MOUR GROUP
ENGINEERING + DESIGN

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

Structural Calculations

for

CBISC-05 Series

CBISCPRS** SERIES

Prepared for:

PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

Date: July 13, 2022

Project Number: PV2203

For wood, concrete and steel attachment see Roof Anchorage Detail, Form No. CB-62.

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

STRUCTURALLY CALCULATED VIBRATION ISOLATION ROOF CURB FOR YORK UNITS

ZX 04-07; XX A7, ZX A7, ZY, ZQ, XY, XQ, ZL 04-06

PROVENT P/N	A	B	EST. WEIGHT
CBISCPRS18**	8"	18"	305 Lbs.
CBISCPRS21**	11"	21"	320 Lbs.
CBISCPRS24**	14"	24"	335 Lbs.

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

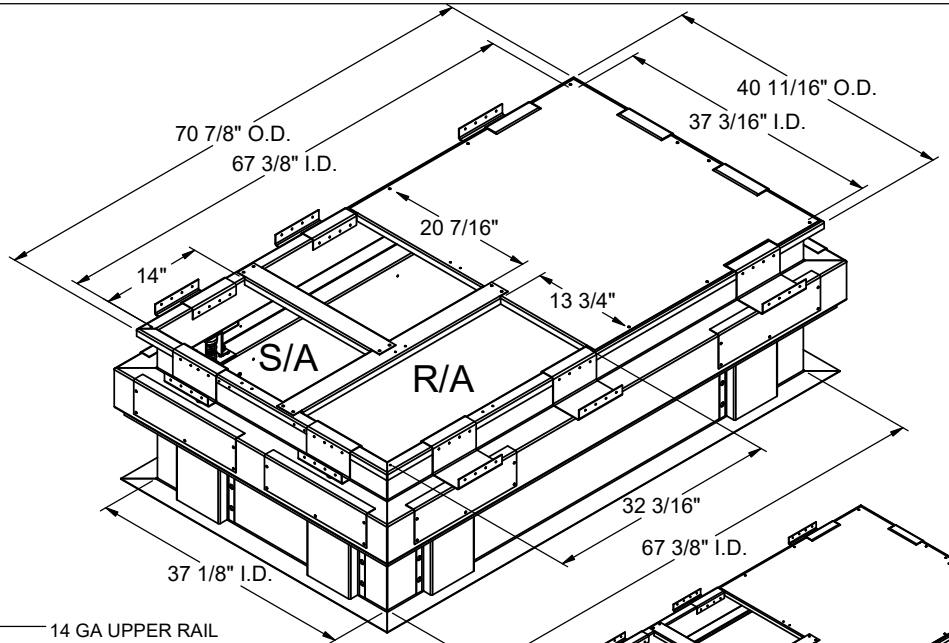
Meets seismic requirements for the following codes:
CBC 2019
IBC 2018

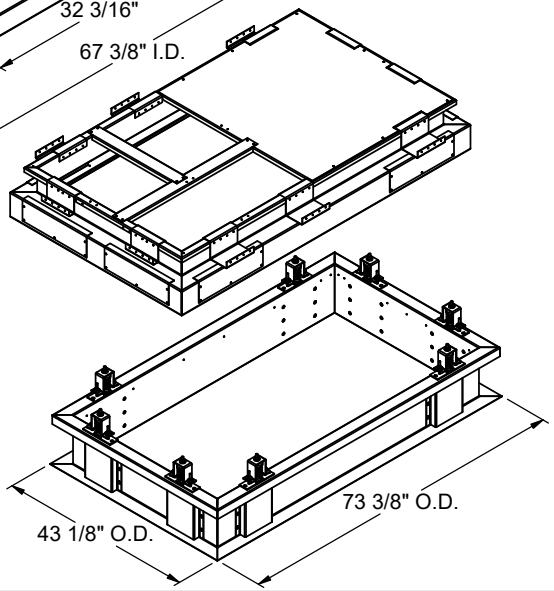
FEATURES

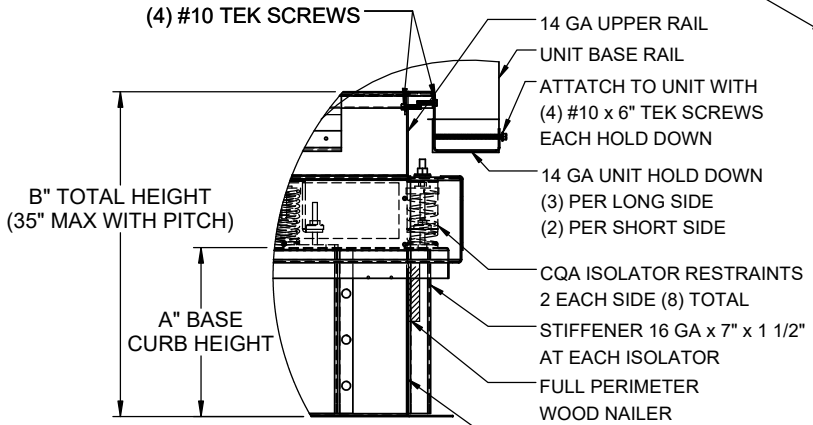
- Roof curbs sides and ends are 14 ga.
- Fully welded construction.
- Gasketing package provided.
- Heat treated wood nailer provided.
- insulated deck pans provided.
- Pitched curbs and taller curbs are available.
- CalDyn OSHPd pre-approved seismic restraints. (OPM-0401-13), (CQA).

