MOUR GROUP
ENGINEERING + DESIGN

6593 Riverdale St.
San Diego, CA 92120

619-727-4800

Structural Calculations
for
Predator & Sunline Magna Series
ISCALSUN3672** Roof Curb

Form No. ISCAL-126

Prepared for:

PROVENT

3847 Wabash Drive
Mira Loma, CA 91725

Date: September 18, 2019

Project Number: PV1906

For wood, concrete and steel attachments see Roof Anchorage Detail, Form No. CB-24A.

STRUCTURALLY CALCULATED VIBRATION ISOLATION CURBS FOR YORK UNITS

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

ProVent P/N (2" Deflection)	A	B	WEIGHT
ISCALSUN367218**	8"	18"	354 Lbs
ISCALSUN367221**	11"	21"	368 Lbs
ISCALSUN367224**	14"	24"	383 Lbs

ProVent P/N (3" Deflection)	A	B	WEIGHT
ISCALSUN3672193**	8"	19"	404 Lbs
ISCALSUN3672223**	11"	22"	418 Lbs
ISCALSUN3672253**	14"	25"	433 Lbs

**Note: Spring configuration must be added to part number at time of order.

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

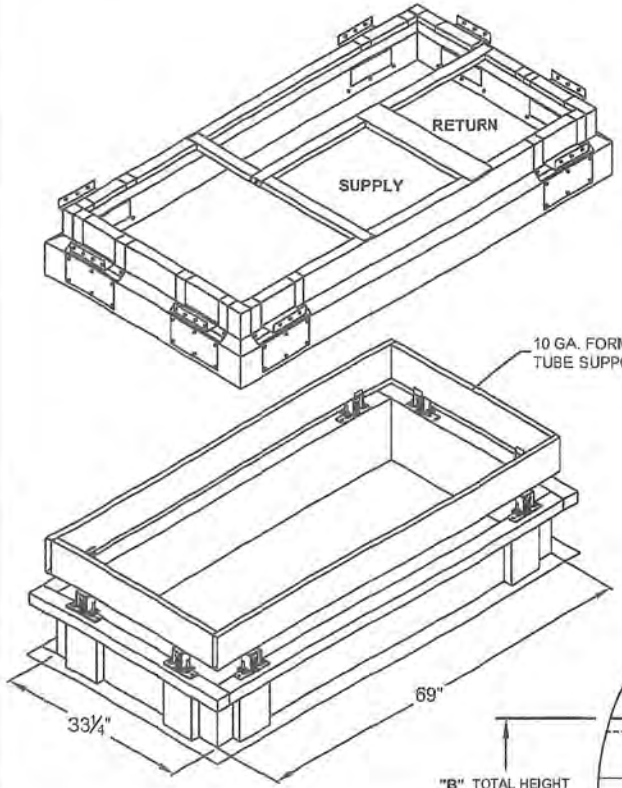
Welded isolation spring housings are standard. For bolted spring housings, neoprene pads and spring cups see Weldment and Bolting Detail, Form No. ISCAL-131.

