MOUR GROUP
ENGINEERING + DESIGN

6593 Riverdale St.
San Diego, CA 92120

619-727-4800

Structural Calculations
for
Sunline Magna Series
ISCALPRD3715** Roof Curb

Form No. ISCAL-127

REGISTERED PROFESSIONAL ENGINEER
GLENN A. MOURITZEN
SE 3578
Exp. 6/30/21
STRUCTURAL
STATE OF CALIFORNIA

11-15-19

Prepared for:

PROVENT

3847 Wabash Drive
Mira Loma, CA 91725

Date: November 14, 2019

Project Number: PV1908

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

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

STRUCTURALLY CALCULATED VIBRATION ISOLATION CURBS FOR YORK UNITS

ZT, ZH, ZJ, ZR 037, 049, 061
ZF, ZH, ZJ, ZR, XP, DH, DM, DF, DR, BP 078-150

ProVent P/N (2" Deflection)	A	B	Wt.
ISCALPRD371519**	8"	19"	494 Lbs
ISCALPRD371522**	11"	22"	511 Lbs
ISCALPRD371525**	14"	25"	528 Lbs
ISCALPRD371531**	20"	31"	754 Lbs

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

ProVent P/N (3" Deflection)	A	B	Wt.
ISCALPRD3715193**	8"	19"	494 Lbs
ISCALPRD3715223**	11"	22"	511 Lbs
ISCALPRD3715253**	14"	25"	528 Lbs

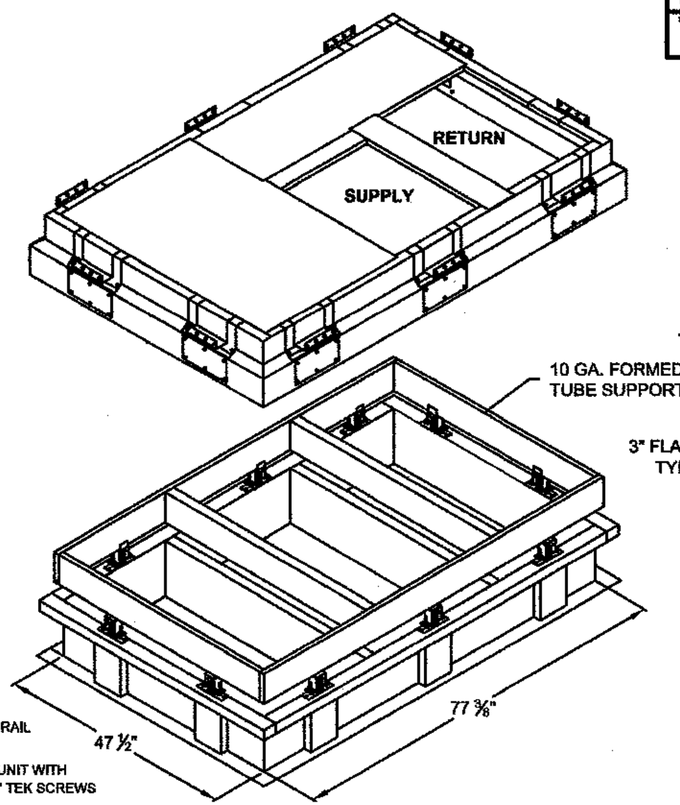
Meets seismic requirements for the following codes:
CBC 2019
IBC 2018

