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Structural Calculations
BJG# 20220039

Project:

CRBV-PR20BHA-xx

Prepared for:

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Date:

August 2022

7/19/23

Micrometl Curb Product Number:
CRBV-PR20BHA-xx

Curb Inputs:

h_{curb}=	46.000	in	**Overall height from support substrate to top of curb*
h_{base}=	36.000	in	**Overall height from support substrate to bottom of isolation*
h_{iso}=	10.000	in	**Overall height from bottom of isolation to top of curb*
L_{curb}=	80.500	in	**Length of curb, inside dimension wall-to-wall*
W_{curb}=	46.375	in	**Width of curb, inside dimension, wall-to-wall*
d_i=	8.50	in	**Distance from transverse side to center of stiffener*
d_{is}=	8.50	in	**Distance from longitudinal side to center of stiffener*
$Curb_{wght}$=	621	lb	** Weight of curb*

Unit Inputs:

W_p=	1692	lb	**Max Unit Weight*
W_{cmax}=	771	lb	**Max corner weight*
W_{cmin}=	282	lb	**Min corner weight*
h_{unit}=	50.875	in	**Overall unit height above curb*
h_{cm}=	25.438	in	**Height above curb to center of mass*
L_{unit}=	88.125	in	**Overall unit length (longitudinal direction)*
W_{unit}=	53.250	in	**Overall unit width (transverse direction)*

Load Paths:

Vertical: The unit sits flat on the curb's support rail. Downward forces go down from the unit to the top of the support rail which sits on the the isolators, spanning as a beam between the isolators. Forces go down through the isolators and into the stiffeners, then down into the structure the curb sits on. Upward forces go from the curb's holddowns and into the support rail (without bending it, since the isolator and holddowns are lined up) and pulls up on the isolators via a welded connection. Then it goes through the stiffeners to the anchors in the roof structure.

Lateral: For longitudinal loads, shear is transmitted from the unit's base rail through a screw/welded connection to each holddown on the long sides. Shear then transfers through the holddowns and into to the curb's long side support rails and then through a welded connection to the isolators. Then it goes from the isolators down through the curb's web and stiffeners into the curb's bottom flange. The bottom flange of the curb is attached to the roof structure per one of 4 anchor details.

For transverse loads, the load travels through the units base rail directly to the holddowns on the short sides. The holddowns transmit the loads into the support rail which then transmit into the isolators on the short sides. Then it goes down throught the curb walls and into the bottom flange of the curb which is attached to the roof structure per one of the 4 anchors details.

NOTE: All calculations are in LRFD unless noted otherwise.
All calculations assume the base of the unit is a rigid body so that lateral loads are spread evenly amongst the rails beneath it and move as one.

KEY:		
	(orange)	Input
	(gray)	Check Cell
	(green)	Solution

Seismic Loading - 2021 International Building Code (2021 IBC) & 2022 California Building Code (2022 CBC):

S_s= 2.50 *(Assumed value, Conservative for most US locations)*

F_a= 1.20 *(Default minimum value for Site D, per ASCE 7-16, 11.4.4)*

I_p= 1.5 *(1.5 at worst case occupancy)*

a_p= 2.5 R_p= 2.0 Ω_0= 2.0

S_{ms}= 3

S_{ds}= 2.00

$$F_p = \frac{3(.4a_pS_{ds}I_pW_p)}{R_p} = 7614 \text{ lb}$$

(LRFD loads U.N.O.)

F_v = +/- 0.2SdsWp = 677 lbs +/-

Vertical effects of seimic load to the whole unit

Wind Loading:

A_{trans}= 31.1 ft^2 *Max projected area for transverse loads (large side of unit)*

A_{long}= 18.8 ft^2 *Max projected area for longitudinal loads (width side of unit)*

$$P_{EQ} = \frac{F_p}{A_{trans}} = 404.7 \text{ psf}$$

Equivalent Wind Pressure

K_Z= 1.13 K_{Zt}= 1.0 K_d= 0.85 V_w= 155 *(mph, nominal wind speed from ASCE 7-16 Fig. 26.5-1D)*

**for 60 ft bldg height max*

q_h= $0.00256*K_Z*K_{Zt}*K_d*V_w^2$ = 59.07 psf

$GC_{r,horiz}$= 1.9 $GC_{r,uplift}$= 1.5

$F_{w,trans}$= $q_h*GC_{r,horiz}*A_{trans}$ = 3495 lbs < F_p

Horizontal wind force to apply to the unit's long side

$F_{w,long}$= $q_h*GC_{r,horiz}*A_{trans}$ = 2112 lbs < F_p

Horizontal wind force to apply to the unit's short side

If wind controls:

$A_{max,uplift}$= $L_{unit} * W_{unit}$= 32.6 ft^2 *For wind uplift calcs...*

$F_{design,uplift}$ = $q_h * GC_{r,uplift} * A_{max,uplift}$ = 2888 lbs

Simultaneous uplift force

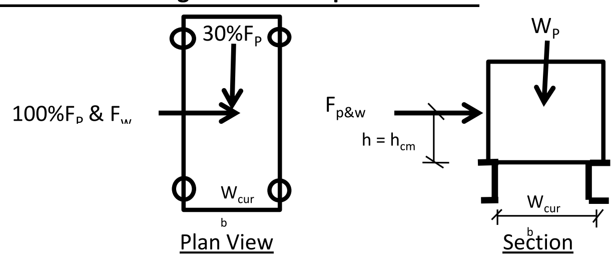
Load Calculations: 100% Transverse Loads For Holddown & Support Rail Loads

From Previous:

F_p =	7614	lb	*Seismic to be applied in each direction*
$F_{w,trans}$ =	3495	lb	*Wind to be applied in transverse direction*

For the transverse loads, the following load combinations show the uplift or downward force to one long side of the curb for both seismic and wind loads. The unit sits flat on the curb's support rail and therefore the downward forces bend the rail - NOT the holddowns. Holddowns only to receive uplift combined with shear. Assume Center of Geometry & Center of Mass coincide.

Transverse Loading: Fw & 100%Fp



Uplift to One Long Side (For Holddowns):

Max uplift force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #7: *-.9D + 1.0E + Fv*

$P_{tu,seis}$ = -(.9*Wp/2) + Fp*h.cm/(Wcurb) + Fv/2 = **3754** lbs

Max upward force to one long side from seismic

Max uplift force to one long side from wind, (Fw,uplift/2 is the uplift to one side of the unit):

2.3.1 Combo #5: *-.9D + 1.0W + Fw,uplift*

$P_{tu,wind}$ = -(.9*Wp/2) + Fw*h.cm/(Wcurb) + Fw,uplift/2= **2599** lbs

Max upward force to one long side from wind

Downward Force to One Long Side (For Support Rail):

Max downward force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #6: *1.2D + 1.0E + Fv*

$P_{td,seis}$ = (1.2*Wp/2) + Fp*h.cm/(Wcurb) + Fv/2 = **5530** lbs

Max downward force to one long side from seismic

Max downward force to one long side from wind:

2.3.1 Combo #4: *1.2D + 1.0W*

$P_{td,wind}$ = (1.2*Wp/2) + Fw*h.cm/(Wcurb) = **2932** lbs

Max downward force to one long side from wind

Shear Transfer (For Holddowns)

Transverse shear is transmitted through the unit's bottom rail, into screwed connections at the holddowns on the short sides of the curb.

$V_{t,seis}$=	$F_p/2$ =	3807	lbs	*Seismic shear to one short side*
$V_{t,wind}$=	$F_{w,long}/2$ =	1747	lbs	*Wind shear to one short side*

Load Calculations: 30% Longitudinal Seismic Loads For Holddown & Support Rail Loads

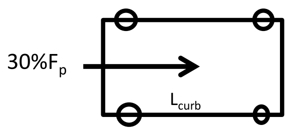
*FOR 30% LONGITUDINAL LOADS TO COMBINE WITH 100% TRANSVERSE LOADS (ASCE 7-16, 12.5.3.1a)

From Previous:

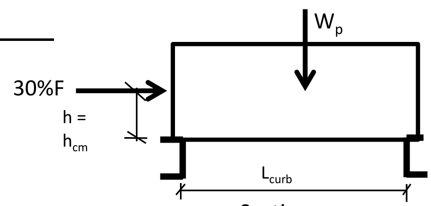
F_p =	7614	lb	*Seismic to be applied in transverse direction*
$30\%F_p$ =	2284	lb	*Seismic to be applied in longitudinal direction simultaneously*

For the longitudinal loads, the following load combinations show the uplift or downward force to one short side of the curb for both seismic and wind loads. The unit sits flat on the curb's support rail and therefore the downward forces bend the rail - NOT the holddowns. Holddowns only to receive uplift combined with shear. Assume Center of Geometry & Center of Mass coincide.

Longitudinal Loading: 30% Fp



Plan View



Section

Uplift to One Short End (For Holddowns):

Max uplift force to one short side from seismic, including Fv (Fv/2 is the vertical effects to one side of the unit):

2.3.6 Combo #7: *-.9D + 1.0E + Fv*

$P_{lu,30\%seis}$ = -(.9*Wp/2) + 30%Fp*h.cm/(Lcurb) + Fv/2 = **299** lbs

Max upward force to one long side from seismic (if negative, no uplift - use 0 for following equations if < 0)

Downward Force to One Short End (For Support Rail):

Max downward force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #6: *1.2D + 1.0E + Fv*

$P_{ld,30\%seis}$ = (1.2*Wp/2) + 30%Fp*h.cm/(Lcurb) + Fv/2 = **2076** lbs

Max downward force to one short side from seismic

Shear Transfer (For Holddowns)

Longitudinal shear is transmitted through the unit's bottom rails, through the screw connections at each HD on the long sides.

$V_{l,30\%seis}$= $F_p/2$ = **1143** lbs *Seismic shear to one long side*

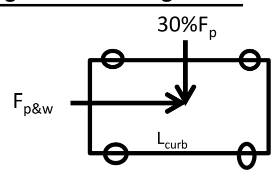
Load Calculations: 100% Longitudinal Loads For Holddown & Support Rail Loads

From Previous:

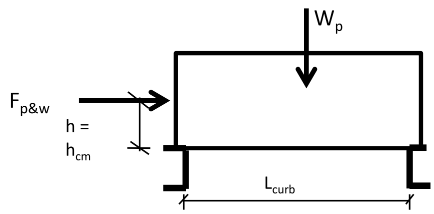
F_p =	7614	lb	*Seismic to be applied in each direction and at worst case angle*
$F_{w,long}$ =	2112	lb	*Wind to be applied in longitudinal direction*

For the longitudinal loads, the following load combinations show the uplift or downward force to one short side of the curb for both seismic and wind loads. The unit sits flat on the curb's support rail and therefore the downward forces bend the rail - NOT the holddowns. Holddowns only to receive uplift combined with shear. Assume Center of Geometry & Center of Mass coincide.

Longitudinal Loading:



Plan View



Section

Uplift to One Short Side (For Holddowns):

Max uplift force to one short side from seismic, including Fv (Fv/2 is the vertical effects to one side of the unit):

2.3.6 Combo #7: *-.9D + 1.0E + Fv*

$P_{lu,seis}$ = -(.9*Wp/2) + Fp*h.cm/(Lcurb) + Fv/2 = **1983** lbs

Max upward force to one short side from seismic

Max uplift force to one long side from wind, including Fw uplift (Fw,uplift/2 is the uplift to one side of the unit):

2.3.1 Combo #5: *-.9D + 1.0W + Fw,uplift*

$P_{lu,wind}$ = -(.9*Wp/2) + Fw*h.cm/(Lcurb) + Fw,uplift/2 = **1350** lbs

Max upward force to one short side from wind

Downward Force to One Short Side (For Support Rail):

Max downward force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #6: *1.2D + 1.0E + Fv*

$P_{ld,seis}$ = (1.2*Wp/2) + Fp*h.cm/(Lcurb) + Fv/2 = **3760** lbs

Max downward force to one short side from seismic

Max uplift force to one long side from wind, including Fw uplift (Fw,uplift/2 is the uplift to one side of the unit):

2.3.1 Combo #4: *1.2D + 1.0W*

$P_{ld,wind}$ = (1.2*Wp/2) + Fw*h.cm/(Lcurb) = **1682** lbs

Max downward force to one short side from wind

Shear Transfer (For Holddowns)

Longitudinal shear is transmitted through the unit's bottom rails, through the screw connections at each HD on the long sides.

$V_{l,seis}$=	$F_p/2$ =	3807	lbs	*Seismic shear to one long side*
$V_{l,wind}$=	$F_{w,long}/2$ =	1056	lbs	*Wind shear to one long side*

Load Calculations: 30% Transverse Loads For Holddown & Support Rail Loads

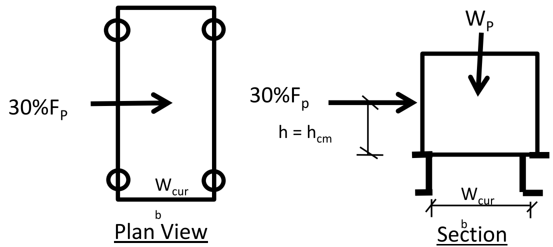
*FOR 30% TRANSVERSE LOADS TO COMBINE WITH 100% LONGITUDINAL LOADS (ASCE 7-16, 12.5.3.1a)

From Previous:

F_p =	7614	lb	*Seismic to be applied in each direction*
$30\%F_p$ =	2284	lb	*Wind to be applied in transverse direction*

For the transverse loads, the following load combinations show the uplift or downward force to one long side of the curb for both seismic and wind loads. The unit sits flat on the curb's support rail and therefore the downward forces bend the rail - NOT the holddowns. Holddowns only to receive uplift combined with shear. Assume Center of Geometry & Center of Mass coincide.

Transverse Loading: 30%Fp



Uplift to One Long Side (For Holddowns):

Max uplift force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #7: *-.9D + 1.0E + Fv*

$P_{tu,30\%seis}$ = -(.9*Wp/2) + .3Fp*h.cm/(Wcurb) + Fv/2 = **830** lbs

Max upward force to one long side from seismic

Downward Force to One Long Side (For Support Rails):

Max downward force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #6: *1.2D + 1.0E + Fv*

$P_{td,30\%seis}$ = (1.2*Wp/2) + Fp*h.cm/(Wcurb) + Fv/2 = **2607** lbs

Max downward force to one long side from seismic

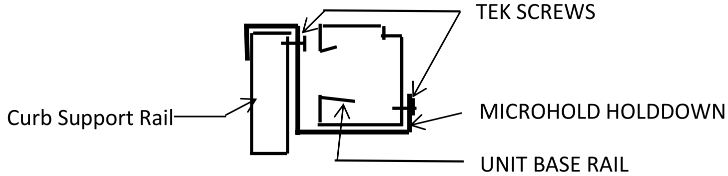
Shear Transfer (For Holddowns)

Transverse shear is transmitted through the unit's bottom rail, into screwed connections at the holddowns on the short sides of the curb.

$V_{t,30\%seis}$= $F_p/2$ = **1142** lbs *Seismic shear to one short side*

Holddown Design Loads: Transverse

Connections between the holddowns & the unit base rail or curb flange are designed for uplift and shear. Loads in the tranverse direction transmit shear to the holddowns on the short sides and uplift to the holddowns on the long sides. Effects from 30% seismic loads in the longitudinal direction, per ASCE 7-16 12.5.3, transmit shear to the holddowns on the long sides and uplift to the holddowns on the short sides.



