

**ATS-Sales, LLC**  
14522-K Lee Rd, Chantilly VA 20151-1639

703.631.6661(O)  
703.631.6694(F)

November 5, 2021

Re: Mast Arm Poles  
MP-3 Standard Loads – 70 MPH Wind  
Virginia  
ATS# 16362-1

This is to certify that the traffic poles for the above referenced intersection were designed in accordance with:

- **The project plans and specifications**
- **VDOT 2020 Road and Bridge Specifications**
- **The 2013 AASHTO Specification (LTS-6), Using:**
  - **70 mph wind velocity with Appendix C**
  - **25 Year Recurrence**
  - **Fatigue Category II (No fatigue loads for mast arms smaller than 50')**
    - **Natural Wind Gusts (11.2 MPH)**
    - **No Galloping Loads**
    - **No truck-induced Gust**
  - **Maximum Standard Loading (MP-3)**

The following identifies this submittal's documents:

ATS Drawings: 16362-1(A) Rev. C, 16362-1(B) Rev. C & 16362-1(C) Rev. C  
16362-1(D) Rev. C, 16362-1(E) Rev. C & 16362-1(F) Rev. C  
Calculations Dated: November 5, 2021, Consisting of 371 pages

In accordance with the Virginia Department of Transportation Road and Bridge Specification, I am a registered Professional Engineer holding a valid license in the Commonwealth of Virginia.

Sincerely,

Armand A Damiano, P.E.

VIRGINIA DEPARTMENT OF TRANSPORTATION C.O. STRUCTURE AND BRIDGE REVIEW OF WORKING DRAWINGS	
Working drawings have been reviewed in accordance with Section 105.10 of the Specifications with the following comments.	
<input checked="" type="checkbox"/> Reviewed	<input type="checkbox"/> Revise and Resubmit
<input type="checkbox"/> Reviewed as Noted	
Reviewed by: Karl Larson 11/30/2021	



**Submittal Revisions**

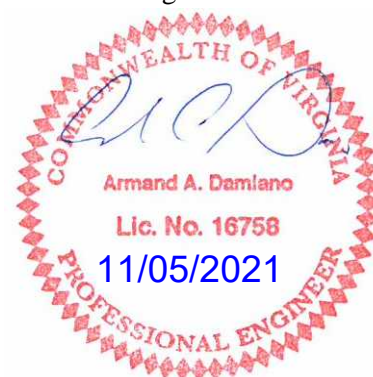
<u>Description</u>	<u>Pages</u>	<u>Signed Date</u>
Original Design	1 - 367	April 04, 2019
Revision per VDOT Review Comments	1 - 370	September 11, 2019
Revision per VDOT Review Comments	1 - 370	October 2, 2019
Revision per VDOT Review Comments, conformance to updated VDOT Std., Flange Connection Data Table Added, corrections to minor errors & typos.	1 - 371	November 5, 2021



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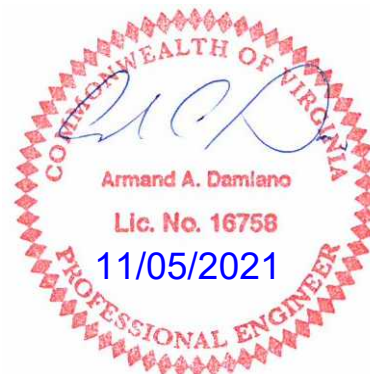
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**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-1 - VA - 70 MPH - MP-3 Standard Loads - Type A - 49' Arm

11/04/21

**General**

Wind Vel. - mph	70	No	Roadway - mph	55	<i>Fatigue Importance Factors</i>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.00
Fatigue Cat.	0		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.00
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.00
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	0		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

**Pole Variables**

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.2500	0.14	15.00	19.50	-	-	-	0	55	29000	-
Traffic Arm #1	0.1793	0.14	13.00	49.00	18.00	-	2.57	0	55	29000	180
Traffic Arm #2					-	-		0	55	29000	90
Lum Arm #1					-	-		0	36	29000	180
Lum Arm #2					-	-		0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	6	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	Double Top Nuts	Yes	
A.B. Bolt Circle	24.00	Foundation Diameter	48	in
Baseplate Dia.	30.00	Concrete Cover	4	in
Baseplate Thk.	2.00	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	10.50	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.	Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50	in
Flange Plate Length (V)	24.00	in
Flange Plate Width (H)	24.00	in
Spac. Between Bolt (V)	19.50	in
Spac. Between Bolt (H)	19.50	in
Flange Plate Thk.	2.00	in
Flange Plate Yield (Fy)	50	ksi
Gusset Thk.	0.375	in
Plate Center Hole	5.00	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	<b>Shaft At</b>		<b>Arm#1</b>		<b>Arm#2</b>		<b>Lum#1</b>		<b>Lum#2</b>		<b>Tip Deflection (in)</b>	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.27	0.38	0.49								19.43	0.00
GP II CSR	0.70	0.72	0.90									
GP III CSR	0.54	0.64	0.79								34.09	