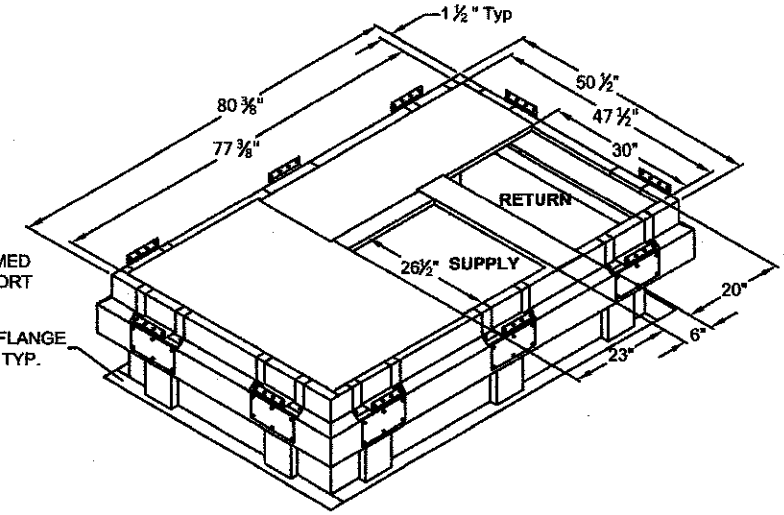
FEATURES

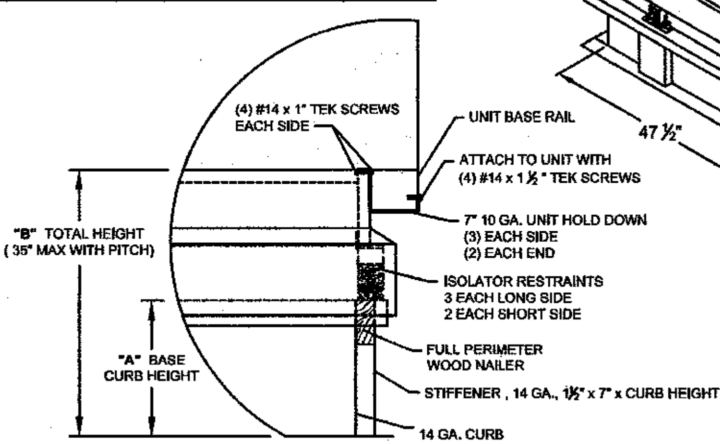
- Roof curb sides and ends are 14 ga. galvanized steel.
- Fully welded construction.
- Gasketing package provided.
- Heat treated wood nailer provided.
- Insulated deck pans provided.
- Pitched curbs and taller curbs are available.
- CalDyn OSHPD pre-approved 2" or 3" deflection seismic restraints. (OPA-0070), (JQB).

NOTES

- Attach ductwork to roof curb. Flanges of duct rest on top of curb. Support ductwork below the curb.
- Thru the curb utilities are available. Contact your York distributor or ProVent directly.







PROFILE DETAIL

** UNITS UNDER 1280 LBS (2) ISOLATOR RESTRAINTS, OVER 1280 LBS (3) ISOLATOR RESTRAINTS

REGISTERED PROFESSIONAL ENGINEER ★ GLENN A. MOURITZEN ★ SE 3578 ★ Exp. 6/30/21 ★ STRUCTURAL ★ STATE OF CALIFORNIA
11-15-19

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

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

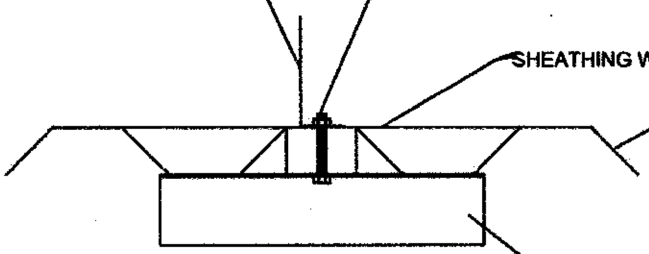
FORM NO:		PART NUMBER:
ISCAL-127		ISCALPRD3715 SERIES
DATE:	REV:	DRAWN BY:
11/13/19	4	ALL

ROOF ANCHORAGE DETAIL

CBKD Series	CBWC Series	ISCAL Series
SUN3672	SUN3672	SUN3672
PRD3715	PRD3715	PRD3715
SLM1830	SLM1830	SLM1830

Meets seismic requirements for the following codes:
CBC 2019
IBC 2018

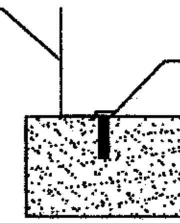
STEEL ATTACHMENT



CURB	NO. OF ANCHORAGE BOLTS REQUIRED	
	LONG SIDE	SHORT SIDE
SUN3672	2 @ 62.13 in o.c.	2 @ 24.75 in o.c.
PRD3715	2 @ 68.38 in o.c.	2 @ 38.50 in o.c.
SLM1830	3 @ 56.88 in o.c.	3 @ 35.75 in o.c.

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

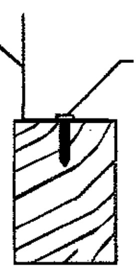
CONCRETE ATTACHMENT



CURB	NO. OF ANCHORAGE BOLTS REQUIRED	
	LONG SIDE	SHORT SIDE
SUN3672	13 @ 5.18 in o.c.	8 @ 3.54 in o.c.
PRD3715	19 @ 3.8 in o.c.	14 @ 2.96 in o.c.
SLM1830	23 @ 5.17 in o.c.	17 @ 4.47 in o.c.

