Edge
Consulting Engineers, Inc.

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April 20, 2018

Zayo
5005 Cheshire Parkway
Suite 1
Plymouth, MN 55446
Contact: David Bushaw
Phone: (952) 230-9662

SUBJECT: POLE REVIEW AND FOUNDATION DESIGN REPORT
SMALL CELL INSTALLATION
PORTILLO'S [MS90XSU24] – CANDIDATE N
MAPLE GROVE, MINNESOTA
EDGE PROJECT #17258

Mr. Bushaw:

Edge Consulting Engineers, Inc. has been asked to complete a pole review and foundation design for the above mentioned site per your Small Cell installation request. One loading scenario was considered in the analysis. This loading condition takes into account the existing loading along with the proposed loading. The proposed primary equipment elevation is at 32 feet above ground level on this 40 foot tall pole.

For this analysis, the loads were calculated in accordance with the Minnesota Building Code (IBC 2012) and all of its referenced standards. The capacities of the pole were calculated in accordance with the current LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (AASHTO 2015) and all of its referenced standards. See the Antenna Wind Load Calculations and pole design drawing attachments for further details.

EQUIPMENT INFORMATION

#	Appurtenance	Status
1	**AW3406-S**	**Proposed**
1	**Airspan iR460-SPB-ST-1-P-0 w/ Side Arm**	**Proposed**
1	**Airspan AirHarmony 4400 w/ Mount & Sunshield**	**Proposed**
1	**Tallysman GPS-ANT-3**	**Proposed**
1	**Transector 1101-1207-1012**	**Proposed**
1	**Square D D221NRB**	**Proposed**
1	**Milbank U4801-XL-5TP**	**Proposed**
1	LED Light	Existing
1	JCT 61	Existing

It is not permitted to mount overhead wires on to the proposed pole.

Utilizing the Sabre 17-6094 Option 1 pole design dated 3/17/2017, it was determined that the applied reactions and stresses at the base of the pole from the proposed equipment loading condition are less than the Sabre calculated design capacities. Therefore, it was determined that the structure is **safely capable of supporting** the proposed loading. The anchor rods are to be provided by Sabre, and have been sized accordingly to the demand required.

It is proposed to install the pole on a new cast-in-place foundation constructed with normal weight concrete having a minimum f'c of 4,500psi and ASTM A615 Grade 60 rebar. The proposed foundation is a 11'-0" long x 2'-6" diameter concrete pier that is to be flush with the ground. The foundation is to have twelve (12) #7 vertical reinforcing bars and twelve (12) #4 horizontal shear reinforcing bars with two shear ties in the top 5 inches of the pier and the ties evenly spaced thereafter. See the Drilled Pier Foundation Calculations attachment for further details.

If the proposed loading condition is altered from that analyzed or it is determined that any of the assumptions are not accurate, this analysis shall be deemed obsolete and further analysis will be required.

Refer to the Portillo's Construction Drawings created by Edge Consulting Engineers for all applicable plan work, notes, and details.

Please feel free to contact us if you have any questions or concerns.

Sincerely,

Edge Consulting Engineers, Inc.

Tyler Clausen

Tyler A. Clausen
Structural Engineer
(2) Attachments

PROFESSIONAL ENGINEER
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Minnesota

