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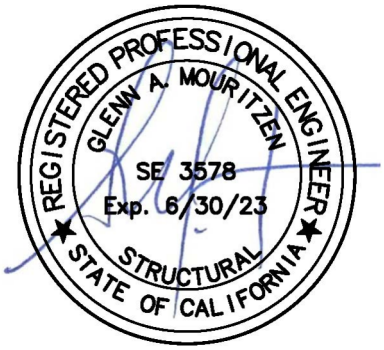
6593 Riverdale St.
San Diego, CA 92120
619-727-4800

Structural Calculations

for

CBISC-15 Series

CBISCSEL2835** SERIES



Prepared for:

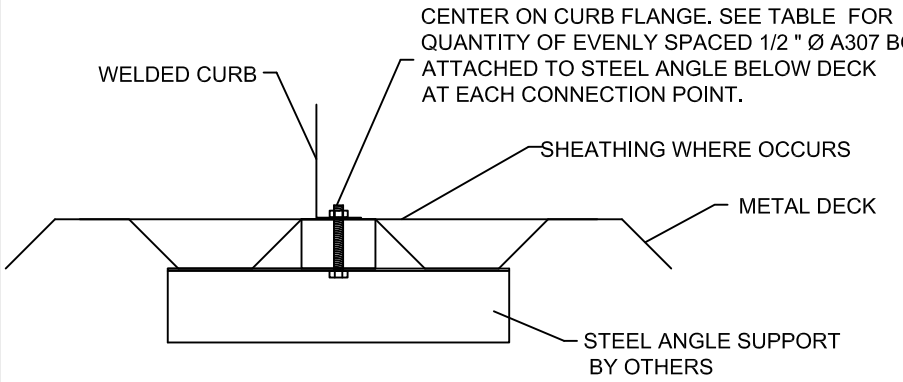
PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

Date: March 2, 2023

Project Number: PV2304

STEEL ATTACHMENT



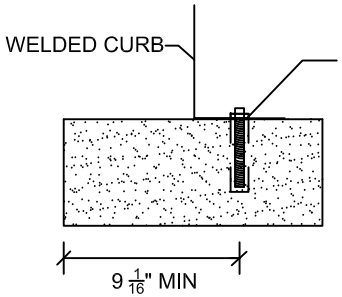
	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
SEL2835	7 @ 27.57" O.C.	4 @ 24.23" O.C.

ASSUMES:
CONC SLAB
f'c= 4000PSI MINIMUM
6" MIN THICKNESS
NORMAL WEIGHT CONCRETE

Meets seismic requirements for the following codes:
CBC 2022
IBC 2021

ROOF ANCHORAGE DETAIL
CBISC Series
SEL2835

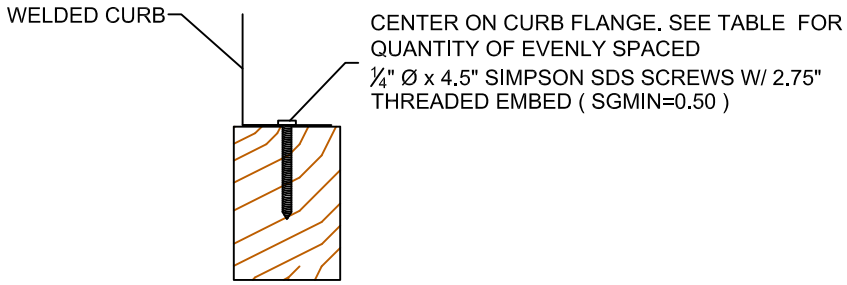
CONCRETE ATTACHMENT



	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
SEL2835	16 @ 11.03" O.C.	8 @ 10.38" O.C.

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

WOOD ATTACHMENT



	NO. OF ANCHORAGE SCREWS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
SEL2835	26 @ 6.78" O.C.	13 @ 6.39" O.C.

FOUR INCHES FROM EACH CORNER EVENLY SPACED

REGISTERED PROFESSIONAL ENGINEER
GLENN A. MOURITZEN
SE 3578
Exp. 6/30/23
STRUCTURAL
STATE OF CALIFORNIA

ProVent
3847 WABASH DRIVE
MIRA LOMA, CA 91752
PHONE (951) 685-1101
FAX (619) 872-9799

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

FORM NO:		
CB-63		
DATE:	**REV:**	**DRAWN BY:**
1/31/2023	2	JG

For wood, concrete and steel attachment see Roof Anchorage Detail, Form No. CB-63.

Welded Isolation springs housing are standard. For bolted spring housing, neoprene pads and spring cups see Weldment and Bolting Detail, Form No. CB-61

VIBRATION ISOLATION ROOF CURBS
YORK UNITS

SUN SELECT 28-35 TON

PROVENT P/N	A	B	EST. WEIGHT
CBISCSEL283518**	8"	18"	587 Lbs
CBISCSEL283521**	11"	21"	632 Lbs
CBISCSEL283524**	14"	24"	682 Lbs
CBISCSEL283528**	18"	28"	807 Lbs