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

WOOD ATTACHMENT



CURB	NO. OF ANCHORAGE SCREWS REQUIRED	
	LONG SIDE	SHORT SIDE
SUN3672	14 @ 5.09 in o.c.	10 @ 3.19 in o.c.
PRD3715	17 @ 4.52 in o.c.	12 @ 3.86 in o.c.
SLM1830	19 @ 6.54 in o.c.	16 @ 5.03 in o.c.

FOUR INCHES FROM EACH CORNER EVENLY SPACED

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11-15-19

ProVent

3847 WABASH DRIVE
MIRA LOMA, CA 91725

PHONE (951) 685-1101
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SUBMITTED TO: ____
COMPANY: ____
JOB NAME: ____
EQUIPMENT: ____
NOTES: ____

FORM NO:		
CB-24A		
DATE:	REV:	DRAWN BY:
11/15/19	15	ALL

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San Diego, CA 92120
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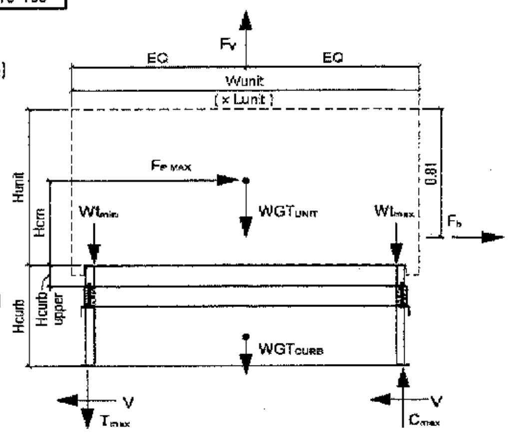
Client:	ProVent PV1908	Upper curb tube
Curb:	ISCAL-127 Iso Curb (ISCALPRD3715**)	
Unit:	ZT,ZJ,ZH,ZR037,049,061;ZF,ZH,ZJ,ZR,XP,DH,DM,DF,DR,BP078-150	



Curb Information

Hcurb upper =	6	in	(Height of upper curb tube)
Lcurb =	80.375	in	(Length of curb)
wcurb =	50.5	in	(Width of curb)
WGTcurb top=	161	lbs	(Weight of upper curb)
# Clips long side =	3		# Clips short side = 2

Unit Information

WGTunit =	2095	lbs	(Weight of Unit)
Wtmax =	719	lbs	(Maximum corner weight)
Wtmin =	293	lbs	(Minimum corner weight)
Hunit =	50.75	in	(Height of unit above curb)
Hcm =	25.375	in	(Height to center of mass)
Lunit =	119.5	in	(Length of unit)
Wunit =	59	in	(Width of unit)

Seismic Loading - 2018 IBC/2019 CBC

Ss =	2.000	(Conservative for majority of CA - Design Category D)
Fa =	1.000	(From Table 11.4-1 ASCE 7-10)
Sms =	2.000	(Fa*Ss)
Sds =	1.333	(2/3*Sms)
Ip =	1.50	(Importance Factor Category IV Building)
Fpmax =	3.200 Wp	(1.6*Sds*Ip)*Wp
FpmaxASD =	4693 lbs	(0.7*Fpmax)

(unit only)

FpmaxASD = 5053 lbs (unit and upper curb)

Wind Loading - 2018 IBC/2019 CBC

*** Exposure Category C ***

Kz =	1.13	(For 60 ft roof height, Exposure C - Table 29.3-1 ACSE 7-16)
Kzt =	1.0	(No topographic effects assumed for rooftop mounted units)
Kd =	0.85	(Directionality factor Table 26.6-1 ASCE 7-16)
V =	115	(Max wind velocity, mph for Cat III & IV bldgs Exp. Cat C)
$GCr_{(horiz)}$ =	1.9	(Refer Sect 29.5.1 ASCE 7-16)
$GCr_{(vert)}$ =	1.5	(Refer Sect 29.5.1 ASCE 7-16)
qz	32.5 psf	$= 0.00256*Kz*Kzt*Kd*V^2$ (Eq. 29.3-1 ASCE 7-16)
$F_{h\ ASD\ trans}$ =	1746 lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb upper) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	862 lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb upper)
$F_{vert\ ASD}$ =	1433 lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	4064 lbs	$=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb$
$Tension_{SEISMIC}$ =	3199 lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	1024 lbs	$=[F_{h\ transASD}*Hcm+2*0.6*Wtmax*wcurb-F_{vertASD}*wcurb/2]/wcurb$
$Tension_{WIND}$ =	1200 lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Longitudinal:

$Compression_{SEISMIC}$ =	3188 lbs	$=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb$
$Tension_{SEISMIC}$ =	2322 lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	418 lbs	$=[F_{h\ transASD}*Hcm+2*0.6*Wtmax*Lcurb-F_{vertASD}*Lcurb/2]/Lcurb$
$Tension_{WIND}$ =	594 lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	4064	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	3199	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	3188	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2322	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 =	55 ksi						
Fu =	65 ksi	Ag =	1.871 in^2	R =	0.1875	d =	5.625
E =	29500 ksi	Ix =	3.742 in^4	Iy =	0.412 in^4	wt =	135.723
height =	6 in	Sx =	1.247 in^3	Sy =	0.550 in^3		
width =	1.5 in	rx =	1.414 in	ry =	0.469 in	b/t =	12.07729
t =	0.1242 in	Zx =	1.625 in^3	Zy =	0.595 in^3	d/t =	45.28986

Check weak axis bending of tube:

Long side			Short side		
# clips =	3		# clips =	2	
compression =	58.386 lb/in		compression =	92.927 lb/in	
clip spacing =	36.19 in		clip spacing =	35.50 in	
Mmax =	9.6 k-in		Mmax =	14.64 k-in	
Yielding	My =	30.24 k-in	Mp_y/Ω =	18.11 k-in	O.K.
Flange local buckling	Mn =	30.24 k-in	<--Section is compact, FLB does not apply		
Web local buckling	Mn =	30.24 k-in	<--Section is compact, WLB does not apply		

Axial Compression

Pa =	2.346 k	(Max Axial Comp)
Pn/Ωc =	8.272 k	
Fe =	16.01 ksi	
λc =	1.767	
Fn =	14.04 ksi	
Ly =	70.13 in	Lateral unbraced length
k_yL_y/r_y =	135	(assume k=0.8)

Ω_c = 1.80

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

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

Compression Check = O.K.

Check Web Crippling

h =	6 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 =	48.31 ≤ 200	C_R = 0.08	
N =	7.00	N/t =	56.36 ≤ 210	C_N = 0.12	
Ω_w =	1.75	N/h =	1.167 ≤ 2.0	C_h = 0.048	
P_n =	5.907 k	R/t =	1.51 ≤ 12.0		
P_n/Ω_w =	3.375 k				
Long side: Pa_{Trans} =	1.355 k	O.K.	# clips = 3		
Short side: Pa_{Long} =	1.594 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

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

Pwc =	5.907 k	Ae =	0.380 in^2
Pn =	17.441 k		
Pn/Ω_c =	10.259 k	**Not Req'd**	

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

Tcrnmax =	1173 lbs	Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax =	1599 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 = 0.5

# of Bolts required for Shear = 1.5 ***If combined fails:

# of Bolts Used = 2.0 USE --> 3.0

Check Combined Stress in Bolts & Inserts: 0.966 O.K. StressComb = 0.644 O.K.

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

Assume L/t > 25: 25*t =	3.105 in
Lreq'd =	0.621 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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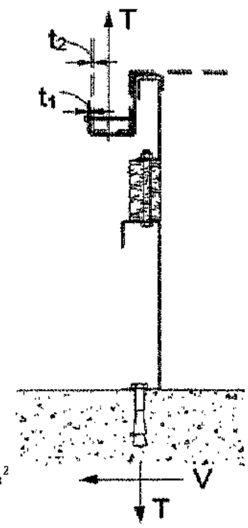
Connection Unit to Curb Clip — #14 SMS screw — Ω = 3.0

t1 = 0.1017 in (clip thickness) — Fu1 = 65 ksi
t2 = 0.1242 in (unit base rail thickness) — Fu2 = 65 ksi
d = 0.242 in (screw diameter) — dw = 0.500 in (nom. washer diameter)
t2/t1 = 1.2

For t2/t1 ≤ 1.0: — Pns = 4319 # — For t2/t1 ≥ 2.5:

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ 5.88 k — Pns = 4319 #
$P_{ns} = 2.7t_1 dF_{u1}$ 4.32 k — $P_{ns} = 2.7t_1 dF_{u1}$ 4.32 k
$P_{ns} = 2.7t_2 dF_{u2}$ 5.27 k — $P_{ns} = 2.7t_2 dF_{u2}$ 5.27 k
Pns/Ω = 1440 #
Pss/Ω = 1045 # <- Controls

