CA Group, Inc
CAVIOLA ANSON

Fremont Street Improvements
Las Vegas Blvd to 14th Street

Client:

City of Las Vegas

STRUCTURAL DESIGN CALCULATIONS

ERA 1929 Light Pole Spread Footing

CA Group Project No. CA2158

PROFESSIONAL ENGINEER - STATE OF NEVADA
CHRISTOPHER A. WUNSCH
EXP. 6/30/20
CIVIL
No. 18349

11/15/2019

TABLE OF CONTENTS

ATC Hazards by Location

Search Information

Address: Fremont St, Las Vegas, NV, USA

Coordinates: 36.16139229999999, -115.12242709999998

Elevation: ft

Timestamp: 2019-11-14T18:18:09.007Z

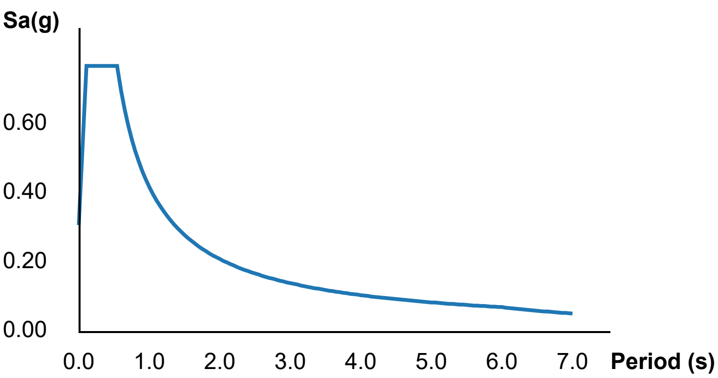
Hazard Type: Seismic

Reference Document: ASCE7-16

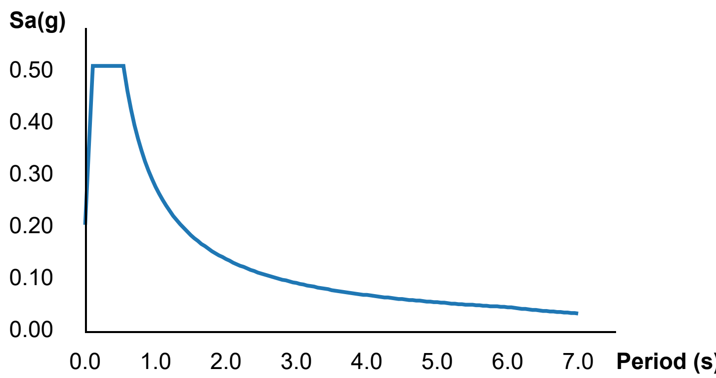
Risk Category: II

Site Class: D

MCER Horizontal Response Spectrum



Design Horizontal Response Spectrum



Basic Parameters

Name	Value	Description
S_S	0.571	MCE_R ground motion (period=0.2s)
S_1	0.187	MCE_R ground motion (period=1.0s)
S_{MS}	0.767	Site-modified spectral acceleration value
S_{M1}	0.417	Site-modified spectral acceleration value
S_{DS}	0.511	Numeric seismic design value at 0.2s SA
S_{D1}	0.278	Numeric seismic design value at 1.0s SA

Additional Information

Name	Value	Description
SDC	D	Seismic design category
F_a	1.343	Site amplification factor at 0.2s
F_v	2.225	Site amplification factor at 1.0s

CR_S	0.897	Coefficient of risk (0.2s)
CR_1	0.919	Coefficient of risk (1.0s)
PGA	0.251	MCE_G peak ground acceleration
F_{PGA}	1.349	Site amplification factor at PGA
PGA_M	0.339	Site modified peak ground acceleration
T_L	6	Long-period transition period (s)
SsRT	0.571	Probabilistic risk-targeted ground motion (0.2s)
SsUH	0.637	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.755	Factored deterministic acceleration value (0.2s)
S1RT	0.187	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.204	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.6	Factored deterministic acceleration value (1.0s)
PGAd	0.692	Factored deterministic acceleration value (PGA)

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

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ATC Hazards by Location

Search Information

Address: Fremont St, Las Vegas, NV, USA

Coordinates: 36.16139229999999, -115.12242709999998

Elevation: ft

Timestamp: 2019-11-14T15:53:27.873Z

Hazard Type: Wind

ASCE 7-16

MRI 10-Year	70 mph
MRI 25-Year	75 mph
MRI 50-Year	80 mph
MRI 100-Year	85 mph
Risk Category I	93 mph
Risk Category II	99 mph
Risk Category III	105 mph
Risk Category IV	110 mph

ASCE 7-10

MRI 10-Year	76 mph
MRI 25-Year	84 mph
MRI 50-Year	90 mph
MRI 100-Year	96 mph
Risk Category I	105 mph
Risk Category II	115 mph
Risk Category III-IV	120 mph

ASCE 7-05

ASCE 7-05 Wind Speed	90 mph

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are interpolated from data provided in ASCE 7 and rounded up to the nearest whole integer. Per ASCE 7, islands and coastal areas outside the last contour should use the last wind speed contour of the coastal area – in some cases, this website will extrapolate past the last wind speed contour and therefore, provide a wind speed that is slightly higher. NOTE: For queries near wind-borne debris region boundaries, the resulting determination is sensitive to rounding which may affect whether or not it is considered to be within a wind-borne debris region.

Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.