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

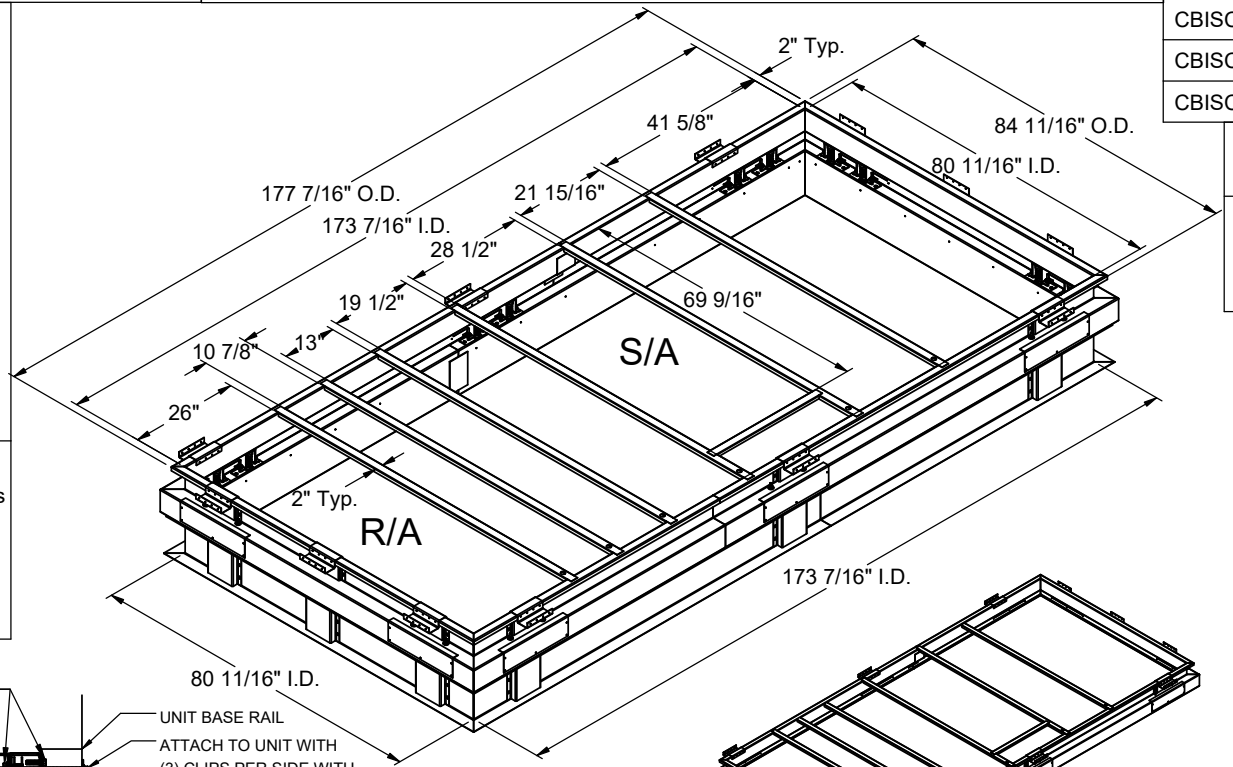
Meets seismic requirements for the following codes:
CBC 2022
IBC 2021

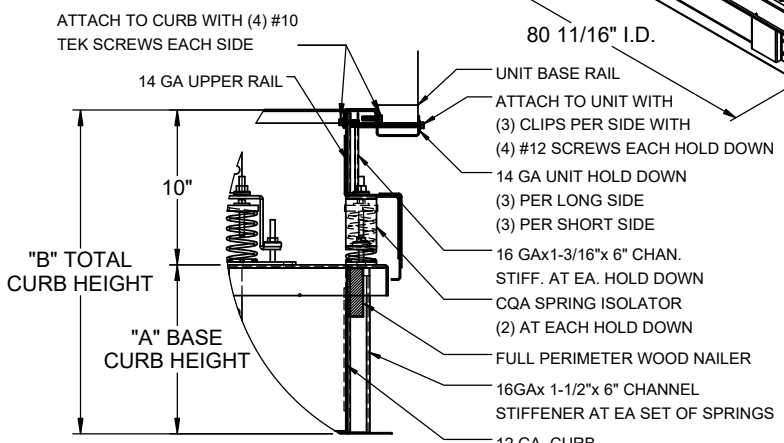
FEATURES

- Roof curb base 12 ga.
- Roof curb upper rail 14 ga.
- 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 seismic restraints. (OPM-0401-13), (CQA).

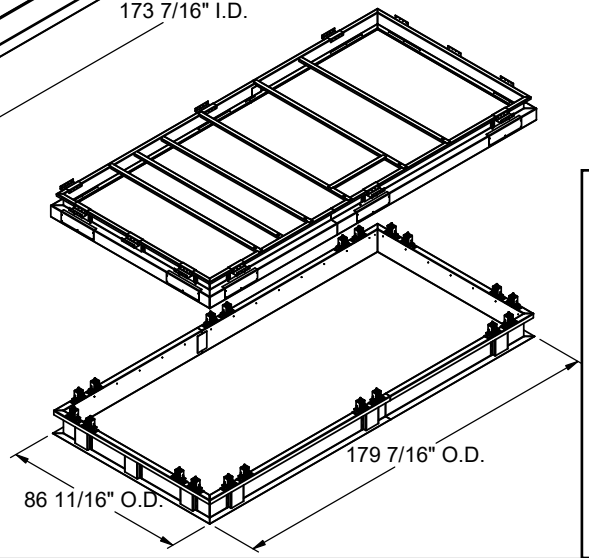
NOTES

- Attach ductwork to roof curb. Flanges of duct rest on top of the curb, Support ductwork below the curb.
- Thru the curb utillities are available. Contact you York distributor or Provent directly.