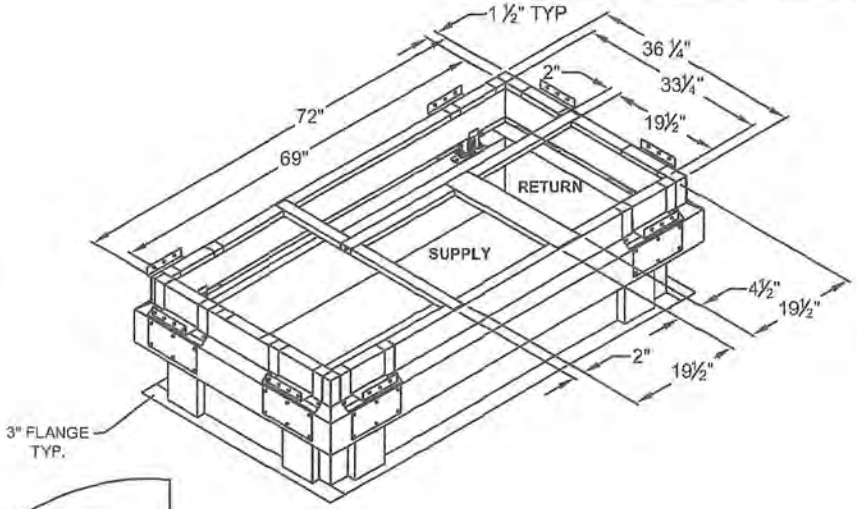
FEATURES

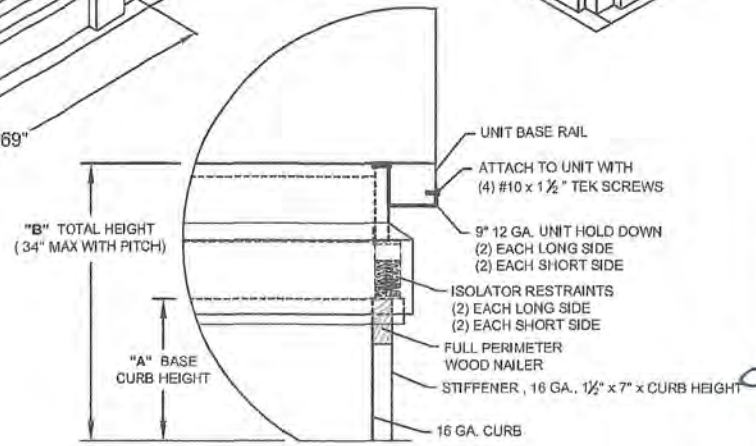
- Roof curb sides and ends are 16 ga. galvanized steel.
- Fully welded construction.
- Gasketing package provided.
- Heat treated wood nailer provided.
- Insulated deck pans provided.
- Pitched curbs and taller curbs are available.
- CalDyn OSHPD pre-approved 2" or 3" deflection seismic restraints. (OPA-0070), (JQA).

NOTES

Attach ductwork to roof curb. Flanges of duct rest on top of curb. Support ductwork below the curb.







PROFILE DETAIL

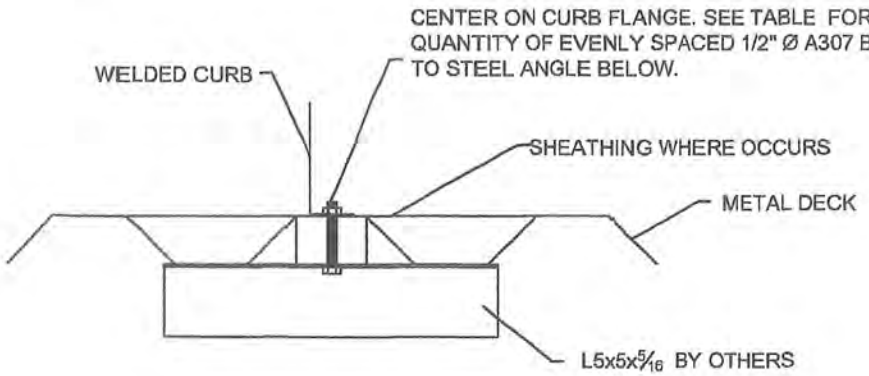
REGISTERED PROFESSIONAL ENGINEER
GLENN A. MOURITZEN
NO. 3578
EXP. 06/30/2021
STRUCTURAL
STATE OF CALIFORNIA
9/19/19

ProVent
3847 WABASH DR.
MIRA LOMA, CA 91725
PHONE (951) 685-1101
FAX (619) 872-9799

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

FORM NO:		PART NUMBER:
ISCAL-126		ISCALSUN3672 SERIES
DATE: 09/13/19	REV: 6	DRAWN BY: ALL

STEEL ATTACHMENT



	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
SUN3672	2 @ 62.13 in o.c.	2 @ 24.75 in o.c.

