valmont MICROFLECT

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DRILLED PIER FOUNDATION DESIGN CALCULATIONS

Valmont Order No.: 334229
Customer: VERIZON
Site: PORTLAND 3
Pole Ht: 89 FT (100 FT AGL)

valmont Monopole Pier Design Lateral Pressure

CUSTOMER:	VERIZON	
SITE:	PORTLAND 3	
S.O.#	334229	
DWG NO.	B-144243	
FS	1.0	EIA-F = 2 (Default), TIA-G = 1
Ø FACTOR	0.75	EIA-F = 1, TIA-G = 0.75
GW DEPTH (FT)	3.5	BGS

**CHECK UNIT WEIGHT BELOW THE WATER TABLE.*

ultimate lateral pressure = $\gamma z \tan^2(45+(\phi/2))+2c\tan(45+(\phi/2))$ *(ref. Bowles, eq. 2-41)*

allow. Lat. Pressure = (ult. Lat. Pressure)/FS

Group	Soil Type	Depth start (ft)	Depth end (ft)	c (psf)	ϕ (degrees)	γ (pcf)	lateral pressure start (psf)	lateral pressure end (psf)	slope (psf/ft)
		0.5	3.5		30.0	117.0	0.00	789.75	263.25
		3.5	20.5		30.0	55.0	789.75	2893.50	123.75
		20.5	25.5		35.0	144.0	3559.17	5551.86	398.54

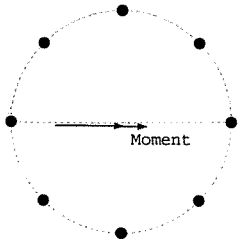
Americas Lighting and Communication Structures
Valmont Industries, Inc. 7002 North 288th Street, Valley, NE 68064-0358 USA
Toll Free: 800-825-6668 Fax: 402-359-6091 www.valmont.com

Pole Geometry

Bolt Circle =	**44.46**	Inches
# of Bolts =	**8.0**	
Bolt Diameter =	**1.75**	Inches
Bolt Projection =	**8.8**	Inches
Bolt Length =	**66.0**	Inches
Base Plate Diameter =	**48.0**	Inches

Pole Loads

Factored Moment =	**466.8**	ft-Kips
Factored Shear =	**8.5**	Kips
Factored Weight =	**12.8**	Kips
Shear Height =	**54.7**	Ft



Anchor Bolt Allowables

Fu =	**100.0**	Ksi
Fy =	**75.0**	Ksi
At =	**1.90**	in^2

Anchor Bolt Loads

Moment =	**5601.8**	in-Kips
Shear =	**8.5**	Kips
Weight =	**12.8**	Kips

Calculate the Bolt Maximum Applied Force

$$\text{Bolt Applied Force} = \frac{5601.8 \text{ in-Kips}}{44.5*(8/4)"} + \frac{935317639 \ / \ 0.}{8} = \mathbf{65.1 \text{ Kips}}$$

Bolt Allowable = .8 * Fu * At = **152.0 Kips** (per EIA-G Sec. 4.9.9)

Bolt Allowable > Bolt Applied Force

152 Kips > 65.1 Kips ====> OK

Calculate the Anchor Bolt Development Length

ACI 318

$$ld = db*Fy*\alpha\beta\gamma\lambda*\frac{3}{(40*(fc')^{\wedge}.5) * ((c+Ktr)/db))}$$

Given all minimums are met for the Bar Installation Per ACI

$\alpha = 1$

$\beta = 1$

$\lambda = 1$

$((c+Ktr)/db)_{\text{anchor bolts}} = 1.5$

$$ld = 1.75*75000*\frac{3}{(40*(4000)^{\wedge}.5)*1.5} = \mathbf{104 \text{ in}}$$

Calculate the Ultimate Bond Stress

Fy*Ag/(π*db*ld) = Bond_Allowable = 0.250 Ksi

Calculate the Allowable Bond Stress

.6*Bond_Allow*1.33 = 0.199 Ksi

Calculate the Required Bolt Length

$$Lreq = \frac{\text{Bolt Applied Force}}{3.14*db*0.199} + \text{Bolt Projection} = \mathbf{68.2 \text{ in}}$$

>66 in provided, bottom template needs to be double nutted

Check AB pullout via Rebar Development length with bottom template double nutted:

((c+Ktr)/db)rebar= 2.5

Ldb = (3*db*fy/(40*f'c^0.5*((c+Ktr)/db)))*(As_req/As_prov'd) = **13.2 in**

L_reqd = Ldb + abproj + 5.7075" + 3" = **30.7 in**

Bolt Length > Bolt Required Length

66 in > 30.7 in ====> OK

HDG REPORT FOR PORTLAND 3, ME DATED 08/13/2015

Ref: ACI 318 BUILDING CODE REQUIREMENTS

Calculate the Concrete Shear Strength

ACI 318

$V_c = 2*(fc')^{0.5}*bw*d$

Given:

bw	=	66 in
d	=	51.2 in
f_c'	=	4000 in
ϕ_c	=	0.85
$\phi_c V_c$	=	**363** Kips

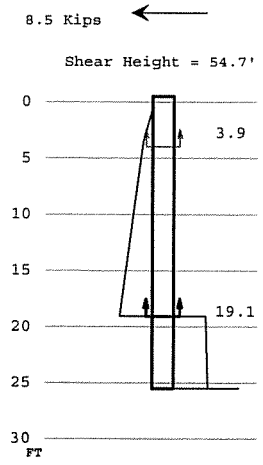
Calculate the Reinforcment Shear Strength

ACI 318

$$V_s = \frac{\text{\#4 horizontal ties at 12" spacing.}\ (4/3)*A_v*f_y*d}{s}$$

Given:

A_v	=	0.4 in^2
f_y	=	60 ksi
d	=	4.263 Ft
s	=	1 Ft
ϕ_s		0.85
$\phi_s V_s$	=	**116** Kips



SECTION AT 3.9 THE MAX MOMENT IN THE PIER
MAX PRESSURE 2714 PSF

SECTION AT 19.1 THE MAX SHEAR IN THE PIER
MAX NEGATIVE PRESSURE 2893 PSF

Pressure Profile for Analysis

The Maximum Shear in the Pier occurs at Reaction Inflection Point 19.1'

Load Factors for the design

ACI 318

EIA222-G wind loads are factored by 1.6 already

U_{ACI}	=	1.0
U_{EIA}	=	1.0
U_{TOTAL}	=	$U_{EIA}*U_{ACI}$
U_{TOTAL}	=	1.0
Vdesign=U_{TOTAL}*Vmax	=	**147.6 Kips**

ϕV_c	+	ϕV_s			> Vdesign	
363 Kips	+	**116 Kips**	=	**479 Kips**	> **147.6 Kips**	**====> OK**

The maximum bending stress in the pier occurs at 3.9' below the ground level.
Where the (passive pressure reaction) = (the applied shear)

M_{MAX} = 6057.3 At The Location

$$\int_{Ground\_Line}^{(Depth\_Mmax)} \frac{Passive\ Pressure}{ft}\,dft = Applied\ Shear$$

Use only the steel to carry the bending loads - Calculate the Reinforcment Bending Strength

Use (20) #9 vertical rebar.

Vertical Rebar Section Properties

$$I = \frac{A_{STEEL}*R_{VBAR}^2}{2}\ in^4$$

A_{rebar}	=	20 in^2
RVBAR	=	27.9 in
I	=	7804.2 in^4
S	=	279.4 in^3

Base the bending strength on factored Vertical bar Fy per TIA-222-G of 54 Ksi

F_{TY}	=	60 KSI
ϕ	=	0.9
$F_{TYALLOWABLE}$	=	$F_{TY}*\phi$
$F_{TYALLOWABLE}$	=	54 KSI

Max Design Moment

M_{MAX}	=	6057 in*KIP
M_{DESIGN}	=	$M_{MAX}*U_{TOTAL}$
M_{DESIGN}	=	6057 in*KIP

$$F_{TYDESIGN} = \frac{M_{DESIGN}}{S} + \frac{Weight}{A_{rebar}}$$

$F_{TYDESIGN}$ = 22.3 KSI

$F_{TYALLOWABLE}$	>	$F_{TYDESIGN}$	
54 KSI	>	**22.3 KSI**	**====> OK**

HDG REPORT FOR PORTLAND 3, ME DATED 08/13/2015

Ref: ACI 318 BUILDING CODE REQUIREMENTS

valmont MICROFLECT

Monopole Pier Design

CUSTOMER: VERIZON
SITE: PORTLAND 3
S.O.# 334229
DWG NO. B-144243
Geotec Rpt HDG REPORT FOR PORTLAND 3, ME DATED 08/13/2015
Geotec Report Water Depth 3.5 FT
Original Run Date: 07/15/16
VERSION: 1.15
Engineer: NAR Checker: NAR

Pole Geometry

Pole height =	89	ft
Bolt Circle =	44.46	Inches
# of Bolts =	8	
Bolt Diameter =	1.75	Inches
Bolt Projection =	8.75	Inches
Bolt Length =	66.0	Inches
Bottom Template Diameter =	48.0	Inches

Pole Loads

Factored Moment =	466.8	ft-Kips
Factored Shear =	8.53	Kips
Factored Weight =	12.76	Kips
Shear Height =	54.7	Ft
e (col offset) =	439.1	in

