 11/16	
BASE CURB THICKNESS: 0.0566 in 16 Gauge	
WEB STIFFENER: 16Ga x 1.5in x 7in (C-channel) stiffener at each clip on base curb	
CORNER CONNECTION: Use minimum 4 - 1/4" ϕ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts	

CURB ANCHORAGE	WOOD	STEEL	CONCRETE
	1/4" ϕ wood lag screws w/ 3.5" Min. Embed (SGmin = 0.43)	1/2" ϕ A307 Bolts to steel angle below deck	3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy w/ 4" embed
LONG DIRECTION	11 @ 6.7 in o.c.	2 @ 63 in o.c.	8 @ 9 in o.c.
SHORT DIRECTION	9 @ 3.91 in o.c.	2 @ 27.25 in o.c.	5 @ 6.81 in o.c.