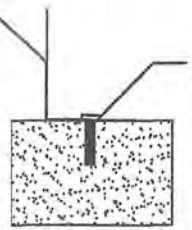
Meets seismic requirements for the following codes:
CBC 2016
IBC 2015

ROOF ANCHORAGE DETAIL

CBKD Series	CBWC Series	ISCAL Series
SUN3672	SUN3672	SUN3672

ASSUMES:
CONC SLAB
f'c= 4000PSI MINIMUM
5 ½" MIN THICKNESS
NORMAL WEIGHT CONCRETE
OR SAND LIGHT WEIGHT

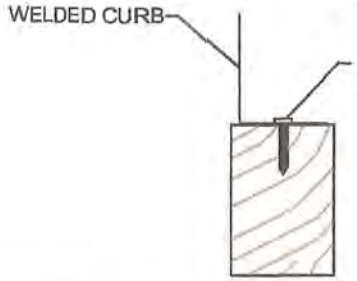
CONCRETE ATTACHMENT



	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
SUN3672	13 @ 5.18 in o.c.	8 @ 3.54 in o.c.

*** SIX INCHES FROM EACH CORNER EVENLY SPACED.**
**** CENTERED.**

WOOD ATTACHMENT



	NO. OF ANCHORAGE SCREWS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
SUN3672	14 @ 5.09 in o.c.	10 @ 3.19 in o.c.

FOUR INCHES FROM EACH CORNER EVENLY SPACED

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: CB-24A

DATE:	REV:	DRAWN BY:
09/18/19	13	ALL

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

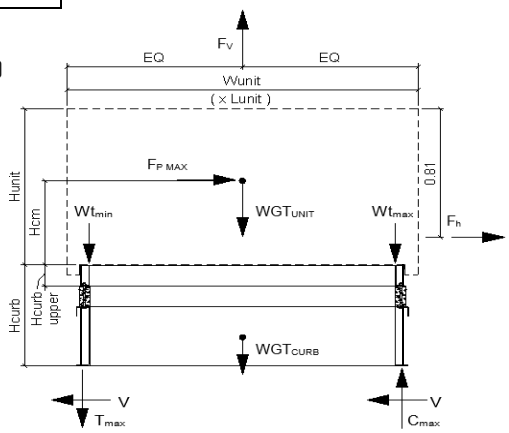
Client:	ProVent	PV1906	Upper curb tube
Curb:	ISCAL-126	Iso Curb	(ISCALSUN3672**)
Unit:	ZE 036-072; XN 036-060; ZR/XP/ZF 036-072		

Curb Information

Hcurb upper =	6.5	in	(Height of upper curb tube)
Lcurb =	74.125	in	(Length of curb)
wcurb =	36.75	in	(Width of curb)
WGTcurb =	148	lbs	(Weight of upper curb)
# Clips long side =	2	# Clips short side =	2

Unit Information

WGTunit =	665	lbs	(Weight of Unit)
Wtmax =	399	lbs	(Maximum corner weight)
Wtmin =	266	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 =	1.50		(Importance Factor Category IV Building)
Fpmax =	4.560	Wp	(1.6*Sds*Ip)*Wp
FpmaxASD =	2123	lbs	(0.7*Fpmax) FpmaxASD = 2595 lbs
	(unit only)		(unit and upper 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)
$F_{h\ ASD\ trans}$ =	828	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb upper) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	452	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:

$Compression_{SEISMIC}$ =	1952	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1730	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	471	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	823	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	1477	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1255	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	203	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	554	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	1952	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1730	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1477	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1255	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 =	0.1242	10 Gauge	
E =	29500 ksi						

Tube Curb Design

Section Properties of Tube - 6.5x1.5x10Ga

Fy =	50 ksi						
Fu =	65 ksi	Ag =	1.996 in^2	R =	0.1875	d =	6.125
E =	29500 ksi	Ix =	4.613 in^4	Iy =	0.444 in^4	wt =	122.094
height =	6.5 in	Sx =	1.419 in^3	Sy =	0.593 in^3		
width =	1.5 in	rx =	1.520 in	ry =	0.472 in	b/t =	12.07729
t =	0.1242 in	Zx =	1.862 in^3	Zy =	0.639 in^3	d/t =	49.31562