PROFILE DETAIL



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SUBMITED TO: _____
COMPANY: _____
JOB NAME: _____
EQUIPMENT: _____
NOTES: _____

FORM NO:	PART NUMBER:	
CBISC-15	CBISCSEL2835 SERIES	
DATE:	**REV:**	**DRAWN BY:**
1/31/2023	-	JG

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San Diego, CA 92120
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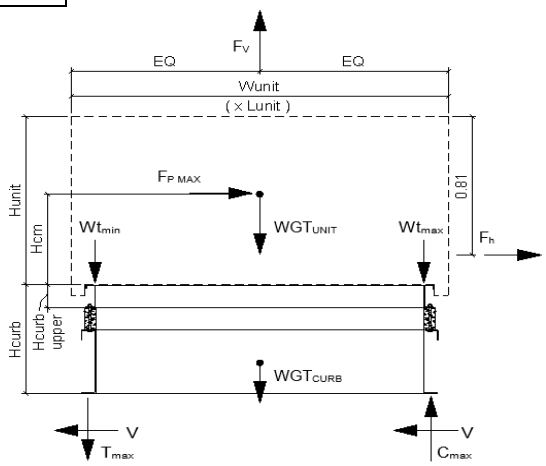
Client:	ProVent	PV	Upper curb rail
Project:	CBISC-15	Iso Curb	CBISCSEL2835
Unit:	Sun Select 28-35 Ton		

Upper Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	177.4375	in	(Length of upper curb)
wcurb =	84.6875	in	(Width of upper curb)
WGTupper =	140	lbs	(Weight of upper curb)
# Clips long side =	3		# Clips short side = 2

Unit Information

WGTunit =	4191	lbs	(Oper. Weight of Unit)
Wtmax =	1207	lbs	(Maximum corner weight)
Wtmin =	897	lbs	(Minimum corner weight)
Hunit =	70	in	(Height of unit above curb)
Hcm =	35	in	(Height to center of mass)
Lunit =	180	in	(Length of unit)
Wunit =	90	in	(Width of unit)



Seismic Loading - 2021 IBC/2022 CBC

Ss =	2.85		(Worst case for majority of California)		
Fa =	1.20		(Default Site Class D - Table 11.4-1 ASCE 7-16)		
Ip =	1.50		(Importance Factor Category III Building)		
Sms =	3.420		(Fa*Ss)	ap =	2.5
Sds =	2.280		(2/3*Sms)	Rp =	2
Fpmax =	5.130	Wp	(0.4*ap*Sds*Ip)*Wp*3/Rp <=1.6*Sds*Ip*Wp		
FpmaxASD =	15050	lbs	(0.7*Fpmax)	FpmaxASD =	15553 lbs
	(unit only)				(unit + upper rail)

Wind Loading - 2021 IBC/2022 CBC

Kz =	1.13		(For 60 ft roof height, Exposure C - Table 26.10-1 ACSE 7-16)
Kzt =	1.00		(Max. assumed topographic factor)
Kd =	0.85		(Directionality factor Table 26.6-1 ASCE 7-16)
Ke =	1.00		(Ground Elevation Factor Table 26.9-1 ASCE 7-16)
V =	110		(Wind velocity, mph for Occupancy Cat III-IV bldgs Exp. Cat C, Fig 26.5-1D - ASCE7-16)
$GCr_{(horiz)}$ =	1.9		(Refer Sect 29.4.1 ASCE 7-16)
$GCr_{(vert)}$ =	1.5		(Refer Sect 29.4.1 ASCE 7-16)
qz	29.8	psf	= 0.00256*Kz*Kzt*Kd*Ke*V^2 (Eq. 26.10-1 ASCE 7-16)
$F_{h\ ASD\ trans}$ =	3201	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	1600	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	3632	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Upper Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	9404	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	5716	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*wcurb)]/wcurb
$Compression_{WIND}$ =	955	lbs	=[$F_{h\ ASD\ trans}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	2062	lbs	=[$F_{h\ ASD\ trans}$*Hcm-2*0.6*Wtmin*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	6153	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	2465	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*Lcurb)]/Lcurb
$Compression_{WIND}$ =	-52	lbs	=[$F_{h\ ASD\ long}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	1055	lbs	=[$F_{h\ ASD\ long}$*Hcm-2*0.6*Wtmin*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	9404	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	5716	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	6153	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	2465	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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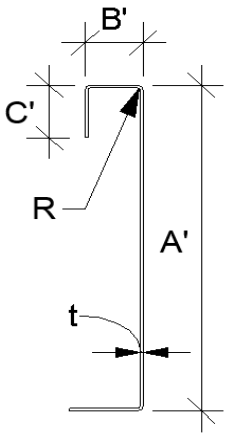
Curb Design

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

Calculate Section Properties of Curb

A'=	5.500 in		a =	5.144 in	= A'-(2r+t)
B'=	2.000 in		a'=	5.429 in	= A'-t
C'=	0.500 in (0 if no lips)		b =	1.733 in	= B'-[r+t/2+α(r+t/2)]
α =	0.500 (0 - no Lip; 1 w/ lip)		b'=	1.947 in	= B'-(t/2+αt/2)
R =	0.1069 (Inside bend radius)		c =	0.161 in	= α[C'-(r+t/2)]
t =	0.0713 in		c'=	0.232 in	= α(C'-t/2)
r'=	0.143 in = R+t/2		u =	0.224 in	= πr/2
x =	0.454 in (Distance between centroid and web centerline)				
Ix =	3.041 in^4		rx =	2.13 in	
Iy =	0.283 in^4		ry =	0.649 in	
A =	0.67 in^2		rmin =	0.649 in	



Axial Compression

Pa =	7.525 k	(Max Axial Comp)
Pn/Ωc =	9.178 k	
Fe =	29.41 ksi	
λc =	1.30	
Fn =	24.54 ksi	
Ly =	80.69 in	Lateral unbraced length
k_yL_y/r_y =	100	(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 =	5.5 in	-- Check limits:		C =	7.50
t =	0.0713 in	h/t =	77.14 ≤ 200	C_R =	0.08
N =	7.00	N/t =	98.18 ≤ 210	C_N =	0.12
Ω_w =	1.75	N/h =	1.273 ≤ 2.0	C_h =	0.048
P_n =	1.947 k	R/t =	1.50 ≤ 12.0		
P_n/Ω_w =	1.112 k				
Long side: Pu_{Trans} =	3.135 k	**web stiffener REQ'D**	# clips = 3		
Short side: Pu_{Long} =	3.077 k	**web stiffener REQ'D**	# clips = 2		

