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

Structural Calculations
for
CBWC-300 Series

Prepared for:

PROVENT / RRS

3847 Wabash Drive
Mira Loma, CA 91725

Date: July 29, 2019

Project Number: PV1806

For wood, concrete and steel attachments see Roof Anchorage Detail, Form Nos. CB-60.

FEATURES

- Roof curb sides and ends are 16 Ga. galvanized steel.
- Gasketing package provided.
- Heat treated wood nailer provided.
- Pitched curbs and taller curbs are available.

Notes

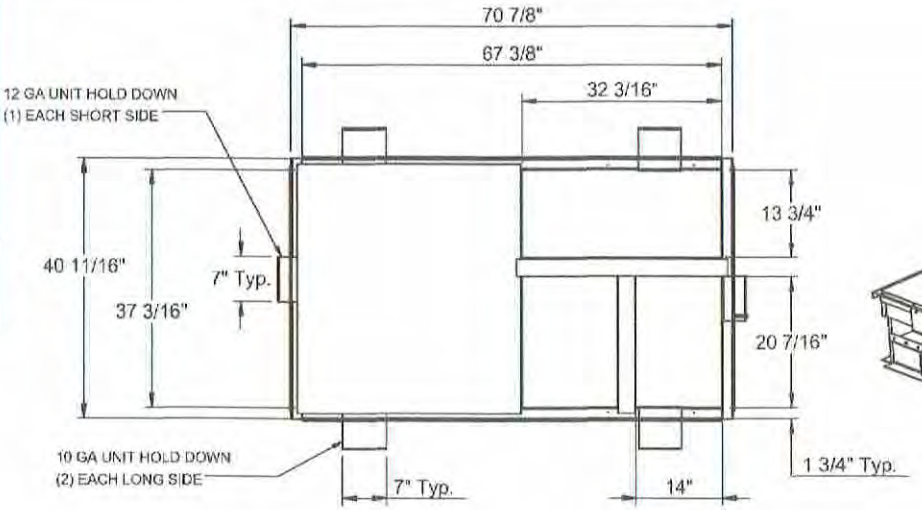
Attached ductwork to roof curb. Flanges of duct rest on top of curb. Support ductwork below the curb.

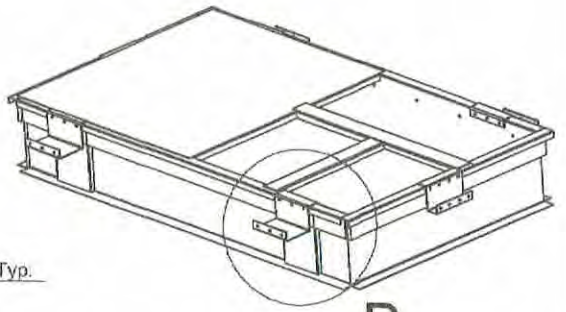
STRUCTURALLY CALCULATED WELDED ROOF CURBS FOR YORK UNITS

ZX 04-07
ZY, ZQ, XY 04-06

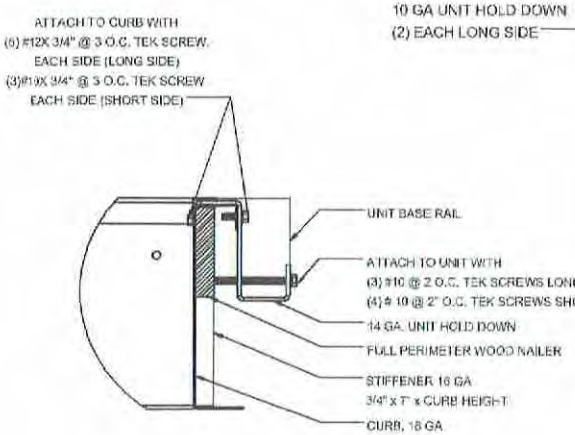
PROVENT P/N	A	EST. WEIGHT
CBWCPRS08	8"	125 Lbs.
CBWCPRS11	11"	136 Lbs.
CBWCPRS14	14	147 Lbs.
CBWCPRS24	24"	186 Lbs.