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CA Group, Inc
CAVIOLA ANSON

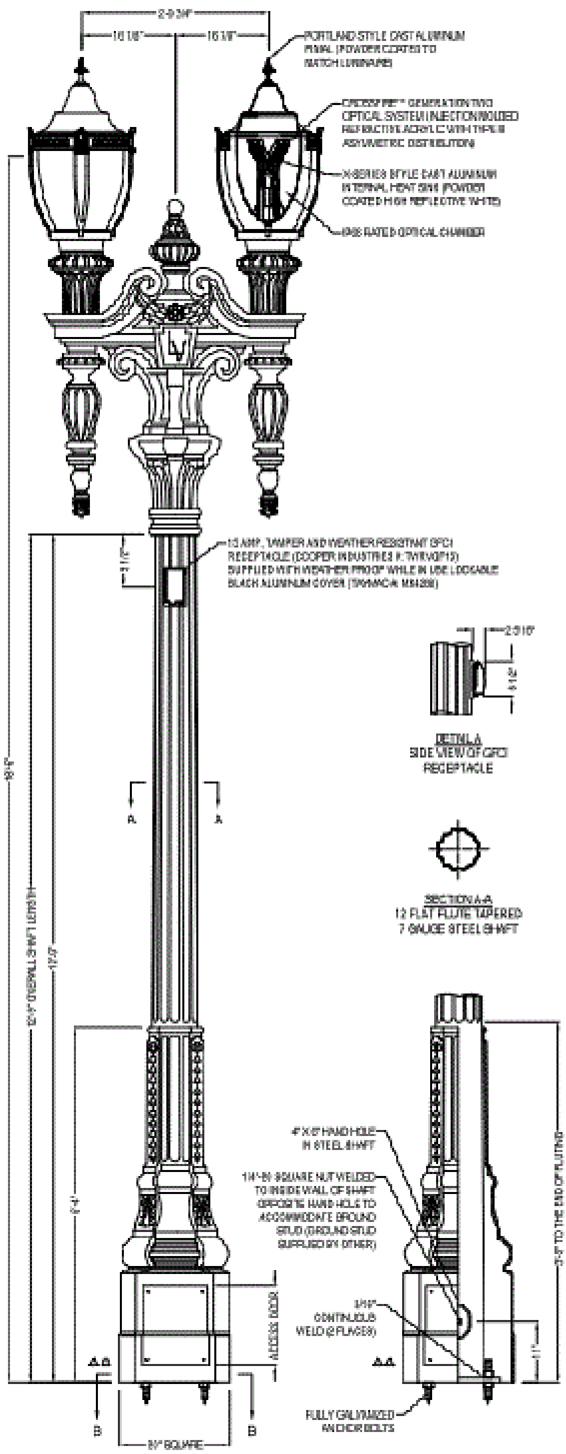
Job Title: Fremont St - LV Blvd to 14th St
Subject: RFI #011
Title: 1929 ERA Street Light Pole
Subtitle: Spread Ftg Design

Designed By: CAW
Date: 11/15/2019
Page No. 1

ERA 1929 LIGHT POLE SPREAD FOOTING DESIGN:

Applicable Code - AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

ERA 1929 Light Pole Geometry:



Wind Load Criteria:

Risk Category II:	$Risk := 2$	Height and Exposure Factor:	$K_z := 1.0$
Exposure Category:	$Exp := C$	Gust Effect Factor:	$G := 0.85$
Basic Wind Speed:	$V_{basic} := 99mph$	Exposure Condition Factor:	$z_g := 900ft$
Wind Importance Factor:	$I_r := 1.0$	Exposure Condition Factor:	$\alpha := 9.5$

EPA INFORMATION						
SECTION	PROJECTED AREA (Sq. Ft.)	X CENTROID (Ft.)	Y CENTROID (Ft.)	Cd	EPA (Sq. Ft.)	APPROXIMATE WEIGHT (lbs.)
BASE	6.30	0.00 Ft.	2.18 Ft.	1.10	6.93	450
SHAFT	4.73	0.00 Ft.	8.91 Ft.	1.10	5.20	212
CROSSARM	8.03	0.00 Ft.	15.13 Ft.	1.10	8.83	150
RIGHT LUMINAIRE	3.43	1.41Ft.	17.92 Ft.	0.50	1.72	55
LEFT LUMINAIRE	3.43	-1.41 Ft.	17.92 Ft.	0.50	1.72	55
Drag Coefficient According To Standard Specifications for Structural Supports (Table 3.8.6-1)				OVERALL WEIGHT		922

Pole Base:

Centroid: $z_{base} := 2.18ft$

Drag Coefficient: $C_{d\_base} := 1.10$

Area: $A_{base} := 6.30ft^2$

Factor: $$K_{z\_base} := 2.01 \cdot \left[\left(\frac{z_{base}}{z_g} \right) \right]^{\left(\frac{2}{\alpha} \right)} = 0.57$$

Wind Pressure: $$P_{z\_base} := 0.00256 \cdot K_{z\_base} \cdot G \cdot \left(\frac{V_{basic}}{mph} \right)^2 I_r \cdot C_{d\_base} \cdot psf = 13.27 \cdot psf$$

Wind Force: $$F_{base} := P_{z\_base} \cdot A_{base} = 83.6\,lbf$$

Pole Shaft:

Centroid: $z_{shaft} := 8.91ft$

Area: $A_{shaft} := 4.73ft^2$

Drag Coefficient: $C_{d\_shaft} := 1.10$

Factor: $K_{z\_shaft} := 2.01\cdot\left[\frac{(z_{shaft})}{z_g}\right]^{\left(\frac{2}{\alpha}\right)} = 0.76$

Wind Pressure: $P_{z\_shaft} := 0.00256\cdot K_{z\_shaft}\cdot G\cdot\left(\frac{V_{basic}}{mph}\right)^2 I_r\cdot C_{d\_shaft}\cdot psf = 17.85\cdot psf$

Wind Force: $F_{shaft} := P_{z\_shaft}\cdot A_{shaft} = 84.4\,lbf$

Pole Crossarm:

Centroid: $z_{arm} := 15.13ft$

Area: $A_{arm} := 8.03ft^2$

Drag Coefficient: $C_{d\_arm} := 1.10$

Factor: $K_{z\_arm} := 2.01\cdot\left[\frac{(z_{arm})}{z_g}\right]^{\left(\frac{2}{\alpha}\right)} = 0.85$

Wind Pressure: $P_{z\_arm} := 0.00256\cdot K_{z\_arm}\cdot G\cdot\left(\frac{V_{basic}}{mph}\right)^2 I_r\cdot C_{d\_arm}\cdot psf = 19.95\cdot psf$

Wind Force: $F_{arm} := P_{z\_arm}\cdot A_{arm} = 160.2\,lbf$

Pole Luminaires:

Centroid: $z_{lum} := 17.92ft$

Area: $A_{lum} := (2)\cdot 3.43ft^2 = 6.9\,ft^2$

Drag Coefficient: $C_{d\_lum} := 0.5$

Factor: $K_{z\_lum} := 2.01\cdot\left[\frac{(z_{lum})}{z_g}\right]^{\left(\frac{2}{\alpha}\right)} = 0.88$

Wind Pressure: $P_{z\_lum} := 0.00256\cdot K_{z\_lum}\cdot G\cdot\left(\frac{V_{basic}}{mph}\right)^2 I_r\cdot C_{d\_lum}\cdot psf = 9.40\cdot psf$

Wind Force: $F_{lum} := P_{z\_lum}\cdot A_{lum} = 64.5\,lbf$

Total Overturning Moment:

$M_{wind} := F_{base}\cdot z_{base} + F_{shaft}\cdot z_{shaft} + F_{arm}\cdot z_{arm} + F_{lum}\cdot z_{lum} = 4.51\cdot kip\cdot ft$

Seismic Load:

Peak Ground Acceleration: $PGA := 0.251$

Base Weight: $W_{base} := 450lbf$

Shaft Weight: $W_{shaft} := 212lbf$

Arm Weight: $W_{arm} := 150lbf$

Luminaire Weight: $W_{lum} := 2 \cdot 55lbf = 110\ lbf$

Total Overturning Moment:

$$M_{seismic} := PGA \cdot \left(W_{base} \cdot z_{base} + W_{shaft} \cdot z_{shaft} + W_{arm} \cdot z_{arm} + W_{lum} \cdot z_{lum}\right) = 1.78 \cdot kip \cdot ft$$

Spread Footing Design:

The *overturning moment due to wind load governs* the footing design: The following service and strength load groups will be considered:

Service:	1.0D + 1.0W
Strength:	1.2D + 1.6W

Refer to the spreadsheets that follow for footing bearing pressures and reinforcement design:

Max Service Bearing Pressure = 700 psf < 2000 psf, therefore, O.K.