Tension: Pnot = 1.661 k (screw pull-out strength) — $P_{not} = 0.85t_c dF_{u2})$, $t_c = \min(t_1, t_2)$
Pnov = 4.958 k (screw pull-over strength) — $P_{nov} = 1.5t_1 d_w F_{u1}$
Pts/Ω = 554 # <- Controls
Pts/Ω = 1220 # (full tensile screw capacity)



	Shear (k)	# clips	V_{clip} (k)	V_{allow}(lb)	# screws	spacing
Long side:	4.693	2	2.35	1045 #	4	2.00 in
Short side:	4.693	2	2.35	1045 #	4	2.00 in

clip width (in) = 7.00 — clip height = 2.5 in
min spacing = 0.73 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 in^2 — Anv = 0.575 in^2 — Ant = 0.115 in^2
Rn/Ω = 12.295 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)

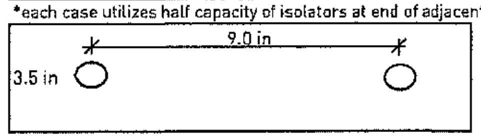
Transverse: (on long edge)	$Comp_{MAX}$ =	4064	lbs
	$Tens_{MAX}$ =	3199	lbs
	$Shear_{MAX}$ =	2346	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	3188	lbs
	$Tens_{MAX}$ =	2322	lbs
	$Shear_{MAX}$ =	2346	lbs

Loads at each Isolator Type: **JQB**

Transverse loading:	$Comp_{MAX}$ =	1016.1	lbs
(on long edge)*	$Tens_{MAX}$ =	799.6	lbs
# isolators: 4	$Shear_{MAX}$ =	335.2	lbs
Longitudinal loading:	$Comp_{MAX}$ =	1062.7	lbs
(on short edge)*	$Tens_{MAX}$ =	774.0	lbs
# isolators: 3	$Shear_{MAX}$ =	335.2	lbs

*each case utilizes half capacity of isolators at end of adjacent edge.

Max compression force on isolator: 1.063 k ≤ 1.600 k **O.K.**
Max uplift on isolator: 0.800 k ≤ 1.600 k **O.K.**
Max shear on isolator: 0.335 k ≤ 1.000 k **O.K.**



Forces on top bolt:
d_b = 0.5 in
upper rail, t = 0.1242 in
Tension = 0.800 k
Shear = 0.335 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 = 10.293 k — An = 0.186 in
N.S.R. O.K. — $F_t = (0.1 + 3d/s)F_u \le F_u =$ 55.250 ksi

Bolt Bearing Strength: $P_n = Cm_f dtF_u$ — Ω = 2.50 (Section E3.3.1 AISI)
Pn/Ω = 4.844 k — d/t = 4.03
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 (Table E3.4-1, AISI)

Shear: $P_{nv} = A_b F_{nv}$ — Fnv = 27.0 ksi — Ωv = 2.40 (Table E3.4-1, AISI)
Pnv/Ω = 2.209 k **Bolt shear O.K.**

$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \le F_{nt}$ — fv = 1.71 ksi O.K.

Combined Not Applicable — F'nt = 45.00 ksi — Fnv/Ω = 11.25 ksi

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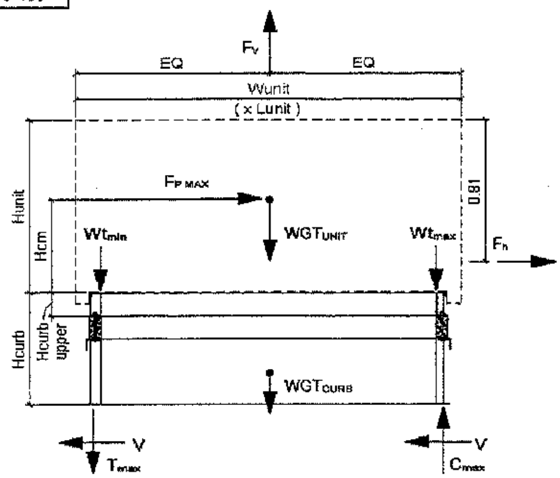
Client:	ProVent PV1908	Base curb
Project:	ISCAL-127 Iso Curb (ISCALPRD3715**)	
Unit:	ZT,ZJ,ZH,ZR037,049,061;ZF,ZH,ZJ,ZR,XP,DH,DM,DF,DR,BP078-150	