$N_{HD,long}$ = 3 *# of holddowns on each long side*
$N_{HD,short}$ = 2 *# of holddowns on each short side*

Loads to a Single Holddown:

Transverse Loading: 100%

Uplift: *Uplift force from the transverse loading will distribute to all holddowns on one long side.*

$P_{long,E}$ =	$P_{tu,seis}/N_{HD,long}$ =	1251	lb	**seismic uplift to one HD due to trans. loads*
$P_{long,W}$ =	$P_{tu,wind}/N_{HD,long}$ =	866	lb	**wind uplift to one HD due to trans. loads*

Shear: *Shear force from the transverse loading will distribute to all holddowns on one short side.*

$V_{short,E}$=	$V_{t,seis}/N_{HD,short}$ =	1904	lb	**seismic shear to one HD due to trans. loads*
$V_{short,W}$=	$V_{t,wind}/N_{HD,short}$=	874	lb	**wind shear to one HD due to trans. loads*

Longitudinal Loading: 30%

Uplift: *Uplift force from the 30% longitudinal loading will distribute to all holddowns on one short side.*

$P_{short,30\%E}$ =	$P_{lu,30\%seis}/N_{HD,short}$ =	149	lb	**seismic uplift to one HD due to 30% longitudinal loads*

Shear: *Shear force from the 30% longitudinal loading will distribute to all holddowns on one long side.*

$V_{long,30\%E}$ =	$V_{l,30\%seis}/N_{HD,long}$ =	381	lb	**seismic shear to one HD due to 30% longitudinal loads*

Transverse Holddown Connection Design Loads:

$P_{t,long,seis}$ =	$\sqrt{P_{long,E}^2 + V_{long,30\%E}^2}$ =	1308	lb
$P_{t,long,wind}$=	$P_{long,W}$ =	866	lb
$P_{t,short,seis}$=	$\sqrt{V_{short,E}^2 + P_{short,30\%E}^2}$ =	1909	lb
$P_{t,short,wind}$=	$V_{short,W}$ =	874	lb

**for design of the connections from the holddown to the unit base rail and the holddown to the curb flange in combined shear and uplift from analysis in the transverse direction*

Holddown Design Loads: Longitudinal

Connections between the holddowns & the unit base rail or curb flange are designed for uplift and shear. Loads in the longitudinal direction transmit shear to the holddowns on the long side and uplift to the holddowns on the short sides. Effects from 30% seismic loads in the transverse direction, per ASCE 7-16 12.5.3, transmit shear to the holddowns on the short sides and uplift to the holddowns on the long sides.

Loads to a Single Holddown:

Longitudinal Loading: 100%

Uplift: *Uplift force from the longitudinal loading will distribute to all holddowns on one short side.*

$P_{short,E}$ = $P_{lu,seis}/N_{HD,short}$ = 992 lb **seismic uplift to one HD due to long. loads*

$P_{short,W}$ = $P_{lu,wind}/N_{HD,short}$ = 675 lb **seismic uplift to one HD due to long. loads*

Shear: *Shear force from the longitudinal loading will distribute to all holddowns on one long side.*

$V_{long,E}$ = $V_{l,seis}/N_{HD,long}$ = 1269 lb **seismic shear to one HD due to long. loads*

$V_{long,W}$ = $V_{l,wind}/N_{HD,long}$ = 352 lb **wind shear to one HD due to long. loads*

Tranverse Loading: 30%

Uplift: *Uplift force from the 30% transverse loading will distribute to all holddowns on one long side.*

$P_{long,30\%E}$ = $P_{tu,30\%seis}/N_{HD,long}$ = 277 lb **seismic uplift to one HD due to 30% transverse loads*

Shear: *Shear force from the 30% transverse loading will distribute to all holddowns on one short side.*

$V_{short,30\%E}$ = $V_{t,30\%seis}/N_{HD,short}$ = 571 lb **seismic shear to one HD due to 30% transverse loads*

Longitudinal Holddown Connection Design Loads:

$P_{l,long,seis} = \sqrt{V_{long,E}^2 + P_{long,30\%E}^2} =$ 1299 lb

$P_{l,long,wind} = V_{long,W} =$ 352 lb

$P_{l,short,seis} = \sqrt{P_{short,E}^2 + V_{short,30\%E}^2} =$ 1144 lb

$P_{l,short,wind} = P_{short,W} =$ 675 lb

**for design of the connections from the holddown to the unit base rail and the holddown to the curb flange in combined shear and uplift from analysis in the longitudinal direction*

Controlling Load to a Single Holddown Connection: (Either Direction)

The loads below are combined uplift and shear loads for design of the holddown connections to the unit base rail and the curb top flange. These connections are screwed and welded and acting in shear. The 100% + 30% rule is included for each directional seismic load per ASCE 7-16, 12.5.3.

FOR CONNECTIONS AT HOLDDOWN CONNECTIONS

Max Shear due to Seismic Load=	1909	lb
Max Shear due to Wind Load=	874	lb
Max load to 1 HD connection: $P_{HD,screws}$ =	1909	lb
SEISMIC CONTROLS		

Unit Base Rail to HD Connection: (Direct Shear)

Use Self-drilling, Self-tapping Steel Screw, Assume unit base rail is minimum 16 gage.
With screw type #10 in 16 gage minimum hold down materal ultimate = 605 lbs
With screw type #12 in 16 gage minimum hold down materal ultimate = 645 lbs

V_{n1} = 605 lb *per screw*

Total Screws required at each HD to Unit Base Rail:

$$\#\text{ of screws} = \frac{P_{HD,screws}}{V_{n1}} = 4$$

Use 3 screws min

Per HD, for the Unit to the HD

Holddown FBD

Holddown In Bending

Several curbs and units of similar size and weight have been shake table tested in the past. These tests demonstrated that the holddowns can flex elastically in uplift, but do not fail. After flexing they retain their original shape and are assumed to retain their full capacity after flexing. These calculations assume that the unit's base rail, which attaches inside of the holddown and spans the length of the unit, is stiff enough to prevent the holddowns from failing in uplift.

Support Rail Vertical Design: Transverse Loads to Long Sides

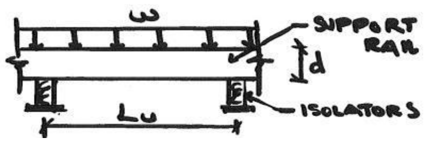
The unit sits flat on the support rail, which runs under each side of the unit. The support rail sits on top of the isolator, acting as a beam spanning between the isolators. Check the rail in bending caused by vertical loads.
Use 10 ga. cold-formed overlapping channels. Use properties for hollow rectangle. Conditions and formulas per AISI Cold-Formed Steel Specification (2016).

Bending (Per F2.1):

t =	0.1345	in	C_b =	1.14	
F_y =	33	ksi	E =	29000	ksi
b =	1.438	in	G =	11500	ksi
d =	6.132	in	ϕ_b =	0.9	

$N_{stiff,long}$ = 3
number of stiffeners per long side

A_x = 2*t*d = 1.649508 in^2
b_1 = b -2t = 1.169 in
d_1 = d - 2t = 5.863 in
b_{eff} = b - 3t = 1.0345 in
h_{eff} = d - 3t = 5.7285 in



$$L_{u,long} = \frac{(L_{curb}-2d_i)}{N_{stiff,long}-1} = 31.750 \text{ in}$$

$$J = \frac{(2b^2 * d^2 * t^2)}{t*(b+d)} = 2.76 \text{ in}^4$$

$$S_x = \frac{b*d^2}{6} - \frac{b_1 d_1{}^2}{6} = 2.31 \text{ in}^3$$

$$I_y = \frac{d*b^3}{12} - \frac{d_1 b_1{}^3}{12} = 0.74 \text{ in}^4$$

Allowed Lateral Unbraced Length, L_a *For lateral-torsional buckling strength of closed box member*

Eq. F2.1.4-1

$$L_a = \frac{.36 * C_b * \pi}{F_y * S_x} * \sqrt{EGJI_y} = 440.5 \text{ in}$$

Lu < La, OK

Since Lu < La, use flexural strength determined per Section C3.1.1

Nominal Moment, M_n

Eq. F2.1-2

M_n = S_x * F_y = 76.4 k-in
$\phi_b M_n$ = 68.74 k-in

Max Moment, M_u

$P_{transverse}$= 5530 lb

**max vertical load due to transverse loads from previous*

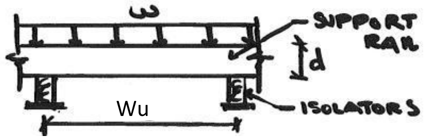
$$M_u = \frac{\left(\frac{P_{transverse}}{1000 * L_{curb}}\right) * L_{u,long}{}^2}{8} = 8.66 \text{ k-in} < 68.74$$

LONG SIDE BENDING OK

Support Rail: Short Side Vertical Loads

The support rail acts as a beam spanning between the isolators. If there are no isolators on the short sides, use the rail's unbraced length as width of curb for beam spanning from long side to long side.

Use 10 ga. cold-formed overlapping channels. Use properties for hollow rectangle from previous. Conditions and formuals per AISI Cold-Formed Steel Specification (2016), analyze as a beam.



Bending: (Per F2.1)

$N_{stiff,short}$ = 3 **number of stiffeners per short side*

$W_{u,short} = \dfrac{(W_{curb} - 2d_{is})}{N_{stiff,short} - 1} =$ 14.688 in **unbraced length of short side rail*

Allowed Lateral Unbraced Short Side Length, W_a

Eq. F2.1.4-1 $W_a = \dfrac{.36 * C_b * \pi}{F_y * S_x} * \sqrt{EGJI_y} =$ 440.5 in **Wu < Wa, OK**

Nominal Moment, M_n

Eq. F2.1-2 $M_n = S_x * F_y =$ 76.4 k-in

$\phi_b M_n$ = 68.74 k-in

Max Moment, M_u $P_{longitudinal}$ = 3760 lb **max vertical load due to longitudinal loads from previous*

$M_u = \dfrac{\left(\dfrac{P_{longitudinal}}{1000 * W_{curb}}\right) * W_{u,long}^{2}}{8} =$ 2.19 k-in < 68.74

SHORT SIDE BENDING OK

Check Angled Seismic Load to Support Rail Corner

At the corner, assume the support rail spans as a beam from the last isolator on the long side to the short side of the curb. Check this portion of the rail for bending due to seismic loads at an angle. The 100% + 30% rule is included for each directional seismic load per ASCE 7-16, 12.5.3.

Design Loads for Transverse Direction to One Corner:

Uplift:

$P_{tu,corner,\ seis} = \frac{P_{tu,seis}}{2} + \frac{P_{lu,30\%seis}}{2} =$ 2026 *lb*

$P_{tu,corner,\ wind} = \frac{P_{tu,wind}}{2} =$ 1300 *lb*

Downward:

$P_{td,\ corner,seis} = \frac{P_{td,seis}}{2} + \frac{P_{ld,30\%seis}}{2} =$ 3803 *lb*

$P_{td,\ corner,wind} = \frac{P_{td,wind}}{2} =$ 1466 *lb*

Design Loads for Longitudinal Direction to One Corner:

Uplift:

$P_{lu,\ corner,seis} = \frac{P_{lu,seis}}{2} + \frac{P_{tu,30\%seis}}{2} =$ 1407 *lb*

$P_{lu,\ corner,wind} = \frac{P_{lu,wind}}{2} =$ 675 *lb*

Downward:

$P_{ld,\ corner,seis} = \frac{P_{ld,seis}}{2} + \frac{P_{td,30\%seis}}{2} =$ 3183 *lb*

$P_{ld,\ corner,wind} = \frac{P_{ld,wind}}{2} =$ 841 *lb*

Controlling Design Loads to (1) Corner:

Max Force to Corner from Seismic= 3803 lb

Max Force to Corner from Wind= 1466 lb

Max load to one Corner: P_{Corner} = **3803** lb

SEISMIC CONTROLS

Check Angled Seismic Load to Support Rail Corner

Use 10 ga. cold-formed overlapping channels. Use properties for hollow rectangle from previous. Conditions and formuals per AISI Cold-Formed Steel Specification (2016), analyze as a beam.

Bending: (Per F2.1)

$L_{u,corner}$ = d_i = 8.500 in **unbraced length of rail at corner*

Allowed Lateral Unbraced Short Side Length, W_a

Eq. F2.1.4-1 $W_a = \frac{.36 * C_b * \pi}{F_y * S_x} * \sqrt{EGJI_y} =$ 440.5 in **Lu < La, OK**

Nominal Moment, M_n

Eq. F2.1-2 $M_n = S_x * F_y =$ 76.4 k-in

$\phi_b M_n =$ 68.74 k-in

Max Moment, M_u P_{corner} = 3803 lb **max vertical load due to angled sesimic loads from previous*

$$M_u = \frac{\left(\frac{P_{corner}}{1000 * L_{u,corner}}\right) * L_{u,corner}^2}{2} =$$ 16.16 < 68.74

**for distributed load on cantilever* CORNER BENDING OK

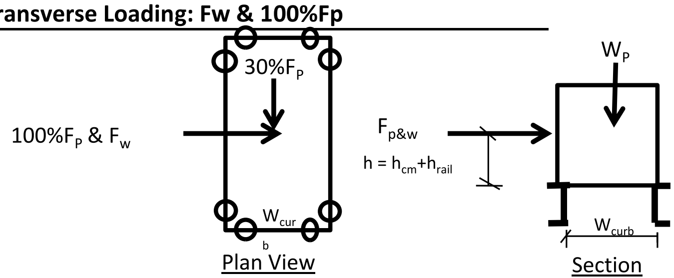
Recalculate Loads for Isolators (Include Support Rail Height) (ASD)

Load Recalculations: 100% Transverse Loads for Isolators

From Previous for ASD Loads:			
$.7F_p$ =	5330	lb	*Seismic to be applied in each direction*
$.6F_{w,trans}$ =	2097	lb	*Wind to be applied in transverse direction*

For the transverse loads, the following load combinations show the uplift or downward force to one long side of the curb for both seismic and wind loads. The following load calculations include the height of the support rail in order to calculate the vertical loads to the isolators. Assume Center of Geometry & Center of Mass coincide.

Transverse Loading: Fw & 100%Fp



Uplift to One Long Side (For Isolators):

Max uplift force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.4.5 Combo #10: *-.6D + 0.7E + .7Fv*

$F_{tu,seis,ASD}$ = -(.6*Wp/2) + .7Fp*(h.cm+h.rail)/(Wcurb) + .7Fv/2 = **3358** lbs

Max up force to one long side from seismic

Max uplift force to one long side from wind, (Fw,uplift/2 is the uplift to one side of the unit):

2.4.1 Combo #7: *-.6D + 0.6W + .6Fw,uplift*

$F_{tu,wind,ASD}$ = -(.6*Wp/2) + .6Fw,trans*(h.cm+h.rail)/(Wcurb) + .6Fw,uplift/2= **1786** lbs

Max up force to one long side from wind

Downward Force to One Long Side (For Isolators):

Max downward force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.4.5 Combo #8: *1.0D + 0.7E + 0.7Fv*

$F_{td,seis,ASD}$ = (1.0*Wp/2) + .7*Fp*(h.cm+h.rail)/(Wcurb) + .7Fv/2 = **4711** lbs

Max down force to one long side from seismic

Max downward force to one long side from wind:

2.4.1Combo #5: *1.0D + 0.6W*

$F_{td,wind,ASD}$ = (1.0*Wp/2) + .6Fw,trans*(h.cm+h.rail)/(Wcurb) = **2273** lbs

Max down force to one long side from wind

Shear Force to One Short Side (For Isolators):

Max shear force to one short side from seismic and wind, repsectively:

$V_{t,seis,ASD}$ = $.7F_p$ /2 = **2665** lb

$V_{t,wind,ASD}$ = $.6F_{w,trans}$ /2 = **1048** lb

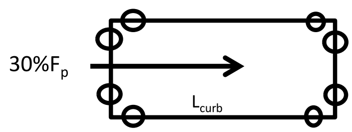
Load Recalculations: 30% Longitudinal Seismic Loads For Isolators Loads (ASD)

*FOR 30% LONGITUDINAL LOADS TO COMBINE WITH 100% TRANSVERSE LOADS (ASCE 7-16, 12.5.3.1a)

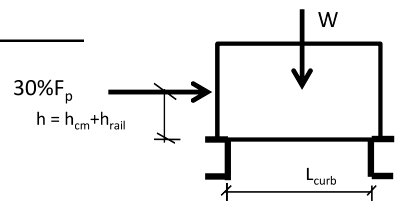
From previous for ASD Loads:			
$.7F_p$ =	5330	lb	*Seismic to be applied in transverse direction*
$30\%*.7F_p$ =	1599	lb	*Seismic to be applied in longitudinal direction simultaneously*

For the longitudinal loads, the following load combinations show the uplift or downward force to one short side of the curb for both seismic and wind loads. The following load calculations include the height of the support rail in order to calculate the vertical loads to the isolators. Assume Center of Geometry & Center of Mass coincide.