Anchor Bolt Load

Factored Moment =	5602	in-Kips
Factored Shear =	8.53	Kips
Factored Weight =	12.76	Kips

Anchor Bolt Allowable

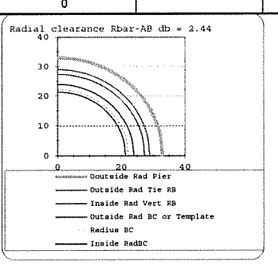
Fu =	100.0	Ksi
Fy =	75.0	Ksi
Area tensile =	1.90	in^2

Soil Properties

ZERO = GROUND LINE

Level #	ϕ Ultimate Pas Pressure PSF Start	ϕ Ultimate Pas Press Slope PSF/FT	Depth Start (ft)	Depth End (ft)	End Prss	Max Moment Depth (ft)
1	0	263.25	0.5	3.5	790	3.95
2	790	123.75	3.5	20.5	2894	Max Pier Moment
3	3559	398.5386119	20.5	25.5	5552	(in-Kips) (ft-Kips)
4	0	0	0			6057 505
5	0	0	0			

$$\int_{Ground\_Line}^{Depth\_Mmax} \frac{Passive\ Pressure}{ft}\,dft = Applied\ Shear$$



Footing Concrete Geometry

Cap Height (Above Ground Line) =	0.5	Ft
Diameter Pier =	5.5	Ft
Length (below ground) =	25.5	Ft
Concrete Volume =	22.9	cubic yards

Summation of shear and passive pressure forces to find LID: $\Sigma F_x = 0$

Load Inflection-Point Depth (LID) = 19.05 Ft

Summation of moments about LID: $\Sigma M_{LID} = RM_{total}$ - OTM >= 0

			Resisting	Soil FS above allowable	
OTM =	633.6 ft-Kips	RM_{total} =	1594	2.52	= RM_{total}/OTM
$Shear_{applied}$ =	8.5 Kips	$Shear_{resisting}$ =	8.71	1.02	= resisting V/applied V
Weight =	12.8 Kips				

Foundation Load Properties

About Load Inflection Point

ZERO = GROUND LINE

Level #	Passive Pressure PSF Start	Pas Press Slope PSF/FT	Depth Start (ft)	Depth End (ft)	Forces Constant Kips	Forces Slope Kips	Moments Constant Kip-Ft	Moments Slope Kip-Ft	V_{max} KIP
1	0	263	0.5	3.5	0.00	6.52	0	108	147.63
2	790	124	3.5	19.1	67.54	82.29	525	427	
3	2714	124	19.1	20.5	-21.64	-0.72	16	1	
4	3559	399	20.5	25.5	-98	-27	387	131	

Footing Reinforcement Requirements

Tie Bar # 4 Ties OK Seismic Ties? No

Tie Vertical Spacing	1	FT =	12"	
Number of Ties	28	-		
Area_Ties	0.4	in^2		AREA OF TIE CUT BY VERTICAL SECTION (2*Area of the tie)
MP_Tc	4	in		THICKNESS OF CONCRETE COVER
MP_Rin	27.9	in		RADIUS OF VERT. REBAR
MP_Asteel	20.0	in^2		TOTAL AREA OF VERT. BARS
MP_Esteel	29000	KSI		YOUNG'S MODULUS
MP_Isteel	7804	in^4		REBAR MOMENT OF INERTIA
EI	226321828	in^2*LB		E*I
S	279.4	in^3		REBAR SECTION MODULUS
M	6057	in*KIP		APPLIED MAXIMUM MOMENT @ AT DEPTH ZERO SHEAR ON PIER
Vertical Bar #	9		13	= Min # based on 200*bw*d/fy per ACI 318
Bar Count	20	>=	18	= Min # based on area
ϕ_{shear}	0.85			Strength Reduction Factor for Capacity Of Steel Shear
$\phi_{flexure}$	0.9			Strength Reduction Factor for Capacity Of Steel Flexure
MP_Fty_T&V	60	Ksi		REBAR Fty Grade 60
MP_Fty_T&V_ALL	54	Ksi		REBAR Fty Allowable Pier Design includes PHI_Steel
FTYDESIGN	22.3	Ksi		calculated
ϕVs	116.0	Kip		REBAR Shear Allowable Pier Design ACI 318
Vertical Rebar Horiz Spacing =	7.65	in		
Diameter of hoops =	4.83	FT		
Diameter of vertical rebar circle =	55.875	in		

Footing Concrete Requirements

f_c'	4000	psi	Concrete compression properties
$\phi_{concrete}$	0.85		Strength Reduction Factor for Capacity Of Concrete
ϕV_c	363	Kips	SHEAR CAPACITY OF CONCRETE ACI 318
d	4.26	FT	distance from extreme com fiber to cent of tension reaction group