Curb Information

Hcurb =	24	in	(Height of curb)
Lcurb =	80.375	in	(Length of curb)
wcurb =	50.5	in	(Width of curb)
WGTcurb =	593	lbs	(Weight of curb)
# springs long side =	3		# springs short side = 2

Unit Information

WGTunit =	2095	lbs	(Weight of Unit)
Wtmax =	719	lbs	(Maximum corner weight)
Wtmin =	293	lbs	(Minimum corner weight)
Hunit =	50.75	in	(Height of unit above curb)
Hcm =	36.375	in	(Ht to ctr mass + 11")
Lunit =	119.5	in	(Length of unit)
Wunit =	59	in	(Width of unit)

Seismic Loading - 2018 IBC/2019 CBC

Ss =	2.000	(Conservative for majority of CA - Design Category D)
Fa =	1.000	(From Table 11.4-1 ASCE 7-16)
Sms =	2.000	(Fa*Ss)
Sds =	1.333	(2/3*Sms)
Ip =	1.50	(Importance Factor Category IV Building)
Fpmax =	3.200 Wp	(1.6*Sds*Ip)*Wp
FpmaxASD =	5053 lbs	(0.7*Fpmax) FpmaxASD = 6021 lbs

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

Wind Loading - 2018 IBC/2019 CBC

*** Exposure Category C ***

Kz =	1.13	(For 60 ft roof height, Exposure C - Table 29.3-1 ACSE 7-16)
Kzt =	1.0	(No topographic effects assumed for rooftop mounted units)
Kd =	0.85	(Directionality factor Table 26.6-1 ASCE 7-16)
V =	115	(Max wind velocity, mph for Cat III & IV bldgs Exp. Cat C)
$GCr_{(horiz)}$ =	1.9	(Refer Sect 29.5.1 ASCE 7-16)
$GCr_{(vert)}$ =	1.5	(Refer Sect 29.5.1 ASCE 7-16)
qz	32.5 psf	= $0.00256*Kz*Kzt*Kd*V^2$ (Eq. 29.3-1 ASCE 7-16)
$F_{h\ ASD\ trans}$ =	2638 lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	1302 lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	1433 lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	5346 lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	4480 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	2046 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	2222 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	3993 lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	3128 lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	736 lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	912 lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	5346	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	4480	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	3993	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	3128	lbs	---> Along short edge of curb.

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

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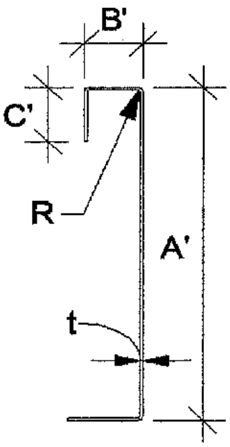
Curb Design

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

Calculate Section Properties of Curb

A'=	24.000 in	a =	23.644 in	= A'-(2r+t)
B'=	1.750 in	a'=	23.929 in	= A'-t
C'=	0.000 in (0 if no lips)	b =	1.572 in	= B'-[r+t/2+α(r+t/2)]
α =	0.000 (0 - no Lip; 1 w/ lip)	b'=	1.714 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 =	0.108 in (Distance between centroid and web centerline)			
Ix =	115.211 in (Moment of Inertia about X-Axis)			
Iy =	0.217 in (Moment of Inertia about Y-Axis)			
A =	1.94 in^2			
rx =	7.70 in			
ry =	0.334 in			
rmin =	0.334 in			



Axial Compression

Pa =	2.527 k	(Max Axial Comp)
Pn/Ωc =	8.927 k	
Fe =	9.44 ksi	
λc =	2.30	
Fn =	8.28 ksi	
Ly =	73.38 in	Lateral unbraced length
k_yL_y/r_y =	176	(assume k=0.8)

Ω_c = 1.80

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

Compression Check = O.K.

Check Web Crippling

h =	24 in	-- Check limits:		C = 4.00
t =	0.0713 in	h/t =	336.61 ≤ 200	C_R = 0.14
N =	7.00	N/t =	98.18 ≤ 210	C_N = 0.35
Ω_w =	1.75	N/h =	0.291667 ≤ 2.0	C_h = 0.02
P_n =	2.130 k	R/t =	1.50 ≤ 9.0	
P_n/Ω_w =	1.217 k			
Long side: Pa_{Trans} =	1.782 k	web stiffener REQ'D	# clips = 3	
Short side: Pa_{Long} =	1.997 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

$P_n = 0.7(P_{wc} + A_eF_y) \geq P_{wc}$

Pwc =	2.130 k	Ae =	0.380 in^2
Pn =	14.798 k		
Pn/Ω_c =	8.704 k	O.K.	