Min Service Bearing Pressure = 0 psf (no uplift), therefore, O.K.

Reinforcement Design Loads:

Assume the footing 'bends' about the light pole location at 2.125' and apply the pressure as a uniform load over the back 2.125', which is a conservative approach:

Service Shear: $V_w := 400plf \cdot 2.125ft = 0.85 \cdot kip$

Service Moment: $M_w := V_w \cdot (2.125ft) \cdot 0.5 = 0.90 \cdot kip \cdot ft$

Factored Shear: $V_u := 630plf \cdot 2.125ft = 1.34 \cdot kip$

Factored Moment: $M_u := V_u \cdot (2.125ft) \cdot 0.5 = 1.42 \cdot kip \cdot ft$

CLIENT: City of Las Vegas	JOB NUMBER: CA2158	PAGE NO.
PROJECT: Fremont Street Improvement Project	SUBJECT: ERA Light Pole Spread Footing (D + W)	
BY: cw / CHECKED BY: jm	APPROVED BY:	DATE: 11/15/2019

MATERIAL PROPERTIES: Concrete: f'_c = 4,000 psi α_c = 150 pcf

Steel: f_y = 60,000 psi

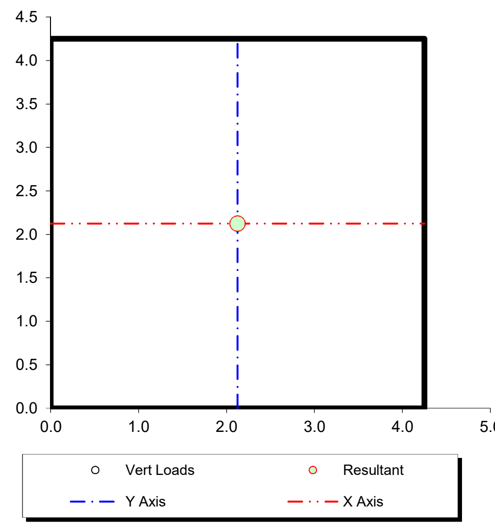
FOOTING DATA:

Footing Length:	4.250	ft	Volume =	30.10	cf	Footing Surcharge:	0	psf
Footing Width:	4.250	ft	Pressure =	249.99	psf	Surcharge Weight =	0.00	lbs
Footing Depth:	1.667	ft	Weight =	4,515.44	lbs			

Total Dead Load (Footing + Surcharge) = 4,515.44 lbs

FOOTING PLAN: I_x = **27.19** ft^4

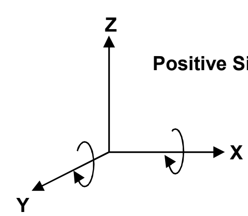
I_y = **27.19** ft^4



FOOTING LOADS:

Vertical Loads			Moment about N.A.	
Position		Magnitude	M_{xx}	M_{yy}
"X"	"Y"	(kips)	(k-ft)	(k-ft)
2.13	2.13	0.922	0.00	0.00
TOTALS:		**0.92**	**0.00**	**0.00**

Positive Sign Convention:



Footing Moments: M_{xx} : 0.00 k-ft

M_{yy} : 4.51 k-ft

RESULTANT LOCATION: e_x = **0.000 ft**

e_y = **0.000 ft**

FACTORED FOOTING PRESSURES:

Corner No.	Coordinates		Distance from N.A.		P/A	M/S		Pressure (G)	Pressure (N)
	"X"	"Y"	$N.A._{xx}$	$N.A._{yy}$	(k/ft^2)	M_x/S_x	M_y/S_y	(ksf)	(ksf)
1	0.00	0.00	-2.13	-2.13	0.35	0.00	-0.35	**0.00**	**-0.30**
2	4.25	0.00	-2.13	2.13	0.35	0.00	0.35	**0.70**	**0.40**
3	4.25	4.25	2.13	2.13	0.35	0.00	0.35	**0.70**	**0.40**
4	0.00	4.25	2.13	-2.13	0.35	0.00	-0.35	**0.00**	**-0.30**

CLIENT: City of Las Vegas	JOB NUMBER: CA2158	PAGE NO.
PROJECT: Fremont Street Improvement Project	SUBJECT: ERA Light Pole Spread Footing (1.2D + 1.6W)	
BY: cw / CHECKED BY: jm	APPROVED BY:	DATE: 11/15/2019

MATERIAL PROPERTIES:

Concrete: f'_c = 4,000 psi α_c = 150 pcf

Steel: f_y = 60,000 psi

FOOTING DATA:

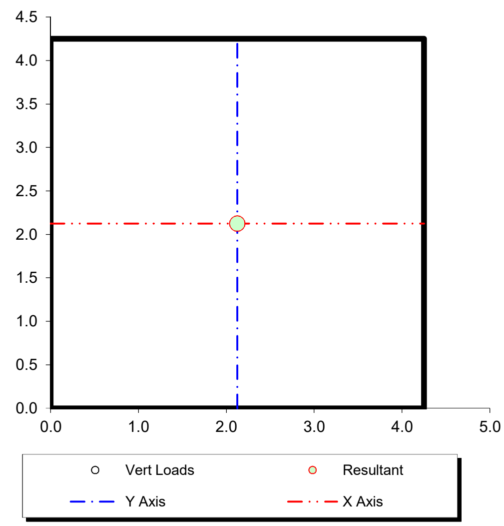
Footing Length:	4.250	ft	Volume =	30.10	cf	Footing Surcharge:	0	psf
Footing Width:	4.250	ft	Pressure =	249.99	psf	Surcharge Weight =	0.00	lbs
Footing Depth:	1.667	ft	Weight =	4,515.44	lbs			

Total Dead Load (Footing + Surcharge) = 4,515.44 lbs

FOOTING PLAN:

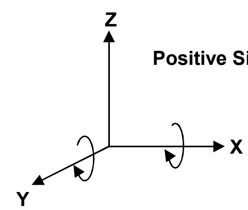
I_x = 27.19 ft^4

I_y = 27.19 ft^4



FOOTING LOADS:

Vertical Loads			Moment about N.A.	
Position		Magnitude	M_{xx}	M_{yy}
"X"	"Y"	(kips)	(k-ft)	(k-ft)
2.13	2.13	1.106	0.00	0.00
TOTALS:		**1.11**	**0.00**	**0.00**



Positive Sign Convention:

Footing Moments: M_{xx} : 0.00 k-ft

M_{yy} : 7.22 k-ft

RESULTANT LOCATION: e_x = 0.000 ft

e_y = 0.000 ft

FACTORED FOOTING PRESSURES:

Corner No.	Coordinates		Distance from N.A.		P/A	M/S		Pressure (G)	Pressure (N)
	"X"	"Y"	$N.A._{xx}$	$N.A._{yy}$	(k/ft^2)	M_x/S_x	M_y/S_y	(ksf)	(ksf)
1	0.00	0.00	-2.13	-2.13	0.36	0.00	-0.56	**-0.20**	**-0.50**
2	4.25	0.00	-2.13	2.13	0.36	0.00	0.56	**0.93**	**0.63**
3	4.25	4.25	2.13	2.13	0.36	0.00	0.56	**0.93**	**0.63**
4	0.00	4.25	2.13	-2.13	0.36	0.00	-0.56	**-0.20**	**-0.50**

CLIENT: City of Las Vegas		JOB NUMBER: CA2158	PAGE NO.
PROJECT: Fremont Street Improvement Project		SUBJECT: ERA Light Pole Spread Footing (6" Cover)	
BY: cw	CHECKED BY: jm	APPROVED BY:	DATE: 11/14/2019

MATERIAL PROPERTIES:

Concrete: f'_c = 4,000 psi α_c = 150 pcf

Steel: f_y = 60,000 psi

FOOTING DATA:

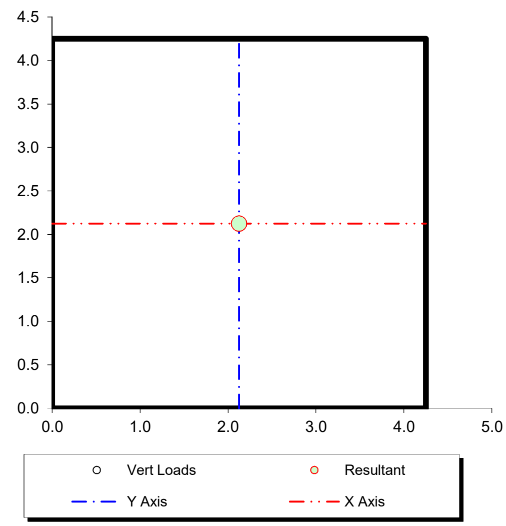
Footing Length: 4.250 ft	Volume =	22.58 cf	Footing Surcharge:	62.5 psf
Footing Width: 4.250 ft	Pressure =	187.50 psf	Surcharge Weight =	1,128.91 lbs
Footing Depth: 1.250 ft	Weight =	3,386.72 lbs		

Total Dead Load (Footing + Surcharge) = 4,515.63 lbs

FOOTING PLAN:

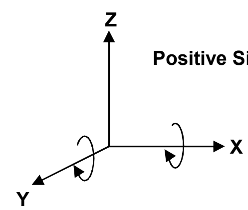
I_x = 27.19 ft^4

I_y = 27.19 ft^4



FOOTING LOADS:

Vertical Loads			Moment about N.A.	
Position		Magnitude	M_{xx}	M_{yy}
"X"	"Y"	(kips)	(k-ft)	(k-ft)
2.13	2.13	0.922	0.00	0.00
TOTALS:		0.92	0.00	0.00



Positive Sign Convention:

Footing Moments: M_{xx} : 0.00 k-ft

M_{yy} : 4.51 k-ft

RESULTANT LOCATION: e_x = 0.000 ft

e_y = 0.000 ft

FACTORED FOOTING PRESSURES:

Corner No.	Coordinates		Distance from N.A.		P/A	M/S		Pressure (G)	Pressure (N)
	"X"	"Y"	$N.A._{xx}$	$N.A._{yy}$	(k/ft^2)	M_x/S_x	M_y/S_y	(ksf)	(ksf)
1	0.00	0.00	-2.13	-2.13	0.35	0.00	-0.35	**0.00**	**-0.30**
2	4.25	0.00	-2.13	2.13	0.35	0.00	0.35	**0.70**	**0.40**
3	4.25	4.25	2.13	2.13	0.35	0.00	0.35	**0.70**	**0.40**
4	0.00	4.25	2.13	-2.13	0.35	0.00	-0.35	**0.00**	**-0.30**

CLIENT: City of Las Vegas		JOB NUMBER: CA2158	PAGE NO.
PROJECT: Fremont Street Improvement Project		SUBJECT: ERA Light Pole Spread Footing (12" Cover)	
BY: cw	CHECKED BY: jm	APPROVED BY:	DATE: 11/14/2019

MATERIAL PROPERTIES:

Concrete: f'_c = 4,000 psi α_c = 150 pcf

Steel: f_y = 60,000 psi

FOOTING DATA:

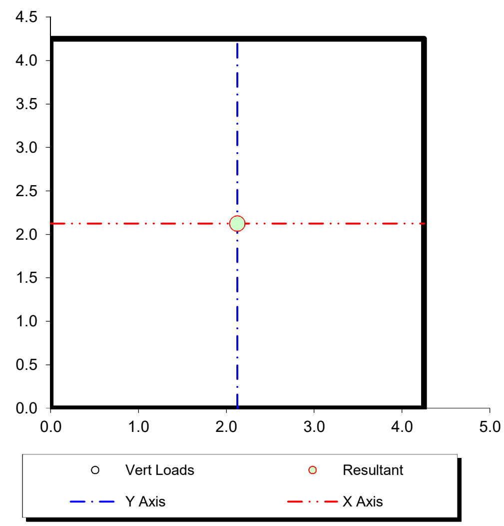
Footing Length:	4.250	ft	Volume =	18.06	cf	Footing Surcharge:	125	psf
Footing Width:	4.250	ft	Pressure =	150.00	psf	Surcharge Weight =	2,257.81	lbs
Footing Depth:	1.000	ft	Weight =	2,709.38	lbs			

Total Dead Load (Footing + Surcharge) = 4,967.19 lbs

FOOTING PLAN:

I_x = **27.19** ft^4

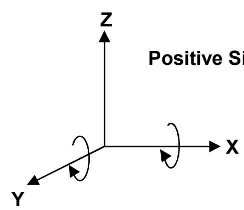
I_y = **27.19** ft^4



FOOTING LOADS:

Vertical Loads			Moment about N.A.	
Position		Magnitude	M_{xx}	M_{yy}
"X"	"Y"	(kips)	(k-ft)	(k-ft)
2.13	2.13	0.922	0.00	0.00
TOTALS:		**0.92**	**0.00**	**0.00**

Positive Sign Convention:



Footing Moments: M_{xx} : 0.00 k-ft

M_{yy} : 4.51 k-ft

RESULTANT LOCATION: e_x = **0.000 ft**

e_y = **0.000 ft**

FACTORED FOOTING PRESSURES:

Corner No.	Coordinates		Distance from N.A.		P/A	M/S		Pressure (G)	Pressure (N)
	"X"	"Y"	$N.A._{xx}$	$N.A._{yy}$	(k/ft^2)	M_x/S_x	M_y/S_y	(ksf)	(ksf)
1	0.00	0.00	-2.13	-2.13	0.38	0.00	-0.35	**0.03**	**-0.30**
2	4.25	0.00	-2.13	2.13	0.38	0.00	0.35	**0.73**	**0.40**
3	4.25	4.25	2.13	2.13	0.38	0.00	0.35	**0.73**	**0.40**
4	0.00	4.25	2.13	-2.13	0.38	0.00	-0.35	**0.03**	**-0.30**

CLIENT:	City of Las Vegas	JOB NUMBER:	CA2158	PAGE NO.
PROJECT:	Fremont Street Improvement Project	SUBJECT:	ERA Light Pole Spread Footing	
BY: cw	CHECKED BY: jm	APPROVED BY:		DATE: 11/14/2019

CONCRETE SECTION DESIGN:

DESIGN REQUIREMENTS:

Factored moment:	M_u =	1.42	ft-kip
Service moment:	M_w =	0.90	ft-kip
Factored shear:	V_u =	1.34	kip
Service shear:	V_w =	0.85	kip

RESISTANCE FACTORS: (5.5.4.2)

Flexure:	ϕ_f =	0.9
Shear:	ϕ_v =	0.9

Maximum Aggregate Size: 1.50 in

MATERIAL PROPERTIES:

Concrete compressive strength:	f'_c =	4000	psi
Concrete unit weight:	W_c =	150	pcf
Concrete modulus of elasticity: (5.4.2.4)	E_c =	3834	ksi
Concrete modulus of rupture: (5.4.2.6)	f_{r1} =	480.00	psi
	f_{r2} =	740.00	psi
	f_{r3} =	400.00	psi
Steel yield strength:	f_y =	60000	psi
Steel modulus of elasticity:	E_s =	29000	ksi
Modulus ratio:	n =	7.56	ksi
Factor:	β_1 =	0.85	ksi

Equations:

$$E_c := (W_c)^{1.5} \cdot 33 \cdot \sqrt{f'_c}$$

$$f_{r1} := 0.24 \cdot \sqrt{f'_c}$$

$$f_{r2} := 0.37 \cdot \sqrt{f'_c}$$

$$f_{r3} := 0.20 \cdot \sqrt{f'_c}$$

$$n := \frac{E_s}{E_c}$$

$$\beta_1 := \text{if}\left[f'_c < 4000\text{psi}, 0.85, 0.85 - \left(\frac{f'_c}{1000\text{psi}} - 4.0\right) \cdot 0.05\right]$$

SECTION PROPERTIES:

Section type:	Type	Slab	
Height:	h =	12	in
Width:	b =	12	in
Moment of inertia:	I_g =	1728	in^4
Section modulus:	S_c =	288	in^3
Cracking moment:	M_{cr1} =	11.52	ft-kip
	M_{cr2} =	17.76	ft-kip
	M_{cr3} =	9.60	ft-kip

Equations:

$$I_g := \left(\frac{b \cdot h^3}{12}\right)$$

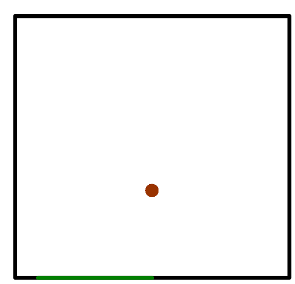
$$S_c := \frac{I_g}{0.5 \cdot h}$$

$$M_{cr1} := S_c \cdot f_{r1}$$

$$M_{cr2} := S_c \cdot f_{r2}$$

$$M_{cr3} := S_c \cdot f_{r3}$$

Graphic:



FLEXURAL REINFORCEMENT DATA:

	Bottom:	Sides:	Between Rows:
Clear cover (in):	3.00	2.00	3.00

Layer	No. of Bars	Bar Size	Bar Diam. (in)	A_s/bar (in^2)	A_s/layer (in^2)	d (in)	Clr. Spa. (in)
1	1	5	0.625	0.307	0.307	8.688	12.000
					0.000	0.000	
					0.000	0.000	
Totals:	**1**				**0.307**	**8.688**	

SHEAR REINFORCEMENT DATA:

Bar Size	Bar Diam. (in)	No. of Legs	Spacing (in)	A_v (in^2)
3	0.000	0	6	0.000

Spacing Requirements: (5.8.2.7)

Concrete shear stress: v_u= 0.014 ksi < 0.125 * f'_c

Maximum spacing: s = 7.0 in

CLIENT: City of Las Vegas		JOB NUMBER: CA2158	PAGE NO.
PROJECT: Fremont Street Improvement Project		SUBJECT: ERA Light Pole Spread Footing	
BY: cw	CHECKED BY: jm	APPROVED BY:	DATE: 11/14/2019

DESIGN CALCULATIONS:

Depth of compression section: (5.7.3.1.2-4)	c =	0.531	in
Depth of equivalent stress block: (5.7.2.2)	a =	0.451	in
Nominal flexural resistance: (5.7.3.2.2-1)	M_n =	12.98	ft-kip
Strain in reinforcing at ultimate: (5.7.2.1)	ε_s =	0.0461	
For grade 60 reinforcement:	ε_y =	0.0021	
Ratio:	c/d_s =	0.061	
Factored resistance: (5.7.3.2.1)	M_r =	11.68	ft-kip
Minimum reinforcement: (5.7.3.3.2)	$1.33M_u$=	1.89	ft-kip
	$1.2M_{cr}$ =	11.52	ft-kip

CHECK SERVICEABILITY: (5.7.3.4)

Exposure factor:	γ_e =	1.00	
Concrete cover thickness:	d_c =	3.313	in
Factor:	β_s =	1.545	in
Tension reinforcement ratio:	ρ =	0.0029	in
Constant:	k =	0.190	
Constant:	j =	0.937	
Tensile stress at service limit state:	f_{ss} =	4.33	ksi
Maximum permitted bar spacing:	s_{max} =	98.13	in

SKIN REINFORCEMENT:

Is skin reinforcement required?:	Req'd:	No	
Skin reinf req'd (in^2 / ft of height, each face):	A_{sk} =	-0.256	in^2
Maximum spacing:	S_{skin} =	1.45	in

SHEAR DESIGN: (5.8.3.3)

Minimum shear steel req'd: (5.8.2.5)	A_v =	0.000	in^2
Effective shear depth:	d_v =	8.64	in
Strain:	ε_s =	0.00037	
Crack spacing parameter:	s_{xe} =	5.60	
Beta:	β =	4.291	
Theta:	θ =	30.303	deg
Shear strength of the concrete:	V_c =	28.27	kip
Shear strength of the reinforcement:	V_s =	0.00	kip
Factored shear resistance:	ϕV_n =	25.44	kip

