MOUR GROUP
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6593 Riverdale St.
San Diego, CA 92120

619-727-4800

Structural Calculations

for

Sunline Magna Series

ISCALSLM1830** Roof Curb

Form No. ISCAL-129

Prepared for:

PROVENT

3847 Wabash Drive
Mira Loma, CA 91725

Date: November 14, 2019

Project Number: PV1907

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.

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).
- Optional bottom bumper CalDyn #KT-382B, with a ½" washer and nut installed on seismic reistraints.

NOTES

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

CORNER	ZF 210-300	XP 180-240 ZJ, ZR 180-300	WITH PE ZF 210-300	WITH PE XP 180-240 ZJ, ZR 180-300
A	348-171	241-241	348	348
B	590	453-171	453-171	453-171
C	453	453-171	348-171	453-171
D	453-171	241-241	348-171	348-171
E	348	241	348-171	348-171
F	348	453-171	348	453-171
G	453-171	453-171	453-171	453-171
H	348	241	453-171	348

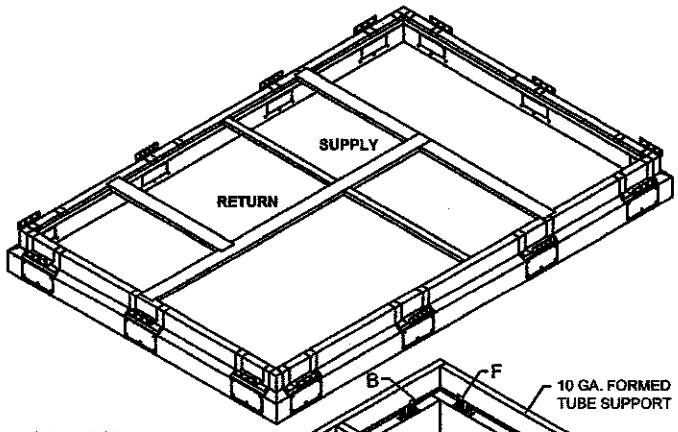