Longitudinal Loading: 30% Fp



Plan View



Section

Uplift to One Short End (For Isolators):

Max uplift force to one short side from seismic, including Fv (Fv/2 is the vertical effects to one side of the unit):

2.4.5 Combo #10: *-.6D + 0.7E + 0.7Fv*

$F_{lu,30\%seis,ASD}$ = -(.6*Wp/2) + 30%*.7Fp*(h.cm+h.rail)/(Lcurb) + .7Fv/2 = **356** lbs

Max uplift force to one short side from seismic

Downward Force to One Short End (For Isolators):

Max downward force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.4.5 Combo #8: *1.0D + 0.7E + 0.7Fv*

$F_{ld,30\%seis,ASD}$ = (1.0*Wp/2) + 30%*.7Fp*(h.cm+h.rail)/(Lcurb) + .7Fv/2 = **1710** lbs

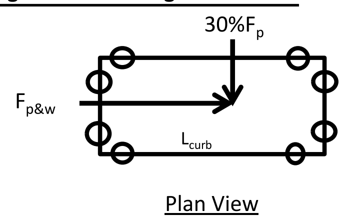
Max down force to one short side from seismic

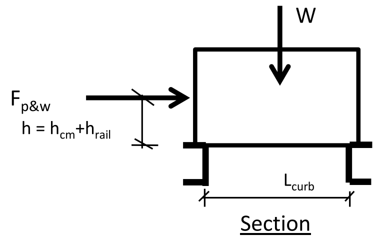
Load Recalculations: 100% Longitudinal Loads For Isolator Loads (ASD)

From Previous for ASD Loads:			
$.7F_p$ =	5330	lb	*Seismic to be applied in each direction and at worst case angle*
$.6F_{w,long}$ =	1267	lb	*Wind to be applied in longitudinal direction*

For the longitudinal loads, the following load combinations show the uplift or downward force to one short side of the curb for both seismic and wind loads. The following load calculations include the height of the support rail in order to calculate the vertical loads to the isolators. Assume Center of Geometry & Center of Mass coincide.

Longitudinal Loading:





Uplift to One Short Side (For Isolators):

Max uplift force to one short side from seismic, including Fv/2, the vertical effects to one side of the unit):

2.4.5 Combo #10: *-.6D + 0.7E + 0.7Fv*

$F_{lu,seis,ASD}$ = -(.6*Wp/2) + .7Fp*(h.cm+h.rail)/(Lcurb) + .7Fv/2 = **1820** lbs

Max up force to one short side from seismic

Max uplift force to one long side from wind, including Fw,uplift/2, the uplift to one side of the unit):

2.4.1 Combo #7: *-.6D + 0.6W + 0.6Fw,uplift*

$F_{lu,wind,ASD}$ = -(.9*Wp/2) + Fw,long*(h.cm+h.rail)/(Lcurb) + Fw,uplift/2 = **856** lbs

Max up force to one short side from wind

Downward Force to One Short Side (For Isolators):

Max downward force to one long side from seismic, including Fv/2, the vertical effects to one side of the unit):

2.4.5 Combo #8: *1.0D + 0.7E + 0.7Fv*

$F_{ld,seis,ASD}$ = (1.0*Wp/2) + .7Fp*(h.cm+h.rail)/(Lcurb) + .7Fv/2 = **3173** lbs

Max down to one short side from seismic

Max downward force to one long side from wind

2.4.1Combo #5: *1.0D + 0.6W*

$F_{ld,wind,ASD}$ = (1.0*Wp/2) + .6Fw*(h.cm+h.rail)/(Lcurb) = **1343** lbs

Max down force to one short side from wind

Shear Force to One Long Side (For Isolators):

Max shear force to one long side from seismic and wind, repsectively:

$V_{l,seis,ASD}$ = $.7F_p$ /2 = **2665** lb

$V_{l,wind,ASD}$ = $.6F_{w,long}$ /2 = **633** lb

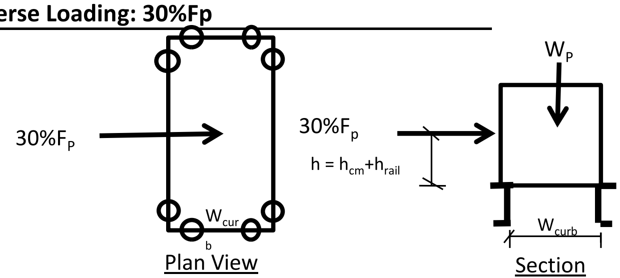
Load Recalculations: 30% Transverse Loads For Isolators Loads (ASD)

*FOR 30% TRANSVERSE LOADS TO COMBINE WITH 100% LONGITUDINAL LOADS (ASCE 7-16, 12.5.3.1a)

From Previous:			
$.7F_p$ =	5330	lb	*Seismic to be applied in each direction*
$30\%*.7F_p$=	1599	lb	*Seismic applied in transverse direction simultaneously*

For the transverse loads, the following load combinations show the uplift or downward force to one long side of the curb for both seismic and wind loads. The following load calculations include the height of the support rail in order to calculate the vertical loads to the isolators. Assume Center of Geometry & Center of Mass coincide.

Transverse Loading: 30%Fp



Uplift to One Long Side (For Isolators):

Max uplift force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.4.5 Combo #10: *-.6D + 0.7E + 0.7Fv*

$F_{tu,30\%seis,ASD}$ = -(.6*Wp/2) + 30%*.7Fp*(h.cm+h.rail)/(Wcurb) + .7Fv/2 = **564** lbs

Max uplift force to one long side from seismic

Downward Force to One Long Side (For Isolators):

Max downward force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.4.5 Combo #8: *1.0D + .7E + .7 Fv*

$F_{td,30\%seis,ASD}$ = (Wp/2) + 30%*.7Fp*(h.cm+h.rail)/(Wcurb) + .7Fv/2 = **2341** lbs

Max down force to one long side from seismic

Isolator Vertical Design Loads: (ASD)

Isolators to take all uplift, downward, and shear loads from the unit through the support rail. Transverse loads are assumed to cause overturning loads on the long sides and shear loads on the short sides. Longitudinal loads are assumed to cause overturning loads on the short sides and shear loads on the long sides.

N_{long} =	3		*Number of Type CQA Isolators on each long side*
N_{short} =	3		*Number of Type CQA Isolators on each short side side*
Allowable Vert=	2117	lb	*from OPM-0401-13 Report*
Allowable Horiz=	1322	lb	*from OPM-0401-13 Report*

The following show the max vertical or shear loads to one isolator on any side as caused by transverse or longitudinal loading on the unit.

Vertical Force per Isolator on a Long Side:

Max Vertical Force to Long Side:

$MaxVert_{long} = \max(F_{tu,seis,ASD}, F_{tu,wind,ASD}, F_{td,seis,ASD}, F_{td,wind,ASD}) =$ 4711 lb

$R_{iso,long} = \frac{MaxVert_{long}}{N_{long}} =$ 1570.4 < 2117 **OK**

Horizontal Force per Isolator on a Long Side:

Max Shear Force to Long Side:

$MaxHoriz_{long} = \max(V_{l,seis,ASD}, V_{l,wind,ASD}) =$ 2665 lb

$V_{iso,long} = \frac{MaxHoriz_{long}}{N_{long}} =$ 888.3 < 1322 **OK**

Vertical Force per Isolator on a Short Side:

Max Vertical Force to Short Side:

$MaxVert_{short} = \max(F_{lu,seis,ASD}, F_{lu,wind,ASD}, F_{ld,seis,ASD}, F_{ld,wind,ASD}) =$ 3173 lb

$R_{iso,short} = \frac{MaxVert_{short}}{N_{short}} =$ 1057.7 < 2117 **OK**

Horizontal Force per Isolator on a Short Side:

Max Shear Force to Short Side:

$MaxHoriz_{short} = \max(V_{t,seis,ASD}, V_{t,wind,ASD}) =$ 2665 lb

$V_{iso,long} = \frac{MaxHoriz_{short}}{N_{short}} =$ 888.3 < 1322 **OK**

ISOLATOR SUMMARY

USE 3 ISOLATORS PER LONG SIDE

USE 3 ISOLATORS PER SHORT SIDE

Recalculate Loads for Isolators/Stiffeners (Include Support Rail Height) (LRFD)

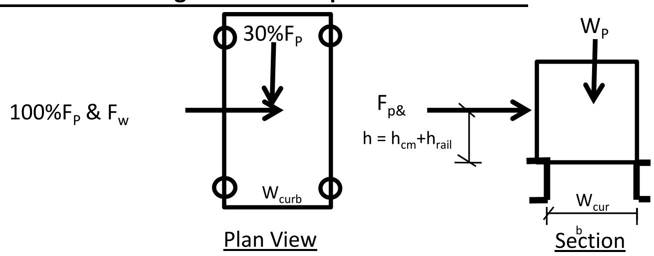
Load Recalculations: 100% Transverse Loads for Isolators & Stiffeners

From Previous:

F_p =	7614	lb	*Seismic to be applied in each direction*
$F_{w,trans}$ =	3495	lb	*Wind to be applied in transverse direction*

For the transverse loads, the following load combinations show the uplift or downward force to one long side of the curb for both seismic and wind loads. The following load calculations include the height of the support rail in order to calculate the vertical loads to the isolators. Assume Center of Geometry & Center of Mass coincide.

Transverse Loading: Fw & 100%Fp



Uplift to One Long Side (For Isolators):

Max uplift force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #7: *-.9D + 1.0E + Fv*

$F_{tu,seis}$ = -(.9*Wp/2) + Fp*(h.cm+h.rail)/(Wcurb) + Fv/2 = **4760** lbs

Max up force to one long side from seismic

Max uplift force to one long side from wind, (Fw,uplift/2 is the uplift to one side of the unit):

2.3.1 Combo #5: *-.9D + 1.0W + Fw,uplift*

$F_{tu,wind}$ = -(.9*Wp/2) + Fw,trans*(h.cm+h.rail)/(Wcurb) + Fw,uplift/2= **3061** lbs

Max up force to one long side from wind

Downward Force to One Long Side (For Isolators):

Max downward force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #6: *1.2D + 1.0E + Fv*

$F_{td,seis}$ = (1.2*Wp/2) + Fp*(h.cm+h.rail)/(Wcurb) + Fv/2 = **6537** lbs

Max down force to one long side from seismic

Max downward force to one long side from wind:

2.3.1 Combo #4: *1.2D + 1.0W*

$F_{td,wind}$ = (1.2*Wp/2) + Fw,trans*(h.cm+h.rail)/(Wcurb) = **3394** lbs

Max down force to one long side from wind

Load Recalculations: 30% Longitudinal Seismic Loads For Isolators Loads

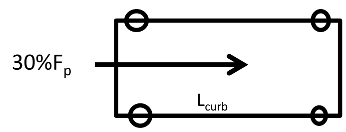
*FOR 30% LONGITUDINAL LOADS TO COMBINE WITH 100% TRANSVERSE LOADS (ASCE 7-16, 12.5.3.1a)

From Previous:

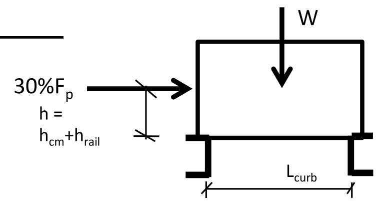
F_p =	7614	lb	*Seismic to be applied in transverse direction*
30%F_p =	2284	lb	*Seismic to be applied in longitudinal direction simultaneously*

For the longitudinal loads, the following load combinations show the uplift or downward force to one short side of the curb for both seismic and wind loads. The following load calculations include the height of the support rail in order to calculate the vertical loads to the isolators. Assume Center of Geometry & Center of Mass coincide.

Longitudinal Loading: 30% Fp



Plan View



Section

Uplift to One Short End (For Isolators):

Max uplift force to one short side from seismic, including Fv (Fv/2 is the vertical effects to one side of the unit):

2.3.6 Combo #7: -.9D + 1.0E + Fv

$F_{lu,30\%seis}$ = -(.9*Wp/2) + 30%Fp*(h.cm+h.rail)/(Lcurb) + Fv/2 = **473** lbs

Max uplift force to one short side from seismic

Downward Force to One Short End (For Isolators):

Max downward force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #6: 1.2D + 1.0E + Fv

$F_{ld,30\%seis}$ = (1.2*Wp/2) + 30%Fp*(h.cm+h.rail)/(Lcurb) + Fv/2 = **2250** lbs

Max down force to one short side from seismic

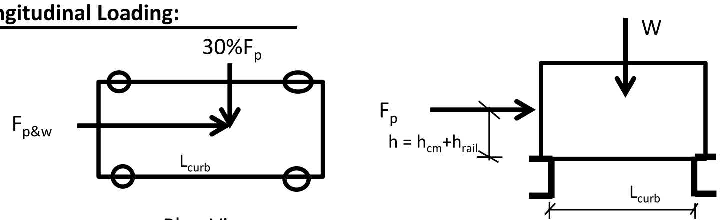
Load Recalculations: 100% Longitudinal Loads For Isolator Loads

From Previous:

F_p =	7614	lb	*Seismic to be applied in each direction and at worst case angle*
$F_{w,long}$ =	2112	lb	*Wind to be applied in longitudinal direction*

For the longitudinal loads, the following load combinations show the uplift or downward force to one short side of the curb for both seismic and wind loads. The following load calculations include the height of the support rail in order to calculate the vertical loads to the isolators. Assume Center of Geometry & Center of Mass coincide.

Longitudinal Loading:



Plan View

Section

Uplift to One Short Side (For Holddowns):

Max uplift force to one short side from seismic, including Fv (Fv/2 is the vertical effects to one side of the unit):

2.3.6 Combo #7: *-.9D + 1.0E + Fv*

$F_{lu,seis}$ = -(.9*Wp/2) + Fp*(h.cm+h.rail)/(Lcurb) + Fv/2 = **2563** lbs

Max up force to one short side from seismic

Max uplift force to one long side from wind, includes Fw uplift (Fw,uplift/2 is the uplift to one side of the unit):

2.3.1 Combo #5: *-.9D + 1.0W + Fw,uplift*

$F_{lu,wind}$ = -(.9*Wp/2) + Fw,long*(h.cm+h.rail)/(Lcurb) + Fw,uplift/2 = **1511** lbs

Max up force to one short side from wind

Downward Force to One Short Side (For Support Rail):

Max downward force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #6: *1.2D + 1.0E + Fv*

$F_{ld,seis}$ = (1.2*Wp/2) + Fp*(h.cm+h.rail)/(Lcurb) + Fv/2 = **4340** lbs

Max down to one short side from seismic

Max downward force to one long side from wind

2.3.1 Combo #4: *1.2D + 1.0W*

$F_{ld,wind}$ = (1.2*Wp/2) + Fw*(h.cm+h.rail)/(Lcurb) = **1843** lbs

Max down force to one short side from wind

Load Recalculations: 30% Transverse Loads For Isolators Loads

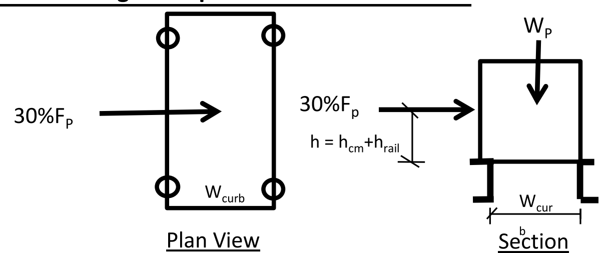
*FOR 30% TRANSVERSE LOADS TO COMBINE WITH 100% LONGITUDINAL LOADS (ASCE 7-16, 12.5.3.1a)

From Previous:

F_p =	7614	lb	*Seismic to be applied in each direction*
$30\%F_p$ =	2284	lb	*Wind to be applied in transverse direction*

For the transverse loads, the following load combinations show the uplift or downward force to one long side of the curb for both seismic and wind loads. The following load calculations include the height of the support rail in order to calculate the vertical loads to the isolators. Assume Center of Geometry & Center of Mass coincide.

Transverse Loading: 30%Fp



Plan View　　　Section

Uplift to One Long Side (For Holddowns):

Max uplift force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #7:　　*-.9D + 1.0E + Fv*

$F_{tu,30\%seis}$ = -(.9*Wp/2) + 30%Fp*(h.cm+h.rail)/(Wcurb) + Fv/2 = **1132** lbs

Max upward force to one long side from seismic

Downward Force to One Long Side (For Support Rails):

Max downward force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #6:　　*1.2D + 1.0E + Fv*

$F_{td,30\%seis}$ = (1.2*Wp/2) + 30%Fp*(h.cm+h.rail)/(Wcurb) + Fv/2 = **2909** lbs

Max down force to one long side from seismic

Isolator & Stiffener Vertical Design Loads: (LRFD)

Isolators & Stiffeners to take all uplift and downward loads from the unit through the support rail. All seismic loads include 30% load effects from the perpendicular direction from previous load calculations per ASCE 7-16 12.5.3

N_{long} = 3 *Number of CQA Isolators on each long side*

N_{short} = 3 *Number of CQA Isolators on each long side*

The isolators and stiffeners located at the long sides are assumed to take vertical loads from transverse loads and shear load from longitudinal loads. The isolators and stiffeners on the short sides will take vertical loads from the longitudinal loads and shear loads from the transverse loads.