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

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

Check Web Stiffener 16Ga x 1-3/16in x 6in (C-channel)

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

width of stiffener =	6.000 in	ts =	0.0566	16 Gauge	Pwc =	1.947 k	
web of stiff. w =	5.717 in	Rs =	0.0849 in		Pn =	12.688 k	
***Check w/ts ≤ 1.28√E/Fys		Ω_c =	1.70		Ae =	0.324 in^2	
w/ts =	101.007						
1.28√(E/Fys) =	31.091	--> w/ts over limit	Use C3.7.2		Pn/Ω_c =	7.464 k	**O.K.**

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

Tcrnmax = 3888 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)

Vcrnmax = 4702 lbs Max(Tens/2 -OR- Comp/2 corner connections per side)

Bolt:	Tall =	2480	lbs	Vall =	1208	lbs
Threaded Insert:	Tall =	2860	lbs	Vall =	1536	lbs

# of Bolts required for Tension = 1.6

# of Bolts required for Shear = 3.9

# of Bolts Used = 5.0

Check Combined Stress in Bolts & Inserts: 1.092 **N.G. -->** USE WELDED CORNER CONNECTION

Check welded connection <--- USE WELD Ω = 2.35

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

Lreq'd = 3.179 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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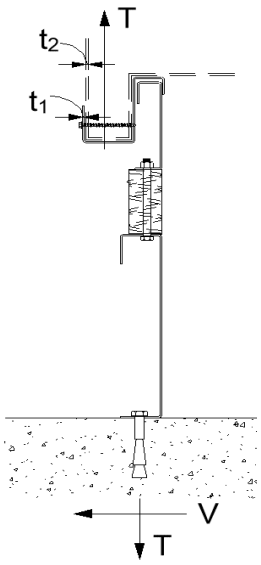
Connection Unit to Curb Clip | #12 SMS screw | Ω = 3.0

t1 = 0.1017 in (clip thickness) | t2/t1 = 0.7 | Fu1 = 65 ksi

t2 = 0.0713 in (unit base rail thickness) | Fu2 = 65 ksi

d = 0.216 in (screw diameter) | dw = 0.375 in (nom. washer diameter)



For t2/t1 ≤ 1.0: | Pns = 2416 #

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ 2.42 k

Tension: $P_{ns} = 2.7t_1 dF_{u1}$ 3.86 k

$P_{ns} = 2.7t_2 dF_{u2}$ 2.70 k

Pns/Ω = 805 # <- Controls

Pss/Ω = 840 #

Pnot = 0.851 k (screw pull-out strength)

Pnov = 3.718 k (screw pull-over strength)

Pts/Ω = 284 # <- Controls

Pts/Ω = 845 # (full tensile screw capacity)

For t2/t1 ≥ 2.5: | Pns = 2703 #

$P_{ns} = 2.7t_1 dF_{u1}$ 3.86 k

$P_{ns} = 2.7t_2 dF_{u2}$ 2.70 k

$P_{not} = 0.85t_c dF_{u2})$

$t_c = \min(t_1, t_2)$

$P_{nov} = 1.5t_1 d_w F_{u1}$

	Shear (k)	# clips	V_{clip} (k)	V_{allow}(lb)	# screws	spacing
Long side:	7.525	3	2.51	805 #	4	2.00 in
Short side:	7.525	2	3.76	805 #	5	1.50 in

clip width (in) = 7.00 | clip height = 2.5 in

min spacing = 0.65 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 = 0.661 in² | Anv = 0.562 in² | Ant = 0.116 in²

Rn/Ω = 12.334 k | $R_n = 0.6F_y A_{gv} + F_u A_{nt} \leq 0.6F_u A_{nv} + F_u A_{nt}$

BSR O.K. (AISI Sect. E5.3)

Curb Loads (copied from above)

Transverse: (on long edge)	$Comp_{MAX}$ =	10294	lbs
	$Tens_{MAX}$ =	6830	lbs
	$Shear_{MAX}$ =	15553	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	6407	lbs
	$Tens_{MAX}$ =	2942	lbs
	$Shear_{MAX}$ =	15553	lbs

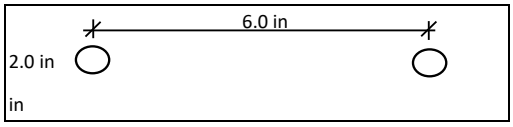
Loads at each Isolator Type: **CQA**

Transverse loading: (on long edge) # isolators: 6	$Comp_{MAX}$ =	1715.7	lbs
	$Tens_{MAX}$ =	1138.3	lbs
	$Shear_{MAX}$ =	777.6	lbs
Longitudinal loading: (on short edge) # isolators: 4	$Comp_{MAX}$ =	1601.7	lbs
	$Tens_{MAX}$ =	735.5	lbs
	$Shear_{MAX}$ =	777.6	lbs

Max compression force on isolator: 1.716 k ≤ 3.176 k **O.K.**

Max uplift on isolator: 1.138 k ≤ 3.176 k **O.K.**

Max shear on isolator: 0.778 k ≤ 1.163 k **O.K.**



Forces on top bolt:

Tension = 1.138 k | d_b = 0.375 in

Shear = 0.778 k | upper rail, t = 0.0713 in | 7.0 in

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

Shear O.K. Pn/Ω = 4.635 k | e = 1.0 in

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

Pn/Ω = 4.989 k | An = 0.116 in

N.S.R. O.K. $F_t = (0.1 + 3d/s)F_u \leq F_u =$ 43.063 ksi

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

Pn/Ω = 2.086 k | d/t = 5.26

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.**

Combined Shear and tension in bolt:

$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \leq F_{nt}$ | ft = 10.31 ksi | fv = 7.04 ksi O.K.