Check weak axis bending of tube:

Long side			Short side		
# clips =	2		# clips =	2	
compression =	28.636 lb/in		compression =	57.760 lb/in	
clip spacing =	66.13 in		clip spacing =	28.75 in	
Mmax =	15.7 k-in		Mmax =	5.97 k-in	
Yielding	My = 29.63 k-in		Mp_y/Ω =	17.74 k-in	**O.K.**
Flange local buckling	Mn = 29.63 k-in	<--Section is compact, FLB does not apply			
Web local buckling	Mn = 29.63 k-in	<--Section is compact, WLB does not apply			

Axial Compression

Pa =	1.061 k	(Max Axial Comp)	Ω_c = 1.80
Pn/Ωc =	8.429 k		
Fe =	15.41 ksi	$\frac{P_n}{\Omega_c} = \frac{F_n A}{\Omega_c}$	$If\ \lambda_c \le 1.5;\ F_n = \left(0.658^{\lambda_c{}^2}\right)F_y$
λc =	1.801		$If\ \lambda_c > 1.5;\ F_n = \frac{0.877}{\lambda_c{}^2}F_y$
Fn =	13.52 ksi		$\lambda_c = \sqrt{\frac{F_y}{F_e}}$
Ly =	70.13 in	Lateral unbraced length	$F_e = \frac{\pi^2 E}{\left(kl/r\right)^2}$
k_yL_y/r_y =	137	(assume k=0.8)	

Compression Check = **O.K.**

Check Web Crippling

h =	6.5 in	-- Check limits:		C = 7.50	(See table C3.4.1-2, fastened to support, two flange, end loading)
t =	0.1242 in	h/t =	52.33 ≤ 200	C_R = 0.08	
N =	7.00	N/t =	56.36 ≤ 210	C_N = 0.12	
Ω_w =	1.75	N/h =	1.077 ≤ 2.0	C_h = 0.048	
P_n =	5.786 k	R/t =	1.51 ≤ 12.0		
P_n/Ω_w =	3.306 k				
Long side: Pa_{Trans} =	0.976 k	**O.K.**	# clips = 2		
Short side: Pa_{Long} =	0.739 k	**O.K.**	# clips = 2		

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

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		Ω_c =	1.70
w/ts =	118.675		
1.28√(E/Fys) =	31.091	--> w/ts over limit	Use C3.7.2

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

Pwc =	5.786 k	Ae =	0.380 in^2
Pn =	17.357 k		
Pn/Ω_c =	10.210 k	**Not Req'd**	

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

Tcrnmax = 531 lbs — Max($F_{pmaxASD}/4$ -OR- $Fh_{ASDtrans}/4$ corner connections)

Vcrnmax = 865 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 = 0.8 ***If combined fails:

# of Bolts Used = 1.0 USE --> 2.0

Check Combined Stress in Bolts & Inserts: 1.003 N.G. StressComb = 0.502 **O.K.**

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

Assume L/t > 25: 25*t = 3.105 in

Lreq'd = 0.336 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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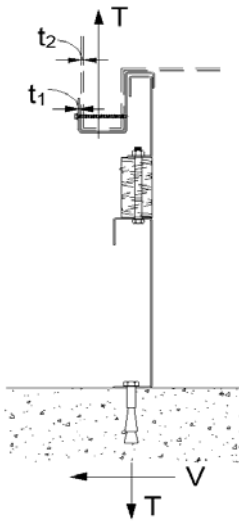
Connection Unit to Curb Clip — #10 SMS screw — Ω = 3.0

t1 = 0.1017 in (clip thickness) — Fu1 = 65 ksi

t2 = 0.1242 in (unit base rail thickness) — Fu2 = 65 ksi

d = 0.190 in (screw diameter) — dw = 0.375 in (nom. washer diameter)