Design Loads for Transverse Direction to Single Isolator & Stiffener:

Uplift to Long Side:

$F_{iso,tu,\,seis} = \dfrac{F_{tu,seis}}{N_{long}} =$ 1587 *lb*

$F_{iso,tu,wind} = \dfrac{F_{tu,wind}}{N_{long}} =$ 1020 *lb*

Downward to Long Side:

$F_{iso,td,\,seis} = \dfrac{F_{td,seis}}{N_{long}} =$ 2179 *lb*

$F_{iso,td,\,wind} = \dfrac{F_{td,wind}}{N_{long}} =$ 1131 *lb*

Shear to Short Side:

$V_{iso,t,seis} = \dfrac{F_p/2}{N_{short}} =$ 1269 *lb*

$V_{iso,t,wind} = \dfrac{F_{w,trans}/2}{N_{short}} =$ 582 *lb*

For 30% loads in Longidutinal Direction

30% Vert to Short Sides:

$F_{iso,30\%long,\,seis} = \dfrac{\max(F_{lu,30\%seis}, F_{ld,30\%seis})}{N_{short}} =$ 750 *lb*

30% Shear to Long Sides:

$V_{iso,30\%long,\,seis} = \dfrac{(30\%F_{p)})/2}{N_{long}} =$ 381 *lb*

Isolator & Stiffener Vertical Design Loads: (LRFD)

The isolators and stiffeners located at the long sides are assumed to take vertical loads from transverse loads and shear load from longitudinal loads. The isolators and stiffeners on the short sides will take vertical loads from the longitudinal loads and shear loads from the transverse loads.

Design Loads for Longitudinal Direction to Single Isolator & Stiffener:

Uplift to Short Side:

$F_{iso,lu,\ seis} = \dfrac{F_{lu,seis}}{N_{short}} =$ 854 *lb*

$F_{iso,lu,\ wind} = \dfrac{F_{lu,wind}}{N_{short}} =$ 504 *lb*

Downward to Short Side:

$F_{iso,ld,\ seis} = \dfrac{F_{ld,seis}}{N_{short}} =$ 1447 *lb*

$F_{iso,ld,\ wind} = \dfrac{F_{ld,wind}}{N_{short}} =$ 614 *lb*

Shear to Long Side:

$V_{iso,l,seis} = \dfrac{(F_p/2)}{N_{long}} =$ 1269 *lb*

$V_{iso,l,wind} = \dfrac{(F_{w,long}/2)}{N_{long}} =$ 352 *lb*

For 30% loads in Transverse Direction

30% Vertical to Long Sides:

$F_{iso,30\%trans,\ seis} = \dfrac{\max(F_{tu,30\%seis}, F_{td,30\%seis})}{N_{long}} =$ 970 *lb*

30% Shear to Short Sides:

$V_{iso,30\%long,\ seis} = \dfrac{(30\%F_p)/2}{N_{short}} =$ 381 *lb*

Component Loads for Isolator Connection and Stiffener Design

Max Uplift Load to One Isolator Connection:

$F_{iso,seis,up}$ = 1587

$F_{iso,wind}$ = 1020

$F_{iso,up}$ = **1587** SEISMIC CONTROLS

Max Shear Load to One Isolator Connection:

V_{seis} = 1269

V_{wind}= 582

V_{iso} = **1269** SEISMIC CONTROLS

Max Downward Load to One Isolator Connection:

$F_{iso,seis,dn}$ = 2179

$F_{iso,wind,dn}$ = 1131

$F_{iso,dn}$ = **2179** SEISMIC CONTROLS

Check Isolator Connection to Support Rail

Assume the isolator housing is pinned to the support beam at the top and fixed to the top flange of the base curb.

The isolator is connected to the support rail by a 1/8" fillet weld around the 1" tall by 2" wide tab at the top of this isolator to the support beam on 3 sides. Check the strength of the 4" total length of fillet weld.

ϕR_n = 1.392Dl = 1.392*(2 sixteenths)(4 in) = 11.14 k

From previous: F_{iso} = 1587 lb **combined max uplift and shear to one isolator*

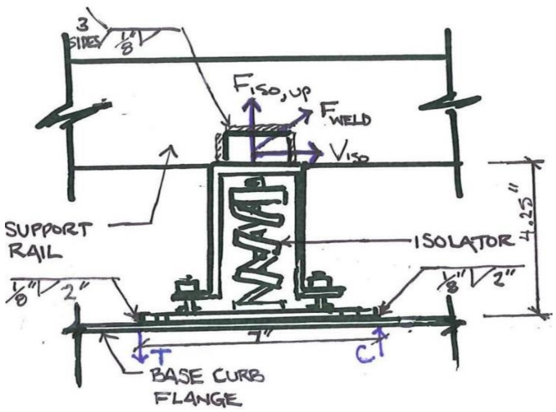
V_{iso} = 1269 lb

$F_{weld} = \sqrt{F_{iso}^2 + V_{iso}^2} =$ 2032 lb < 11136 lb

WELD OK

Check Isolator Connection to Base Curb Flange: In-Plane Loads

The isolator is connected to the base curb top flange by a 2" long, 1/8" fillet weld at each side of the isolator housing base. Check the strength of one 2" long weld at one side of the base of the isolator. Assume fixed to the curb flange.



Tension to one side of the isolator base:	F_{up} =	$F_{iso,up}/2$ =	793	lb	**direct uplift*
	F_O=	V_{iso}*4.25"/7" =	770	lb	**from overturn*
		T =	1564	lb	**combined uplift and overturn*
Shear to one side of the isolator base:	V_{weld} =	$V_{iso}/2$=	635	lb	**lateral load to 1 side of 1 isolator*
	F_{weld} =	$\sqrt{T^2 + V_{weld}{}^2}$ =	1688	lb	

For weld design strength w/ tranverse loading:

Eq. J2.1-1	ϕR_n =	ϕtLF_u =	.6(.06")(4")(45ksi) =	8.10	k	>	1.69	k

WELD OK

Check Shear in Base Curb Web G2

Shear from the controlling lateral load is transferred from the isolators into the curb flange and down through the base curb web. Check the shear strength of the base curb web on the short sides.

W_{curb} =	46.4	in	**from previous*
t =	0.075	in	**from previous*
ϕ_v =	0.90		

Max Shear from Lateral Load, V_u:

V_u= max(F_p, $F_{w,trans}$)/2 = 3807 lbs **to one side*

Nominal Shear from Lateral Load, V_n:

$\phi_v V_n$ = $\phi_v A_w F_y$ = $\phi_v W_{curb} t F_y$ = 103.3 ksi > 3.81 k

BASE CURB WEB OK

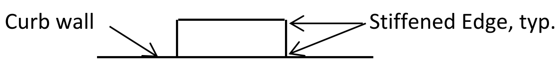
Frame Assembly Stiffeners: For Max 36" Height

Stiffeners to take all upward and downward forces from a group of 3 isolators, there is a stiffener under each group of 3 isolators. All vertical seismic loads in the tranverse direction include effects from 30% load from the longitudinal direction and loads in the longitudinal direction include effects from 30% load in the transverse directions from previous load calculations per ASCE 7-16 12.5.3.

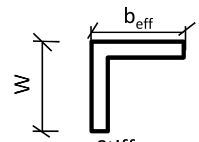
**Using 14 gage stiffener material*

Conditions and formulas per AISI Cold-Formed Steel Specification (2016)

Assume each stiffener is a closed rectangular section. Effective width of eash side based on stiffened corners at each corner of the rectangle. Stiffeners to take entire vertical load.



Plan View of Stiffener



Stiffener corner

Inputs:

t =	0.075	in	F_y =	33	ksi	N =	1	*# of isolators per stiff.*
H =	36	in	E =	29000	ksi	$N_{stiff,long}$ =	3	*# stiff per long side*
L =	7	in	ϕ_c =	0.85		$N_{stiff,short}$ =	3	*# stiff per short side*
W =	1.50	in	μ =	0.29		$N*F_{iso}$ =	2179	*lbs - 1 stiffener at 2 isolators*

A_n = L*W - (L-2t)(W-2t) = 1.253 in^2 **unreduced rectangular area for "r" calculation*

$$r_1 = \left(\frac{L*W^3-(L-2t)(W-2t)^3}{12A}\right)^{0.5} = 0.671 \text{ in}$$

$$r_2 = \left(\frac{W*L^3-(W-2t)(L-2t)^3}{12A}\right)^{0.5} = 2.316 \text{ in}$$

k = 1 $\quad r_{min}$ = min(r_1,r_2) = 0.671 in $\quad \frac{k*H}{r_{min}}$ = 53.634

Eq. E2.1-1 $\quad F_e = \frac{\pi^2 E}{\left(\frac{kH}{r_{min}}\right)^2} = 99.50$ ksi

Eq. E2-4 $\quad \lambda_c = \left(\frac{F_y}{F_e}\right)^{0.5} = 0.58$

Eq E2-3 $\quad F_n = \frac{.877}{\lambda^2} * F_y$ if $\lambda_c > 1.5$

Eq E2-2 $\quad$ or $(.658^{\lambda_c^2}) * F_y$ if $\lambda_c < 1.5$ ⟶ F_n = 28.72 ksi

Eq 1.1-4 $\quad F_{cr} = k\left(\frac{\pi^2 E}{12(1-\mu^2)}\right)\left(\frac{t}{L-2t}\right)^2 = 12.49$ ksi $\quad$ **k = 4 for stiffened edges*

Eq 1.1-3 $\quad \lambda = \left(\frac{F_n}{F_{cr}}\right)^{0.5} = 1.52$ [>] 0.673

b_{eff} = ρb = 3.86 in $\quad$ **Reduced length based on stiffened edges*

A_e = (2*b_{eff}*t) + (2*W*t) = 0.80 in^2 $\quad$ **2 short sides + beff of 2 long sides*

P_n = A_e*F_n = 23.10 kip ⟶

P_u = 2.18 kip **from above*

ϕ_c*P_n =	19.63	kip
P_u =	2.18	kip
STIFFENERS OKAY		

Check Stiffener in Bending and Compression

The isolator connection to the base curb causes a moment in the stiffener below to combine with the above direct axial loads. The following calculations assume that the stiffener doubly symmetric column and checks the combined bending and axial compression in accordance with 2016 AISI Cold-Formed Steel Code. There are 3 isolators per stiffener.

Compression load from 30% overturn load in opp. direction

$$\frac{N\bar{P}}{\phi_c P_n} = \frac{0.97}{19.63} = 0.049 < 0.15$$

Use Eq. H1.2-1

Eq. H1.2-1

$$\frac{\bar{P}}{\phi_c P_n} + \frac{\bar{M}_x}{\phi_b M_{nx}} + \frac{\bar{M}_y}{\phi_b M_{ny}} \leq 1.0$$

Stiffener Section Properties:

b =	W=	1.50	in
d =	L =	7.00	in
b_1 =	b -2t =	1.35	in
d_1 =	d - 2t =	6.85	in
b_{eff} =	b - 3t =	1.275	in
h_{eff} =	d - 3t =	6.775	in
L_{stiff}=	H =	36	in

$$J = \frac{(2b^2 * d^2 * t^2)}{t * (b + d)} = 1.95 \text{ in}^4 \qquad I = \frac{b * d^3}{12} - \frac{b_1 d_1{}^3}{12} = 6.72 \text{ in}^4$$

$$S_x = \frac{b * d^2}{6} - \frac{b_1 d_1{}^2}{6} = 1.69 \text{ in}^3$$

Inputs:

ϕ_b = 0.9 $\qquad C_b$ = 1.00 $\qquad$ G = 11500 ksi

Lateral Unbraced Length, L_u: *For lateral-torsional buckling strength of closed box member*

Eq. F2.1.4-1

$$L_u = \frac{.36 * C_b * \pi}{F_y * S_x} * \sqrt{EGJI} = 1337 \text{ in} > 36$$

Lu > Lstiff, OK

Since $L_u > L_{stiff}$, use flexural strength determined per Section C3.1.1

Nominal Moment, M_n:

Eq. F2.1-2 $\quad M_n = S_x * F_y =$ 55.9 k-in

$\phi_b M_n$ = 50.27 k-in

Max Moment, M_u: *N = number of isolators per stiffener, from previous*

V_{iso} = 1269 *(from previous)*

$M_x = NV_{iso}*(h_{iso}) =$ 5.71 k-in < 50.27 k-in

BENDING OK

Combinded Moment and Compression:

Eq. H1.2-1

$$\frac{\bar{P}}{\phi_c P_n} + \frac{\bar{M}_x}{\phi_b M_{nx}} + \frac{\bar{M}_y}{\phi_b M_{ny}} = 0.16 < 1.0$$

COMBINED BENDING & COMPRESSION OK

Recalculate Loads for Anchorage:

h_{curb}= 36 in

Loads to anchor to include the curb weight in the seismic load calculations and the curb height in the wind load calculations.

Seismic Loading - 2021 IBC & 2022 CBC

$F_{p,anchors} = \dfrac{3(.4a_pS_{ds}I_p)}{R_p}(W_p + Curb_{wght}) =$ **10409** lb

$F_{v,anch} =$ $0.2Sds(Wp+Curb_{wght})$= 926 lbs +/- *Vertical effects of seimic load to the whole unit*

Wind Loading - 2021 IBC & 2022 CBC

$A_{trans,anchors} =$ $(h_{unit}+h_{curb})*L_{unit} =$ 59 ft^2

$A_{long,anchors} =$ $(h_{unit}+h_{curb})*W_{unit} =$ 36 ft^2

$F_{w,trans,anch} =$ $q_h*GC_{r,horiz}*A_{trans,anchors} =$ **6654** lb

Horizontal wind force to apply to the unit and curb's long side

$F_{w,long,anch} =$ $q_h*GC_{r,horiz}*A_{long,anchors} =$ **4021** lb

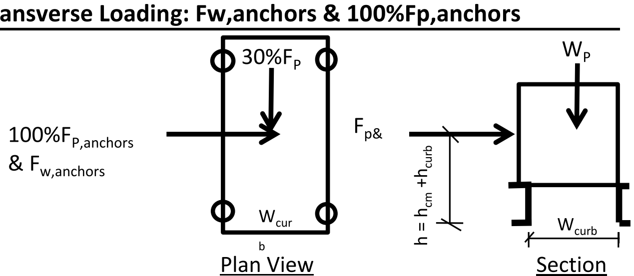
Horizontal wind force to apply to the unit and curb's short side

$F_{design,uplift} =$ 2888 lb *from previous - uplift force to be applied simultaneuously*

Load Recalculations: 100% Transverse Loads For Anchors

For the transverse loads, the following load combinations show the uplift force to one long side of the curb for both seismic and wind loads. Seismic loads to long side also include loads cause by 30% of the seismic force in the longitudinal direction per ASCE 7-16 21.5.3.a. Assume Center of Geometry & Center of Mass coincide.