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

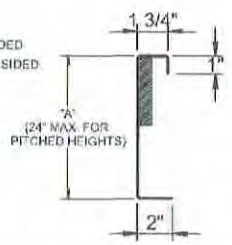




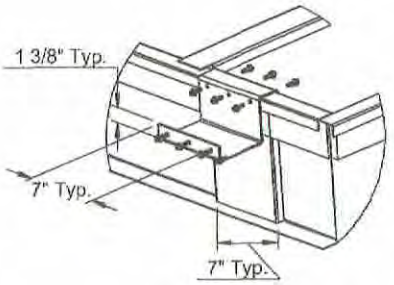
B



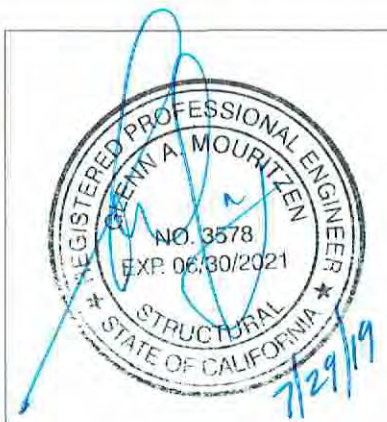
HOLD DOWN DETAIL



CURB DETAIL



DETAIL B



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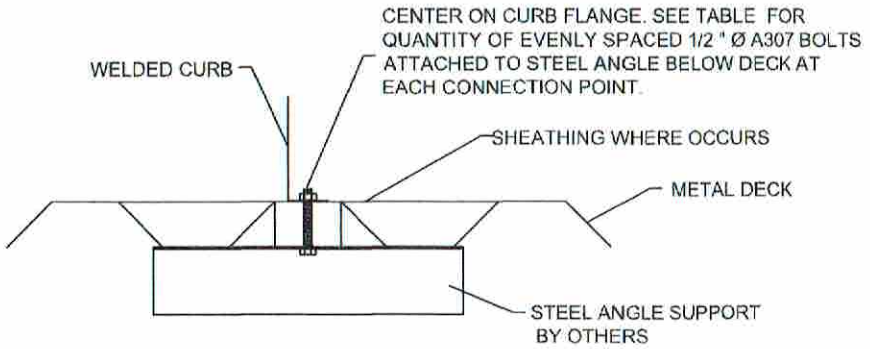
MIRA LOMA, CA 91725
PHONE (951) 685-1101
FAX (619) 872-9799

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

FORM NO:	PART NUMBER:		
CBWC-300	CBWCPRS SERIES		
DATE:	REV:	DRAWN BY:	
9/27/2018	6	ALL	

STEEL ATTACHMENT



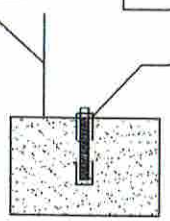
CURB	NO. OF ANCHORAGE BOLTS REQUIRED	
	LONG SIDE	SHORT SIDE
LXS	2 @ 34.5" O.C	XX @ 2 @ 19" O.C
LXL	2 @ 34.5" O.C.XX	2 @ 29" O.C
SUN3672	2 @ 60" O.C	2 @ 24.25" O.C
PRD3715	2 @ 68.38" O.C	2 @ 38.5" O.C
PRS	2 @ 58.38" O.C	2 @ 28.19" O.C.
PRL	2 @ 72" O.C	2 @ 41" O.C
SLU180	2 @ 102.25" O.C.	2 @ 71" O.C.
SLM1830	2 @ 113.25" O.C	2 @ 71" O.C.

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

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

ROOF ANCHORAGE DETAIL		
CBKD Series	CBWC Series	CBISC Series
LXS	LXS	LXS
LXL	LXL	LXL
SUN3672	SUN3672	SUN3672
PRD3715	PRD3715	PRD3715
PRS	PRS	PRS
PRL	PRL	PRL
	SLU180	SLU180
	SLM1830	SLM1830