t2/t1 = 1.2



For t2/t1 ≤ 1.0: — Pns = 3391 #

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ = 5.21 k

$P_{ns} = 2.7t_1 dF_{u1}$ = 3.39 k

$P_{ns} = 2.7t_2 dF_{u2}$ = 4.14 k

Pns/Ω = 1130 #

Pss/Ω = 540 # <- Controls

For t2/t1 ≥ 2.5: — Pns = 3391 #

$P_{ns} = 2.7t_1 dF_{u1}$ = 3.39 k

$P_{ns} = 2.7t_2 dF_{u2}$ = 4.14 k

Tension: Pnot = 1.304 k (screw pull-out strength) — $P_{not} = 0.85t_c dF_{u2})$

$t_c = \min(t_1, t_2)$

Pnov = 3.718 k (screw pull-over strength) — $P_{nov} = 1.5t_1 d_w F_{u1}$

Pts/Ω = 435 # <- Controls

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

	Shear (k)	# clips	V_{clip} (k)	V_{allow}(lb)	# screws	spacing
Long side:	2.123	2	1.06	540 #	4	2.00 in
Short side:	2.123	2	1.06	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 = 0.1017 AISI BSR applies

Fy = 50 ksi — Ω = 2.22 bolt/screw connection

Agv = 0.661 in² — Anv = 0.593 in² — Ant = 0.117 in²

Rn/Ω = 12.372 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)

Curb Loads (copied from above)

Transverse: (on long edge)	$Comp_{MAX}$ =	1952	lbs
	$Tens_{MAX}$ =	1730	lbs
	$Shear_{MAX}$ =	1061	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	1477	lbs
	$Tens_{MAX}$ =	1255	lbs
	$Shear_{MAX}$ =	1061	lbs

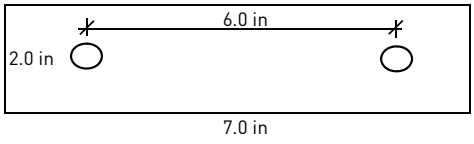
Loads at each Isolator Type: **JQA**

Transverse loading: (on long edge)	$Comp_{MAX}$ =	976.2	lbs
	$Tens_{MAX}$ =	865.2	lbs
# isolators: 2	$Shear_{MAX}$ =	265.3	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	738.7	lbs
	$Tens_{MAX}$ =	627.6	lbs
# isolators: 2	$Shear_{MAX}$ =	265.3	lbs

Max compression force on isolator: 0.976 k ≤ 1.660 k **O.K.**

Max uplift on isolator: 0.865 k ≤ 1.660 k **O.K.**

Max shear on isolator: 0.265 k ≤ 0.800 k **O.K.**



Forces on top bolt:

d_b = 0.375 in

upper rail, t = 0.1242 in

Tension = 0.865 k

Shear = 0.265 k

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

Pn/Ω = 8.073 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 = 8.691 k — An = 0.202 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 = 3.633 k — d/t = 3.02

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 in²

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 = 2.40 ksi O.K.

Combined Not Applicable — F'nt = 40.50 ksi — Fnv/Ω = 10.00 ksi

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

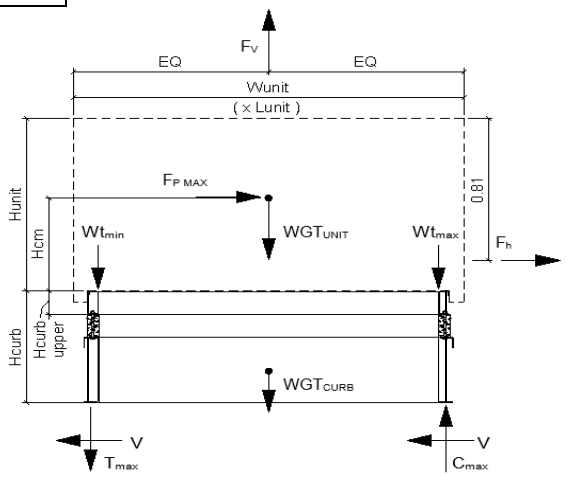
Client:	ProVent PV1906	Base curb
Project:	ISCAL-126 Iso Curb	(ISCALSUN3672**)
Unit:	ZE 036-072; XN 036-060; ZR/XP/ZF 036-072	