Transverse Loading: Fw,anchors & 100%Fp,anchors



Uplift to One Long Side (For Anchors):

Max uplift force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #7: -.9D + 1.0E + Fv

$P_{tu,seis,anch}$= -(.9*Wp/2) + Fp,anchors*(h.cm+h.curb)/(Wcurb) + Fv,anch/2 = **15735** lbs

Max uplift force to one long side from wind, including Fw uplift (Fw,uplift/2 is the uplift to one side of the unit):

2.3.1 Combo #5: -.9D + 1.0W + Fw,uplift

$P_{tu,wind,anch}$= -(.9*Wp/2) + Fw,long,anch*(h.cm+h.curb)/(Wcurb) + Fw,uplift/2 = **10933** lbs

Load Recalculations: 100% Transverse Loads For Anchors Continued:

Shear Transfer (For Anchors)

Max shear force due to seismic in the transverse direction from the unit & curb to be distributed to all anchors:

$V_{t,seis,anch}$ = $F_{p,anchors}$ = **10409** lb

Max shear force due to wind in transverse direction from the unit & curb to be distributed to all anchors:

$V_{t,wind,anch}$ = $F_{w,trans,anch}$ = **6654** lb

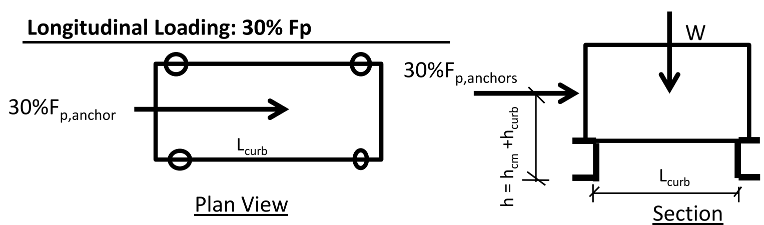
Load Recalculations: 30% Longitudinal Loads For Anchors:

*FOR 30% LONGITUDINAL LOADS TO COMBINE WITH 100% TRANSVERSE LOADS (ASCE 7-16, 12.5.3.1a)

From Previous:			
$F_{p,anchors}$ =	10409	lb	*Seismic to be applied in transverse direction*
$30\%F_{p,anchors}$ =	3123	lb	*Seismic to be applied in longitudinal direction simultaneously*

For the longitudinal loads, the following load combinations show the uplift force to one short side of the curb for both seismic and wind loads. Seismic loads to short side also include loads cause by 30% of the seismic force in the transverse direction per ASCE 7-16 21.5.3.1a. Assume Center of Geometry & Center of Mass coincide.

Longitudinal Loading: 30% Fp



Uplift to One Short Side (For Anchors):

Max uplift force to one short side from seismic, including Fv (Fv/2 is the vertical effects to one side of the unit):

2.3.6 Combo #7: -.9D + 1.0E + Fv

$P_{lu,30\%seis,anch}$ = -(.9*Wp/2) + 30%Fp,anchors*(h.cm+h.curb)/(Lcurb) + Fv,anchors/2 = **2473** lbs

Max upward force to one short side from seismic

Shear Transfer (For Anchors)

Longitudinal shear transmitted to all of the anchors.

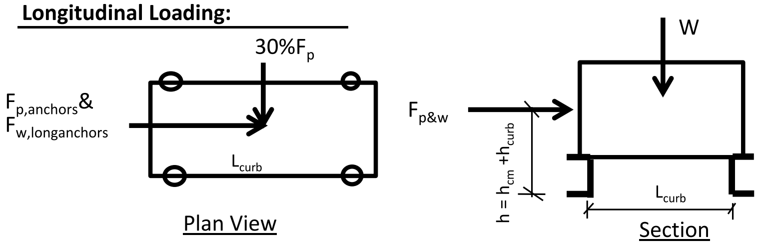
$V_{l,30\%seis,anch}$= $30\%F_{p,anchors}$ = **3123** lbs *Seismic shear to distribute to all anchors*

Load Recalculations: 100% Longitudinal Loads For Anchors

From Previous:			
$F_{p,anchors}$ =	10409	lb	*Seismic to be applied in longitudinal*
$F_{w,long,anch}$ =	4021	lb	*Wind to be applied in longitudinal direction*

For the longitudinal loads, the following load combinations show the uplift force to one short side of the curb for both seismic and wind loads. Seismic loads to short side also include loads cause by 30% of the seismic force in the transverse direction per ASCE 7-16 21.5.3.1a. Assume Center of Geometry & Center of Mass coincide.

Longitudinal Loading:



Uplift to One Short Side (For Anchors):

Max uplift force to one short side from seismic, including Fv (Fv/2 is the vertical effects to one side of the unit):

2.3.6 Combo #7: -.9D + 1.0E + Fv

$P_{lu,seis,anch}$ = -(.9*Wp/2) + Fp,anchors*(h.cm+h.curb)/(Lcurb) + Fv,anch/2 = **8938** lbs

Max upward force to one short side from seismic

Max uplift force to one long side from wind, including Fw uplift (Fw,uplift/2 is the uplift to one side of the unit):

2.3.1 Combo #5: -.9D + 1.0W + Fw,uplift

$P_{lu,wind,anch}$ = -(.9*Wp/2) + Fw,long,anch*(h.cm+h.curb)/(Lcurb) + Fw,uplift/2 = **4251** lbs

Max upward force to one short side from wind

Shear Transfer (For Anchors)

Max shear force due to seismic in the longitudinal direction to be distributed to all anchors:

$V_{l,seis,anch}$= $F_{p,anchors}$= **10409** lbs *Seismic shear to one long side*

Max shear force due to wind in the longitudinal direction to be distributed to all anchors:

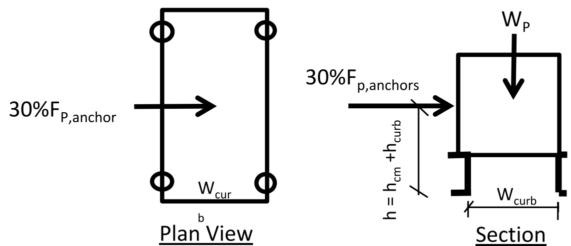
$V_{l,wind,anch}$= $F_{w,long,anch}$ = **4021** lbs *Wind shear to one long side*

Load Recalculations: 30% Transverse Loads For Anchors

From Previous:			
F_p =	10409	lb	*Seismic to be applied in each direction*
$30\%F_p$ =	3123	lb	*Wind to be applied in transverse direction*

For the transverse loads, the following load combinations show the uplift force to one long side of the curb for both seismic and wind loads. Seismic loads to long side also include loads cause by 30% of the seismic force in the longitudinal direction per ASCE 7-16 21.5.3.1a. Assume Center of Geometry & Center of Mass coincide.

Transverse Loading: 30%Fp



Uplift to One Long Side (For Anchors):

Max uplift force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #7: -.9D + 1.0E + Fv

$P_{tu,30\%seis,anch}$ = -(.9*Wp/2) + 30%Fp,anchors*(h.cm+h.curb)/(Wcurb) + Fv,anch/2 = **4512** lbs

upward force to one long side from seismic

Shear Transfer (For Anchors):

30% transverse shear transmitted to all of the anchors.

$V_{t,30\%seis,anch}$= $30\%F_{p,anchors}$ = **3123** lbs

Seismic shear to distribute to all anchors

Anchor Loads: Combined 100% with 30% opposite direction

**Distribute the loads to one corner. Assume anchors at each corner to take the worst case tension load from overturn equally. Shear to be distributed equally amongst anchors along the sides between the anchors used for uplift at the corners.*

Design Loads for Transverse Direction to One Corner:

Uplift:

$R_{tu,corner,\ seis,anch} = \dfrac{P_{tu,seis,anch}}{2} + \dfrac{P_{lu,30\%seis,anch}}{2} =$ 9104 *lb*

$R_{tu,corner,\ wind,anch} = \dfrac{P_{tu,wind,anch}}{2} =$ 5467 *lb*

Design Loads for Longitudinal Direction to One Corner:

Uplift:

$R_{lu,\ corner,seis,anch} = \dfrac{P_{lu,seis,anch}}{2} + \dfrac{P_{tu,30\%seis,anch}}{2} =$ 6725 *lb*

$R_{lu,\ corner,wind,anch} = \dfrac{P_{lu,wind,anch}}{2} =$ 2125 *lb*

Controlling Uplift Loads to One Corner:

Max Force to Corner from Seismic= 9104 lb
Max Force to Corner from Wind= 5467 lb

Max load to one Corner: T_{Corner} = **9104** lb — SEISMIC CONTROLS

Controlling Shear Loads to Anchors on All Sides:

Combined shear for loads to distribute to all anchors along all sides of the curb (not at corners.)

$V_{t,conc,seis} = \sqrt{F_p^{\,2} + 30\% F_p^{\,2}} =$ 10867 lb

$V_{t,conc,wind} = \sqrt{F_{w,long.anch}^{\,2} + F_{w,trans,anch}^{\,2}} =$ 7775 lb

Max Shear to Anchors at Sides: $V_{maxanchors}$ = **10867** lb — SEISMIC CONTROLS

Anchorage to Steel sub-Structure (LRFD):

For ultimate loads for connecting the curb flange to steel, use 1/2" Dia. 307 Bolts.

1/2" A307 Steel Bearing w/ Washer:	
18 gage min flange = 1.44 kip	**from Table IV-8C of 2016 AISI Cold Formed Steel Manual*
16 gage min flange = 1.82 kip	
14 gage min flange = 2.28 kip	

Table IV-6	$A307_T$ =	6.63	kip	
Table IV-7	$A307_V$ =	3.44	kip	
	$A307_{bearing}$ =	2.28	kip	**Using 14 gage*

$A307_{Tallow}$ = min($A307_T$, $A307_V$, $A307_{bearing}$) = 2.28 kip

For Bolts Screws (Uplift Only):

Number of Bolts at Corner= $T_{corner}/A307_{Tallow}$ = 4 bolts per corner

For Side Bolts (Shear Only):

$BoltSpacing_{corner}$=	6	**inches from curb corner to next corner bolt along side*
$Number\_Bolts_L$ =	2	*# bolts per long side, min*
$Number\_Bolts_S$ =	1	*# bolts per short side, min*
a=	2	**inches from corner edge to first corner anchor*

$$BoltSpacing_{Long} = \frac{L_{curb} - \left(BoltSpacing_{corner} * (Number\_Bolts_{corner} - 2)\right) - 2a}{Number\_Bolts_L + 1} = 21.500 \text{ in}$$

$$BoltSpacing_{Short} = \frac{W_{curb} - \left(BoltSpacing_{corner} * (Number\_Bolts_{corner} - 2)\right) - 2a}{Number\_Bolts_S + 1} = 15.188 \text{ in}$$

Total # of Bolts = 6 bolts

$$V_{perScrew} = \frac{V_{maxanchors}}{A307_{Allow}} = 5 \text{ bolts} \quad < \text{ or } = \quad 6$$

OK

Use	2	Bolts per Long Side
Use	1	Bolts per Short Side
Use	4	Bolts per Corner
	22	Total Bolts

Optional Weld Instead of Bolting:

ϕ_w = 0.50

For welding curb directly to steel structural member, matching to strength of 1/2" A307 bolt.

For Fillet weld: (Table IV-1)
18 gage allow = 1.62 kip/in
16 gage allow = 2.03 kip/in
14 gage allow = 2.53 kip/in

For Fillet Weld on Flange: $R_{perinch}$ = 2.53 k/in **Using 14 gage*

$W_{length} = \dfrac{A307_{allow}}{\phi_w * R_{perinch}} =$ 1.80 in < 2.5 in

For a 1/8" Fillet Weld: Weld_capacity = W_{length} * 2.8 k/in = 5.05 kip > $A307_{allow}$

Use 2.5" long 1/8" Fillet Weld to replace each required A307 bolt as indicated above

Anchorage to Wood sub-Structure: (LRFD)

Using hex lag screw : Shear per NDS Table 12K *With 1/2" lag screws into 14 or 16 gage curb with (2) 12 gage thickeners = 690 lbs* *With 5/8" lag screws into 14 or 16 gage curb with (2) 12 gage thickeners = 949 lbs*	
Using hex lag screw: Withdrawal per NDS Table 12.2A *1/2"x4" long hex lag screw into wood = 1784 lbs* *1/2"x5" long hex lag screw into wood = 2192 lbs* *5/8"x5" long hex lag screw into wood = 2502 lbs* *5/8"x6" long hex lag screw into wood = 2984 lbs*	*For 1/2" Steel Bearing Washers* *18 gage min. flange = 1914 lbs* *16 gage min. flange = 2430 lbs* *14 gage min. flange = 3036 lbs*
Using Simpson 1/4x3" SDS: Shear per NDS Table 12M *14 gage min. flange = 349 lbs* *16 gage min. flange = 250 lbs* *18 gage min. flange = 194 lbs*	*Using Simpson 1/4xL" SDS: Withdrawal per NDS Table 12.2B* *3" long #14 screw (2" penetration)= 742 lbs* *4" long #14 screw (2.67" penetration)= 990 lbs*

Ultimate Shear Capacity: Z_{wood} = 349 lb *Using 1/4 x 4in. SDS*

*Zwood = Z * Kf * φ * λ = Z * 3.32 * .65 * 1.0*

Ultimate Withdrawal Capacity: W_{wood} = 742 lb

*Wwood = W * Kf * φ * λ = W * (Lscrew*(2/3)) * 3.32 * .65 * 1.0*

For Corner Screws (Uplift Only):

Number of Screws at Corner= T_{corner}/W_{Wood} = 14 Screws at corner

For Side Screws (Shear Only):

$ScrewSpacing_{corner}$= 3 **inches from curb corner to next corner screw along side*

$Number\_Screws_L$ = 14 *# screws per long side, min*

$Number\_Screws_S$ = 2 *# screws per short side, min*

$$ScrewSpacing_{Long} = \frac{L_{curb} - (ScrewSpacing_{corner} * (Number\_Screws_{corner} - 2)) - 2in}{Number\_Screws_L + 1} = 2.833$$

$$ScrewSpacing_{Short} = \frac{W_{curb} - (ScrewSpacing_{corner} * (Number\_Screws_{corner} - 2)) - 2in}{Number\_Screws_S + 1} = 2.792$$

Total # of Screws in Shear = 32 screws

$V_{perScrew} = \frac{V_{maxanchors}}{Z_{wood}} = 32$ screws < or = 32 **OK**

Use	14	SDS per Long Side
Use	2	SDS per Short Side
Use	14	SDS per Corner
	88	Total SDS

Recalculate Loads for Anchorage:

h_{curb}= 24 in

Loads to anchor to include the curb weight in the seismic load calculations and the curb height in the wind load calculations.

Seismic Loading - 2021 IBC & 2022 CBC

$F_{p,anchors}$ = $\frac{3(.4a_p S_{ds} I_p)}{R_p}(W_p + Curb_{wght})$ = **10409** lb

$F_{v,anch}$ = 0.2Sds(Wp+$Curb_{wght}$)= 926 lbs +/- *Vertical effects of seimic load to the whole unit*

Wind Loading - 2021 IBC & 2022 CBC

$A_{trans,anchors}$ = $(h_{unit}+h_{curb})*L_{unit}$ = 52 ft^2

$A_{long,anchors}$ = $(h_{unit}+h_{curb})*W_{unit}$ = 31 ft^2

$F_{w,trans,anch}$ = $q_h*GC_{r,horiz}*A_{trans,anchors}$ = **5830** lb

Horizontal wind force to apply to the unit and curb's long side

$F_{w,long,anch}$ = $q_h*GC_{r,horiz}*A_{long,anchors}$ = **3523** lb

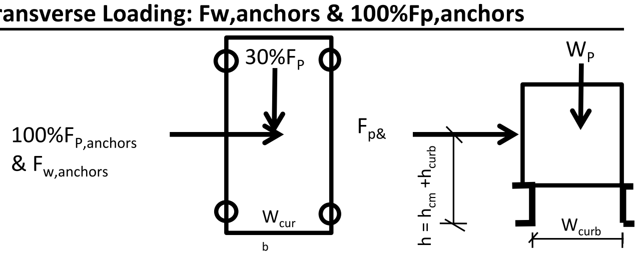
Horizontal wind force to apply to the unit and curb's short side

$F_{design,uplift}$ = 2888 lb *from previous - uplift force to be applied simultaneuously*

Load Recalculations: 100% Transverse Loads For Anchors

For the transverse loads, the following load combinations show the uplift force to one long side of the curb for both seismic and wind loads. Seismic loads to long side also include loads cause by 30% of the seismic force in the longitudinal direction per ASCE 7-16 21.5.3.a. Assume Center of Geometry & Center of Mass coincide.