NOTES

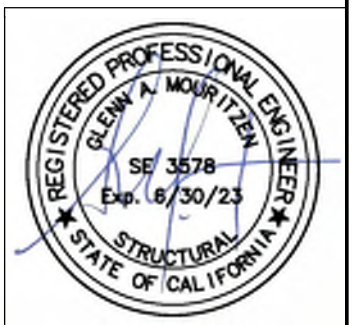
- Attach ductwork to roof curb. Flanges of duct rest on top of the curb, Support ductwork below the curb.
- Thru the curb utillities are available. Contact you York distributor or Provent directly.







PROFILE DETAIL



ProVent

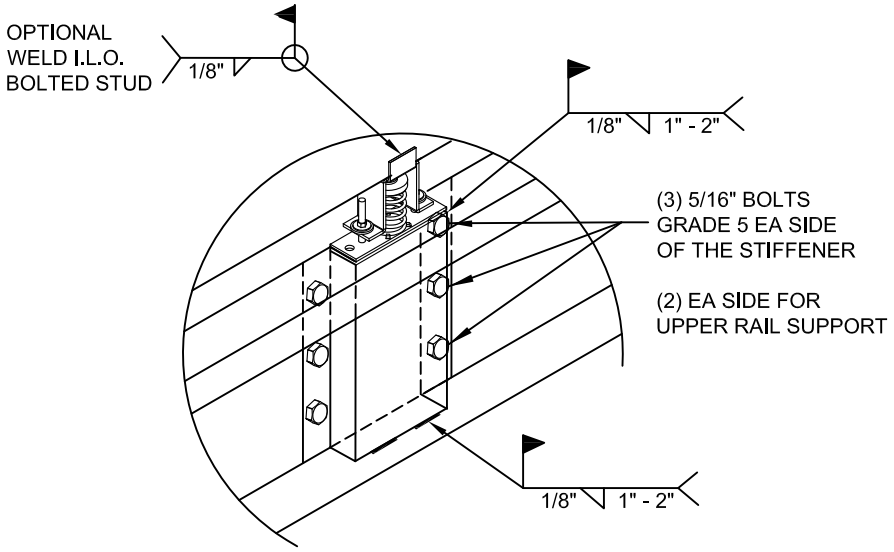
3847 WABASH DRIVE
MIRA LOMA, CA 91752

PHONE (951) 685-1101
FAX (619) 872-9799

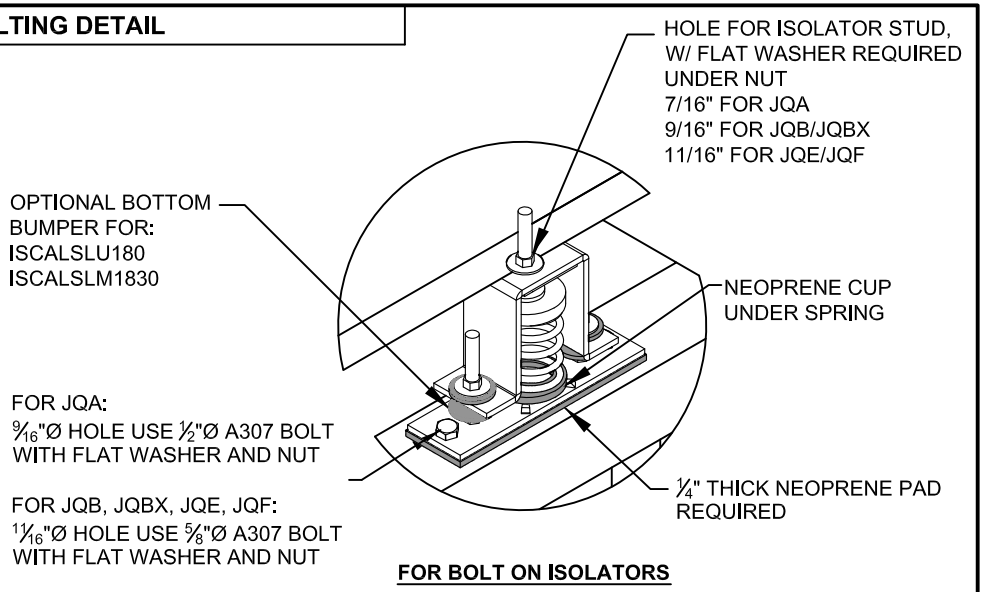
SUBMITED TO: _____
COMPANY: _____
JOB NAME: _____
EQUIPMENT: _____
NOTES: _____