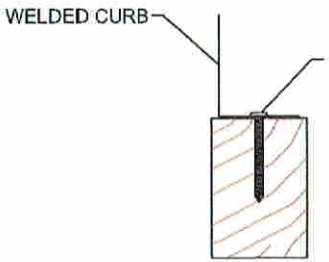
CONCRETE ATTACHMENT



CURB	NO. OF ANCHORAGE BOLTS REQUIRED	
	LONG SIDE	SHORT SIDE
LXS	10 @ 3.73" O.C.	9 @ 2.38" O.C.
LXL	8 @ 4.93" O.C.	7 @ 4.83" O.C.
SUN3672	9 @ 7.5" O.C.	6 @ 4.85" O.C.
PRD3715	17 @ 4.27" O.C.	13 @ 3.21" O.C.
PRS	9 @ 7.3" O.C.	7 @ 4.7" O.C.
PRL	11 @ 7.2" O.C.	9 @ 5.13" O.C.
SLU180	16 @ 6.82" O.C.	13 @ 5.92" O.C.
SLM1830	18 @ 6.66" O.C.	13 @ 5.92" O.C.

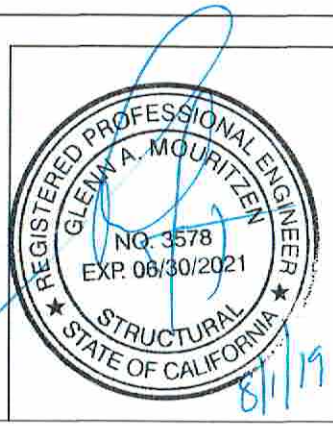
* SIX INCHES FROM EACH CORNER EVENLY SPACED.
** CENTERED.

WOOD ATTACHMENT



CURB	NO. OF ANCHORAGE SCREWS REQUIRED	
	LONG SIDE	SHORT SIDE
LXS	7 @ 6.42" O.C.	4 @ 7.67" O.C.
LXL	7 @ 6.42" O.C.	6 @ 6.6" O.C.
SUN3672	4 @ 21.33" O.C.	3 @ 14.13" O.C.
PRD3715	8 @ 10.34" O.C.	6 @ 8.5" O.C.
PRS	4 @ 20.79" O.C.	3 @ 16.09" O.C.
PRL	4 @ 25.33" O.C.	3 @ 22.5" O.C.
SLU180	7 @ 17.71" O.C.	7 @ 12.5" O.C.
SLM1830	8 @ 16.75" O.C.	6 @ 15" O.C.

FOUR INCHES FROM EACH CORNER EVENLY SPACED



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SUBMITTED TO: _____
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FORM NO: CB-60

DATE:	REV:	DRAWN BY:
07/31/18	3	ALL

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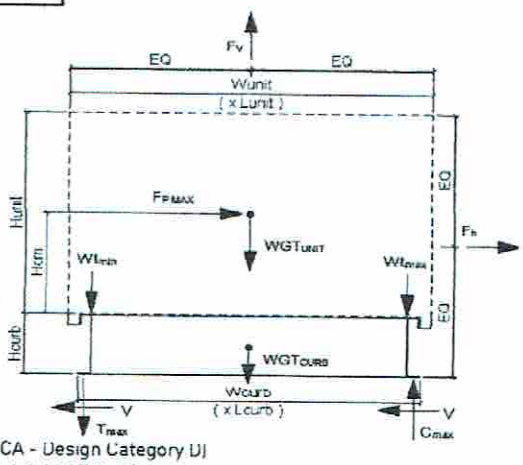
Client: ProVent PV1806
Description: CBWC-300 (CBWCPRS**)
Unit: ZX 04-07; ZY,ZQ,XY 04-06

Curb Information

Hcurb =	24	in	(Height of curb)
Lcurb =	70.375	in	(Length of curb)
wcurb =	40.1875	in	(Width of curb)
WGTcurb =	186	lbs	(Weight of curb)
# Clips long side =	2	# Clips short side =	1

Unit Information

WGTunit =	711	lbs	(Weight of Unit)
Wtmax =	181	lbs	(Maximum corner weight)
Wtmin =	142	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 - 2015 IBC/2016 CBC