$P'_{nt} = A_b F'_{nt}$ | F'nt = 24.13 ksi | Fnv/Ω = 10.00 ksi

P'nt/Ω = 1.185 k **Combined O.K.**

Longitudinal weld loading: L = | $1.5P_n/\Omega = \frac{1}{\Omega}\left(1 - \frac{0.01L}{t_2}\right)Lt_2F_{u2} \geq V_{req}$ | Ω = 2.55

If L/t < 25: L/t = 14.75 | t = 0.1017 | Pn/Ω = 3.315 k

Transverse weld loading: t = 0.1017 | $P_n/\Omega = \frac{1}{\Omega}tLF_u \geq T_{req}$ | Ω = 2.35

L = 1 | Fu = 65 ksi | Pn/Ω = 2.813 k

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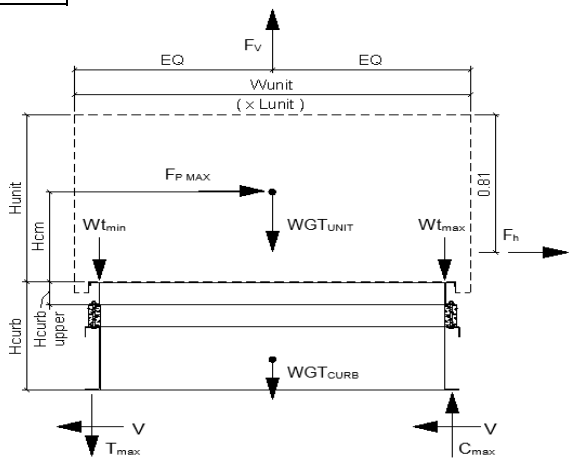
Client:	ProVent	PV	Base curb
Project:	CBISC-15	Iso Curb	CBISCSEL2835
Unit:	Sun Select 28-35 Ton		

Base Curb Information

Hbase curb =	18	in	(Height of base curb)
Lcurb =	177.4375	in	(Length of base curb)
wcurb =	84.6875	in	(Width of base curb)
WGTbase =	667	lbs	(Weight of base curb)
# Springs long side =	6		# Springs short side = 4

Unit Information

WGTunit =	4191	lbs	(Oper. Weight of Unit + 5%)
Wt'max =	1242	lbs	(Wtmax+1/4*WGTupper)
Wt'min =	932	lbs	(Wtmin+1/4*WGTupper))
Hunit =	70	in	(Height of unit above curb)
H'cm =	45	in	(Hcm+10"(upper+spring))
Lunit =	180	in	(Length of unit)
Wunit =	90	in	(Width of unit)
WGTunit+upper+base =	4998	lbs	(Total weight)



Seismic Loading - 2021 IBC/2022 CBC

Ss =	2.85		(Worst case for majority of California)		
Fa =	1.20		(Default Site Class D - Table 11.4-1 ASCE 7-16)		
Ip =	1.50		(Importance Factor Category III Building)		
Sms =	3.420		(Fa*Ss)	ap =	2.5
Sds =	2.280		(2/3*Sms)	Rp =	2
Fpmax =	5.130	Wp	(0.4*ap*Sds*Ip)*Wp*3/Rp <=1.6*Sds*Ip*Wp		
FpmaxASD =	15553	lbs	(0.7*Fpmax)	FpmaxASD =	17948 lbs
	(unit + upper rail)			(unit + upper rail + base curb)	

Wind Loading - 2021 IBC/2022 CBC

Kz =	1.13		(For 60 ft roof height, Exposure C - Table 26.10-1 ACSE 7-16)
Kzt =	1.00		(Max. assumed topographic factor)
Kd =	0.85		(Directionality factor Table 26.6-1 ASCE 7-16)
Ke =	1.00		(Ground Elevation Factor Table 26.9-1 ASCE 7-16)
V =	110		(Wind velocity, mph for Occupancy Cat III-IV bldgs Exp. Cat C, Fig 26.5-1D - ASCE7-16)
$GCr_{(horiz)}$ =	1.9		(Refer Sect 29.4.1 ASCE 7-16)
$GCr_{(vert)}$ =	1.5		(Refer Sect 29.4.1 ASCE 7-16)
qz	29.8	psf	= 0.00256*Kz*Kzt*Kd*Ke*V^2 (Eq. 26.10-1 ASCE 7-16)
$F_{h\ ASD\ trans}$ =	4155	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hbase curb+10") (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	2077	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hbase curb+10")
$F_{vert\ ASD}$ =	3632	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Base Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	11541	lbs	=[FpmaxASD*H'cm+2*(1+0.14S_{DS})*Wt'max*wcurb]/wcurb
$Tension_{SEISMIC}$ =	7741	lbs	=[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*wcurb)]/wcurb
$Compression_{WIND}$ =	1882	lbs	=[$F_{h\ ASD\ trans}$*H'cm+2*0.6*Wt'max*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	2905	lbs	=[$F_{h\ ASD\ trans}$*H'cm-2*0.6*Wt'min*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	7221	lbs	=[FpmaxASD*H'cm+2*(1+0.14*S_{DS})*Wt'max*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	3421	lbs	=[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*Lcurb)]/Lcurb
$Compression_{WIND}$ =	201	lbs	=[$F_{h\ ASD\ long}$*H'cm+2*0.6*Wt'max*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	1224	lbs	=[$F_{h\ ASD\ long}$*H'cm-2*0.6*Wt'min*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	11541	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	7741	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	7221	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	3421	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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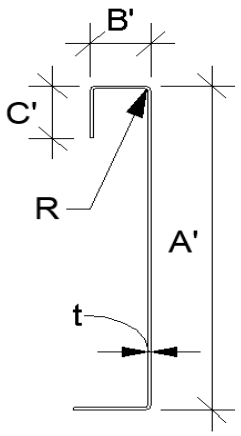
Curb Design