Curb Information

Hcurb =	23	in	(Height of curb)
Lcurb =	74.125	in	(Length of curb)
wcurb =	36.75	in	(Width of curb)
WGTcurb =	433	lbs	(Weight of curb)
# springs long side =	2	# springs short side =	2

Unit Information

WGTunit =	665	lbs	(Weight of Unit)
Wtmax =	399	lbs	(Maximum corner weight)
Wtmin =	266	lbs	(Minimum corner weight)
Hunit =	32.625	in	(Height of unit above curb)
Hcm =	27.3125	in	(Ht to ctr mass + 11")
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 =	1.50		(Importance Factor Category IV Building)
Fpmax =	4.560	Wp	(1.6*Sds*Ip)*Wp
FpmaxASD =	2595	lbs	(0.7*Fpmax)

FpmaxASD = 3505 lbs (unit and curb)

(unit + upper curb only - from upper rail calc)

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)
$F_{h\ ASD\ trans}$ =	1178	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	643	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:

$Compression_{SEISMIC}$ =	2939	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	2717	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	979	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1330	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	1966	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1744	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	341	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	692	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	2939	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	2717	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1966	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1744	lbs	---> Along short edge of curb.

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

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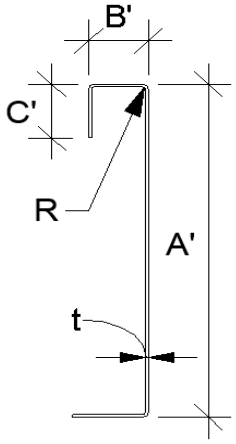
Curb Design

Fy = 50 ksi Fu = 65 ksi t = 0.0566 [16 Gauge]
E = 29500 ksi



Calculate Section Properties of Curb

A'=	[23.000] in		a =	22.717 in	= A'-(2r+t)
B'=	[1.750] in		a'=	22.943 in	= A'-t
C'=	[0.000] in (0 if no lips)		b =	1.609 in	= B'-[r+t/2+a(r+t/2)]
a =	[0.000] (0 - no Lip; 1 w/ lip)		b'=	1.722 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 = 0.113 in (Distance between centroid and web centerline)
Ix = 81.932 in (Moment of Inertia about X-Axis)
Iy = 0.174 in (Moment of Inertia about Y-Axis)
A = 1.49 in^2
rx = 7.42 in
ry = 0.342 in
rmin = 0.342 in

Axial Compression

Pa = 1.298 k (Max Axial Comp) Ω_c = 1.80
Pn/Ωc = 7.149 k
Fe = 9.86 ksi
λc = 2.25
Fn = 8.65 ksi
Ly = 73.38 in Lateral unbraced length
k_yL_y/r_y = 172 (assume k=0.8)

$$\frac{P_n}{\Omega_c}=\frac{F_nA}{\Omega_c} \qquad If\ \lambda_c \le 1.5;\ F_n=\left(0.658^{\lambda_c{}^2}\right)F_y \qquad If\ \lambda_c > 1.5;\ F_n=\frac{0.877}{\lambda_c{}^2}F_y \qquad \lambda_c=\sqrt{\frac{F_y}{F_e}} \qquad F_e=\frac{\pi^2E}{\left(kl/r\right)^2}$$

Compression Check = **O.K.**

Check Web Crippling

h = 23 in -- Check limits: C = 4.00
t = 0.0566 in h/t = 406.36 ≤ 200 C_R = 0.14
N = 7.00 N/t = 123.67 ≤ 210 C_N = 0.35
Ω_w = 1.75 N/h = 0.304348 ≤ 2.0 C_h = 0.02
P_n = 1.386 k R/t = 1.50 ≤ 9.0
P_n/Ω_w = 0.792 k
Long side: Pa_{Trans} = 1.469 k **web stiffener REQ'D** # clips = 2
Short side: Pa_{Long} = 0.983 k **web stiffener REQ'D** # clips = 2