DESIGN CHECKS:

(1) Flexural Capacity:	OK!
(2) Ductile Failure:	OK!
(3) Minimum Flexural Steel:	OK!
(4) Flexural Steel Spacing:	OK!
(5) Shear Capacity:	OK!
(6) Minimum Shear Steel:	Not Required
(7) Stirrup Spacing:	Not Required

Equations:

$$c := \frac{\left[\left(A_{sr1} + A_{sr2} + A_{sr3}\right)\cdot f_y\right]}{0.85\cdot f'_c\cdot \beta_1\cdot b}$$

$$a := c\cdot \beta_1$$

$$M_n := \left(A_{sr1} + A_{sr2} + A_{sr3}\right)\cdot f_y\cdot\left(d - \frac{a}{2}\right)$$

$$\varepsilon_s := 0.003\cdot\frac{(d - c)}{c}$$

$$\varepsilon_y := \frac{f_y}{E_s}$$

$$M_r := \phi_f\cdot M_n$$

$$d_c := h - d$$

$$\beta_s := 1 + \frac{d_c}{0.7\cdot\left(h - d_c\right)}$$

$$\rho := \frac{\left(A_{sr1} + A_{sr2} + A_{sr3}\right)}{b\cdot d}$$

$$k := \sqrt{(2\cdot\rho\cdot n) + (\rho\cdot n)^2} - \rho\cdot n$$

$$j := 1 - \frac{k}{3}$$

$$f_{ss} := \frac{M_w}{\left(A_{sr1} + A_{sr2} + A_{sr3}\right)\cdot j\cdot d}$$

$$s_{max} := \left[\frac{\left(700\cdot\gamma_e\right)}{\beta_s\cdot f_{ss}}\right] - 2\cdot d_c$$

$$A_{sk} := \min\left[0.012\cdot(d - 30), \frac{\left(A_{sr1} + A_{sr2} + A_{sr3}\right)}{4}\right]$$

$$S_{skin} := \min\left(12.0, \frac{d}{6}\right)$$

$$A_v \geq 0.0316\cdot\sqrt{f'_c}\cdot\frac{(b\cdot Spacing)}{f_y}$$

$$d_v := \max\left(0.9\cdot d, 0.72\cdot h, \frac{M_n}{A_s\cdot f_y}\right)$$

$$\varepsilon_s := \frac{\left[\left(\frac{M_u}{d}\right) + V_u\right]}{E_s\cdot A_s}$$

$$\beta := \frac{4.8}{\left(1 + 750\cdot\varepsilon_s\right)} \quad \text{OR} \quad \beta := \left[\frac{4.8}{\left(1 + 750\cdot\varepsilon_s\right)}\right]\cdot\left[\frac{51}{\left(39 + s_{xe}\right)}\right]$$

$$s_{xe} := s_x\cdot\left(\frac{1.38}{a_g + 0.63}\right)$$

$$\theta := 29 + 3500\cdot\varepsilon_s$$

$$V_c := 0.0316\cdot\beta\cdot\sqrt{f'_c}\cdot b\cdot d$$

$$V_s := \frac{\left(A_v\cdot f_y\cdot d\cdot\cot(\theta)\right)}{Spacing}$$

CA Group, Inc
CAVIOLA ANSON

Job Title: Fremont St - LV Blvd to 14th St
Subject: RFI #011
Title: 1929 ERA Street Light
Subtitle: Base Plate Design

Designed By: Chris Wunsch
Date: 11/14/2019
Job No. CA2158

DESIGN CODES:
1. ACI 318-14 Building Code Requirements for Structural Concrete
2. AISC Manual of Steel Construction ASD

DESIGN LOADS:

Anchor Reactions:

Service Axial Load: $P_w := 0.922\text{kip}$

Service Moment: $M_w := 4.51\text{kip}\cdot\text{ft}$

Service Shear Load: $V_w := 0.393\text{kip}$

Base Plate Dimensions:

Dimension b1: $b_1 := 2.1875\text{in}$

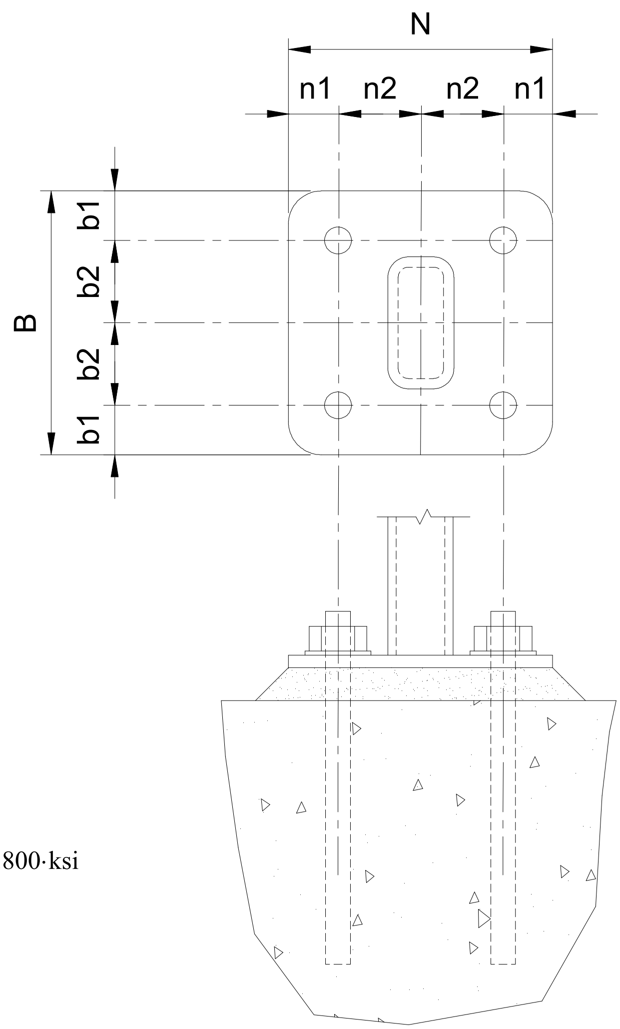
Dimension b2: $b_2 := 5.3125\text{in}$

Dimension B: $B := 2\cdot b_1 + 2\cdot b_2 = 15.00\cdot\text{in}$

Dimension n1: $n_1 := 2.1875\text{in}$

Dimension n2: $n_2 := 5.3125\text{in}$

Dimension N: $N := 2\cdot n_1 + 2\cdot n_2 = 15.00\cdot\text{in}$



Design Calculations:

Column Depth: $d_{col} := 9.0\text{in}$

Concrete Compressive Strength: $f'_c := 4000\text{psi}$

Steel Yield Strength: $f_y := 36.0\text{ksi}$

Distance, $N' := N - n_1 = 12.813\cdot\text{in}$

Distance, $A' := 0.5\cdot N - n_1 = 5.313\cdot\text{in}$

Axial Load, $P_w = 0.9\cdot\text{kip}$

Maximum Design Bearing Stress, $F_p := 0.35\cdot f'_c\cdot 2 = 2.800\cdot\text{ksi}$

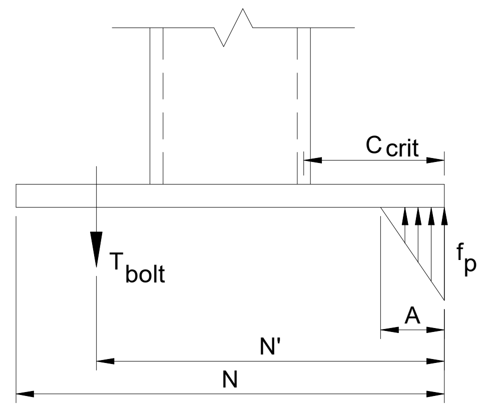
Eccentricity, $e := \dfrac{M_w}{P_w} = 58.70\cdot\text{in}$

$$f' := \frac{\left(F_p\cdot B\cdot N'\right)}{2} = 269.1\cdot\text{kip}$$

Length of Bearing: $$A := \frac{\left[f' - \sqrt{f'^2 - 4\cdot\left(F_p\cdot\frac{B}{6}\right)\cdot\left(P_w\cdot A' + M_w\right)}\right]}{\left(F_p\cdot\frac{B}{3}\right)} = 0.221\cdot\text{in}$$

Single Bolt Tension, $T_{bolt} := \left[\frac{(F_p \cdot A \cdot B)}{2}\right] - \frac{P_w}{2} = 4.17 \cdot kip$

Critical Section: $c_{crit} := 0.5 \cdot N - 0.5 \cdot d_{col} = 3 \cdot in$



Moment in the Plate due to Bearing Stress:

$$M_{plate1} := 0.5 \cdot F_p \cdot A \cdot \left(c_{crit} - A \cdot \frac{1}{3}\right) = 0.90 \cdot kip$$

Moment in the Plate due to Bolt Tension:

$$M_{plate2} := \frac{T_{bolt}}{2} = 2.09 \cdot kip$$

Required Plate Thickness: $T_{plate} := \sqrt{6 \cdot \frac{\max(M_{plate1}, M_{plate2})}{0.75 \cdot f_y}} = 0.681 \cdot in$ Use a 1" Thick Plate

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Company:		Date:	9/23/2019
Engineer:	caw	Page:	1/6
Project:	Fremont St Improvements		
Address:			
Phone:			
E-mail:			

1.Project information

Customer company:
Customer contact name:
Customer e-mail:
Comment: Anchor Bolt Check

Project description: ERA 1929 Light Pole Spread Footing
Location:
Fastening description:

2. Input Data & Anchor Parameters

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

Anchor Information:
Anchor type: Cast-in-place
Material: F1554 Grade 36
Diameter (inch): 1.000
Effective Embedment depth, h_{ef} (inch): 8.000
Anchor category: -
Anchor ductility: Yes
h_{min} (inch): 9.75
C_{min} (inch): 6.00
S_{min} (inch): 6.00

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 12.00
State: Cracked
Compressive strength, f'_c (psi): 4000
$\Psi_{c,V}$: 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: No
Build-up grout pad: No

Base Plate
Length x Width x Thickness (inch): 15.00 x 15.00 x 1.00

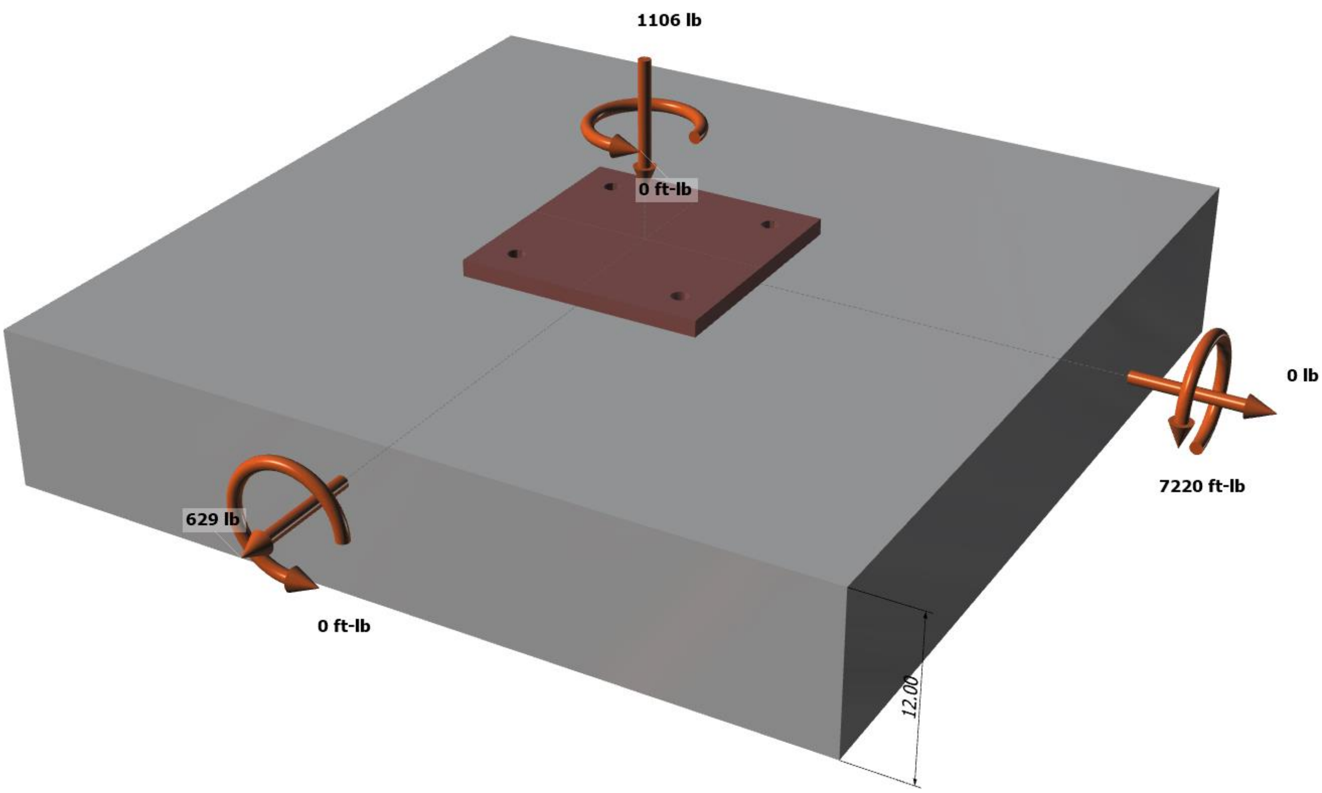
Recommended Anchor
Anchor Name: J- or L-Bolt - 1"Ø J- or L-Bolt, F1554 Gr. 36