Ss =	2.85		(Worst case for majority of CA - Design Category D)
Fa =	1		(Interpolated from Table 11.4-1 ASCE 7-10)
Sms =	2.850		(Fa*Ss)
Sds =	1.900		(2/3*Sms)
Ip =	1.25		(Importance Factor Category III Building)
Fpmax =	3.800	Wp	(1.6*Sds*Ip)*Wp
FpmaxASD =	1891	lbs	(0.7*Fpmax) FpmaxASD = 2386 lbs (unit and curb)
	(unit only)		

Wind Loading - 2015 IBC/2016 CBC

*** Exposure Category C ***

Kz =	1.13		(For 60 ft roof height, Exposure C - Table 29.3-1 ACSE 7-10)
Kzt =	1.0		(No topographic effects assumed for rooftop mounted units)
Kd =	0.85		(Directionality factor Table 26.6-1 ASCE 7-10)
V =	115		(Max wind velocity, mph for Cat III & IV bldgs Exp. Cat C)
$GCr_{(horiz)}$ =	1.9		(Refer Sect 29.5.1 ASCE 7-10)
$GCr_{(vert)}$ =	1.5		(Refer Sect 29.5.1 ASCE 7-10)
qz	32.5	psf	= 0.00256*Kz*Kzt*Kd*V^2 (Eq. 29.3-1 ASCE 7-10)
$F_{h\ ASD\ trans}$ =	1231	lbs	= 0.6*qz*GCr*Lunit*(Hunit+Hcurb) (Eq. 29.5-2)
$F_{h\ ASD\ long}$ =	812	lbs	= 0.6*qz*GCr*Wunit*(Hunit+Hcurb)
$F_{vert\ ASD}$ =	736	lbs	= 0.6*qz*GCr*Lunit*Wunit (Eq. 29.5-3)

Curb Loading

Transverse:

$Compression_{SEISMIC}$ =	1413	lbs	=[FpmaxASD*Hcm+2*(1+0.14S_{DS})*Wtmax*wcurb]/wcurb
$Tension_{SEISMIC}$ =	1175	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	470	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*wcurb-$F_{vertASD}$*wcurb/2)/wcurb
$Tension_{WIND}$ =	779	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Longitudinal:

$Compression_{SEISMIC}$ =	1003	lbs	=[FpmaxASD*Hcm+2*(1+0.14*S_{DS})*Wtmax*Lcurb]/Lcurb
$Tension_{SEISMIC}$ =	766	lbs	= $Comp_{SEISMIC}$-(0.6-0.14S_{DS})*WGTunit
$Compression_{WIND}$ =	83	lbs	=[$F_{h\ transASD}$*Hcm+2*0.6*Wtmax*Lcurb-$F_{vertASD}$*Lcurb/2]/Lcurb
$Tension_{WIND}$ =	393	lbs	= $Comp_{WIND}$+Fvert-0.6*WGTunit

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

Governing Reactions:

Transverse:	$Comp_{MAX}$ =	1413	lbs	---> Along long edge of curb.
(on long edge)	$Tens_{MAX}$ =	1175	lbs	---> Along long edge of curb.
Longitudinal:	$Comp_{MAX}$ =	1003	lbs	---> Along short edge of curb.
(on short edge)	$Tens_{MAX}$ =	766	lbs	---> Along short edge of curb.

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

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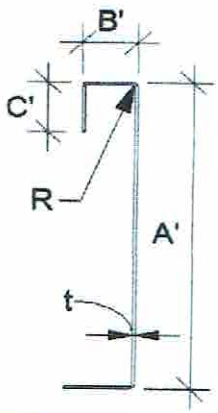
Curb Design

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



Calculate Section Properties of Curb

A'=	24.000 in	a =	23.717 in	= A'-(2r+t)
B'=	3.000 in	a'=	23.943 in	= A'-t
C'=	1.000 in (0 if no lips)	b =	2.717 in	= B'-[r+t/2+a(r+t/2)]
a =	1.000 (0 - no Lip; 1 w/ lip)	b'=	2.943 in	= B'-(t/2+at/2)
R =	0.0849 (Inside bend radius)	c =	0.859 in	= a[C'-(r+t/2)]
t =	0.0566 in	c'=	0.972 in	= a[C'-t/2]
r'=	0.113 in = R+t/2	u =	0.178 in	= πr/2

x = 0.446 in (Distance between centroid and web centerline)
Ix = 125.486 in (Moment of Inertia about X-Axis)
Iy = 1.511 in (Moment of Inertia about Y-Axis)
A = 1.79 in²
rx = 8.38 in
ry = 0.919 in
rmin = 0.919 in