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

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

*****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 = 1.386 k Ae = 0.380 in^2
Pn = 14.276 k
Pn/Ω_c = 8.398 k **O.K.**

Corner Connections

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

Tcrnmax = 649 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 1358 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 = 0.3
# of Bolts required for Shear = 1.2 ***If combined fails:
# of Bolts Used = [2.0] USE --> 4.0

Check Combined Stress in Bolts & Inserts: 0.751 O.K. StressComb = 0.375 **O.K.**

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

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

Lreq'd = 1.157 in

Curb Loads

Transverse: (on long edge)	$Comp_{MAX}$ =	2939	lbs
	$Tens_{MAX}$ =	2717	lbs
	$Shear_{MAX}$ =	1298	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	1966	lbs
	$Tens_{MAX}$ =	1744	lbs
	$Shear_{MAX}$ =	1298	lbs

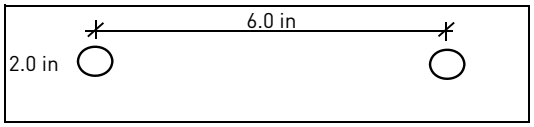
Loads at each Isolator Type: **JQA**

Transverse loading: (on long edge) # isolators: 2	$Comp_{MAX}$ =	1469.5	lbs
	$Tens_{MAX}$ =	1358.4	lbs
	$Shear_{MAX}$ =	648.8	lbs
Longitudinal loading: (on short edge) # isolators: 2	$Comp_{MAX}$ =	983.2	lbs
	$Tens_{MAX}$ =	872.2	lbs
	$Shear_{MAX}$ =	648.8	lbs

Max compression force on isolator: 1.469 k ≤ 1.660 k **O.K.**

Max uplift on isolator: 1.358 k ≤ 1.660 k **O.K.**

Max shear on isolator: 0.649 k ≤ 0.800 k **O.K.**



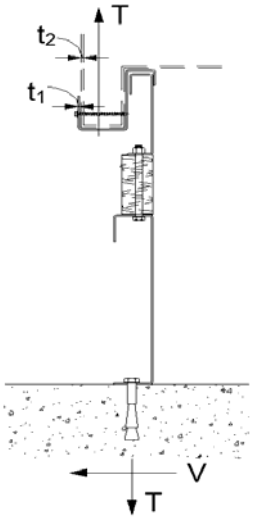
Forces on bottom bolts:

d_b = 0.5 in

base curb, t = 0.0566 in

Tension = 0.679 k / bolt

Shear = 0.324 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: $P_n = A_n F_t$ Ω = 2.22 (Appendix A, Section E3.2 AISI)

Pn/Ω = 4.691 k An = 0.085 in

N.S.R. O.K. $F_t = (0.1 + 3d/s)F_u \leq F_u$ = 55.250 ksi

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

Pn/Ω = 2.207 k d/t = 8.83

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 = 45.0 ksi A_b = 0.1963 in^2

Pnt/Ω = 3.927 k **Bolt tension O.K.** Ωt = 2.25

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

Pnv/Ω = 2.209 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 = 1.65 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: $Uplift_{MAX}$ = 5127 lbs $Shear_{MAX}$ = 1752 lbs

$Compression_{SEISMIC}$ = 5493 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 5127 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 1567 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb

$Tension_{WIND}$ = 1658 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: $Uplift_{MAX}$ = 2707 lbs $Shear_{MAX}$ = 1752 lbs

$Compression_{SEISMIC}$ = 3074 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 2707 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 390 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb

$Tension_{WIND}$ = 482 lbs =[$F_{h\ transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

Wood Attachment: **1/4" φ Simpson SDS screws** **w/ 3.0" min. embed** (SGmin = 0.43)

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

$Tall_{wood}$ = 552 lbs $Vall_{wood}$ = 400 lbs

# of Screws Req'd for Uplift = 9.29 COMBINED LOADING: 0.976 O.K.

# of Screws Req'd for Shear = 4.38 Req'd Min Spacing = 5.1 in o.c.

Total # of screws required = 14

Use 14 - 1/4" φ Simpson SDS screws @ 5.1 in o.c. along long side of curb w/ 3.0" min. embed