FORM NO:	PART NUMBER:	
CBISC-05	-	
DATE:	REV:	DRAWN BY:
4/25/2022	3	FMM

WELDMENT AND BOLTING DETAIL



BASE CURB SUPPORT



FOR BOLT ON ISOLATORS

ProVent
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COMPANY:
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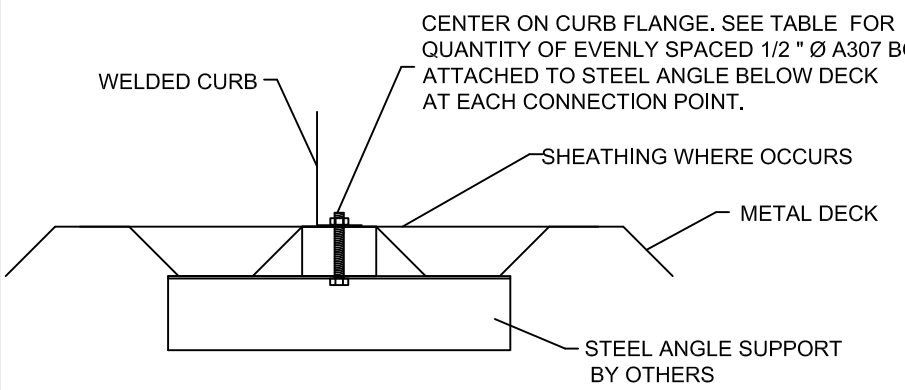
FORM NO:		
CB-61		
DATE:	REV:	DRAWN BY:
02/08/18	1	ALL

STEEL ATTACHMENT



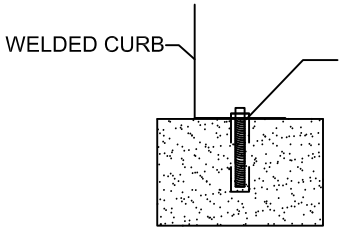
	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
LXS	3 @ 19.25" O.C.	2 @ 23" O.C.
LXL	3 @ 19.25" O.C.	2 @ 33" O.C.
SUN3672	4 @ 21" O.C.	2 @ 27.25" O.C.
PRD3715	6 @ 14.28" O.C.	3 @ 20.75" O.C.
PRS	4 @ 20.46" O.C.	2 @ 31.13" O.C.
PRL	3 @ 36.13" O.C.	2 @ 44" O.C.
SLU180	4 @ 35.08" O.C.	3 @ 37" O.C.
SLM1830	5 @ 29.06" O.C	4 @ 24.67" O.C.
SAV1518	4 @ 37.38" O.C	3 @ 35.56" O.C.
SAV2025	4 @ 42.04" O.C	3 @ 35.56" O.C.
SAV28	5 @ 35.63" O.C	3 @ 35.56" O.C.

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

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

ROOF ANCHORAGE DETAIL
CBISC Series
LXS
LXL
SUN3672
PRD3715
PRS
PRL
SLU180
SLM1830
SAV1518
SAV2025
SAV28

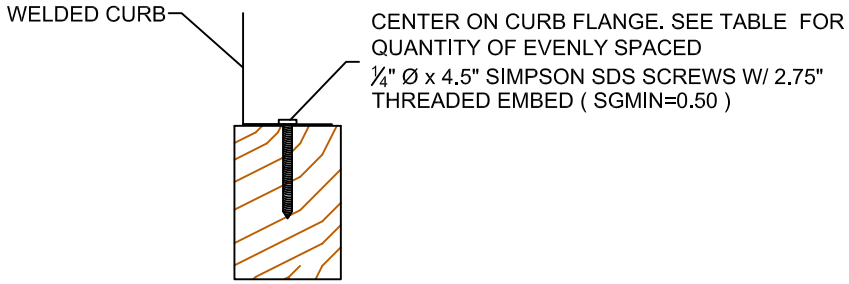
CONCRETE ATTACHMENT



	NO. OF ANCHORAGE BOLTS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
LXS	7 @ 6.42" O.C.	4 @ 7.67" O.C.
LXL	7 @ 6.42" O.C.	5 @ 8.25" O.C.
SUN3672	9 @ 7.88" O.C.	4 @ 9.08" O.C.
PRD3715	14 @ 5.49" O.C.	9 @ 5.19" O.C.
PRS	10 @ 6.82" O.C.	5 @ 7.78" O.C.
PRL	11 @ 7.23" O.C.	6 @ 8.8" O.C.
SLU180	12 @ 9.57" O.C.	8 @ 10.57" O.C.
SLM1830	18 @ 6.84" O.C.	11 @7.4" O.C.
SAV1518	12 @ 10.19" O.C.	6 @ 14.23" O.C.
SAV2025	14 @ 14.97" O.C.	6 @ 14.23" O.C.
SAV28	14 @ 10.96" O.C.	6 @ 14.23" O.C.

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

WOOD ATTACHMENT



	NO. OF ANCHORAGE SCREWS REQUIRED	
CURB	LONG SIDE	SHORT SIDE
LXS	7 @ 7.08" O.C.	5 @ 6.75" O.C.
LXL	7 @ 7.08" O.C.	7 @ 6.17" O.C.
SUN3672	9 @ 8.38" O.C.	5 @ 7.81" O.C.
PRD3715	15 @ 5.38" O.C.	10 @ 5.06" O.C.
PRS	10 @ 7.26" O.C.	6 @ 7.03" O.C.
PRL	12 @ 6.93" O.C.	8 @ 6.86" O.C.
SLU180	14 @ 8.4" O.C.	10 @ 8.67" O.C.
SLM1830	19 @ 6.68" O.C.	13 @ 6.5" O.C.
SAV1518	13 @ 9.68" O.C.	9 @ 9.39" O.C.
SAV2025	15 @ 9.29" O.C.	9 @ 9.39" O.C.
SAV28	16 @ 9.77" O.C.	9 @ 9.39" O.C.