STRUCTURALLY CALCULATED VIBRATION ISOLATION CURBS FOR YORK UNITS

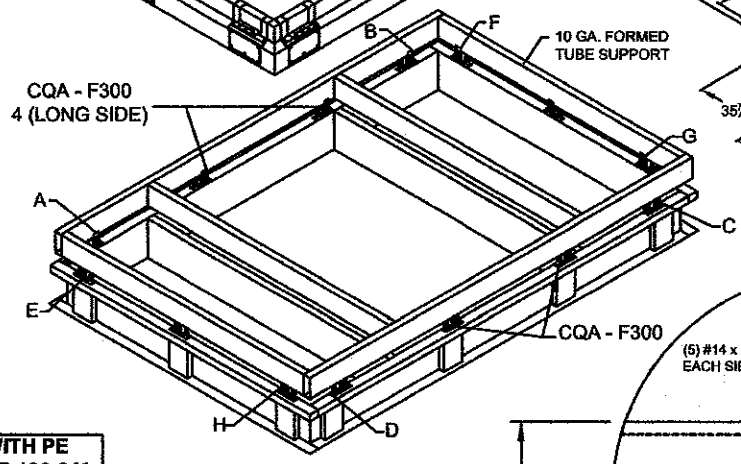
ZJ/ZR 180-300: ZF 210-300: XP 180-240

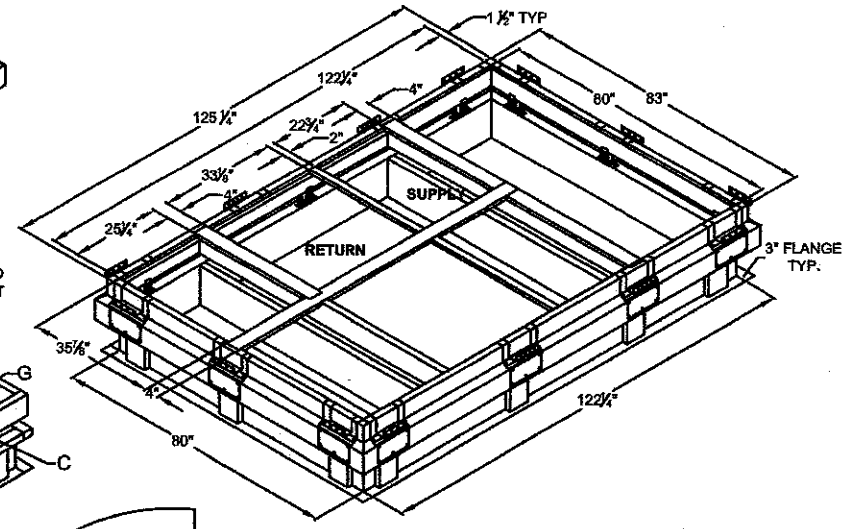
ProVent P/N (2" Deflection)	A	B	WEIGHT	ProVent P/N (3" Deflection)	A	B	WEIGHT
ISCALSLM183019**	8"	19"	825 Lbs	ISCALSLM1830193**	8"	19"	825 Lbs
ISCALSLM183022**	11"	22"	855 Lbs	ISCALSLM1830223**	11"	22"	855 Lbs
ISCALSLM183025**	14"	25"	885 Lbs	ISCALSLM1830253**	14"	25"	885 Lbs

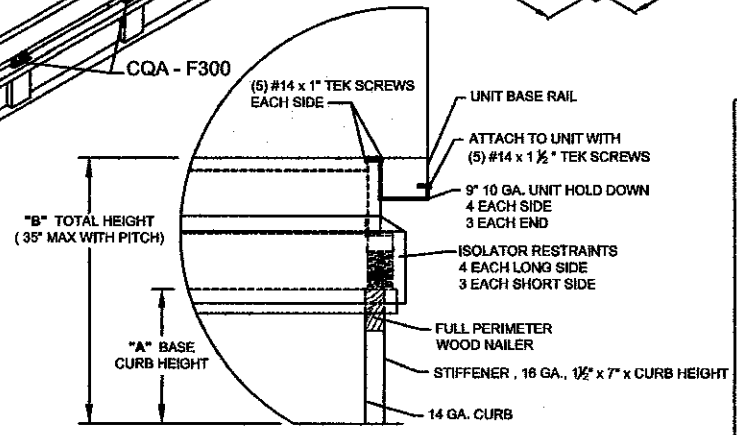
**Note: Spring configuration must be added to part number at time of order.

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









PROFILE DETAIL

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

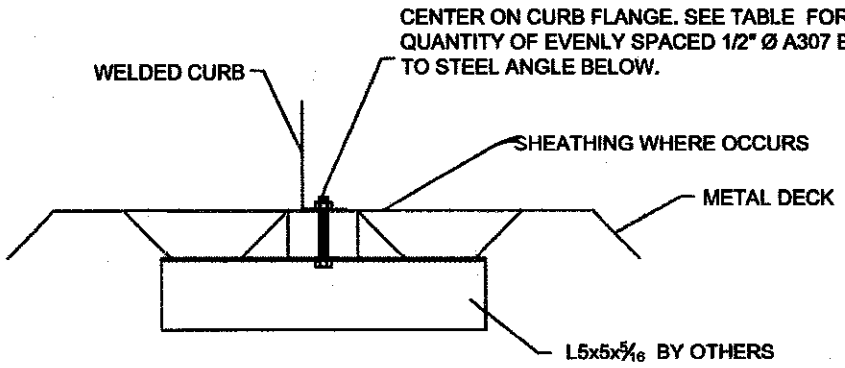
11-15-19

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-129	ISCALSLM1830 SERIES
DATE: 11/13/19	**REV:** 7
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.
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.