Axial Compression

Pu = 0.946 k (Max Axial Comp) Ωc = 1.80
Pn/Ωc = 33.817 k
Fe = 54.49 ksi
λc = 0.96
Fn = 34.06 ksi
Ly = 84 in (Lateral unbraced length)
k_yL_y/r_y = 73 (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 = 24 in -- Check limits:
t = 0.0566 in h/t = 424.03 ≤ 200
N = 7.00 N/t = 123.67 ≤ 210
Ωw = 1.75 N/h = 0.291667 ≤ 2.0
Pn = 1.366 k R/t = 1.50 ≤ 9.0
Pn/Ωw = 0.780 k
Long side: Pu_{Trans} = 0.706 k **O.K.** # clips = 2
Short side: Pu_{Long} = 1.003 k **web stiffener REQ'D** # clips = 1

C = 4.00
C_R = 0.14
C_N = 0.35
C_h = 0.02
(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 3/4" x 7" (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 Ωc = 1.70
w/ts = 118.675
1.28√(E/Fys) = 31.091 --> w/ts over limit Use C3.7.2

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

Pwc = 1.366 k Ae = 0.380 in²
Pn = 14.262 k Pn/Ω = 8.390 k
O.K.

Corner Connections

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

Tcrnmax = 473 lbs Max($F_{pmaxASD}$/4 -OR- $Fh_{ASDtrans}$/4 corner connections)
Vcrnmax = 588 lbs (Max Ten/2 corner connections per side)

Bolt:	Tall =	2480 lbs	Vall =	1096 lbs
Threaded Insert:	Tall =	2860 lbs	Vall =	1714 lbs

# of Bolts required for Tension = 0.2
# of Bolts required for Shear = 0.5
# of Bolts Used = 1.0
***If combined fails: USE --> 2.0
Check Combined Stress in Bolts & Inserts: 0.727 O.K. StressComb = 0.363 **O.K.**

Check 1/8" welded connection

<--- USE WELD Ω = 2.35
Assume L/t > 25: 25*t = 1.415 in
Lreq'd = 0.500 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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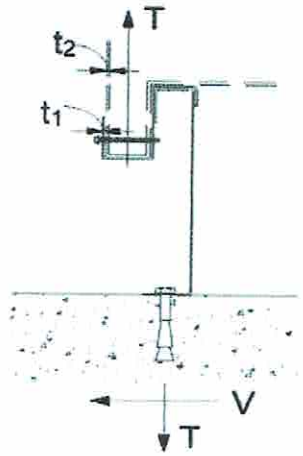
Connection Unit to Curb Clip | #10 SMS screw | Ω = 3.0

t1 = 0.0566 in | Fu1 = 65 ksi
t2 = 0.1017 in (unit base rail thickness) | Fu2 = 65 ksi
d = 0.190 in (screw diameter) | dw = 0.375 in (nom. washer diameter)
t2/t1 = 1.8



For t2/t1 ≤ 1.0:			For t2/t1 ≥ 2.5:	
Shear:	$P_{ns} = 4.2F_{u2}\sqrt{t_2^3 d}$	Pns = 1887 #		Pns = 1887 #
		3.86 k		
	$P_{ns} = 2.7t_1 dF_{u1}$	1.89 k	$P_{ns} = 2.7t_1 dF_{u1}$	1.89 k
	$P_{ns} = 2.7t_2 dF_{u2}$	3.39 k	$P_{ns} = 2.7t_2 dF_{u2}$	3.39 k
Pns/Ω =	629 #			
Pss/Ω =	540 # <- Controls			

Tension: Pnot = 1.068 k (screw pull-out strength) $P_{not} = 0.85t_c dF_{u2}$ where $t_c = \min(t_1, t_2)$
Pnov = 2.069 k (screw pull-over strength) $P_{nov} = 1.5t_1 d_w F_{u1}$
Pts/Ω = 356 # <- Controls
Pts/Ω = 820 # (full tensile screw capacity)