FOUR INCHES FROM EACH CORNER EVENLY SPACED

ProVent

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6/30/2022	2	FMM

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

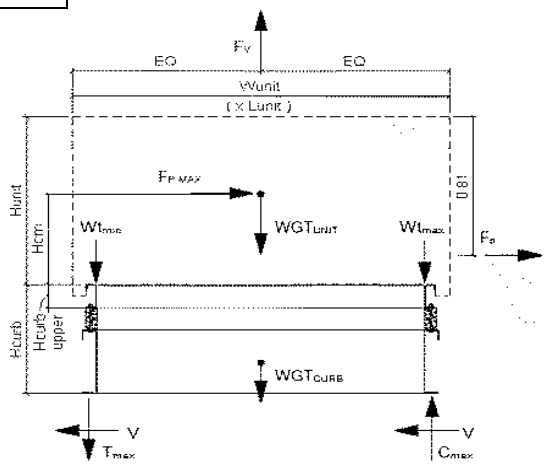
Client:	ProVent	PV2203	Upper curb rail
Project:	CBISC-05	Iso Curb	CBISCPRS
Unit:	YORK ZX 04-07; XX A7; ZY, ZQ, XY, XQ 04-06		

Upper Curb Information

Hcurb upper =	5.5	in	(Height of upper curb rail)
Lcurb =	70.375	in	(Length of upper curb)
wcurb =	40.1875	in	(Width of upper curb)
WGTupper =	56	lbs	(Weight of upper curb)
# Clips long side =	3	# Clips short side =	2

Unit Information

WGTunit =	916	lbs	(Weight of Unit)
Wtmax =	275	lbs	(Maximum corner weight)
Wtmin =	195	lbs	(Minimum corner weight)
Hunit =	40.56	in	(Height of unit above curb)
Hcm =	20.28	in	(Height to center of mass)
Lunit =	74.05	in	(Length of unit)
Wunit =	48.88	in	(Width of unit)



Seismic Loading - 2018 IBC/2019 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 =	3289	lbs	(0.7*Fpmax) FpmaxASD = 3490 lbs
	(unit only)		(unit + upper rail)

Wind Loading - 2018 IBC/2019 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)
$F_{h\ ASD\ trans}$ =	803	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	530	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	673	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Upper Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	2385	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1551	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*wcurb)]/wcurb
$Compression_{WIND}$ =	399	lbs	=[$F_{h\ ASD\ trans}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	508	lbs	=[$F_{h\ ASD\ trans}$*Hcm-2*0.6*Wtmin*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	1673	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	839	lbs	=[FpmaxASD*Hcm-2*(0.6-0.14S_{DS})*Wtmin*Lcurb)]/Lcurb
$Compression_{WIND}$ =	146	lbs	=[$F_{h\ ASD\ long}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	256	lbs	=[$F_{h\ ASD\ long}$*Hcm-2*0.6*Wtmin*Lcurb+$F_{vertASD}$*Lcurb/2]/Lcurb

---> Negative values indicate opposite load.

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	2385	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1551	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1673	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	839	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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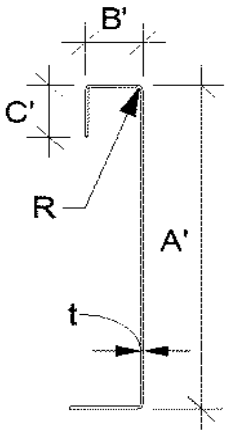
Curb Design

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'=	1.750 in		a'=	5.429 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 =	0.337 in	(Distance between centroid and web centerline)			
Ix =	2.687 in^4		rx =	2.08 in	
Iy =	0.169 in^4		ry =	0.521 in	
A =	0.62 in^2		rmin =	0.521 in	



Axial Compression

Pa =	1.645 k	(Max Axial Comp)
Pn/Ωc =	13.768 k	
Fe =	91.64 ksi	
λc =	0.74	
Fn =	39.79 ksi	
Ly =	36.69 in	Lateral unbraced length
k_yL_y/r_y =	56	(assume k=0.8)

Ω_c = 1.80

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

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

Compression Check = **O.K.**

Check Web Crippling

h =	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} =	0.795 k	**O.K.**	# clips = 3		
Short side: Pu_{Long} =	0.836 k	**O.K.**	# 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

N/A

width of stiffener =	7.000 in	ts =	0.0566 16 Gauge	Pwc =	1.947 k
web of stiff. w =	6.717 in	Rs =	0.0849 in	Pn =	14.669 k
***Check w/ts ≤ 1.28√E/Fys		Ω_c =	1.70	Ae =	0.380 in^2
w/ts =	118.675				
1.28√(E/Fys) =	31.091	--> w/ts over limit	Use C3.7.2	Pn/Ω_c =	8.629 k