Transverse Loading: Fw,anchors & 100%Fp,anchors



Plan View Section

Uplift to One Long Side (For Anchors):

Max uplift force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #7: -.9D + 1.0E + Fv

$P_{tu,seis,anch}$= -(.9*Wp/2) + Fp,anchors*(h.cm+h.curb)/(Wcurb) + Fv,anch/2 = **13042** lbs

Max uplift force to one long side from wind, including Fw uplift (Fw,uplift/2 is the uplift to one side of the unit):

2.3.1 Combo #5: -.9D + 1.0W + Fw,uplift

$P_{tu,wind,anch}$= -(.9*Wp/2) + Fw,long,anch*(h.cm+h.curb)/(Wcurb) + Fw,uplift/2 = **8155** lbs

Load Recalculations: 100% Transverse Loads For Anchors Continued:

Shear Transfer (For Anchors)

Max shear force due to seismic in the transverse direction from the unit & curb to be distributed to all anchors:

$V_{t,seis,anch}$ = $F_{p,anchors}$ = **10409** lb

Max shear force due to wind in transverse direction from the unit & curb to be distributed to all anchors:

$V_{t,wind,anch}$ = $F_{w,trans,anch}$ = **5830** lb

Load Recalculations: 30% Longitudinal Loads For Anchors:

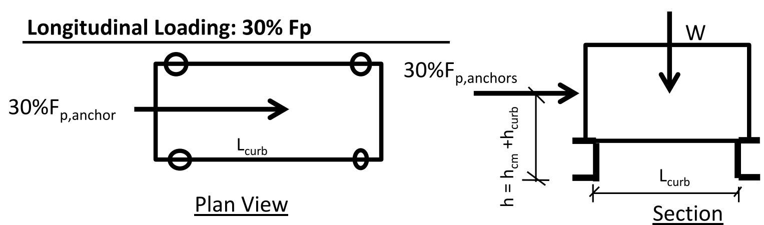
*FOR 30% LONGITUDINAL LOADS TO COMBINE WITH 100% TRANSVERSE LOADS (ASCE 7-16, 12.5.3.1a)

From Previous:

$F_{p,anchors}$ =	10409	lb	*Seismic to be applied in transverse direction*
$30\%F_{p,anchors}$ =	3123	lb	*Seismic to be applied in longitudinal direction simultaneously*

For the longitudinal loads, the following load combinations show the uplift force to one short side of the curb for both seismic and wind loads. Seismic loads to short side also include loads cause by 30% of the seismic force in the transverse direction per ASCE 7-16 21.5.3.1a. Assume Center of Geometry & Center of Mass coincide.

Longitudinal Loading: 30% Fp



Uplift to One Short Side (For Anchors):

Max uplift force to one short side from seismic, including Fv (Fv/2 is the vertical effects to one side of the unit):

2.3.6 Combo #7: -.9D + 1.0E + Fv

$P_{lu,30\%seis,anch}$ = -(.9*Wp/2) + 30%Fp,anchors*(h.cm+h.curb)/(Lcurb) + Fv,anchors/2 = **2007** lbs

Max upward force to one short side from seismic

Shear Transfer (For Anchors)

Longitudinal shear transmitted to all of the anchors.

$V_{l,30\%seis,anch}$= $30\%F_{p,anchors}$ = **3123** lbs *Seismic shear to distribute to all anchors*

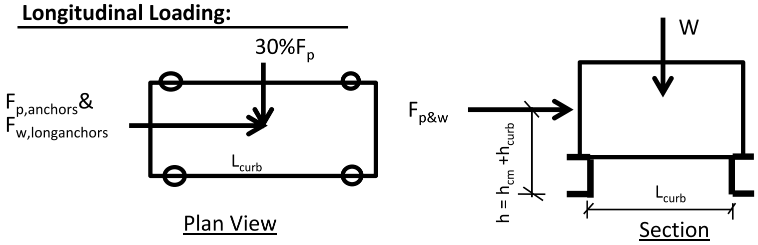
Load Recalculations: 100% Longitudinal Loads For Anchors

From Previous:

$F_{p,anchors}$ =	10409	lb	*Seismic to be applied in longitudinal*
$F_{w,long,anch}$ =	3523	lb	*Wind to be applied in longitudinal direction*

For the longitudinal loads, the following load combinations show the uplift force to one short side of the curb for both seismic and wind loads. Seismic loads to short side also include loads cause by 30% of the seismic force in the transverse direction per ASCE 7-16 21.5.3.1a. Assume Center of Geometry & Center of Mass coincide.

Longitudinal Loading:



Uplift to One Short Side (For Anchors):

Max uplift force to one short side from seismic, including Fv (Fv/2 is the vertical effects to one side of the unit):

2.3.6 Combo #7: -.9D + 1.0E + Fv

$P_{lu,seis,anch}$ = -(.9*Wp/2) + Fp,anchors*(h.cm+h.curb)/(Lcurb) + Fv,anch/2 = **7387** lbs

Max upward force to one short side from seismic

Max uplift force to one long side from wind, including Fw uplift (Fw,uplift/2 is the uplift to one side of the unit):

2.3.1 Combo #5: -.9D + 1.0W + Fw,uplift

$P_{lu,wind,anch}$ = -(.9*Wp/2) + Fw,long,anch*(h.cm+h.curb)/(Lcurb) + Fw,uplift/2 = **3284** lbs

Max upward force to one short side from wind

Shear Transfer (For Anchors)

Max shear force due to seismic in the longitudinal direction to be distributed to all anchors:

$V_{l,seis,anch}$= $F_{p,anchors}$= **10409** lbs *Seismic shear to one long side*

Max shear force due to wind in the longitudinal direction to be distributed to all anchors:

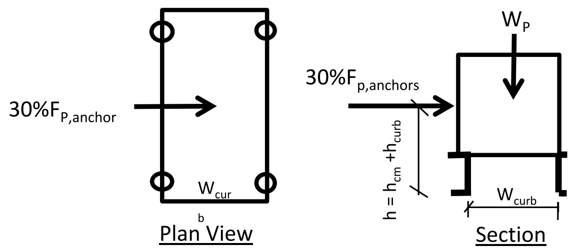
$V_{l,wind,anch}$= $F_{w,long,anch}$ = **3523** lbs *Wind shear to one long side*

Load Recalculations: 30% Transverse Loads For Anchors

From Previous:			
F_p =	10409	lb	*Seismic to be applied in each direction*
$30\%F_p$ =	3123	lb	*Wind to be applied in transverse direction*

For the transverse loads, the following load combinations show the uplift force to one long side of the curb for both seismic and wind loads. Seismic loads to long side also include loads cause by 30% of the seismic force in the longitudinal direction per ASCE 7-16 21.5.3.1a. Assume Center of Geometry & Center of Mass coincide.

Transverse Loading: 30%Fp



Uplift to One Long Side (For Anchors):

Max uplift force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #7: -.9D + 1.0E + Fv

$P_{tu,30\%seis,anch}$ = -(.9*Wp/2) + 30%Fp,anchors*(h.cm+h.curb)/(Wcurb) + Fv,anch/2 = **3704** lbs

upward force to one long side from seismic

Shear Transfer (For Anchors):

30% transverse shear transmitted to all of the anchors.

$V_{t,30\%seis,anch}$ = $30\%F_{p,anchors}$ = **3123** lbs

Seismic shear to distribute to all anchors

Anchor Loads: Combined 100% with 30% opposite direction

**Distribute the loads to one corner. Assume anchors at each corner to take the worst case tension load from overturn equally. Shear to be distributed equally amongst anchors along the sides between the anchors used for uplift at the corners.*

Design Loads for Transverse Direction to One Corner:

Uplift:

$R_{tu,corner,\ seis,anch} = \frac{P_{tu,seis,anch}}{2} + \frac{P_{lu,30\%seis,anch}}{2} =$ 7525 *lb*

$R_{tu,corner,\ wind,anch} = \frac{P_{tu,wind,anch}}{2} =$ 4077 *lb*

Design Loads for Longitudinal Direction to One Corner:

Uplift:

$R_{lu,\ corner,seis,anch} = \frac{P_{lu,seis,anch}}{2} + \frac{P_{tu,30\%seis,anch}}{2} =$ 5545 *lb*

$R_{lu,\ corner,wind,anch} = \frac{P_{lu,wind,anch}}{2} =$ 1642 *lb*

Controlling Uplift Loads to One Corner:

Max Force to Corner from Seismic= 7525 lb
Max Force to Corner from Wind= 4077 lb

Max load to one Corner: T_{Corner} = **7525** lb — SEISMIC CONTROLS

Controlling Shear Loads to Anchors on All Sides:

Combined shear for loads to distribute to all anchors along all sides of the curb (not at corners.)

$V_{t,conc,seis} = \sqrt{F_p^{\,2} + 30\%F_p^{\,2}} =$ 10867 lb

$V_{t,conc,wind} = \sqrt{F_{w,long.anch}^{\,2} + F_{w,trans,anch}^{\,2}} =$ 6812 lb

Max Shear to Anchors at Sides: $V_{maxanchors}$ = **10867** lb — SEISMIC CONTROLS

Anchorage to Steel sub-Structure (LRFD):

For ultimate loads for connecting the curb flange to steel, use 1/2" Dia. 307 Bolts.

1/2" A307 Steel Bearing w/ Washer:	
18 gage min flange = 1.44 kip	**from Table IV-8C of 2016 AISI*
16 gage min flange = 1.82 kip	*Cold Formed Steel Manual*
14 gage min flange = 2.28 kip	

Table IV-6	$A307_T$ =	6.63	kip	
Table IV-7	$A307_V$ =	3.44	kip	
	$A307_{bearing}$ =	2.28	kip	**Using 14 gage*

$A307_{Tallow}$ = min($A307_T$, $A307_V$, $A307_{bearing}$) = 2.28 kip

For Bolts Screws (Uplift Only):

Number of Bolts at Corner= $T_{corner}/A307_{Tallow}$ = 4 bolts per corner

For Side Bolts (Shear Only):

$BoltSpacing_{corner}$= 6 **inches from curb corner to next corner bolt along side*

$Number\_Bolts_L$ = 2 *# bolts per long side, min*

$Number\_Bolts_S$ = 1 *# bolts per short side, min*

a= 2 **inches from corner edge to first corner anchor*

$$BoltSpacing_{Long} = \frac{L_{curb} - \left(BoltSpacing_{corner} * (Number\_Bolts_{corner} - 2)\right) - 2a}{Number\_Bolts_L + 1} = 21.500 \text{ in}$$

$$BoltSpacing_{Short} = \frac{W_{curb} - \left(BoltSpacing_{corner} * (Number\_Bolts_{corner} - 2)\right) - 2a}{Number\_Bolts_S + 1} = 15.188 \text{ in}$$

Total # of Bolts = 6 bolts

$$V_{perScrew} = \frac{V_{maxanchors}}{A307_{Allow}} =$$ 5 bolts < or = 6 **OK**

Use	2	Bolts per Long Side
Use	1	Bolts per Short Side
Use	4	Bolts per Corner
	22	Total Bolts

Optional Weld Instead of Bolting:

ϕ_w = 0.50

For welding curb directly to steel structural member, matching to strength of 1/2" A307 bolt.

For Fillet weld: (Table IV-1)
18 gage allow = 1.62 kip/in
16 gage allow = 2.03 kip/in
14 gage allow = 2.53 kip/in

For Fillet Weld on Flange: $R_{perinch}$ = 2.53 k/in **Using 14 gage*

$W_{length} = \dfrac{A307_{allow}}{\phi_w * R_{perinch}} =$ 1.80 in < 2.5 in

For a 1/8" Fillet Weld: Weld_capacity = W_{length} * 2.8 k/in = 5.05 kip > $A307_{allow}$

Use 2.5" long 1/8" Fillet Weld to replace each required A307 bolt as indicated above

Anchorage to Wood sub-Structure: (LRFD)

Using hex lag screw : Shear per NDS Table 12K *With 1/2" lag screws into 14 or 16 gage curb with (2) 12 gage thickeners = 690 lbs* *With 5/8" lag screws into 14 or 16 gage curb with (2) 12 gage thickeners = 949 lbs*	
Using hex lag screw: Withdrawal per NDS Table 12.2A *1/2"x4" long hex lag screw into wood = 1784 lbs* *1/2"x5" long hex lag screw into wood = 2192 lbs* *5/8"x5" long hex lag screw into wood = 2502 lbs* *5/8"x6" long hex lag screw into wood = 2984 lbs*	*For 1/2" Steel Bearing Washers* *18 gage min. flange = 1914 lbs* *16 gage min. flange = 2430 lbs* *14 gage min. flange = 3036 lbs*
Using Simpson 1/4x3" SDS: Shear per NDS Table 12M *14 gage min. flange = 349 lbs* *16 gage min. flange = 250 lbs* *18 gage min. flange = 194 lbs*	*Using Simpson 1/4xL" SDS: Withdrawal per NDS Table 12.2B* *3" long #14 screw (2" penetration)= 742 lbs* *4" long #14 screw (2.67" penetration)= 990 lbs*

Ultimate Shear Capacity: Z_{wood} = 349 lb *Using 1/4 x 4in. SDS*

*Zwood = Z * Kf * φ * λ = Z * 3.32 * .65 * 1.0*

Ultimate Withdrawal Capacity: W_{wood} = 742 lb

*Wwood = W * Kf * φ * λ = W * (Lscrew*(2/3)) * 3.32 * .65 * 1.0*

For Corner Screws (Uplift Only):

Number of Screws at Corner= T_{corner}/W_{Wood} = 12 Screws at corner

For Side Screws (Shear Only):

$ScrewSpacing_{corner}$= 3 **inches from curb corner to next corner screw along side*

$Number\_Screws_L$ = 13 *# screws per long side, min*

$Number\_Screws_S$ = 3 *# screws per short side, min*

$$ScrewSpacing_{Long} = \frac{L_{curb} - (ScrewSpacing_{corner} * (Number\_Screws_{corner} - 2)) - 2in}{Number\_Screws_L + 1} = 3.464$$

$$ScrewSpacing_{Short} = \frac{W_{curb} - (ScrewSpacing_{corner} * (Number\_Screws_{corner} - 2)) - 2in}{Number\_Screws_S + 1} = 3.594$$

Total # of Screws in Shear = 32 screws

$$V_{perScrew} = \frac{V_{maxanchors}}{Z_{wood}} = 32$$ screws < or = 32 **OK**

Use	13	SDS per Long Side
Use	3	SDS per Short Side
Use	12	SDS per Corner
	80	Total SDS

Load Recalculation - Anchorage
14" Base Curb

Recalculate Loads for Anchorage:

h_{curb}= 14 in

Loads to anchor to include the curb weight in the seismic load calculations and the curb height in the wind load calculations.

Seismic Loading - 2021 IBC & 2022 CBC

$F_{p,anchors} = \frac{3(.4a_pS_{ds}I_p)}{R_p}(W_p + Curb_{wght}) =$ **10409** lb

$F_{v,anch}$ = $0.2S_{ds}(W_p+Curb_{wght})$= 926 lbs +/- *Vertical effects of seimic load to the whole unit*

Wind Loading - 2021 IBC & 2022 CBC

$A_{trans,anchors}$ = $(h_{unit}+h_{curb})*L_{unit}$ = 46 ft^2

$A_{long,anchors}$ = $(h_{unit}+h_{curb})*W_{unit}$ = 28 ft^2

$F_{w,trans,anch}$ = $q_h*GC_{r,horiz}*A_{trans,anchors}$ = **5143** lb

Horizontal wind force to apply to the unit and curb's long side

$F_{w,long,anch}$ = $q_h*GC_{r,horiz}*A_{long,anchors}$ = **3108** lb

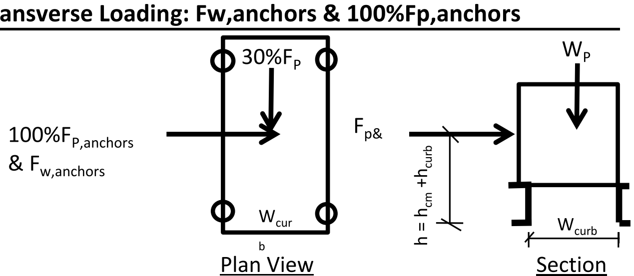
Horizontal wind force to apply to the unit and curb's short side

$F_{design,uplift}$ = 2888 lb *from previous - uplift force to be applied simultaneuously*

Load Recalculations: 100% Transverse Loads For Anchors

For the transverse loads, the following load combinations show the uplift force to one long side of the curb for both seismic and wind loads. Seismic loads to long side also include loads cause by 30% of the seismic force in the longitudinal direction per ASCE 7-16 21.5.3.a. Assume Center of Geometry & Center of Mass coincide.