Print Name: Chris C. Kanne

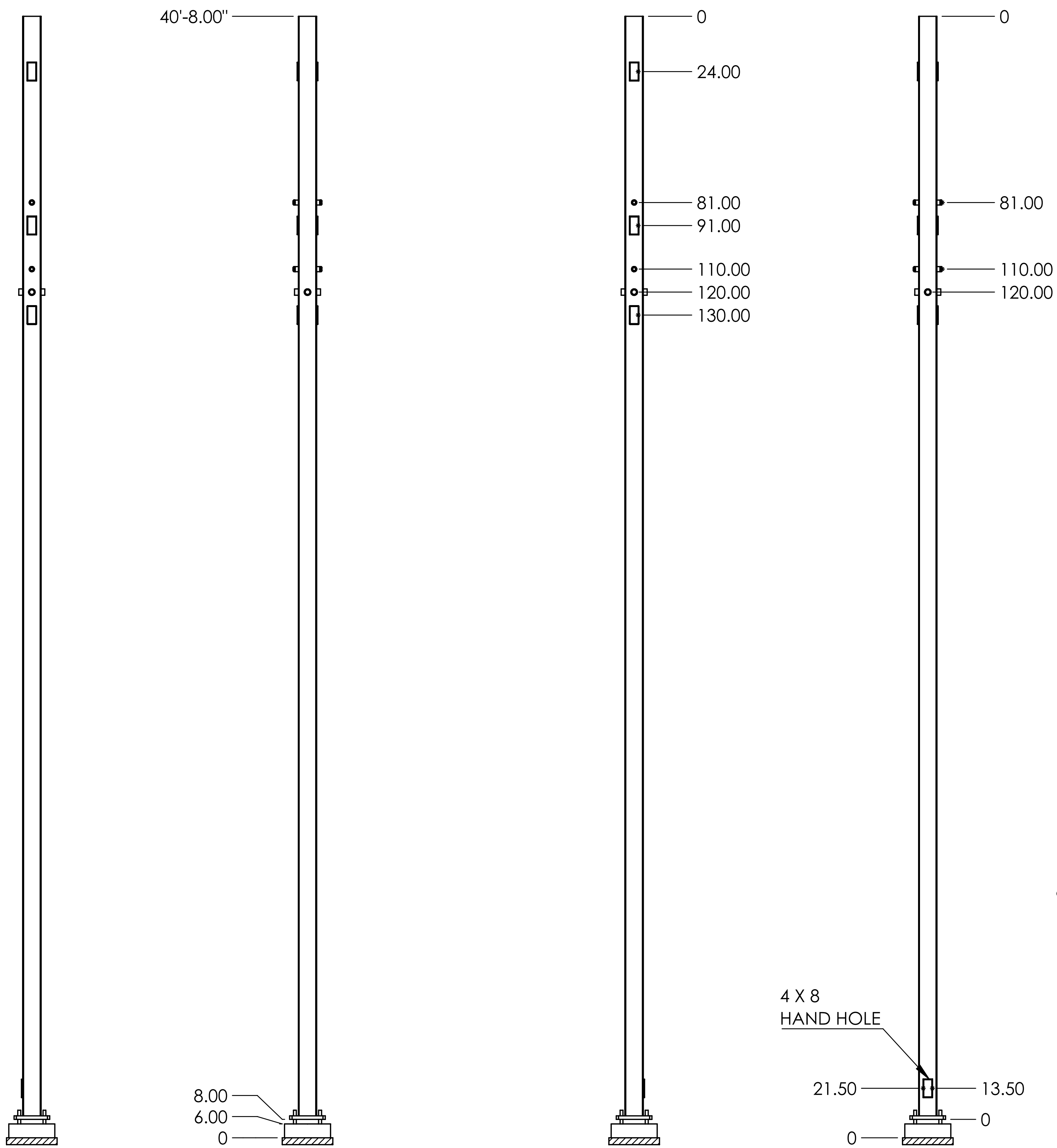
Signature: Chris Kanne

Date: 4/20/2018 License#: 55580

LIMITATIONS AND RESTRICTIONS

1. This report was prepared in accordance with generally accepted structural engineering practices common to the industry and makes no other warranties, either expressed or implied, as to the professional advice provided under the terms of the agreement between Engineer and Client. This report has not been prepared for uses or parties other than those specifically named, or for uses or applications other than those enumerated herein. The report may contain insufficient or inaccurate information for other purposes, applications, and/or other uses.
2. This report is intended for the use of the client, and cannot be utilized or relied upon by other parties without the written consent of Edge Consulting Engineers.
3. Edge Consulting Engineers is not responsible for any, and all, modifications completed prior to, or hereafter, which Edge Consulting Engineers was not, or will not, be directly involved.
4. The model, conclusions, and recommendations contained within this report are based upon the supplied and attained information as described within the report. If it is known, or becomes known, that any item(s) are in conflict with what is described within this document, this report should be considered void and Edge Consulting Engineers should be contacted immediately.
5. Edge Consulting Engineers disclaims all liability for any information, conclusion, or recommendation that is not expressly stated or represented within this report.
6. Edge Consulting Engineers shall not be liable for any incidental, consequential, indirect, special or punitive damages arising out of any claim associated with the use of this report.
7. The scope of worked performed for this analysis is limited to the items in which we were furnished complete and accurate information.
8. Accessories and appurtenances such as antenna mounts, feed line ladders, climbing ladders, lighting mounts, etc. were not analyzed as part of this work, and Edge Consulting Engineers, Inc. makes no claim as to their adequacy of their design or their installation.
9. This analysis provided by Edge Consulting Engineers, Inc. addresses the structural adequacy or deficiencies of the primary structural members under wind load only. This analysis assumes that the stresses applied at the base of the vertical shaft controls the design. The evaluation of each bolt, plate connection detail, weld, etc. is outside the scope of this analysis. It was assumed that the pole manufacturer designed the pole so items such as T-bases, tapered bases, and breakaway bases do not control the design. Fatigue was also assumed to be checked by the pole manufacturer and/or not control the design.