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

Not Req'd

Corner Connections

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

Tcrnmax =	873 lbs	Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)			
Vcrnmax =	1192 lbs	Max(Tens/2 -OR- Comp/2 corner connections per side)			
Bolt:	Tall =	2480 lbs	Vall =	1208 lbs	
Threaded Insert:	Tall =	2860 lbs	Vall =	1096 lbs	

# of Bolts required for Tension = 0.4

# of Bolts required for Shear = 1.1

# of Bolts Used = 3.0

Check Combined Stress in Bolts & Inserts: 0.480 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35

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

Lreq'd = 0.806 in

$$P_n/\Omega = \frac{1}{\Omega}0.75tLF_u \ge V_{req} \qquad L_{req'd} = \frac{V_{req}\Omega}{0.75tF_u}$$

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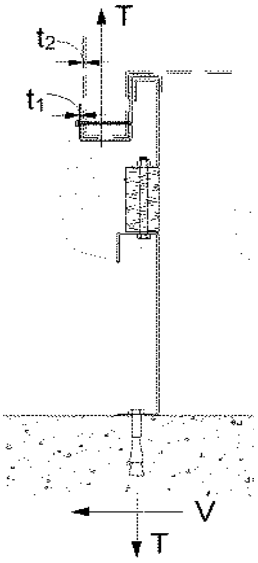
Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

t1 = 0.0713 in (clip thickness) | t2/t1 = 1.0 | Fu1 = 65 ksi

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

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



For t2/t1 ≤ 1.0: | Pns = 2266 # | For t2/t1 ≥ 2.5: | Pns = 2377 #

Shear: $P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$ | 2.27 k

Tension: $P_{ns} = 2.7t_1 dF_{u1}$ | 2.38 k | $P_{ns} = 2.7t_1 dF_{u1}$ | 2.38 k

$P_{ns} = 2.7t_2 dF_{u2}$ | 2.38 k | $P_{ns} = 2.7t_2 dF_{u2}$ | 2.38 k

Pns/Ω = 755 #

Pss/Ω = 540 # <- Controls

Pnot = 0.748 k (screw pull-out strength) $P_{not} = 0.85t_c dF_{u2})$

$t_c = \min(t_1, t_2)$

Pnov = 2.607 k (screw pull-over strength) $P_{nov} = 1.5t_1 d_w F_{u1}$

Pts/Ω = 249 # <- Controls

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

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	1.645	3	0.55	540 #	4	2.00 in
Short side:	1.645	2	0.82	540 #	4	2.00 in

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

min spacing = 0.57 in | edge distance = 0.5 in (min. 1.5d)

Check Block shear rupture: O.K. | thinnest part = 0.0713 AISI BSR applies

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

Agv = 0.463 in^2 | Anv = 0.416 in^2 | Ant = 0.082 in^2

Rn/Ω = 8.674 k $R_n = 0.6F_y A_{gv} + F_u A_{nt} \le 0.6F_u A_{nv} + F_u A_{nt}$

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

Curb Loads (copied from above)

Transverse: (on long edge)	$Comp_{MAX}$ =	2880	lbs
	$Tens_{MAX}$ =	2103	lbs
	$Shear_{MAX}$ =	3490	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	1920	lbs
	$Tens_{MAX}$ =	1142	lbs
	$Shear_{MAX}$ =	3490	lbs

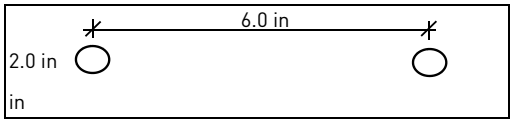
Loads at each Isolator Type: **CQA**

Transverse loading: (on long edge) # isolators: 2	$Comp_{MAX}$ =	1440.1	lbs
	$Tens_{MAX}$ =	1051.3	lbs
	$Shear_{MAX}$ =	436.3	lbs
Longitudinal loading: (on short edge) # isolators: 2	$Comp_{MAX}$ =	959.9	lbs
	$Tens_{MAX}$ =	571.1	lbs
	$Shear_{MAX}$ =	436.3	lbs

Max compression force on isolator: 1.440 k ≤ 3.176 k **O.K.**

Max uplift on isolator: 1.051 k ≤ 3.176 k **O.K.**

Max shear on isolator: 0.436 k ≤ 1.163 k **O.K.**



Forces on top bolt:

Tension = 1.051 k | d_b = 0.375 in

Shear = 0.436 k | per rail, t = 0.0713 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. $F_t = (0.1 + 3d/s)F_u \le F_u$ = 43.063 ksi

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

Pn/Ω = 2.086 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 in^2

Pnt/Ω = 1.988 k **Bolt tension O.K.** | Ωt = 2.25 (Table E3.4-1, AISI)

Shear $P_{nv} = A_b F_{nv}$ | Fnv = 24.0 ksi | Ωv = 2.40 (Table E3.4-1, AISI)

Pnv/Ω = 1.104 k **Bolt shear O.K.**

Combined Shear and tension in bolt:

$F'_{nt} = 1.3F_{nt} - \frac{\Omega F_{nt}}{F_{nv}} f_v \le F_{nt}$ | ft = 9.52 ksi | fv = 3.95 ksi | O.K.