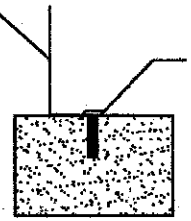
Meets seismic requirements for the following codes:
CBC 2019
IBC 2018

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

ROOF ANCHORAGE DETAIL

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

CONCRETE ATTACHMENT

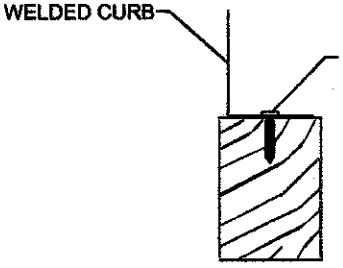


CENTER ON CURB FLANGE. SEE TABLE FOR QUANTITY OF EVENLY SPACED 3/4" Ø THRD'D RODS IN HILTI HIT-HY 200 EPOXY W/ 4" EMBED INTO CONCRETE.

	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	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.**

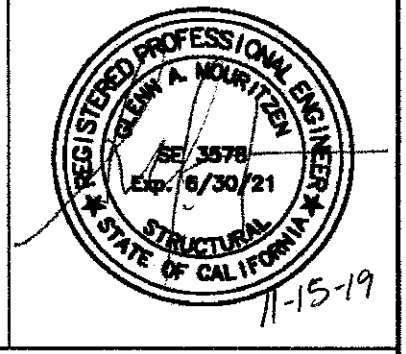
WOOD ATTACHMENT



CENTER ON CURB FLANGE. SEE TABLE FOR QUANTITY OF EVENLY SPACED ¼" Ø SIMPSON SDS SCREWS W/3" MIN. EMBED INTO WOOD (SG MIN = 0.43)

	NO. OF ANCHORAGE SCREWS REQUIRED	
CURB	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



ProVent
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SUBMITTED TO: _____
COMPANY: _____
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NOTES: _____

FORM NO: CB-24A

DATE:	REV:	DRAWN BY:
11/15/19	15	ALL

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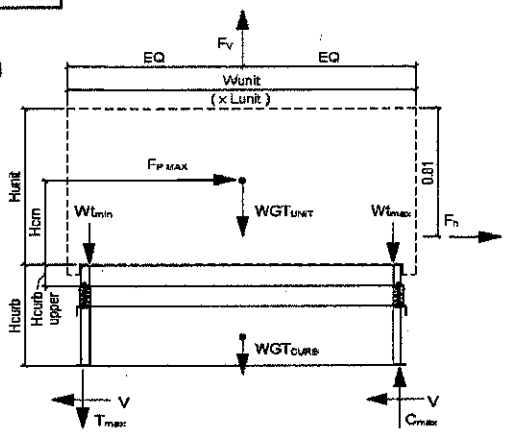
Client:	ProVent	PV1907	Upper curb tube
Curb:	ISCAL-129	Iso Curb	(ISCALSLM1830**)
Unit:	ZJ/ZR 180-300; ZF 210-300; XP 180-240		

Curb Information

Hcurb upper =	6	in	(Height of upper curb tube)
Lcurb =	125.75	in	(Length of curb)
wcurb =	83.5	in	(Width of curb)
WGTcurb top=	244	lbs	(Weight of upper curb)
# Clips long side =	4	# Clips short side =	3

Unit Information

WGTunit =	3930	lbs	(Weight of Unit)
Wtmax =	2116	lbs	(Maximum corner weight)
Wtmin =	1110	lbs	(Minimum corner weight)
Hunit =	52.625	in	(Height of unit above curb)
Hcm =	26.3125	in	(Height to center of mass)
Lunit =	180.5	in	(Length of unit)
Wunit =	92	in	(Width of unit)



Seismic Loading - 2018 IBC/2019 CBC

Ss =	2.000		(Worst case for majority of CA - Design Category D)
Fa =	1.000		(Interpolated 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 =	8803	lbs	(0.7*Fpmax)
	(unit only)		

FpmaxASD = 9350 lbs (unit and upper curb)