10. This analysis was performed under the assumption that all structural elements are in like new condition, free from rust and other deterioration. It is also assumed that everything was properly installed per construction documents. Edge Consulting Engineers cannot account for, nor be held responsible, if elements are deteriorated, damaged, and/or missing.
11. This analysis was performed based upon the antenna and equipment loading and placement as described within this report. Any alterations to the described loading or placement will require re-analysis, and the findings contained in this report are not valid.
12. The loading utilized for this analysis is based on information provided by the client, and readily available manufacturer/vendor information (antenna and mount projected areas, weight and shape factors). For all other appurtenances, the EPA's were based off of ground level images. It is the client's responsibility to gage the acceptable level of uncertainty from these ground images and the heights estimated. If more certainty is required, a climb should be completed. Furthermore, if the described loading criteria and design assumptions within this report are not accurate, are altered, or changed in any form, this analysis shall be considered void and an additional analysis must be performed.
13. It is the responsibility of the client and the building owner to thoroughly review the existing and proposed loading, and bring any discrepancy to the attention of Edge Consulting Engineers.
14. Site-specific loading or local building code requirements may be more stringent than the minimum loading requirements specified in the Standard. These and other unique loads or loading combination requirements are to be specified by the owner (in the procurement specifications).
15. Unless stated otherwise, for the purpose of this analysis, no geotechnical report or properties were provided. It has been assumed that the soils at the site have a minimum strength equivalent to a class 4 soil per the IBC. If it is determined that this assumption is not accurate, this analysis is void and an additional analysis should be performed.

	TYPE	AZIMUTH	ELEV. (from top)
1	HAND HOLE	90 / 270	24
2	HAND HOLE	90 / 270	91
3	HAND HOLE	90 / 270	130
4	1½" NPT FITTING	90 / 270	81
5	1½" NPT FITTING	90 / 270	110
6	2" NPT FITTING	0 / 90 / 180 / 270	120
7	HAND HOLE	180	13.5 (FR. BOTTOM)



90 DEGREE AZIMUTH **0 DEGREE AZIMUTH** **270 DEGREE AZIMUTH** **180 DEGREE AZIMUTH**

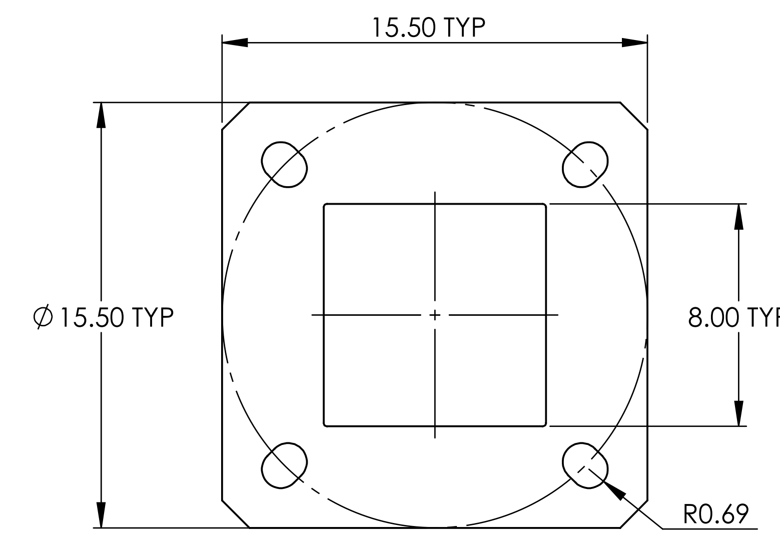
NOTES:

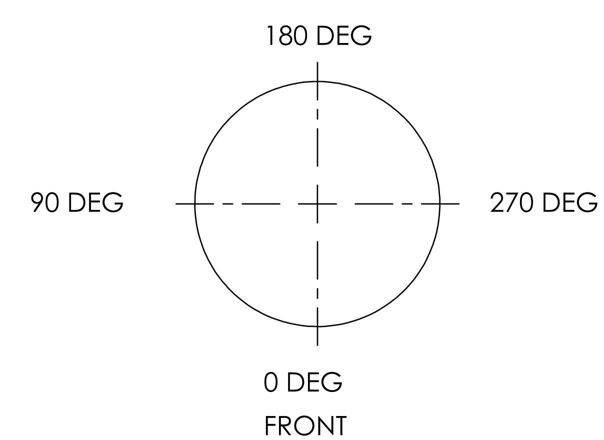
ASTM A500 Gr. C Steel Pole Galvanized

ASTM A572 Gr.50 1.5" thk base plate

Includes anchor bolts and templates

ALL HAND HOLES ARE 4" X 8"





Sabre Industries

CONFIDENTIAL INFORMATION

DO NOT SCALE DRAWING

DATE 5/1/2018

DRAWN BY: CTG

CHECKED BY:

ORDER/QUOTE # EDGE SC STANDARD_R1

DESCRIPTION OPTION 4: 40' SQUARE POLE

CUSTOMER/SITE

SHEET 4 OF 4

Antenna Wind Load Calculations

Project Name - Portillo's (MS90XSU24)
Maple Grove, Minnesota
Edge #17258

Edge
Consulting Engineers, Inc.

Completed By: TAC
Checked By: CCK

Referenced Shape Factor Standard: ASCE 7-10

Pole Base Wind Pressure Calculation:

Exposure Category =	C	
Importance Category =	II	
Topographic Category =	Flat/Rolling Terrain	
Crest Height (H) =	0	ft
K_z =	1.04	
K_e =	1.00	
K_h =	NA	
K_t =	NA	
K_{zt} =	1.00	
K_d =	0.90	
V =	115	mph
Vnom =	89.08	mph

$$q_z = 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot V^2 \cdot I$$

q_z = 31.80 psf

$$F = q_z \cdot G \cdot C_f \cdot A$$

G = 1.10

Wind Force/Weight Calculation:

#	Appurtenance	Type	Normal Orientation	Owner	Elevation ft	K_d	q_z psf	Weight lbs	Bracket lbs	Height (H) in	Width (W) in	Depth (D) in	Front AR	Side AR	Front (C_{af})	Side (C_{as})	EPA_{norm} ft^2	EPA_{tan} ft^2	Total lbs
1	AW3406-S	Antenna	Worst	Zayo	32	0.9	30.34	6.60	1.10	14.50	11.00	3.00	1.3	4.8	1.31	1.36	1.45	0.41	7.70
1	Airspan iR460-SPB-ST-1-P-0 w/ Side Arm	UE Relay	Worst	Zayo	25	0.95	30.40	14.70	N/A	15.00	8.52	8.52	1.8	1.8	0.51	0.51	0.46	0.46	14.70
1	Airspan AirHarmony 4400 w/ Mount & Sunshield	Radio Unit	Worst	Zayo	22	0.9	28.04	65.00	N/A	29.00	11.50	13.90	2.5	2.1	1.33	1.32	3.69	3.07	65.00
1	Tallysman GPS-ANT-3	GPS	Worst	Zayo	22	0.9	28.04	0.30	N/A	2.00	2.60	2.60	1.3	1.3	1.31	1.31	0.05	0.05	0.30
1	Transector 1101-1207-1012	AC Distribution	Worst	Zayo	13	0.9	25.90	17.00	N/A	12.00	12.00	4.00	1.0	3.0	1.30	1.33	1.30	0.44	17.00
1	Square D D221NRB	Disconnect	Worst	Zayo	11	0.9	25.90	4.82	N/A	9.63	7.25	3.75	1.3	2.6	1.31	1.33	0.63	0.33	4.82
1	Milbank U4801-XL-5TP	Electric Meter	Worst	Zayo	5	0.9	25.90	21.00	N/A	19.00	13.00	4.84	1.5	3.9	1.31	1.35	2.24	0.86	21.00
1	LED Light	Light	Worst	Other	39	0.9	31.63	36.00	N/A	7.13	17.50	17.50	2.5	2.5	1.32	1.32	1.15	1.15	36.00
1	JCT 61	Sign	Side	Other	8	0.9	25.90	15.00	N/A	36.00	24.00	0.13	1.5	288.0	1.31	2.00	0.06	7.85	15.00