F'nt = 36.65 ksi | Fnv/Ω = 10.00 ksi

$P'_{nt} = A_b F'_{nt}$ | P'nt/Ω = 1.799 k **Combined O.K.**

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

If L/t < 25: L/t = 21.04 | t = 0.0713 | Pn/Ω = 2.153 k

Transverse weld loading: | t = 0.0713 | $P_n/\Omega = \frac{1}{\Omega}tLF_u \ge T_{req}$ | Ω = 2.35

L = 1 | Fu = 65 ksi | Pn/Ω = 1.972 k

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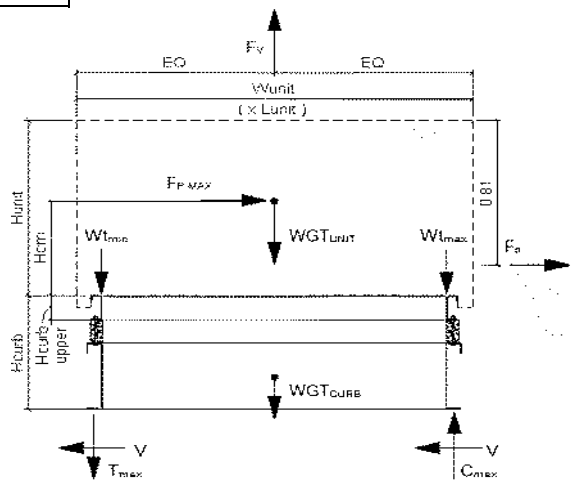
Client:	ProVent	PV2203	Base curb
Project:	CBISC-05	Iso Curb	CBISCPRS
Unit:	YORK ZX 04-07; XX A7; ZY, ZQ, XY, XQ 04-06		

Base Curb Information

Hbase curb =	25	in	(Height of base curb)
Lcurb =	73.375	in	(Length of base curb)
wcurb =	43.125	in	(Width of base curb)
WGTbase =	279	lbs	(Weight of base curb)

Springs long side = 2 # Springs short side = 2



Unit Information

WGTunit =	916	lbs	(Weight of Unit)
Wt'max =	289	lbs	(Wtmax+1/4*WGTupper)
Wt'min =	209	lbs	(Wtmin+1/4*WGTupper))
Hunit =	40.56	in	(Height of unit above curb)
H'cm =	30.28	in	(Hcm+10"(upper+spring))
Lunit =	74.05	in	(Length of unit)
Wunit =	48.88	in	(Width of unit)
$WGT_{unit+upper+base}$ =	1251	lbs	(Total weight)

Seismic Loading - 2018 IBC/2019 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 =	3490	lbs	(0.7*Fpmax) FpmaxASD = 4492 lbs
	(unit + upper rail)		(unit + upper rail + base curb)

Wind Loading - 2018 IBC/2019 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)
$F_{h\ ASD\ trans}$ =	1318	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hbase curb+10") (Eq. 29.4-2)
$F_{h\ ASD\ long}$ =	870	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hbase curb+10")
$F_{vert\ ASD}$ =	673	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.4-3)

Base Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	3213	lbs	=[FpmaxASD*H'cm+2*(1+0.14S_{DS})*Wt'max*wcurb]/wcurb
$Tension_{SEISMIC}$ =	2334	lbs	=[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*wcurb)]/wcurb
$Compression_{WIND}$ =	935	lbs	=[$F_{h\ ASD\ trans}$*H'cm+2*0.6*Wt'max*wcurb-$F_{vert\ ASD}$*wcurb/2]/wcurb
$Tension_{WIND}$ =	1012	lbs	=[$F_{h\ ASD\ trans}$*H'cm-2*0.6*Wt'min*wcurb+$F_{vertASD}$*wcurb/2]/wcurb

---> Negative values indicate opposite load.

Longitudinal:

$Compression_{SEISMIC}$ =	2202	lbs	=[FpmaxASD*H'cm+2*(1+0.14*S_{DS})*Wt'max*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	1323	lbs	=[FpmaxASD*H'cm-2*(0.6-0.14S_{DS})*Wt'min*Lcurb)]/Lcurb
$Compression_{WIND}$ =	369	lbs	=[$F_{h\ ASD\ long}$*H'cm+2*0.6*Wt'max*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	445	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:	$Comp_{MAX}$ =	3213	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	2334	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	2202	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	1323	lbs	---> Along short edge of curb.

---> Negative values indicate opposite load.

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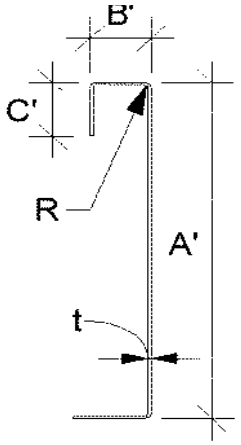
Curb Design

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



Calculate Section Properties of Curb

A'=	[25.000] in		a =	24.644 in	= A'-(2r+t)
B'=	[1.750] in		a'=	24.929 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 =	0.104 in	(Distance between centroid and web centerline)			
Ix =	128.737 in		rx =	8.00 in	
Iy =	0.218 in		ry =	0.329 in	
A =	2.01 in^2		rmin =	0.329 in	