Fy =	50 ksi	Fu =	65 ksi		
E =	29500 ksi	t =	0.1017	12 Gauge	



Calculate Section Properties of Curb

A'=	18.000 in	a =	17.492 in	= A'-(2r+t)	
B'=	1.750 in	a'=	17.898 in	= A'-t	
C'=	1.000 in (0 if no lips)	b =	1.242 in	= B'-[r+t/2+α(r+t/2)]	
α =	1.000 (0 - no Lip; 1 w/ lip)	b'=	1.648 in	= B'-(t/2+αt/2)	
R =	0.1525 (Inside bend radius)	c =	0.746 in	= α[C'-(r+t/2)]	
t =	0.1017 in	c'=	0.949 in	= α(C'-t/2)	
r'=	0.203 in = R+t/2	u =	0.319 in	= πr/2	
x =	0.244 in (Distance between centroid and web centerline)				
Ix =	86.495 in	rx =	6.12 in		
Iy =	0.640 in	ry =	0.526 in		
A =	2.31 in^2	rmin =	0.526 in		

Axial Compression

Pu =	7.776 k	(Max Axial Comp)	Ω_c = 1.80
Pn/Ωc =	6.432 k		
Fe =	5.71 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 =	2.96		$If\ \lambda_c > 1.5;\ F_n = \frac{0.877}{\lambda_c^2} F_y$
Fn =	5.01 ksi	$\lambda_c = \sqrt{\frac{F_y}{F_e}}$	$F_e = \frac{\pi^2 E}{\left(kl/r\right)^2}$
Ly =	148.50 in	Lateral unbraced length	
k_yL_y/r_y =	226	(assume k=0.8)	

Compression Check = N.G.

Check Web Crippling

h =	18 in	-- Check limits:		C = 4.00	(See table C3.4.1-2, fastened to support, one flange, end loading)
t =	0.1017 in	h/t =	176.99 ≤ 200	C_R = 0.14	
N =	7.00	N/t =	68.83 ≤ 210	C_N = 0.35	
Ω_w =	1.75	N/h =	0.388889 ≤ 2.0	C_h = 0.02	
P_n =	4.390 k	R/t =	1.50 ≤ 9.0		
P_n/Ω_w =	2.509 k				
Long side: Pu_{Trans} =	3.847 k	**web stiffener REQ'D**	# clips = 3		
Short side: Pu_{Long} =	3.611 k	**web stiffener REQ'D**	# 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

16Ga x 1.5in x 6in (C-channel)

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

width of stiffener =	6.000 in	ts =	0.0566	16 Gauge	Pwc =	4.390 k	
web of stiff. w =	5.717 in	Rs =	0.0849 in		Pn =	14.398 k	
***Check w/ts ≤ 1.28√E/Fys		Ω_c =	1.70		Ae =	0.324 in^2	
w/ts =	101.007						
1.28√(E/Fys) =	31.091	--> w/ts over limit	Use C3.7.2		Pn/Ω_c =	8.470 k	**O.K.**

Corner Connections

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

Tcrnmax = 4487 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)

Vcrnmax = 5771 lbs Max(Tens/2 -OR- Comp/2 corner connections per side)

Bolt:	Tall =	2480 lbs	Vall =	1208 lbs	
Threaded Insert:	Tall =	2860 lbs	Vall =	1536 lbs	

# of Bolts required for Tension = 1.8

# of Bolts required for Shear = 4.8

# of Bolts Used = 7.0

Check Combined Stress in Bolts & Inserts: 0.941 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35

Assume L/t > 25: 25*t = 2.543 in

Lreq'd = 2.735 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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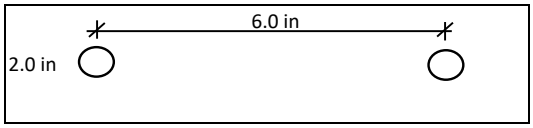
Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	10294	lbs
	$Tens_{MAX}$ =	6830	lbs
	$Shear_{MAX}$ =	15553	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	6407	lbs
	$Tens_{MAX}$ =	2942	lbs
	$Shear_{MAX}$ =	15553	lbs

Loads at each Isolator Type: **CQA**

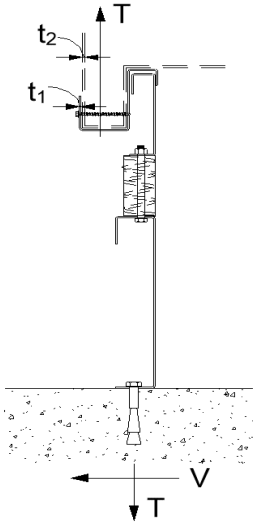
Transverse loading: (on long edge)	$Comp_{MAX}$ =	1715.7	lbs
	$Tens_{MAX}$ =	1138.3	lbs
# isolators: 6	$Shear_{MAX}$ =	777.6	lbs
Longitudinal loading: (on short edge)	$Comp_{MAX}$ =	1601.7	lbs
	$Tens_{MAX}$ =	735.5	lbs
# isolators: 4	$Shear_{MAX}$ =	777.6	lbs

Max compression force on isolator: 1.716 k ≤ 3.176 k **O.K.**
Max uplift on isolator: 1.138 k ≤ 3.176 k **O.K.**
Max shear on isolator: 0.778 k ≤ 1.163 k **O.K.**



Forces on bottom bolts:

d_b = 0.5 in
base curb, t = 0.1017 in
Tension = 0.569 k / bolt
Shear = 0.389 k / bolt



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

Net section rupture: $P_n = A_nF_t$ Ω = 2.22 (Appendix A, Section E3.2 AISI)
Pn/Ω = 8.428 k An = 0.153 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 = 3.966 k d/t = 4.92
Bearing O.K. C = 3.00 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 = 0.1963 in^2
Pnt/Ω = 3.927 k **Bolt tension O.K.** Ωt = 2.25