Load Summary

#	Appurtenance	Total Weight lbs	Norm. lbs	Tan. Force lbs
1	AW3406-S	7.70	48.25	48.25
1	Airspan iR460-SPB-ST-1-P-0 w/ Side Arm	14.70	15.22	15.22
1	Airspan AirHarmony 4400 w/ Mount & Sunshield	65.00	113.80	113.80
1	Tallysman GPS-ANT-3	0.30	1.45	1.45
1	Transector 1101-1207-1012	17.00	37.04	37.04
1	Square D D221NRB	4.82	18.03	18.03
1	Milbank U4801-XL-5TP	21.00	63.90	63.90
1	LED Light	36.00	39.90	39.90
1	JCT 61	15.00	1.78	223.65

Antenna Wind Load Calculations

Project Name - Portillo's (MS90XSU24)
Maple Grove, Minnesota
Edge #17258

Edge Consulting Engineers, Inc.

Completed By: TAC
Checked By: CCK

Summary of Loading Relative to Grade

Component of the Tower	CENTROID X (ft)	CENTROID Y (ft)	CENTROID Z (ft)	F_{dead} (lb)	F_{side} (lb)	F_{front} (lb)
(1) AW3406-S	0.0	32.0	0.0	7.7	48.3	48.3
(1) Airspan iR460-SPB-ST-1-P-0 w/ Side Arm	-1.5	25.0	0.0	14.7	15.2	15.2
(1) Airspan AirHarmony 4400 w/ Mount & Sunshield	0.0	22.0	0.0	65.0	113.8	113.8
(1) Tallysman GPS-ANT-3	0.0	22.0	0.0	0.3	1.5	1.5
(1) Transector 1101-1207-1012	0.0	13.0	0.0	17.0	37.0	37.0
(1) Square D D221NRB	0.0	11.0	0.0	4.8	18.0	18.0
(1) Milbank U4801-XL-5TP	0.0	5.0	0.0	21.0	63.9	63.9
(1) LED Light	2.0	39.0	0.0	36.0	39.9	39.9
(1) JCT 61	0.0	8.0	0.0	15.0	223.6	1.8
Base Plate	0.0	0.1	0.0	71.5	7.8	7.8
Base Pole Section 1	0.0	3.0	0.0	196.2	227.9	227.9
Base Pole Section 2	0.0	9.5	0.0	228.9	265.9	265.9
Base Pole Section 3	0.0	16.5	0.0	228.9	270.9	270.9
Base Pole Section 4	0.0	30.0	0.0	654.0	877.9	877.9

Resulting Forces at Base of Pole

F-X	F-Y	F-Z	$M\text{-}X_{dead}$	$M\text{-}Z_{dead}$	$M\text{-}X_{side}$	$M\text{-}Y_{side}$	$M\text{-}Y_{front}$	$M\text{-}Z_{front}$	Force - X	Force -Y	Force - Z	$M\text{-}X_{Force}$	$M\text{-}Y_{Force}$	$M\text{-}Z_{Force}$
lb	lb	lb	ft-lb	ft-lb	ft-lb	ft-lb	ft-lb	ft-lb	lb	lb	lb	ft-lb	ft-lb	ft-lb
1989.9	-1560.9	2211.8	0.0	-4.2	3568.6	-4.7	0.0	-3420.7	0.0	0.0	0.0	0.0	0.0	0.0

Controlling ASD Base Reactions

F-X	F-Y	F-Z	M-X	M-Y	M-Z
lb	lb	lb	ft-lb	ft-lb	ft-lb
895.45	1560.95	995	19270	-26	-18522

Possible Additional Loading for Coax/Cable 150 lb dead load

*Assuming Bolts are Ungrouted and have the orientation of MAXIMUMS

Number of Anchor Bolts = 4
Bolt Circle Diameter = 15.5 in

Max Tension in Bolt = 20448 lb
Max Compression in Bolt = 21121 lb
Max Shear in Bolt = 345 lb

Resulting Forces at Critical Elevation of 0 ft above concrete

F-X	F-Y	F-Z	$M\text{-}X_{dead}$	$M\text{-}Z_{dead}$	$M\text{-}X_{side}$	$M\text{-}Y_{side}$	$M\text{-}Y_{front}$	$M\text{-}Z_{front}$	Force - X	Force -Y	Force - Z	$M\text{-}X_{Force}$	$M\text{-}Y_{Force}$	$M\text{-}Z_{Force}$
lb	lb	lb	ft-lb	ft-lb	ft-lb	ft-lb	ft-lb	ft-lb	lb	lb	lb	ft-lb	ft-lb	ft-lb
1989.9	-1560.9	2211.8	0.0	-4.2	3568.6	-4.7	0.0	-3420.7	0.0	0.0	0.0	0.0	0.0	0.0