Axial Compression

Pu = 1.745 k (Max Axial Comp) Ω_c = 1.80
Pn/Ωc = 8.960 k
Fe = 9.14 ksi
λc = 2.34
Fn = 8.01 ksi
Ly = 73.38 in Lateral unbraced length
k_yL_y/r_y = 179 (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 =	25 in	-- Check limits:		C =	4.00
t =	0.0713 in	h/t =	350.63 ≤ 200	C_R =	0.14
N =	7.00	N/t =	98.18 ≤ 210	C_N =	0.35
Ω_w =	1.75	N/h =	0.28 ≤ 2.0	C_h =	0.02
P_n =	2.105 k	R/t =	1.50 ≤ 9.0		
P_n/Ω_w =	1.203 k				
Long side: Pu_{Trans} =	1.606 k	**web stiffener REQ'D**	# clips = 2		
Short side: Pu_{Long} =	1.101 k	**O.K.**	# 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 = 2.105 k Ae = 0.380 in^2
Pn = 14.780 k
Pn/Ω_c = 8.694 k **O.K.**

Corner Connections

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

Tcrnmax = 1123 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 1606 lbs Max(Tens/2 -OR- Comp/2 corner connections per side)

Bolt:	Tall =	[2480] lbs	Vall =	[1208] lbs	
Threaded Insert:	Tall =	[2860] lbs	Vall =	[1096] lbs	

# of Bolts required for Tension = 0.5
# of Bolts required for Shear = 1.5
# of Bolts Used = [3.0]
Check Combined Stress in Bolts & Inserts: 0.640 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.783 in
Lreq'd = 1.086 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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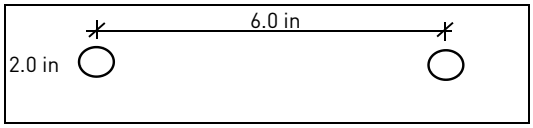
Curb Loads (copied from upper rail calcs)

Transverse: (on long edge)	$Comp_{MAX}$ =	2880	lbs
	$Tens_{MAX}$ =	2103	lbs
	$Shear_{MAX}$ =	3490	lbs
Longitudinal: (on short edge)	$Comp_{MAX}$ =	1920	lbs
	$Tens_{MAX}$ =	1142	lbs
	$Shear_{MAX}$ =	3490	lbs

Loads at each Isolator Type: **CQA**

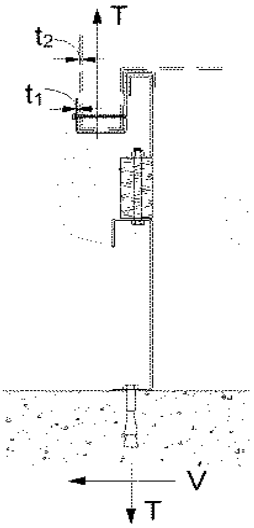
Transverse loading: (on long edge) # isolators: 2	$Comp_{MAX}$ =	1440.1	lbs
	$Tens_{MAX}$ =	1051.3	lbs
	$Shear_{MAX}$ =	436.3	lbs
Longitudinal loading: (on short edge) # isolators: 2	$Comp_{MAX}$ =	959.9	lbs
	$Tens_{MAX}$ =	571.1	lbs
	$Shear_{MAX}$ =	436.3	lbs

Max compression force on isolator: 1.440 k ⩽ 3.176 k **O.K.**
Max uplift on isolator: 1.051 k ⩽ 3.176 k **O.K.**
Max shear on isolator: 0.436 k ⩽ 1.163 k **O.K.**



Forces on bottom bolts:

d_b = 0.5 in
base curb, t = 0.0713 in
Tension = 0.526 k / bolt
Shear = 0.218 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: $P_n = A_nF_t$ Ω = 2.22 (Appendix A, Section E3.2 AISI)
Pn/Ω = 5.909 k An = 0.107 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 = 2.781 k d/t = 7.01
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 = 5.35 ksi fv = 1.11 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:	$Uplift_{MAX}$ =	5583 lbs	$Shear_{MAX}$ =	2246 lbs
$Compression_{SEISMIC}$ =	6584 lbs	=[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb		
$Tension_{SEISMIC}$ =	5583 lbs	=[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*wcurb/2]/wcurb		
$Compression_{WIND}$ =	1728 lbs	=[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*wcurb/2-$F_{vert\ ASD}$*wcurb/2]/wcurb		
$Tension_{WIND}$ =	1651 lbs	=[$F_{h\ ASD\ trans}$*(H'cm+Hbase curb)-0.6*$WGT_{unit+upper+base}$*wcurb/2+$F_{vertASD}$*wcurb/2]/wcurb		
Longitudinal:	$Uplift_{MAX}$ =	3209 lbs	$Shear_{MAX}$ =	2246 lbs
$Compression_{SEISMIC}$ =	4210 lbs	=[FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb		
$Tension_{SEISMIC}$ =	3209 lbs	=[FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+upper+base}$*Lcurb/2]/Lcurb		
$Compression_{WIND}$ =	694 lbs	=[$F_{h\ ASD\ long}$*(H'cm+Hbase curb)+0.6*$WGT_{unit+upper+base}$*Lcurb/2-$F_{vert\ ASD}$*Lcurb/2]/Lcurb		
$Tension_{WIND}$ =	617 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 embt** (SGmin = 0.43)