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

Combined Shear and tension in bolt:

$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \leq F_{nt}$ ft = 5.80 ksi fv = 1.98 ksi O.K.
F'nt = 45.00 ksi Fnv/Ω = 11.25 ksi
$P'_{nt} = A_bF'_{nt}$ P'nt/Ω = 3.927 k **Combined Not Applicable -> F'nt = Fnt**

Connection of Curb to Supporting Structure

Roof Loading SEISMIC: (0.6-0.14S_{DS})D + 0.7E WIND: 0.6D + W

Transverse:	$Uplift_{MAX}$ =	12650 lbs	$Shear_{MAX}$ =	8974 lbs
$Compression_{SEISMIC}$ =	16648 lbs	=[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb		
$Tension_{SEISMIC}$ =	12650 lbs	=[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb		
$Compression_{WIND}$ =	2774 lbs	=[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*wcurb/2-$F_{vert\ ASD}$*wcurb/2]/wcurb		
$Tension_{WIND}$ =	3407 lbs	=[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)-0.6*$WGT_{unit+upper+base}$*wcurb/2+$F_{vertASD}$*wcurb/2]/wcurb		
Longitudinal:	$Uplift_{MAX}$ =	5671 lbs	$Shear_{MAX}$ =	8974 lbs
$Compression_{SEISMIC}$ =	9669 lbs	=[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb		
$Tension_{SEISMIC}$ =	5671 lbs	=[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb		
$Compression_{WIND}$ =	421 lbs	=[$F_{h\ ASD\ long}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*Lcurb/2-$F_{vert\ ASD}$*Lcurb/2]/Lcurb		
$Tension_{WIND}$ =	1054 lbs	=[$F_{h\ ASD\ long}$*(H'cm+Hbase curb)-0.6*$WGT_{unit+upper+base}$*Lcurb/2+$F_{vertASD}$*Lcurb/2]/Lcurb		

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

	$Tall_{metal}$ =	1397 lbs	$Vall_{metal}$ =	1230 lbs
Transverse:	$Tall_{wood}$ =	760 lbs	$Vall_{wood}$ =	672 lbs

# of Screws Req'd for Uplift = 16.64 COMBINED LOADING: 0.983 O.K.
# of Screws Req'd for Shear = 13.35 Req'd Min Spacing = 6.78 in o.c.
Total # of screws required = 26

Use 26 - 1/4"ϕ x 4.5" Simpson SDS screws @ 6.8 in o.c. along long side of curb w/ 2.75" threaded embed

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Longitudinal:

# of Screws Req'd for Uplift =	7.46	COMBINED LOADING:	0.916 O.K.
# of Screws Req'd for Shear =	13.35	Screw Spacing =	6.39 in o.c.
Total # of screws required =	13		

Use 13 - 1/4"ϕ x 4.5" Simpson SDS screws @ 6.4 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

	$Tall_{bolt}$ = 3927 lbs	$Vall_{bolt}$ =	2209 lbs
Transverse:	$Tall_{metal}$ = 2975 lbs	$Vall_{metal}$ =	3072 lbs
# of Bolts Req'd for Uplift =	4.25	COMBINED LOADING:	0.977 O.K.
# of Bolts Req'd for Shear =	4.06	Bolt Spacing =	27.57 in o.c.
Total # of bolts required =	7		

Use 7 - 1/2" ϕ A307 Bolts to steel angle below deck @ 27.6 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift =	1.91	COMBINED LOADING:	0.642 O.K.
# of Bolts Req'd for Shear =	4.06	Bolt Spacing =	24.23 in o.c.
Total # of bolts required =	4		

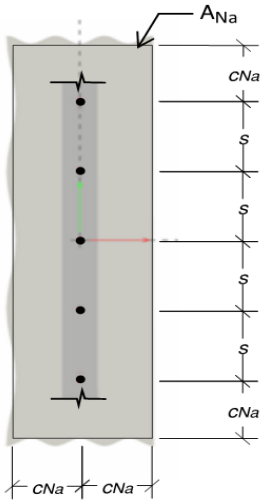
Use 4 - 1/2" ϕ A307 Bolts to steel angle below deck @ 24.2 in o.c. along short side of curb

For Concrete anchorage: SEISMIC $(0.6\text{-}0.14S_{DS})D + 0.7\Omega_o E$ Ωo = 2.0

Concrete Attachment: 5/8"ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy w/ 4.5in embed

Epoxy: Hilti HIT-HY 200 V3 (ICC ESR 4868)

f'c =	4000	psi	
h =	6	in (concrete thickness, t_min = h_ef + 2do)	O.K.
h_ef =	4.5	in (effective embedment)	
da =	0.625	in (anchor diameter)	do = 0.75 in (hole diameter)
n =	3	(number of dummy anchors to check capacity with spacing effect)	
s =	10.375	in (initial spacing estimate)	
τk,cr / uncr =	1170	2220 psi (from ESR 4868, Table 14, Temp range B)	
τk,cr / uncr =	1226	2327 psi	If $f'_c > 2500$, $multiply\ by\ (f'_c/2500)^{0.1}$
c_{Na} =	9.0625	in (min. edge distance for full capacity);	$c_{Na} = 10d_a\sqrt{\frac{\tau_{uncr}}{1100}}$



Tension:

$$N_{ag} = \frac{A_{Na}}{A_{Nao}}\varphi_{ec,Na}\varphi_{ed,Na}\varphi_{cp,Na}N_{ba} \quad \text{(ACI318-14, 17.4.5.1b)}$$