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

Strength level loads:

N_{ua} [lb]: -1106
V_{uax} [lb]: 629
V_{uay} [lb]: 0
M_{ux} [ft-lb]: 0
M_{uy} [ft-lb]: 7220
M_{uz} [ft-lb]: 0

<Figure 1>



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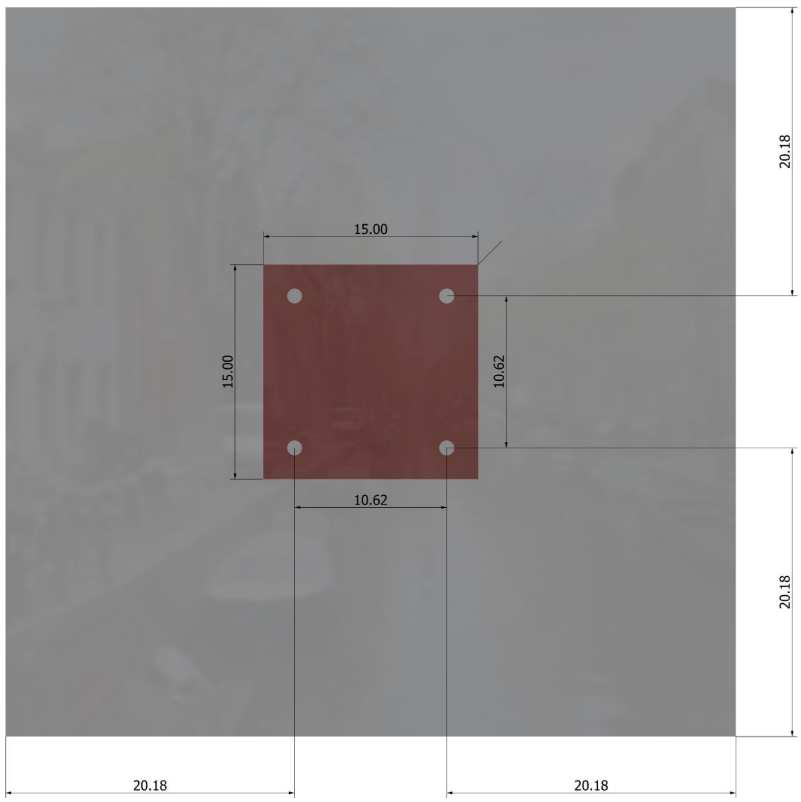
<Figure 2>



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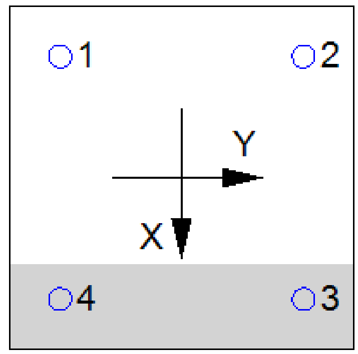
3. Resulting Anchor Forces

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	3443.1	157.3	0.0	157.3
2	3443.1	157.3	0.0	157.3
3	0.0	157.3	0.0	157.3
4	0.0	157.3	0.0	157.3
Sum	6886.2	629.0	0.0	629.0

Maximum concrete compression strain (‰): 0.07
Maximum concrete compression stress (psi): 288
Resultant tension force (lb): 6886
Resultant compression force (lb): 7992
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

<Figure 3>



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

N_{sa} (lb)	ϕ	ϕN_{sa} (lb)
35150	0.75	26363

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)
24.0	1.00	4000	8.000	34346

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

A_{Nc} (in^2)	A_{Nco} (in^2)	$c_{a,min}$ (in)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕN_{cbg} (lb)
830.88	576.00	20.18	1.000	1.000	1.00	1.000	34346	0.70	34681

6. Pullout Strength of Anchor in Tension (Sec. 17.4.3)

$fN_{pn} = fY_{c,P}N_p = fY_{c,P}0.9f'_c e_h d_a$ (Sec. 17.3.1, Eq. 17.4.3.1 & 17.4.3.5)

$\Psi_{c,P}$	f'_c (psi)	d_a (in)	e_h=$3d_a$ (in)	ϕ	ϕN_{pn} (lb)
1.0	4000	1.00	3.00	0.70	7560

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

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
21090	1.0	0.65	13709

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

Shear perpendicular to edge in x-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)
8.00	1.000	1.00	4000	13.45	28088

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

A_{Vc} (in^2)	A_{Vco} (in^2)	$\Psi_{ec,V}$	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	V_{bx} (lb)	ϕ	ϕV_{cbgx} (lb)
611.76	814.46	1.000	1.000	1.000	1.297	28088	0.70	19151

Shear parallel to edge in x-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)
8.00	1.000	1.00	4000	13.45	28088

$\phi V_{cbgx} = \phi\,(2)(A_{Vc} / A_{Vco})\Psi_{ec,V}\Psi_{ed,V}\Psi_{c,V}\Psi_{h,V}V_{by}$ (Sec. 17.3.1, 17.5.2.1(c) & Eq. 17.5.2.1b)

A_{Vc} (in^2)	A_{Vco} (in^2)	$\Psi_{ec,V}$	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	V_{by} (lb)	ϕ	ϕV_{cbgx} (lb)
611.76	814.46	1.000	1.000	1.000	1.297	28088	0.70	38302

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

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

k_{cp}	A_{Nc} (in^2)	A_{Nco} (in^2)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕV_{cpg} (lb)
2.0	1198.54	576.00	1.000	1.000	1.000	1.000	34346	0.70	100054

11. Results

Interaction of Tensile and Shear Forces (Sec. 17.6.)

Tension	Factored Load, N_{ua} (lb)	Design Strength, $øN_n$ (lb)	Ratio	Status
Steel	3443	26363	0.13	Pass
Concrete breakout	6886	34681	0.20	Pass
Pullout	**3443**	**7560**	**0.46**	**Pass (Governs)**

Shear	Factored Load, V_{ua} (lb)	Design Strength, $øV_n$ (lb)	Ratio	Status
Steel	157	13709	0.01	Pass
T Concrete breakout x+	**629**	**19151**	**0.03**	**Pass (Governs)**
|| Concrete breakout y-	**315**	**38302**	**0.01**	**Pass (Governs)**
Pryout	629	100054	0.01	Pass

Interaction check	$N_{ua}/\phi N_n$	$V_{ua}/\phi V_n$	Combined Ratio	Permissible	Status
Sec. 17.6..1	0.46	0.00	45.5%	1.0	Pass

1"Ø J- or L-Bolt, F1554 Gr. 36 with hef = 8.000 inch meets the selected design criteria.

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12. Warnings

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