Wind Loading - 2018 IBC/2019 CBC

*** Exposure Category C ***

Kz =	1.13		(For 60 ft roof height, Exposure C)
Kzt =	1.0		(No topographic effects assumed for rooftop mounted units)
Kd =	0.85		(Directionality factor)
V =	115		(Max wind velocity, mph for Cat III & IV bldgs Exp. Cat C)
$GCr_{(horiz)}$ =	1.9		
$GCr_{(vert)}$ =	1.5		
qz	32.5	psf	$= 0.00256*Kz*Kzt*Kd*V^2$
$F_{h\ ASD\ trans}$ =	2724	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb upper)
$F_{h\ ASD\ long}$ =	1389	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb upper)
$F_{vert\ ASD}$ =	3375	lbs	= 0.6*qz*GCr*Lunit*Wunit

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	7796	lbs	$=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb$
$Tension_{SEISMIC}$ =	6172	lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	1710	lbs	$=[F_{h\ transASD}*Hcm+2*0.6*Wtmax*wcurb-F_{vertASD}*wcurb/2]/wcurb$
$Tension_{WIND}$ =	2727	lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Longitudinal:

$Compression_{SEISMIC}$ =	6864	lbs	$=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb$
$Tension_{SEISMIC}$ =	5240	lbs	$= Comp_{SEISMIC}-(0.6-0.14S_{DS})*WGTunit$
$Compression_{WIND}$ =	1142	lbs	$=[F_{h\ transASD}*Hcm+2*0.6*Wtmax*Lcurb-F_{vertASD}*Lcurb/2]/Lcurb$
$Tension_{WIND}$ =	2159	lbs	$= Comp_{WIND}+Fvert-0.6*WGTunit$

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	7796	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	6172	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	6864	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	5240	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 =	218.908
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 =	[4]		# clips =	[3]	
compression =	70.006 lb/in		compression =	105.428 lb/in	
clip spacing =	39.25 in		clip spacing =	35.75 in	
Mmax =	13.5 k-in		Mmax =	16.84 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 = 4.402 k (Max Axial Comp) Ω_c = 1.80
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)

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

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

Compression Check = O.K.

Check Web Crippling

h = 6 in -- Check limits: C = 7.50
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
Ωw = 1.75 N/h = 1.167 ≤ 2.0 C_h = 0.048
Pn = 5.907 k R/t = 1.51 ≤ 12.0 (See table C3.4.1-2, fastened to support, two flange, end loading)
Pn/Ωw = 3.375 k
Long side: Pa_{Trans} = 1.949 k O.K. # clips = 4
Short side: Pa_{Long} = 2.288 k O.K. # clips = 3

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

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/Ωc = 10.259 k Not Req'd

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

Tcrnmax = 2201 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 3086 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 =	0.9				
# of Bolts required for Shear =	2.8		***If combined fails:		
# of Bolts Used =	[3.0]		USE --> 4.0		

Check Combined Stress in Bolts & Inserts: 1.234 N.G. StressComb = 0.926 O.K.

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

Assume L/t > 25: 25*t = 3.105 in
Lreq'd = 1.198 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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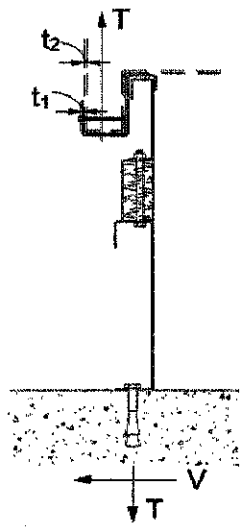
Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

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:

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ Pns = 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:	8.803	4	2.20	540 #	5	1.50 in
Short side:	8.803	3	2.93	540 #	6	1.20 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 = 0.555 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)

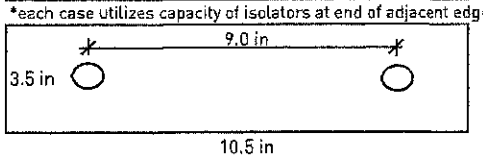
Curb Loads (copied from above)

Transverse: (on long edge)	$Comp_{MAX}$ =	7796	lbs
	$Tens_{MAX}$ =	6172	lbs
	$Shear_{MAX}$ =	4402	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	6864	lbs
	$Tens_{MAX}$ =	5240	lbs
	$Shear_{MAX}$ =	4402	lbs