Bond strength

$$\varphi_{ec,Na}\varphi_{ed,Na}\varphi_{cp,Na} = 1.0$$

***Bond strength will govern over concrete breakout

A_{Na} =	704.61 in^2		
A_{Nao} =	328.52 in^2		
N_{ba} =	10727 lbs	$N_{ba} = \lambda_a\tau_{cr}\pi d_a h_{ef}\alpha_{n,seismic}$	$\alpha_{n,seismic} = 0.99$
N_{ag} =	23007 lbs (group)		λ_a = 1.0
øN_{ag} =	11216 lbs (group)	CONTROLS	λ_a = 1.0 for normal weight conc; 0.6 for lightw

Breakout strength

$$N_{cbg} = \frac{A_{Nc}}{A_{Nco}}\varphi_{ec,N}\varphi_{ed,N}\varphi_{cp,N}N_b \qquad N_b = \lambda_a k_c\sqrt{f'_c}h_{ef}^{1.5}$$

A_{Nc} =	462.375 in^2	N_b = 10264	lbs	ø$_{conc}$ =	0.75
A_{Nco} =	182.25 in^2	kc = 17		ø$_{bond}$ =	0.65
N_{cbg} =	26039 lbs (group)			ø$_{seis}$ =	0.75
øN_{cbg} =	14647 lbs (group)			ø$_{steel}$ =	0.65

Shear: Vsa,eq = 7865 (from ESR4868, Table 11) $\alpha_{v,seismic}$ = 0.6

Steel strength øVsa,eq = 3067

$Tall_{LRFD}$ = 3739 lbs (anchor) $Vall_{LRFD}$ = 3067 lbs $\propto = (1 + 0.2SDS)D + 2.5E = 1.708$

$Tall_{ASD} = Tall_{LRFD}/\alpha$ = 2189 lbs $Vall_{ASD} = Vall_{LRFD}/\alpha$ = 1796 lbs $(D = 0.758, E = 0.242)$

Transverse:	$Uplift_{MAX}$ = 26021 lbs	$Shear_{MAX}$ =	17948 lbs
$Compression_{SEISMIC}$ =	29908 lbs	=[Ωo*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*$WGT_{unit+curb}$*wcurb/2]/wcurb	
$Tension_{SEISMIC}$ =	26021 lbs	=[Ωo*FpmaxASD*(Hcm+Hcurb)-(0.6-0.14S_{DS})*$WGT_{unit+curb}$*wcurb/2]/wcurb	
$Shear_{SEISMIC}$ =	17948 lbs	=Ωo*FpmaxASD/2	

Min Bolts Req'd Uplift =	11.89	spacing =	15.04 in o.c.	Tapplied =	1626.3 lbs
Min Bolts Req'd Shear =	10.00	spacing =	18.38 in o.c.	Vapplied =	747.8 lbs

Try using	16	bolts
spaced at	11.03	in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \le 1.2$ = 1.16 O.K.

Use 16 - 5/8"ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy @ 11 in o.c. max. along long side of curb w/ 4.5in embed

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Longitudinal:	$Uplift_{MAX}$ = 12063 lbs	$Shear_{MAX}$ = 17948 lbs

$Compression_{SEISMIC}$ = 15949 lbs =[Ωo*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*$WGT_{unit+curb}$*Lcurb/2]/Lcurb

$Tension_{SEISMIC}$ = 12063 lbs =[Ωo*FpmaxASD*(Hcm+Hcurb)-(0.6-0.14S_{DS})*$WGT_{unit+curb}$*Lcurb/2]/Lcurb

$Shear_{SEISMIC}$ = 17948 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift = 5.51 spacing = 14.54 in o.c. Tapplied = 1507.9 lbs

Min Bolts Req'd Shear = 10.00 spacing = 8.08 in o.c. Vapplied = 747.8 lbs

Try using 8 bolts
spaced at 10.38 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.11 O.K.

Use 8 - 5/8"ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy @ 10.4 in o.c. max. along short side of curb w/ 4.5in embed

CURB DESIGN SUMMARY:	CBISC-15	CBISCSEL2835	**Unit:**	Sun Select 28-35 Ton
UPPER CURB RAIL THICKNESS:	0.0713 in	14 Gauge		
UNIT CLIP THICKNESS:	0.1017 in	12 Gauge		
# OF CLIPS (LONG SIDE) -	3 clips with 4 - #12 SMS screws each clip			
WEB STIFFENER:	16Ga x 1-3/16in x 6in (C-channel) stiffener at each clip			
# OF CLIPS (SHORT SIDE) -	2 clips with 5 - #12 SMS screws each clip			
WEB STIFFENER:	16Ga x 1-3/16in x 6in (C-channel) stiffener at each clip			
VIBRATION ISOLATOR TYPE:	CQA	Top stud diameter:	3/8	(6) - CQA Isolators long side
Anchor bolt diameter:	1/2	Anchor hole diamter:	9/16	(4) - CQA Isolators short side
BASE CURB THICKNESS:	0.1017 in	12 Gauge		---Bolt or Weld O.K.---
WEB STIFFENER:	16Ga x 1.5in x 6in (C-channel) stiffener at each clip on base curb			
CORNER CONNECTION:	Use minimum 7 - 1/4" ϕ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts			

CURB ANCHORAGE	WOOD	STEEL	CONCRETE
	1/4"ϕ x 4.5" Simpson SDS screws w/ 2.75" threaded embed (SGmin =	1/2" ϕ A307 Bolts to steel angle below deck	5/8"ϕ HAS rods in Hilti HIT-HY 200 V3 epoxy w/ 4.5in embed
LONG DIRECTION	26 @ 6.78 in o.c.	7 @ 27.57 in o.c.	16 @ 11.03 in o.c.
SHORT DIRECTION	13 @ 6.39 in o.c.	4 @ 24.23 in o.c.	8 @ 10.38 in o.c.