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Longitudinal:

# of Screws Req'd for Uplift = 4.90 COMBINED LOADING: 0.929 O.K.
# of Screws Req'd for Shear = 4.38 Screw Spacing = 3.2 in o.c.
Total # of screws required = 10

Use 10 - 1/4" ϕ Simpson SDS screws @ 3.2 in o.c. along short side of curb w/ 3.0" min. embed

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

$T_{all_{bolt}}$ = 6903 lbs $V_{all_{bolt}}$ = 3682 lbs

Transverse: 6903 lbs 3682 lbs

# of Bolts Req'd for Uplift = 0.74 COMBINED LOADING: 0.609 O.K.
# of Bolts Req'd for Shear = 0.48 Bolt Spacing = 62.1 in o.c.
Total # of bolts required = 2

Use 2 - 1/2" ϕ A307 Bolts to steel angle below deck @ 62.1 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.39 COMBINED LOADING: 0.434 O.K.
# of Bolts Req'd for Shear = 0.48 Bolt Spacing = 24.8 in o.c.
Total # of bolts required = 2

Use 2 - 1/2" ϕ A307 Bolts to steel angle below deck @ 24.8 in o.c. along short side of curb

For Concrete anchorage: SEISMIC (0.6-0.14SDS)D + 0.7Ω_oE (Ω_o = 2.5)

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

$T_{all_{LRFD}}$ = 1919 lbs $V_{all_{LRFD}}$ = 3188 lbs $\propto = (1 + 0.2SDS)D + 2.5E$ =1.87

$T_{all_{ASD}} = T_{all_{LRFD}}/\alpha$ = 1026.2 lbs $V_{all_{ASD}} = V_{all_{LRFD}}/\alpha$ = 1704.8 lbs $(D = 0.465, E = 0.535)$

Transverse: $Uplift_{MAX}$ = 12324 lbs $Shear_{MAX}$ = 4381 lbs

$Compression_{SEISMIC}$ = 12691 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 12324 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 4381 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 12.01 spacing = 4.18 in o.c. Tapplied = 948.0 lbs
Min Bolts Req'd Shear = 2.57 spacing = 25.0625 in o.c. Vapplied = 337.0 lbs

Try using 13 bolts
spaced at 5.18 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.12

Use 13 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 5.2 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 6276 lbs $Shear_{MAX}$ = 4381 lbs

$Compression_{SEISMIC}$ = 6642 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 6276 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 4381 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 6.12 spacing = 2.125 in o.c. Tapplied = 784.4 lbs
Min Bolts Req'd Shear = 2.57 spacing = 6.375 in o.c. Vapplied = 547.6 lbs

Try using 8 bolts
spaced at 3.54 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.09

Use 8 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 3.5 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: ISCAL-126 (ISCALSUN3672**) Unit: ZE 036-072; XN 036-060; ZR/XP/ZF 036-072

UPPER CURB TUBE THICKNESS: 0.1242 in 10 Gauge
UNIT CLIP THICKNESS: 0.1017 in 12 Gauge
 # OF CLIPS (LONG SIDE) - 2 clips with 4 - #10 SMS screws each clip
WEB STIFFENER: NOT REQUIRED
 # OF CLIPS (SHORT SIDE) - 2 clips with 4 - #10 SMS screws each clip
WEB STIFFENER: NOT REQUIRED
VIBRATION ISOLATOR TYPE: JQA Top stud diameter: 3/8
Anchor bolt diameter: 1/2 Anchor hole diamter: 9/16
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 1/8" welded connection

CURB ANCHORAGE	WOOD	STEEL	CONCRETE
	1/4" φ Simpson SDS screws w/ 3.0" 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	14 @ 5.09 in o.c.	2 @ 62.13 in o.c.	13 @ 5.18 in o.c.
SHORT DIRECTION	10 @ 3.19 in o.c.	2 @ 24.75 in o.c.	8 @ 3.54 in o.c.