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

Tcrnmax =	1263 lbs	Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax =	2240 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 = 0.5

# of Bolts required for Shear = 2.0 ***If combined fails:

# of Bolts Used = 3.0 USE --> 4.0

Check Combined Stress in Bolts & Inserts: 0.851 O.K. StressComb = 0.638 O.K.

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

Assume L/t > 25: 25*t = 1.783 in

Lreq'd = 1.515 in

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

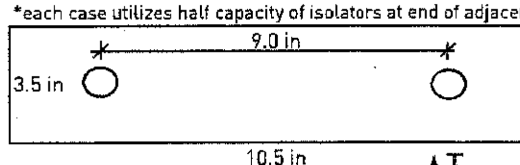
Curb Loads

Transverse: (on long edge)	$Comp_{MAX}$ =	5346	lbs
	$Tens_{MAX}$ =	4480	lbs
	$Shear_{MAX}$ =	5053	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	3993	lbs
	$Tens_{MAX}$ =	3128	lbs
	$Shear_{MAX}$ =	5053	lbs

Loads at each Isolator Type: JQB

Transverse loading: (on long edge)*	$Comp_{MAX}$ =	1336.6	lbs
	$Tens_{MAX}$ =	1120.1	lbs
# isolators: 4	$Shear_{MAX}$ =	361.0	lbs
Longitudinal loading: (on short edge)*	$Comp_{MAX}$ =	1331.1	lbs
	$Tens_{MAX}$ =	1042.5	lbs
# isolators: 3	$Shear_{MAX}$ =	361.0	lbs

*each case utilizes half capacity of isolators at end of adjacent edge.



Max compression force on isolator: 1.337 k ≤ 1.600 k O.K.

Max uplift on isolator: 1.120 k ≤ 1.600 k O.K.

Max shear on isolator: 0.361 k ≤ 1.000 k O.K.

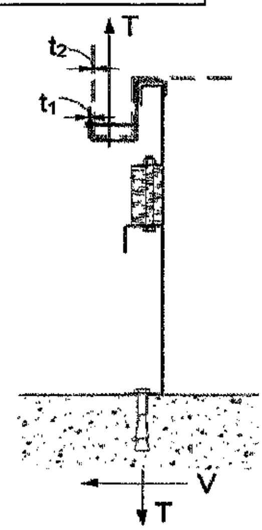
Forces on bottom bolts:

d_b = 0.625 in

base curb, t = 0.0713 in

Tension = 0.560 k / bolt

Shear = 0.180 k / bolt



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

Pn/Ω = 4.635 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 = 6.372 k An = 0.098 in

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

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

Pn/Ω = 3.476 k d/t = 8.77

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 = 0.3068 in^2

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

Shear: $P_{nv} = A_b F_{nv}$ 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 = 0.59 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:	$Uplift_{MAX}$ = 7682 lbs	$Shear_{MAX}$ = 3011 lbs	
$Compression_{SEISMIC}$ =	8793 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit-curb}$/2)*wcurb]/wcurb	
$Tension_{SEISMIC}$ =	7682 lbs	=Comp$_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)	
$Compression_{WIND}$ =	3244 lbs	=[F$_{h\ transASD}$*(Hcm+Hcurb)+0.6*(WGT$_{unit+curb}$/2)*wcurb-F$_{vertASD}$*wcurb/2]/wcurb	
$Tension_{WIND}$ =	3064 lbs	=[F$_{h\ transASD}$*(Hcm+Hcurb)-0.6*(WGT$_{unit+curb}$/2)*wcurb+F$_{vertASD}$*wcurb/2]/wcurb	
Longitudinal:	$Uplift_{MAX}$ = 5007 lbs	$Shear_{MAX}$ = 3011 lbs	
$Compression_{SEISMIC}$ =	6118 lbs	=[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*(WGT$_{unit-curb}$/2)*Lcurb]/Lcurb	
$Tension_{SEISMIC}$ =	5007 lbs	=Comp$_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)	
$Compression_{WIND}$ =	1068 lbs	=[F$_{h\ transASD}$*(Hcm+Hcurb)+0.6*(WGT$_{unit+curb}$/2)*Lcurb-F$_{vertASD}$*Lcurb/2]/Lcurb	
$Tension_{WIND}$ =	888 lbs	=[F$_{h\ transASD}$*(Hcm+Hcurb)-0.6*(WGT$_{unit+curb}$/2)*Lcurb+F$_{vertASD}$*Lcurb/2]/Lcurb	