Transverse Loading: Fw,anchors & 100%Fp,anchors



Uplift to One Long Side (For Anchors):

Max uplift force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #7: -.9D + 1.0E + Fv

$P_{tu,seis,anch}$= -(.9*Wp/2) + Fp,anchors*(h.cm+h.curb)/(Wcurb) + Fv,anch/2 = **10798** lbs

Max uplift force to one long side from wind, including Fw uplift (Fw,uplift/2 is the uplift to one side of the unit):

2.3.1 Combo #5: -.9D + 1.0W + Fw,uplift

$P_{tu,wind,anch}$= -(.9*Wp/2) + Fw,long,anch*(h.cm+h.curb)/(Wcurb) + Fw,uplift/2 = **6165** lbs

Load Recalculations: 100% Transverse Loads For Anchors Continued:

Shear Transfer (For Anchors)

Max shear force due to seismic in the transverse direction from the unit & curb to be distributed to all anchors:

$V_{t,seis,anch}$ = $F_{p,anchors}$ = **10409** lb

Max shear force due to wind in transverse direction from the unit & curb to be distributed to all anchors:

$V_{t,wind,anch}$ = $F_{w,trans,anch}$ = **5143** lb

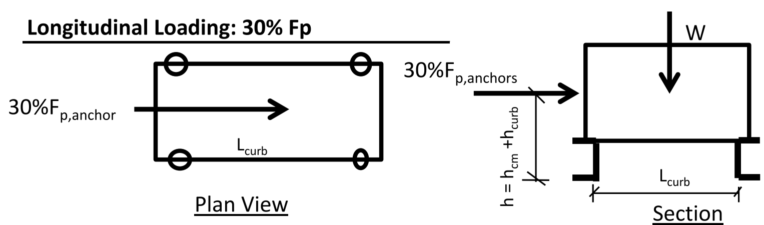
Load Recalculations: 30% Longitudinal Loads For Anchors:

*FOR 30% LONGITUDINAL LOADS TO COMBINE WITH 100% TRANSVERSE LOADS (ASCE 7-16, 12.5.3.1a)

From Previous:			
$F_{p,anchors}$ =	10409	lb	*Seismic to be applied in transverse direction*
$30\%F_{p,anchors}$ =	3123	lb	*Seismic to be applied in longitudinal direction simultaneously*

For the longitudinal loads, the following load combinations show the uplift force to one short side of the curb for both seismic and wind loads. Seismic loads to short side also include loads cause by 30% of the seismic force in the transverse direction per ASCE 7-16 21.5.3.1a. Assume Center of Geometry & Center of Mass coincide.

Longitudinal Loading: 30% Fp



Uplift to One Short Side (For Anchors):

Max uplift force to one short side from seismic, including Fv (Fv/2 is the vertical effects to one side of the unit):

2.3.6 Combo #7: -.9D + 1.0E + Fv

$P_{lu,30\%seis,anch}$ = -(.9*Wp/2) + 30%Fp,anchors*(h.cm+h.curb)/(Lcurb) + Fv,anchors/2 = **1619** lbs

Max upward force to one short side from seismic

Shear Transfer (For Anchors)

Longitudinal shear transmitted to all of the anchors.

$V_{l,30\%seis,anch}$= $30\%F_{p,anchors}$ = **3123** lbs *Seismic shear to distribute to all anchors*

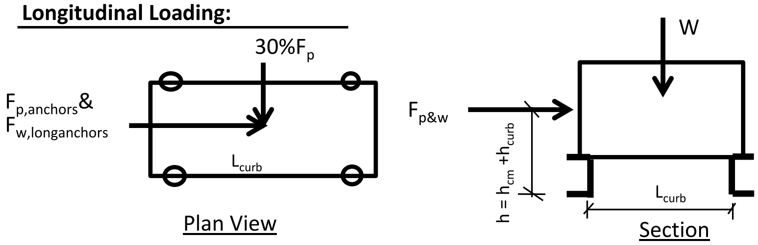
Load Recalculations: 100% Longitudinal Loads For Anchors

From Previous:

$F_{p,anchors}$ =	10409	lb	*Seismic to be applied in longitudinal*
$F_{w,long,anch}$ =	3108	lb	*Wind to be applied in longitudinal direction*

For the longitudinal loads, the following load combinations show the uplift force to one short side of the curb for both seismic and wind loads. Seismic loads to short side also include loads cause by 30% of the seismic force in the transverse direction per ASCE 7-16 21.5.3.1a. Assume Center of Geometry & Center of Mass coincide.

Longitudinal Loading:



Uplift to One Short Side (For Anchors):

Max uplift force to one short side from seismic, including Fv (Fv/2 is the vertical effects to one side of the unit):

2.3.6 Combo #7: -.9D + 1.0E + Fv

$P_{lu,seis,anch}$ = -(.9*Wp/2) + Fp,anchors*(h.cm+h.curb)/(Lcurb) + Fv,anch/2 = **6094** lbs

Max upward force to one short side from seismic

Max uplift force to one long side from wind, including Fw uplift (Fw,uplift/2 is the uplift to one side of the unit):

2.3.1 Combo #5: -.9D + 1.0W + Fw,uplift

$P_{lu,wind,anch}$ = -(.9*Wp/2) + Fw,long,anch*(h.cm+h.curb)/(Lcurb) + Fw,uplift/2 = **2591** lbs

Max upward force to one short side from wind

Shear Transfer (For Anchors)

Max shear force due to seismic in the longitudinal direction to be distributed to all anchors:

$V_{l,seis,anch}$= $F_{p,anchors}$= **10409** lbs *Seismic shear to one long side*

Max shear force due to wind in the longitudinal direction to be distributed to all anchors:

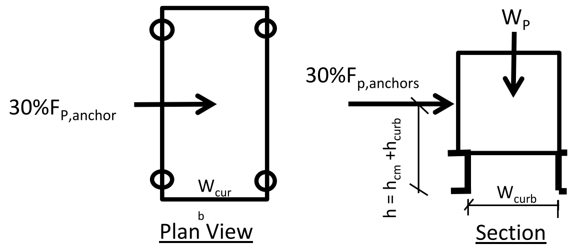
$V_{l,wind,anch}$= $F_{w,long,anch}$ = **3108** lbs *Wind shear to one long side*

Load Recalculations: 30% Transverse Loads For Anchors

From Previous:			
F_p =	10409	lb	*Seismic to be applied in each direction*
$30\%F_p$ =	3123	lb	*Wind to be applied in transverse direction*

For the transverse loads, the following load combinations show the uplift force to one long side of the curb for both seismic and wind loads. Seismic loads to long side also include loads cause by 30% of the seismic force in the longitudinal direction per ASCE 7-16 21.5.3.1a. Assume Center of Geometry & Center of Mass coincide.

Transverse Loading: 30%Fp



Uplift to One Long Side (For Anchors):

Max uplift force to one long side from seismic, including Fv/2 (the vertical effects to one side of the unit):

2.3.6 Combo #7: -.9D + 1.0E + Fv

$P_{tu,30\%seis,anch}$ = -(.9*Wp/2) + 30%Fp,anchors*(h.cm+h.curb)/(Wcurb) + Fv,anch/2 = **3030** lbs

upward force to one long side from seismic

Shear Transfer (For Anchors):

30% transverse shear transmitted to all of the anchors.

$V_{t,30\%seis,anch}$= $30\%F_{p,anchors}$ = **3123** lbs

Seismic shear to distribute to all anchors

Anchor Loads: Combined 100% with 30% opposite direction

**Distribute the loads to one corner. Assume anchors at each corner to take the worst case tension load from overturn equally. Shear to be distributed equally amongst anchors along the sides between the anchors used for uplift at the corners.*

Design Loads for Transverse Direction to One Corner:

Uplift:

$R_{tu,corner,\ seis,anch} = \frac{P_{tu,seis,anch}}{2} + \frac{P_{lu,30\%seis,anch}}{2} =$ 6208 *lb*

$R_{tu,corner,\ wind,anch} = \frac{P_{tu,wind,anch}}{2} =$ 3083 *lb*

Design Loads for Longitudinal Direction to One Corner:

Uplift:

$R_{lu,\ corner,seis,anch} = \frac{P_{lu,seis,anch}}{2} + \frac{P_{tu,30\%seis,anch}}{2} =$ 4562 *lb*

$R_{lu,\ corner,wind,anch} = \frac{P_{lu,wind,anch}}{2} =$ 1296 *lb*

Controlling Uplift Loads to One Corner:

Max Force to Corner from Seismic= 6208 lb
Max Force to Corner from Wind= 3083 lb

Max load to one Corner: T_{Corner} = **6208** lb — SEISMIC CONTROLS

Controlling Shear Loads to Anchors on All Sides:

Combined shear for loads to distribute to all anchors along all sides of the curb (not at corners.)

$V_{t,conc,seis} = \sqrt{F_p^{\,2} + 30\% F_p^{\,2}} =$ 10867 lb

$V_{t,conc,wind} = \sqrt{F_{w,long.anch}^{\,2} + F_{w,trans,anch}^{\,2}} =$ 6009 lb

Max Shear to Anchors at Sides: $V_{maxanchors}$ = **10867** lb — SEISMIC CONTROLS

Anchorage to Steel sub-Structure (LRFD):

For ultimate loads for connecting the curb flange to steel, use 1/2" Dia. 307 Bolts.

1/2" A307 Steel Bearing w/ Washer:	
18 gage min flange = 1.44 kip	**from Table IV-8C of 2016 AISI*
16 gage min flange = 1.82 kip	*Cold Formed Steel Manual*
14 gage min flange = 2.28 kip	

Table IV-6	$A307_T$ =	6.63	kip	
Table IV-7	$A307_V$ =	3.44	kip	
	$A307_{bearing}$ =	2.28	kip	**Using 14 gage*

$A307_{Tallow}$ = min($A307_T$, $A307_V$, $A307_{bearing}$) = 2.28 kip

For Bolts Screws (Uplift Only):

Number of Bolts at Corner= $T_{corner}/A307_{Tallow}$ = **4** bolts per corner

For Side Bolts (Shear Only):

$BoltSpacing_{corner}$=	6	**inches from curb corner to next corner bolt along side*
$Number\_Bolts_L$ =	2	*# bolts per long side, min*
$Number\_Bolts_S$ =	1	*# bolts per short side, min*
a=	2	**inches from corner edge to first corner anchor*

$$BoltSpacing_{Long} = \frac{L_{curb} - \left(BoltSpacing_{corner} * (Number\_Bolts_{corner} - 2)\right) - 2a}{Number\_Bolts_L + 1} = 21.500 \text{ in}$$

$$BoltSpacing_{Short} = \frac{W_{curb} - \left(BoltSpacing_{corner} * (Number\_Bolts_{corner} - 2)\right) - 2a}{Number\_Bolts_S + 1} = 15.188 \text{ in}$$

Total # of Bolts = 6 bolts

$$V_{perScrew} = \frac{V_{maxanchors}}{A307_{Allow}} = 5 \text{ bolts} \le 6$$

OK

Use	2	Bolts per Long Side
Use	1	Bolts per Short Side
Use	4	Bolts per Corner
	22	Total Bolts

Optional Weld Instead of Bolting:

ϕ_w = 0.50

For welding curb directly to steel structural member, matching to strength of 1/2" A307 bolt.

For Fillet weld: *(Table IV-1)*
18 gage allow = 1.62 kip/in
16 gage allow = 2.03 kip/in
14 gage allow = 2.53 kip/in

For Fillet Weld on Flange: $R_{perinch}$ = 2.53 k/in **Using 14 gage*

$$W_{length} = \frac{A307_{allow}}{\phi_w * R_{perinch}} = 1.80 \text{ in}$$

< 2.5 in

For a 1/8" Fillet Weld: Weld_capacity = W_{length} * 2.8 k/in = 5.05 kip > $A307_{allow}$

Use 2.5" long 1/8" Fillet Weld to replace each required A307 bolt as indicated above

Anchorage to Wood sub-Structure: (LRFD)

Using hex lag screw : Shear per NDS Table 12K *With 1/2" lag screws into 14 or 16 gage curb with (2) 12 gage thickeners = 690 lbs* *With 5/8" lag screws into 14 or 16 gage curb with (2) 12 gage thickeners = 949 lbs*	
Using hex lag screw: Withdrawal per NDS Table 12.2A *1/2"x4" long hex lag screw into wood = 1784 lbs* *1/2"x5" long hex lag screw into wood = 2192 lbs* *5/8"x5" long hex lag screw into wood = 2502 lbs* *5/8"x6" long hex lag screw into wood = 2984 lbs*	*For 1/2" Steel Bearing Washers* *18 gage min. flange = 1914 lbs* *16 gage min. flange = 2430 lbs* *14 gage min. flange = 3036 lbs*
Using Simpson 1/4x3" SDS: Shear per NDS Table 12M *14 gage min. flange = 349 lbs* *16 gage min. flange = 250 lbs* *18 gage min. flange = 194 lbs*	*Using Simpson 1/4xL" SDS: Withdrawal per NDS Table 12.2B* *3" long #14 screw (2" penetration)= 742 lbs* *4" long #14 screw (2.67" penetration)= 990 lbs*

Ultimate Shear Capacity: Z_{wood} = 349 lb *Using 1/4 x 4in. SDS*

*Zwood = Z * Kf * φ * λ = Z * 3.32 * .65 * 1.0*

Ultimate Withdrawal Capacity: W_{wood} = 742 lb

*Wwood = W * Kf * φ * λ = W * (Lscrew*(2/3)) * 3.32 * .65 * 1.0*

For Corner Screws (Uplift Only):

Number of Screws at Corner= T_{corner}/W_{Wood} = 10 Screws at corner

For Side Screws (Shear Only):

$ScrewSpacing_{corner}$= 3 **inches from curb corner to next corner screw along side*

$Number\_Screws_L$ = 12 *# screws per long side, min*

$Number\_Screws_S$ = 4 *# screws per short side, min*

$$ScrewSpacing_{Long} = \frac{L_{curb} - \left(ScrewSpacing_{corner} * (Number\_Screws_{corner} - 2)\right) - 2in}{Number\_Screws_L + 1} = 4.192$$

$$ScrewSpacing_{Short} = \frac{W_{curb} - \left(ScrewSpacing_{corner} * (Number\_Screws_{corner} - 2)\right) - 2in}{Number\_Screws_S + 1} = 4.075$$

Total # of Screws in Shear = 32 screws

$$V_{perScrew} = \frac{V_{maxanchors}}{Z_{wood}} = 32$$ screws < or = 32 **OK**

Use	12	SDS per Long Side
Use	4	SDS per Short Side
Use	10	SDS per Corner
	72	Total SDS

Anchor Designer™
Software
Version 2.7.6990.58

Company:	BJG A/E	Date:	8/21/2019
Engineer:	CRM	Page:	1/5
Project:	Micrometl Curbs		
Address:	449 S. Virginia, Fourth Floor, Reno NV		
Phone:	775-827-1010		
E-mail:	cmeyer@bjginc.com		

1.Project information

Customer company:
Customer contact name:
Customer e-mail:
Comment: Standard Ultimate Design Allowable Uplift Loading - 2019 CBC Update

Project description:
Location:
Fastening description: Seismic Design

2. Input Data & Anchor Parameters

General
Design method:ACI 318-14
Units: Imperial units

Note: There were no changes to the anchorage design between ACI 318-14 and ACI 318-19. This is still valid for the 2022 CBC

Anchor Information:
Anchor type: Concrete screw
Material: Carbon Steel
Diameter (inch): 0.500
Nominal Embedment depth (inch): 3.750
Effective Embedment depth, h_{ef} (inch): 2.780
Code report: ICC-ES ESR-2713
Anchor category: 1
Anchor ductility: No
h_{min} (inch): 5.83
c_{ac} (inch): 4.19
C_{min} (inch): 1.75
S_{min} (inch): 3.00

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 6.00
State: Cracked
Compressive strength, f'_c (psi): 3000
$\Psi_{c,V}$: 1.0
Reinforcement condition: B tension, B shear
Supplemental reinforcement: Not applicable
Reinforcement provided at corners: No
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: No
Ignore 6do requirement: Not applicable
Build-up grout pad: No

Recommended Anchor
Anchor Name: Titen HD® - 1/2"Ø Titen HD, hnom:3.75" (95mm)
Code Report: ICC-ES ESR-2713