Loads at each Isolator Type: JQB (OPM-0401-13)

Transverse loading: (on long edge)*	$Comp_{MAX}$ =	1299.3	lbs
	$Tens_{MAX}$ =	1028.6	lbs
# isolators: 6	$Shear_{MAX}$ =	400.1	lbs
Longitudinal loading: (on short edge)*	$Comp_{MAX}$ =	1372.8	lbs
	$Tens_{MAX}$ =	1047.9	lbs
# isolators: 5	$Shear_{MAX}$ =	400.1	lbs

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



Max compression force on isolator: 1.373 k ≤ 1.600 k **O.K.**
Max uplift on isolator: 1.048 k ≤ 1.600 k **O.K.**
Max shear on isolator: 0.400 k ≤ 1.000 k **O.K.**

Forces on top bolt:
d_b = 0.5 in
upper rail, t = 0.1242 in
Tension = 1.048 k
Shear = 0.400 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 in²
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 = 2.04 ksi O.K.
Combined Not Applicable F'nt = 45.00 ksi Fnv/Ω = 11.25 ksi

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Client:	ProVent	PV1907	Base curb
Project:	ISCAL-129	Iso Curb	(ISCALSLM1830**)
Unit:	ZJ/ZR 180-300; ZF 210-300; XP 180-240		

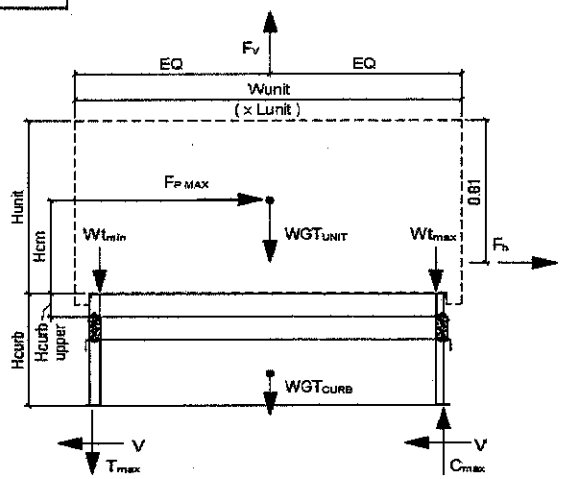
Curb Information

Hcurb =	24	in	(Height of curb)
Lcurb =	125.75	in	(Length of curb)
wcurb =	83.5	in	(Width of curb)
WGTcurb =	641	lbs	(Weight of curb)

springs long side = 4 # springs short side = 3

Unit Information

WGTunit =	3930	lbs	(Weight of Unit)
Wtmax =	2116	lbs	(Maximum corner weight)
Wtmin =	1110	lbs	(Minimum corner weight)
Hunit =	52.625	in	(Height of unit above curb)
Hcm =	37.3125	in	(Ht to ctr mass + 11")
Lunit =	180.5	in	(Length of unit)
Wunit =	92	in	(Width of unit)



Seismic Loading - 2018 IBC/2019 CBC

Ss =	2.000		(Worst case for majority of CA - Design Category D)
Fa =	1.000		(Interpolated 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 =	9350	lbs	(0.7*Fpmax) FpmaxASD = 10239 lbs (unit and curb)

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

Wind Loading - 2018 IBC/2019 CBC

*** Exposure Category C ***

Kz =	1.13		(For 60 ft roof height, Exposure C)
Kzt =	1.0		(No topographic effects assumed for rooftop mounted units)
Kd =	0.85		(Directionality factor)
V =	115		(Max wind velocity, mph for Cat III & IV bldgs Exp. Cat C)
$GCr_{(horiz)}$ =	1.9		
$GCr_{(vert)}$ =	1.5		
qz	32.5	psf	= 0.00256*Kz*Kzt*Kd*V^2
$F_{h\ ASD\ trans}$ =	3561	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb)
$F_{h\ ASD\ long}$ =	1815	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	3375	lbs	= 0.6*qz*GCr*Lunit*Wunit

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	9200	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	7576	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	2443	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	3460	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	7796	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS}]*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	6172	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	1390	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	2407	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	9200	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	7576	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	7796	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	6172	lbs	---> Along short edge of curb.