Controlling LRFD Forces

F-X	F-Y	F-Z	M-X	M-Y	M-Z
lb	lb	lb	ft-lb	ft-lb	ft-lb
0.0	1873.1	2211.8	42823.3	-57.0	-59.9

Possible Additional Loading for Coax/Cable 150 lb dead load

LRFD Pole Capacities

P_T = 483.60 lb
D_P = 1569.53 lb
P_r = 1080.02 lb
B = 1.045

φPn = 19715 lb
φMn = 96669 ft-lb
φVn = 102745 lb
φTn = 67176 ft-lb
P_e = 24992 lb

Axial Ratio = 0.104
Moment Ratio = 0.463
Shear Ratio = 0.022
Combined Ratio = 0.515

Controlling Combined Capacity

$$P_r = \sqrt[3]{\frac{I_B}{I_T}} \cdot P_T + 0.38 \cdot D_P$$

$$B = \frac{1}{1 - P_r/P_e}$$

$$If\ \left(\frac{V_r}{V_n} + \frac{T_r}{T_c}\right) > 0.2 \qquad \frac{P_r}{P_c} + \frac{BM_r}{M_c} + \left(\frac{V_r}{V_n} + \frac{T_r}{T_c}\right)^2 \le 1.0$$

$$Else\ If\ \frac{P_r}{P_c} \ge 0.2 \qquad \frac{P_r}{P_c} + \frac{8}{9} \cdot \frac{BM_r}{M_c} \le 1.0$$

$$Else \qquad \frac{P_r}{2 \cdot P_c} + \frac{BM_r}{M_c} \le 1.0$$

Ratio = 0.515 **OK**

Drilled Pier Foundation Calculations

Project Name - Portillo's (MS90XSU24)
Maple Grove, Minnesota
Edge #17258

Edge Consulting Engineers, Inc.

Completed By: TAC
Checked By: CCK

Applied Loads:

Design Axial w/o Ice (P) =	1.561	kip	
Design Shear (V) =	1338.8	lb	(Reactions w/o ice)
Design Moment (M) =	26728.4	ft-lb	

Foundation Dimensions & Soil Properties:

Pier Diameter (D_{pier}) =	2.50	ft	
Pier Total Height (H_{pier}) =	11.00	ft	
Pier Height Above Ground Surface (H_p) =	0.00	ft	
Pier MOI (I) =	39760.78	in^4	
Pier Area (A) =	706.86	in^2	
Water Table Depth (d_{wt}) =	99	ft	*Based on IBC Table 1806.2, Assumed Class 4 Soil
γ_{soil} =	100	lb/ft^3	
$\gamma_{soil(sub)}$ =	60	lb/ft^3	
φ_{soil} =	30	°	
$Kp^*\gamma$ =	300.00	psf/ft	
q_a =	2000	lb/ft^2	**Net**
γ_c =	150	lb/ft^3	
$\gamma_{c(sub)}$ =	87.6	lb/ft^3	*Concrete below the water table
$H_{pier(sub)}$ =	0.0	ft	

$$H_{ug} = H_{pier} - H_p$$

Underground Pier Length (H_{ug}) = 11.00 ft

Bearing Check

Distance on top of Ignored Skin Friction (d_{sf}) =	0.0	ft	
Allowable Skin Friction (F_a) =	0.0	psf	*All Friction is Ignored

$$W_{concrete} = \left(\left(\frac{D_{pier}}{2}\right)^2 \cdot \pi \cdot H_{ug}\right) \cdot \frac{\gamma_c - \gamma_{soil}}{1000} + \left(\left(\frac{D_{pier}}{2}\right)^2 \cdot \pi \cdot H_p\right) \cdot \frac{\gamma_c}{1000}$$