SIMPSON Strong-Tie® Anchor Designer™ Software
Version 2.7.6990.58

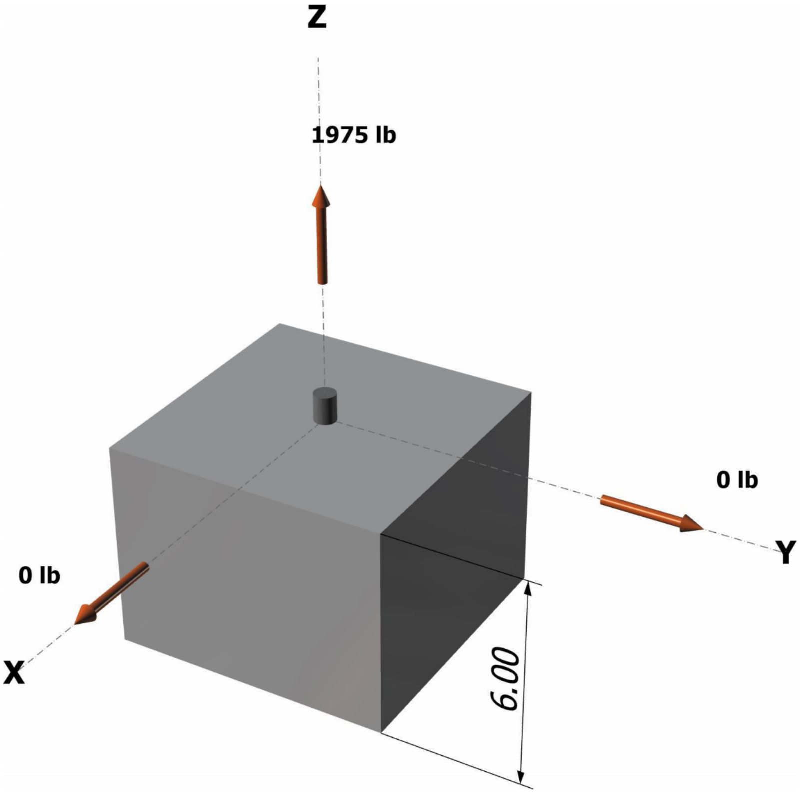
Company:	BJG A/E	Date:	8/21/2019
Engineer:	CRM	Page:	2/5
Project:	Micrometl Curbs		
Address:	449 S. Virginia, Fourth Floor, Reno NV		
Phone:	775-827-1010		
E-mail:	cmeyer@bjginc.com		

Load and Geometry
Load factor source: ACI 318 Section 5.3
Load combination: not set
Seismic design: Yes
Anchors subjected to sustained tension: Not applicable
Ductility section for tension: 17.2.3.4.2 not applicable
Ductility section for shear: 17.2.3.5.2 not applicable
Ω_0 factor: not set
Apply entire shear load at front row: No
Anchors only resisting wind and/or seismic loads: Yes

Strength level loads:

N_{ua} [lb]: 1975
V_{uax} [lb]: 0
V_{uay} [lb]: 0

<Figure 1>



SIMPSON Strong-Tie

Anchor Designer™
Software
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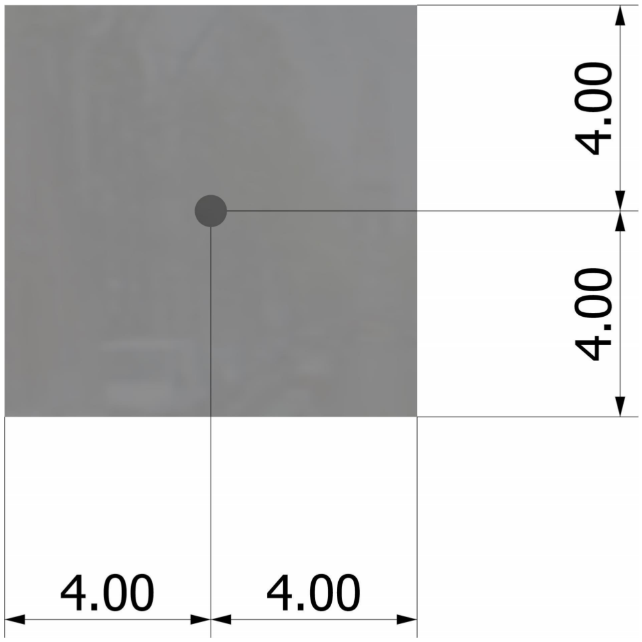
Project:	Micrometl Curbs		
Address:	449 S. Virginia, Fourth Floor, Reno NV		
Phone:	775-827-1010		
E-mail:	cmeyer@bjginc.com		

<Figure 2>



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Anchor Designer™
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Company:	BJG A/E	Date:	8/21/2019
Engineer:	CRM	Page:	4/5
Project:	Micrometl Curbs		
Address:	449 S. Virginia, Fourth Floor, Reno NV		
Phone:	775-827-1010		
E-mail:	cmeyer@bjginc.com		

3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	1975.0	0.0	0.0	0.0
Sum	1975.0	0.0	0.0	0.0

Maximum concrete compression strain (‰): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 1975
Resultant compression force (lb): 0
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00

4. Steel Strength of Anchor in Tension (Sec. 17.4.1)

N_{sa} (lb)	ϕ	ϕN_{sa} (lb)
20130	0.65	13085

5. Concrete Breakout Strength of Anchor in Tension (Sec. 17.4.2)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ (Eq. 17.4.2.2a)

k_c	λ_a	f'_c (psi)	h_{ef} (in)	N_b (lb)
17.0	1.00	3000	2.667	4055

$0.75\phi N_{cb} = 0.75\phi (A_{Nc} / A_{Nco}) \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$ (Sec. 17.3.1 & Eq. 17.4.2.1a)

A_{Nc} (in^2)	A_{Nco} (in^2	$c_{a,min}$ (in)	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	$0.75\phi N_{cb}$ (lb)
64.00	64.00	4.00	1.000	1.00	1.000	4055	0.65	1977

11. Results

11. Interaction of Tensile and Shear Forces (Sec. D.7)?

Tension	Factored Load, N_{ua} (lb)	Design Strength, $øN_n$ (lb)	Ratio	Status
Steel	1975	13085	0.15	Pass
Concrete breakout	**1975**	**1977**	**1.00**	**Pass (Governs)**

1/2"Ø Titen HD, hnom:3.75" (95mm) meets the selected design criteria.

12. Warnings

- Per designer input, the tensile component of the strength-level earthquake force applied to anchors does not exceed 20 percent of the total factored anchor tensile force associated with the same load combination. Therefore the ductility requirements of ACI 318 17.2.3.4.2 for tension need not be satisfied – designer to verify.

- Per designer input, the shear component of the strength-level earthquake force applied to anchors does not exceed 20 percent of the total factored anchor shear force associated with the same load combination. Therefore the ductility requirements of ACI 318 17.2.3.5.2 for shear need not be satisfied – designer to verify.

- Designer must exercise own judgement to determine if this design is suitable.

- Refer to manufacturer's product literature for hole cleaning and installation instructions.

SIMPSON Strong-Tie®

Anchor Designer™
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Company:	BJG A/E	Date:	8/21/2019
Engineer:	CRM	Page:	1/5
Project:	Micrometl Curbs		
Address:	449 S. Virginia, Fourth Floor, Reno NV		
Phone:	775-827-1010		
E-mail:	cmeyer@bjginc.com		

1.Project information

Customer company:
Customer contact name:
Customer e-mail:
Comment: Standard Ultimate Design Allowable Shear Loading - 2019 CBC Update

Project description:
Location:
Fastening description: Seismic Design

2. Input Data & Anchor Parameters

General
Design method:ACI 318-14
Units: Imperial units

Anchor Information:
Anchor type: Concrete screw
Material: Carbon Steel
Diameter (inch): 0.500
Nominal Embedment depth (inch): 3.750
Effective Embedment depth, h_{ef} (inch): 2.780
Code report: ICC-ES ESR-2713
Anchor category: 1
Anchor ductility: No
h_{min} (inch): 5.83
c_{ac} (inch): 4.19
C_{min} (inch): 1.75
S_{min} (inch): 3.00

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 6.00
State: Cracked
Compressive strength, f'$_c$ (psi): 3000
$\Psi_{c,V}$: 1.0
Reinforcement condition: B tension, B shear
Supplemental reinforcement: Not applicable
Reinforcement provided at corners: No
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: No
Ignore 6do requirement: Not applicable
Build-up grout pad: No

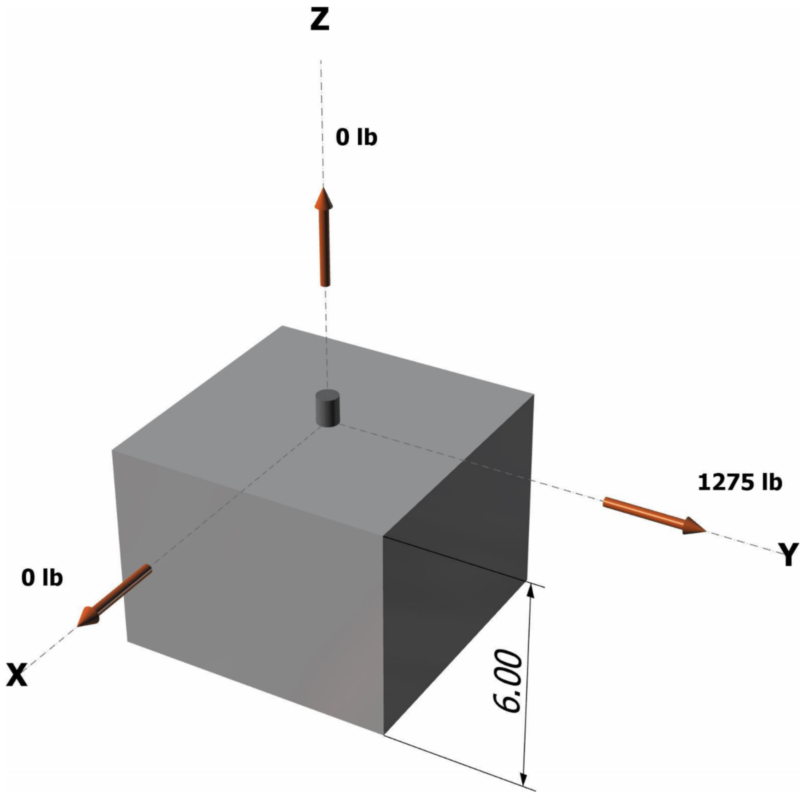
Recommended Anchor
Anchor Name: Titen HD® - 1/2"Ø Titen HD, hnom:3.75" (95mm)
Code Report: ICC-ES ESR-2713

Load and Geometry
Load factor source: ACI 318 Section 5.3
Load combination: not set
Seismic design: Yes
Anchors subjected to sustained tension: Not applicable
Ductility section for tension: 17.2.3.4.2 not applicable
Ductility section for shear: 17.2.3.5.2 not applicable
Ω_0 factor: not set
Apply entire shear load at front row: No
Anchors only resisting wind and/or seismic loads: Yes

Strength level loads:

N_{ua} [lb]: 0
V_{uax} [lb]: 0
V_{uay} [lb]: 1275

<Figure 1>



Anchor Designer™
Software
Version 2.7.6990.59

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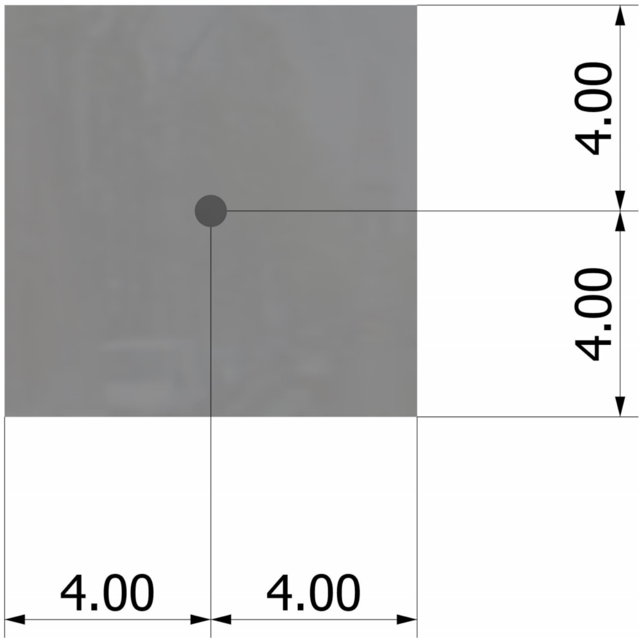
Engineer:	CRM	Page:	3/5
Project:	Micrometl Curbs		
Address:	449 S. Virginia, Fourth Floor, Reno NV		
Phone:	775-827-1010		
E-mail:	cmeyer@bjginc.com		

<Figure 2>



3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	0.0	0.0	1275.0	1275.0
Sum	0.0	0.0	1275.0	1275.0

Maximum concrete compression strain (‰): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 0
Resultant compression force (lb): 0
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00
Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.00
Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.00

8. Steel Strength of Anchor in Shear (Sec. 17.5.1)

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
4790	1.0	0.60	2874

9. Concrete Breakout Strength of Anchor in Shear (Sec. 17.5.2)

Shear perpendicular to edge in y-direction:

$V_{by} = \min|7(l_e / d_a)^{0.2}\sqrt{d_a}\lambda_a\sqrt{f'_c}c_{a1}^{1.5}; 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}|$ (Eq. 17.5.2.2a & Eq. 17.5.2.2b)

l_e (in)	d_a (in)	λ_a	f'_c (psi)	c_{a1} (in)	V_{by} (lb)
2.78	0.500	1.00	3000	4.00	3057

$\phi V_{cby} = \phi\,(A_{Vc} / A_{Vco})\Psi_{ed,V}\Psi_{c,V}\Psi_{h,V}V_{by}$ (Sec. 17.3.1 & Eq. 17.5.2.1a)

A_{Vc} (in^2)	A_{Vco} (in^2)	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	V_{by} (lb)	ϕ	ϕV_{cby} (lb)
48.00	72.00	0.900	1.000	1.000	3057	0.70	1284

Shear parallel to edge in y-direction:

$V_{bx} = \min|7(l_e / d_a)^{0.2}\sqrt{d_a}\lambda_a\sqrt{f'_c}c_{a1}^{1.5}; 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}|$ (Eq. 17.5.2.2a & Eq. 17.5.2.2b)

l_e (in)	d_a (in)	λ_a	f'_c (psi)	c_{a1} (in)	V_{bx} (lb)
2.78	0.500	1.00	3000	4.00	3057

$\phi V_{cby} = \phi\,(2)(A_{Vc} / A_{Vco})\Psi_{ed,V}\Psi_{c,V}\Psi_{h,V}V_{bx}$ (Sec. 17.3.1, 17.5.2.1(c) & Eq. 17.5.2.1a)

A_{Vc} (in^2)	A_{Vco} (in^2)	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	V_{bx} (lb)	ϕ	ϕV_{cby} (lb)
48.00	72.00	1.000	1.000	1.000	3057	0.70	2853

10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.5.3)

$\phi V_{cp} = \phi k_{cp}N_{cb} = \phi k_{cp}(A_{Nc} / A_{Nco})\Psi_{ed,N}\Psi_{c,N}\Psi_{cp,N}N_b$ (Sec. 17.3.1 & Eq. 17.5.3.1a)

k_{cp}	A_{Nc} (in^2)	A_{Nco} (in^2)	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕV_{cp} (lb)
2.0	64.00	64.00	1.000	1.000	1.000	4055	0.70	5677

11. Results

11. Interaction of Tensile and Shear Forces (Sec. D.7)?

Shear	Factored Load, V_{ua} (lb)	Design Strength, øV_n (lb)	Ratio	Status
Steel	1275	2874	0.44	Pass
T Concrete breakout y+	**1275**	**1284**	**0.99**	**Pass (Governs)**
|| Concrete breakout x-	**1275**	**2853**	**0.45**	**Pass (Governs)**
Pryout	1275	5677	0.22	Pass

1/2"Ø Titen HD, hnom:3.75" (95mm) meets the selected design criteria.

12. Warnings

- Per designer input, the tensile component of the strength-level earthquake force applied to anchors does not exceed 20 percent of the total factored anchor tensile force associated with the same load combination. Therefore the ductility requirements of ACI 318 17.2.3.4.2 for tension need not be satisfied – designer to verify.

- Per designer input, the shear component of the strength-level earthquake force applied to anchors does not exceed 20 percent of the total factored anchor shear force associated with the same load combination. Therefore the ductility requirements of ACI 318 17.2.3.5.2 for shear need not be satisfied – designer to verify.

- Designer must exercise own judgement to determine if this design is suitable.

- Refer to manufacturer’s product literature for hole cleaning and installation instructions.