Wood Attachment: 1/4"φ x 4.5" Simpson SDS screw: w/ 2.75" threaded emt (SGmin = 0.43)

Transverse:

$Tall_{metal}$ =	946.67 lbs	$Vall_{metal}$ =	1043.33 lbs
$Tall_{wood}$ =	760 lbs	$Vall_{wood}$ =	672 lbs

# of Screws Req'd for Uplift = 10.11 COMBINED LOADING: 0.858 O.K.

# of Screws Req'd for Shear = 4.48 Req'd Min Spacing = 4.5 in o.c.

Total # of screws required = 17

Use 17 - 1/4"φ x 4.5" Simpson SDS screws @ 4.5 in o.c. along long side of curb w/ 2.75" threaded embed

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Longitudinal:

# of Screws Req'd for Uplift = 6.59 COMBINED LOADING: 0.922 O.K.

# of Screws Req'd for Shear = 4.48 Screw Spacing = 3.9 in o.c.

Total # of screws required = 12

Use 12 - 1/4"ϕ x 4.5" Simpson SDS screws @ 3.9 in o.c. along short side of curb w/ 2.75" threaded 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 = 1.11 COMBINED LOADING: 0.965 O.K.

# of Bolts Req'd for Shear = 0.82 Bolt Spacing = 68.4 in o.c.

Total # of bolts required = 2

Use 2 - 1/2" ϕ A307 Bolts to steel angle below deck @ 68.4 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.73 COMBINED LOADING: 0.772 O.K.

# of Bolts Req'd for Shear = 0.82 Bolt Spacing = 38.5 in o.c.

Total # of bolts required = 2

Use 2 - 1/2" ϕ A307 Bolts to steel angle below deck @ 38.5 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

$Tall_{LRFD}$ = 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: $Uplift_{MAX}$ = 18480 lbs $Shear_{MAX}$ = 7526 lbs

$Compression_{SEISMIC}$ = 19591 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 18480 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 7526 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 18.01 spacing = 3.13 in o.c. Tapplied = 972.6 lbs

Min Bolts Req'd Shear = 4.41 spacing = 14.09375 in o.c. Vapplied = 396.1 lbs

Try using 19 bolts spaced at 3.80 in o.c. COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 1.18

Use 19 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 3.8 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 11791 lbs $Shear_{MAX}$ = 7526 lbs

$Compression_{SEISMIC}$ = 12902 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 11791 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 7526 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 11.49 spacing = 3.5 in o.c. Tapplied = 842.2 lbs

Min Bolts Req'd Shear = 4.41 spacing = 9.625 in o.c. Vapplied = 537.6 lbs

Try using 14 bolts spaced at 2.96 in o.c. COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{aplied}}{V_{allow,ASD}} \leq 1.2$ = 1.14

Use 14 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 3 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY:	ISCAL-127 (ISCALPRD3715**)		
UPPER CURB TUBE THICKNESS: 0.1242 in 10 Gauge **UNIT CLIP THICKNESS:** 0.1017 in 12 Gauge	Unit: ZT,ZJ,ZH,ZR037,049,061; ZF,ZH,ZJ, ZR,XP,DH,DM,DF,DR,BP 078-150		
# OF CLIPS (LONG SIDE) - 2 clips with 4 - #14 SMS screws each clip **WEB STIFFENER:** NOT REQUIRED FOR UPPER TUBE			
# OF CLIPS (SHORT SIDE) - 2 clips with 4 - #14 SMS screws each clip **WEB STIFFENER:** NOT REQUIRED FOR UPPER TUBE			
VIBRATION ISOLATOR TYPE: JQB Top stud diameter: 1/2 Anchor bolt diameter: 5/8 Anchor hole diamter: 11/16			
BASE CURB THICKNESS: 0.0713 in 14 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 1/4"φ x 4.5" Simpson SDS screws w/ 2.75" threaded embed	STEEL 1/2" φ A307 Bolts to steel angle below deck	CONCRETE 3/4" φ thrd'd rods in Hilti Hit-HY 200 epoxy w/ 4" embed
LONG DIRECTION	17 @ 4.52 in o.c.	2 @ 68.38 in o.c.	19 @ 3.8 in o.c.
SHORT DIRECTION	12 @ 3.86 in o.c.	2 @ 38.5 in o.c.	14 @ 2.96 in o.c.