Weight of Concrete ($W_{concrete}$) = 2.7 kip — *γ_{soil} = 0 if q_a is not net

$$R_f = \pi \cdot D_{pier} \cdot (H_{ug} - d_{sf}) \cdot F_a$$

Applied Skin Friction (R_f) = 0.0 kip — **Soil is beared**

$$q_{max} = \left(\frac{P + W_{concrete} - R_f}{\pi \cdot \left(\frac{D_{pier}}{2}\right)^2}\right) \cdot 1000$$

q_{max} = 868 psf — **qmax < qa OK**

IBC Flagpole Nonconstrained Foundation Check

Isolated Pole Increase =	1.0		Per IBC 1806.3.4, Isolated poles not adversely affected by
Factor Of Safety =	2.0		1/2" motion at ground are allowed to be 2x Tabular Values
Allowable Lateral Soil-Bearing Pressure (S_1) =	550	psf	
Effective Height (h_{ef}) =	19.96	ft	

$$A = \frac{2.34 \cdot V}{S_1 \cdot D_{pier}}$$

A = 2.28 ft

$$H_{req} = 0.5 \cdot A \cdot \left(1 + \left(1 + \frac{4.36 \cdot h_{ef}}{A}\right)^{0.5}\right)$$

Required Embedment Depth (H_{req}) = 8.27 ft — **OK**

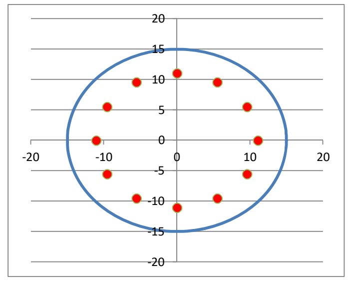
Concrete Column Strength Check

Project Name - Portillo's (MS90XSU24)
Maple Grove, Minnesota
Edge #17258

Edge Consulting Engineers, Inc.

Completed By: TAC
Checked By: CCK

Concrete Column Parameters:

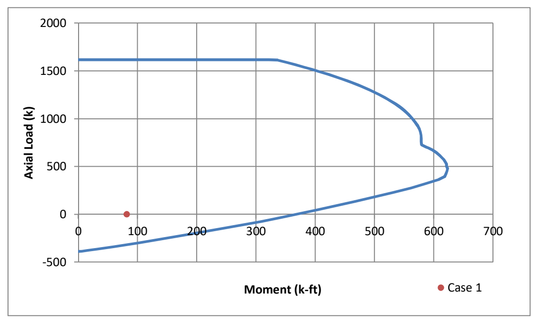


Strength Parameters

Concrete Design Stress (f'c) =	4.5	ksi
Steel Yield Stress (fy) =	60	ksi
Esteel =	29000	ksi

Geometry Parameters

Column Shape =	Circle	
Overall Width (b_w)=	2.50	ft
Overall Height ($_h$)=	2.50	ft
Inner Opening Width =	0.00	ft
Inner Opening Height =	0.00	ft
Rebar Layout	Circle	
# of Vertical Rebar	12	
Size of Vertical Rebar	#7	
Clear Cover	3	in
Tie Size	#4	
Tie Spacing	12	in
Number of Shear Ties Within Spacing	2	



Resulting Foundation Parameters

Provided Area of Vertical Steel (A_{spro}) =	7.2	in^2
Gross Area Concrete (A_{cg}) =	706.9	in^2

$$\rho_{stpro} = \frac{A_{spro}}{A_{cg}}$$

Provided Reinforcement Ratio (ρ_{stpro}) =	1.02%

Design Loads

Case 1

Applied Axial (Pu) =	2.11	kip
Applied Shear (Vu) =	34.63	kip
Applied Moment (Mu) =	81.69	kip-ft

Shear Capacity:

Additional Shear Strength Parameters

Lightweight Concrete Modification Factor (λ) =	1.0
Shear Strength Reduction Factor (ϕ) =	0.75

Steel

$$V_s = \frac{A_v f_y d}{s}$$

Concrete

$$X = \begin{cases} 500, & P_u < 0 \\ 2000, & P_u \geq 0 \end{cases}$$

$$V_c = 2\left(1 + \frac{P_u}{X \cdot A_g}\right)\lambda\sqrt{f_c'} \cdot b_w d$$

Capacity

$$\phi V_n = \phi(V_s + V_c)$$

Resulting Shear Capacities

Area of Steel provided (Av) =	0.40	in^2
Minimum Area of Steel (Av min) =	0.30	in^2
Steel Shear Capacity (Vs) =	48.00	kip

Case 1

Concrete Shear Capacity (Vc) =	96.60	kip	
Nominal Shear Capacity (φVn) =	108.45	kip	
DCR =	0.32		**OK**