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

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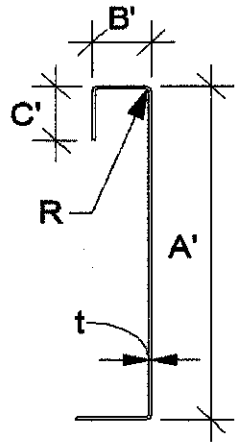
Curb Design

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+a(r+t/2)]
a =	0.000	(0 - no Lip; 1 w/ lip)	b'=	1.714 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 =	0.108 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 = 4.675 k (Max Axial Comp) Ω_c = 1.80
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)

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

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

Compression Check = O.K.

Check Web Crippling

h = 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
Ωw = 1.75 N/h = 0.291667 ≤ 2.0 C_h = 0.02
Pn = 2.130 k R/t = 1.50 ≤ 9.0
Pn/Ωw = 1.217 k
Long side: Pa_{Trans} = 2.300 k web stiffener REQ'D # clips = 4
Short side: Pa_{Long} = 2.599 k web stiffener REQ'D # clips = 3

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

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

***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 = 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 = 2337 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 3788 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 = 0.9
# of Bolts required for Shear = 3.5 ***If combined fails:
# of Bolts Used = 4.0 USE --> 5.0

Check Combined Stress in Bolts & Inserts: 1.100 N.G. StressComb = 0.880 O.K.

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

Assume L/t > 25: 25*t = 1.783 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 = 2.561 in

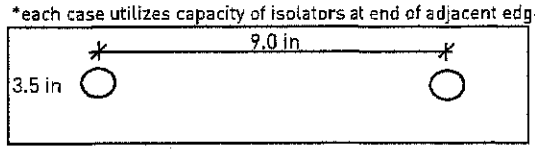
Curb Loads

Transverse: (on long edge)	$Comp_{MAX}$ =	9200	lbs
	$Tens_{MAX}$ =	7576	lbs
	$Shear_{MAX}$ =	9350	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	7796	lbs
	$Tens_{MAX}$ =	6172	lbs
	$Shear_{MAX}$ =	9350	lbs

Loads at each Isolator Type: **JQB**

Transverse loading: (on long edge)*	$Comp_{MAX}$ =	1533.3	lbs
	$Tens_{MAX}$ =	1262.6	lbs
# isolators: 6	$Shear_{MAX}$ =	425.0	lbs
Longitudinal loading: (on short edge)*	$Comp_{MAX}$ =	1559.2	lbs
	$Tens_{MAX}$ =	1234.4	lbs
# isolators: 5	$Shear_{MAX}$ =	425.0	lbs

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



10.5 in

Max compression force on isolator: 1.559 k ≤ 1.600 k O.K.

Max uplift on isolator: 1.263 k ≤ 1.600 k O.K.

Max shear on isolator: 0.425 k ≤ 1.000 k O.K.

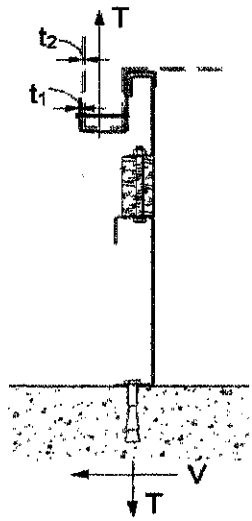
Forces on bottom bolts:

d_b = 0.625 in

base curb, t = 0.0713 in

Tension = 0.631 k / bolt

Shear = 0.212 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 = 0.69 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: $Uplift_{MAX}$ = 8341 lbs $Shear_{MAX}$ = 5120 lbs

$Compression_{SEISMIC}$ = 10230 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 8341 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 2298 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2]/wcurb