	Shear (k)	# clips	V_{clip} (k)	V_{allow} (lb)	# screws	spacing
Long side:	1.891	2	0.95	540 #	2	6.00 in
Short side:	1.891	1	1.89	540 #	4	2.00 in

clip width (in) = 7.00 | clip height = 1.4 in
min spacing = 0.57 in | edge distance = 0.5 in (min. 1.5d)
Check Block shear rupture: O.K. | thinnest part = 0.0566 | AISI BSR applies
Fy = 50 ksi | Ω = 2.22 bolt/screw connection
Agv = 0.368 in² | Anv = 0.330 in² | Ant = 0.034 in²
Rn/Ω = 5.954 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)

Connection of Curb to Supporting Structure

Roof Loading SEISMIC: (0.6-0.14SDS)D + 0.7E | WIND: 0.6D + W

Transverse:	$Uplift_{MAX}$ = 2897 lbs	$Shear_{MAX}$ = 1193 lbs	
$Compression_{SEISMIC}$ =	3197 lbs	=(FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb)/wcurb	
$Tension_{SEISMIC}$ =	2897 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)	
$Compression_{WIND}$ =	1257 lbs	=($F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*wcurb-$F_{vertASD}$*wcurb/2)/wcurb	
$Tension_{WIND}$ =	1455 lbs	=($F_{h\,transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*wcurb+$F_{vertASD}$*wcurb/2)/wcurb	
Longitudinal:	$Uplift_{MAX}$ = 1769 lbs	$Shear_{MAX}$ = 1193 lbs	
$Compression_{SEISMIC}$ =	2069 lbs	=(FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb)/Lcurb	
$Tension_{SEISMIC}$ =	1769 lbs	=$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)	
$Compression_{WIND}$ =	412 lbs	=($F_{h\,transASD}$*(Hcm+Hcurb)+0.6*($WGT_{unit+curb}$/2)*Lcurb-$F_{vertASD}$*Lcurb/2)/Lcurb	
$Tension_{WIND}$ =	610 lbs	=($F_{h\,transASD}$*(Hcm+Hcurb)-0.6*($WGT_{unit+curb}$/2)*Lcurb+$F_{vertASD}$*Lcurb/2)/Lcurb	

Wood Attachment: **Use 5/8" φ wood lag screws w/ 3.5" Min. Embed**

	$Tall_{metal}$ = 946.67 lbs	$Vall_{metal}$ = 1043.33 lbs	
Transverse:	$Tall_{wood}$ = 1195.95 lbs	$Vall_{wood}$ = 1024 lbs	
# of Screws Req'd for Uplift =	3.06	COMBINED LOADING:	0.562 O.K.
# of Screws Req'd for Shear =	1.17	Screw Spacing =	20.8 in o.c.
Total # of screws Required =	4		

Use 5/8" φ wood lag screws @ 20.8 in o.c. along long side of curb w/ 3.5" Min. Embed

Longitudinal:

# of Screws Req'd for Uplift =	1.9	COMBINED LOADING:	0.515 O.K.
# of Screws Req'd for Shear =	1.2	Screw Spacing =	16.1 in o.c.
Total # of screws Required =	3		

Use 5/8" φ wood lag screws @ 16.1 in o.c. along short side of curb w/ 3.5" Min. Embed

Steel Deck Attachment: **Use 5/8" φ A307 Bolts attached to steel angle below deck**

	$Tall_{bolt}$ = 6903 lbs	$Vall_{bolt}$ = 3682 lbs	
Transverse:	6903 lbs	3682 lbs	
# of Bolts Req'd for Uplift =	0.42	COMBINED LOADING:	0.122 O.K.
# of Bolts Req'd for Shear =	0.32	Bolt Spacing =	58.4 in o.c.
Total # of Bolts Required =	2		

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 58.4 in o.c. along long side of curb

Longitudinal:

# of Bolts Req'd for Uplift =	0.26	COMBINED LOADING:	0.081 O.K.
# of Bolts Req'd for Shear =	0.32	Req'd Min Spacing =	28.2 in o.c.
Total # of Bolts Required =	2		