Transverse:
$Tall_{metal}$ = 997 lbs $Vall_{metal}$ = 1097 lbs
$Tall_{wood}$ = 760 lbs $Vall_{wood}$ = 672 lbs

# of Screws Req'd for Uplift = 7.35 COMBINED LOADING: 0.943 O.K.
# of Screws Req'd for Shear = 3.34 Req'd Min Spacing = 7.26 in o.c.
Total # of screws required = 10

Use 10 - 1/4"ϕ x 4.5" Simpson SDS screws @ 7.3 in o.c. along long side of curb w/ 2.75" threaded embed

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Longitudinal:

# of Screws Req'd for Uplift = 4.22 COMBINED LOADING: 0.913 O.K.

# of Screws Req'd for Shear = 3.34 Screw Spacing = 7.03 in o.c.

Total # of screws required = 6

Use 6 - 1/4"ϕ x 4.5" Simpson SDS screws @ 7 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: $Tall_{metal}$ = 2086 lbs $Vall_{metal}$ = 2192 lbs

# of Bolts Req'd for Uplift = 2.68 COMBINED LOADING: 0.840 O.K.

# of Bolts Req'd for Shear = 1.02 Bolt Spacing = 20.46 in o.c.

Total # of bolts required = 4

Use 4 - 1/2" ϕ A307 Bolts to steel angle below deck @ 20.5 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift = 1.54 COMBINED LOADING: 0.555 O.K.

# of Bolts Req'd for Shear = 1.02 Bolt Spacing = 31.13 in o.c.

Total # of bolts required = 2

Use 2 - 1/2" ϕ A307 Bolts to steel angle below deck @ 31.1 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: 3/4" φ thrd'd rods in Hilti Hit-HY 200 epoxy w/ 4" embed

$Tall_{LRFD}$ = 1957 lbs $Vall_{LRFD}$ = 4540 lbs $\propto = (1 + 0.2SDS)D + 2.5E = 1.708$

$Tall_{ASD} = Tall_{LRFD}/\alpha$ = 1146 lbs $Vall_{ASD} = Vall_{LRFD}/\alpha$ = 2658 lbs $(D = 0.758, E = 0.242)$

Transverse: $Uplift_{MAX}$ = 11341 lbs $Shear_{MAX}$ = 4492 lbs

$Compression_{SEISMIC}$ = 12342 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+curb+base}$*wcurb/2]/wcurb

$Tension_{SEISMIC}$ = 11341 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+curb+base}$*wcurb/2]/wcurb

$Shear_{SEISMIC}$ = 4492 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift = 9.90 spacing = 6.82 in o.c. Tapplied = 1134.1 lbs

Min Bolts Req'd Shear = 1.69 spacing = 61.38 in o.c. Vapplied = 299.5 lbs

Try using 10 bolts
spaced at 6.82 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 1.10

Use 10 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 6.8 in o.c. max. along long side of curb w/ 4" embed

Longitudinal: $Uplift_{MAX}$ = 6593 lbs $Shear_{MAX}$ = 4492 lbs

$Compression_{SEISMIC}$ = 7594 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)+(1+0.14S_{DS})*$WGT_{unit+curb+base}$*Lcurb/2]/Lcurb

$Tension_{SEISMIC}$ = 6593 lbs =[Ωo*FpmaxASD*(H'cm+Hbase curb)-(0.6-0.14S_{DS})*$WGT_{unit+curb+base}$*Lcurb/2]/Lcurb

$Shear_{SEISMIC}$ = 4492 lbs =Ωo*FpmaxASD/2

Min Bolts Req'd Uplift = 5.76 spacing = 6.23 in o.c. Tapplied = 941.9 lbs

Min Bolts Req'd Shear = 1.69 spacing = 31.13 in o.c. Vapplied = 299.5 lbs

Try using 5 bolts
spaced at 7.78 in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{apllied}}{V_{allow,ASD}} \leq 1.2$ = 0.93

Use 5 - 3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy @ 7.8 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY:	CBISC-05	CBISCPRS	Unit:	YORK ZX 04-07; XX A7; ZY, ZQ, XY, XQ 04-06
UPPER CURB RAIL THICKNESS:	0.0713 in	14 Gauge		
UNIT CLIP THICKNESS:	0.0713 in	14 Gauge		
# OF CLIPS (LONG SIDE) -	3 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:	CQA	Top stud diameter:	3/8	(2) - CQA Isolators long side
Anchor bolt diameter:	1/2	Anchor hole diamter:	9/16	(2) - CQA Isolators short side
BASE CURB THICKNESS:	0.0713 in	14 Gauge		---Bolt or Weld O.K.---
WEB STIFFENER:	16Ga x 1.5in x 7in (C-channel) stiffener at each clip on base curb			
CORNER CONNECTION:	Use minimum 3 - 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	3/4" ϕ thrd'd rods in Hilti Hit-HY 200 epoxy w/ 4" embed
LONG DIRECTION	10 @ 7.26 in o.c.	4 @ 20.46 in o.c.	10 @ 6.82 in o.c.
SHORT DIRECTION	6 @ 7.03 in o.c.	2 @ 31.13 in o.c.	5 @ 7.78 in o.c.