$Tension_{WIND}$ = 2931 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

Longitudinal: $Uplift_{MAX}$ = 5815 lbs $Shear_{MAX}$ = 5120 lbs

$Compression_{SEISMIC}$ = 7704 lbs =[FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 5815 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Compression_{WIND}$ = 569 lbs =[$F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb

$Tension_{WIND}$ = 1201 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 screws w/ 2.75" threaded emb (SGmin = 0.43)

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

Transverse: $Tall_{wood}$ = 760 lbs $Vall_{wood}$ = 672 lbs

# of Screws Req'd for Uplift = 10.98 COMBINED LOADING: 0.979 O.K.

# of Screws Req'd for Shear = 7.62 Req'd Min Spacing = 6.5 in o.c.

Total # of screws required = 19

Use 19 - 1/4"ϕ x 4.5" Simpson SDS screws @ 6.5 in o.c. along long side of curb w/ 2.75" threaded embed

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Longitudinal:

# of Screws Req'd for Uplift = 7.65 COMBINED LOADING: 0.954 O.K.

# of Screws Req'd for Shear = 7.62 Screw Spacing = 5.0 in o.c.

Total # of screws required = 16

Use 16 - 1/4"ϕ x 4.5" Simpson SDS screws @ 5 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

6903 lbs 3682 lbs

Transverse:

# of Bolts Req'd for Uplift = 1.21 COMBINED LOADING: 0.866 O.K.

# of Bolts Req'd for Shear = 1.39 Bolt Spacing = 56.9 in o.c.

Total # of bolts required = 3

Use 3 - 1/2" ϕ A307 Bolts to steel angle below deck @ 56.9 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 0.84 COMBINED LOADING: 0.744 O.K.

# of Bolts Req'd for Shear = 1.39 Bolt Spacing = 35.8 in o.c.

Total # of bolts required = 3

Use 3 - 1/2" ϕ A307 Bolts to steel angle below deck @ 35.8 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: $Uplift_{MAX}$ = 19619 lbs $Shear_{MAX}$ = 12799 lbs

$Compression_{SEISMIC}$ = 21508 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 19619 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*[WGTunit+curb]

$Shear_{SEISMIC}$ = 12799 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 19.12 spacing = 5.36 in o.c. Tapplied = 853.0 lbs

Min Bolts Req'd Shear = 7.51 spacing = 14.53571 in o.c. Vapplied = 556.5 lbs

Try using 23 bolts
spaced at 5.17 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.16

Use 23 - 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: $Uplift_{MAX}$ = 13304 lbs $Shear_{MAX}$ = 12799 lbs

$Compression_{SEISMIC}$ = 15193 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 13304 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 12799 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 12.96 spacing = 4.958333 in o.c. Tapplied = 782.6 lbs

Min Bolts Req'd Shear = 7.51 spacing = 8.5 in o.c. Vapplied = 752.9 lbs

Try using 17 bolts
spaced at 4.47 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.20

Use 17 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 4.5 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY:	ISCAL-129 (ISCALSLM1830**)		Unit: ZJ/ZR 180-300; ZF 210-300; XP 180-240
UPPER CURB TUBE THICKNESS:	0.1242 in	10 Gauge	
UNIT CLIP THICKNESS:	0.1017 in	12 Gauge	
# OF CLIPS (LONG SIDE) - 4 clips with 5 - #10 SMS screws each clip			
WEB STIFFENER: NOT REQUIRED			
# OF CLIPS (SHORT SIDE) - 3 clips with 6 - #10 SMS screws each clip			
WEB STIFFENER: NOT REQUIRED			
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	STEEL	CONCRETE
	1/4"φ x 4.5" Simpson SDS screws w/ 2.75" threaded embed	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	19 @ 6.54 in o.c.	3 @ 56.88 in o.c.	23 @ 5.17 in o.c.
SHORT DIRECTION	16 @ 5.03 in o.c.	3 @ 35.75 in o.c.	17 @ 4.47 in o.c.