Use 5/8" φ A307 Bolts attached to steel angle below deck @ 28.2 in o.c. along short side of curb

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(619)727-4800

For Concrete anchorage: SEISMIC $(0.6-0.14SDS)D + 0.7\Omega_o E$ $(\Omega_o = 2.5)$

Concrete Attachment: 3/4" φ Hilti Hit-HY 200 adhesive anchors w/ 4" embed

$Tall_{LRFD}$ = 1722 lbs $Vall_{LRFD}$ = 2032 lbs $\alpha = (1 + 0.2SDS)D + 2.5E = 1.87$

$Tall_{ASD} = Tall_{LRFD}/\alpha$ = 920.9 lbs $Vall_{ASD} = Vall_{LRFD}/\alpha$ = 1086.6 lbs $(D = 0.465, E = 0.535)$

Transverse:

$Uplift_{MAX}$ =	6841 lbs	$Shear_{MAX}$ =	2983 lbs

$Compression_{SEISMIC}$ = 7140 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*wcurb]/wcurb

$Tension_{SEISMIC}$ = 6841 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 2983 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 7.43 spacing = 6.63 in o.c. Tapplied = 760.1 lbs

Min Bolts Req'd Shear = 2.74 spacing = 23.1875 in o.c. Vapplied = 331.4 lbs

Try using	9	bolts
spaced at	7.30	in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 1.13

Use 9 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 7.3 in o.c. max. along long side of curb w/ 4" embed

Longitudinal:

$Uplift_{MAX}$ =	4021 lbs	$Shear_{MAX}$ =	2983 lbs

$Compression_{SEISMIC}$ = 4321 lbs =[2.5*FpmaxASD*(Hcm+Hcurb)+(1+0.14S_{DS})*($WGT_{unit+curb}$/2)*Lcurb]/Lcurb

$Tension_{SEISMIC}$ = 4021 lbs =$Comp_{SEISMIC}$-(0.6-0.14S_{DS})*(WGTunit+curb)

$Shear_{SEISMIC}$ = 2983 lbs =2.5*FpmaxASD/2

Min Bolts Req'd Uplift = 4.37 spacing = 4.046875 in o.c. Tapplied = 574.5 lbs

Min Bolts Req'd Shear = 2.74 spacing = 8.09375 in o.c. Vapplied = 426.1 lbs

Try using	7	bolts
spaced at	4.70	in o.c.

COMBINED LOADING = $\frac{T_{applied}}{T_{allow,ASD}} + \frac{V_{applied}}{V_{allow,ASD}} \leq 1.2$ = 1.02

Use 7 - 3/4" φ Hilti Hit-HY 200 adhesive anchors @ 4.7 in o.c. max. along short side of curb w/ 4" embed

CURB DESIGN SUMMARY: CBWC-300

CURB RAIL THICKNESS: 0.0566 in 16 Gauge
UNIT CLIP THICKNESS: 0.0566 in 16 Gauge
 # OF CLIPS (LONG SIDE) - 2 clips with 2 - #10 SMS screws each clip
WEB STIFFENER: 16Ga x 3/4" x 7" (C-channel) stiffener at each clip
 # OF CLIPS (SHORT SIDE) - 1 clips with 4 - #10 SMS screws each clip
WEB STIFFENER: 16Ga x 3/4" x 7" (C-channel) stiffener at each clip
CORNER CONNECTION: Use 2 - 1/4" φ SAE Grade 8 bolts w/ 1/4-20-UNC Threaded inserts

CURB ANCHORAGE	WOOD	STEEL	CONCRETE
	5/8" φ lag screw w/ min. 3.5" embed (SGmin=0.43)	5/8" φ A307 bolts	3/4" φ thrd'd rod in Hilti HIT-HY 200 epoxy, min. 4" embed
LONG DIRECTION	4 @ 20.79 in o.c.	2 @ 58.38 in o.c.	9 @ 7.3 in o.c.
SHORT DIRECTION	3 @ 16.09 in o.c.	2 @ 28.19 in o.c.	7 @ 4.7 in o.c.