Arm #1 Flange Bolt (Max.) CSR	0.28
Arm #1 Flange Bolt Fatigue CSR	0.00
Arm #1 Flange Plate (Max.) CSR	0.46
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.00
Handhole at Toe (Fatigue) CSR	0.00
Minimum Qty of Vertical Reinf. Bars	4

Fatigue Allowable - Shaft to Baseplate	
Fatigue Allowable - Arm#1 to Flange	
Fatigue Allowable - Arm#2 to Flange	
Anchor Bolt Max. CSR	0.40
Anchor Bolt Max. Fatigue Stress Ratio	0.00
Base Plate Max. CSR	0.47
Anchorage Capacity S.F.	2.31
Concrete Pull Out Capacity S.F.	2.64

**Ground Line Reactions**

Axial (lbs)	3612	Shear (lbs)	3690	Bending (ft-lbs)	83009	Torsion (ft-lbs)	73474
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16362-1-1 - VA - 70 MPH - MP-3 Standard Loads - Type A - 49' Arm

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.2
	#2	Ped Head	10.5	2.4	1			1	6	30	1.2
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.2
	#4										
Lum #1	#1										
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	12'x2.5' Sign	7.5			12	2.5	1	30	66	1.20
	#3	5 Section Head w/BP	16	13.75	4			2	42	105	1.20
	#4		2.5'x3' Sign	23			2.5	3	1	7.5	22.5
	#5	Camera	24	1	1			1	3	22	1.20
	#6	3 Section Head w/BP	26	8.7	4			1	26	65	1.20
	#7	2.5'x3' Sign	34			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	37	8.7	4			1	26	65	1.20
	#9	Camera	39	1	1			1	3	22	1.20
	#10	3'x3.5' Sign	45			3	3.5	1	10.5	26.7	1.13
	#11	4 Section Head w/BP	48	11	5			1	34	80	1.20
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
	#8										
	#9										
	#10										
	#11										
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										





16362-1-1 - VA - 70 MPH - MP-3 Standard Loads - Type A - 49' Arm

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	15.000	14.852	41.53	0.5285	0.53	1.317	12.91	0.80
2	I	1.06	1.06	14.852	14.704	41.11	0.5285	1.59	1.304	12.79	0.80
3	I	1.06	2.12	14.704	14.555	40.69	0.5285	2.65	1.291	12.66	0.80
4	I	1.06	3.18	14.555	14.407	40.27	0.5285	3.70	1.278	12.54	0.80
5	I	1.06	4.24	14.407	14.259	39.85	0.5285	4.76	1.265	12.42	0.80
6	I	1.06	5.29	14.259	14.111	39.43	0.5285	5.82	1.252	12.29	0.80
7	I	1.06	6.35	14.111	13.962	39.01	0.5285	6.88	1.239	12.17	0.80
8	I	1.06	7.41	13.962	13.814	38.59	0.5285	7.94	1.225	12.05	0.80
9	I	1.06	8.47	13.814	13.666	38.17	0.5285	9.00	1.212	11.92	0.80
10	I	1.06	9.53	13.666	13.518	37.75	0.5284	10.06	1.199	11.80	0.80
11	I	1.06	10.59	13.518	13.369	37.33	0.5284	11.12	1.186	11.68	0.80
12	I	1.06	11.65	13.369	13.221	36.91	0.5284	12.18	1.173	11.56	0.80
13	I	1.06	12.71	13.221	13.073	36.49	0.5284	13.23	1.160	11.43	1.00
14	I	1.06	13.76	13.073	12.925	36.08	0.5284	14.29	1.147	11.31	1.00
15	I	1.06	14.82	12.925	12.776	35.66	0.5284	15.35	1.134	11.19	1.00
16	I	1.06	15.88	12.776	12.628	35.24	0.5284	16.41	1.121	11.06	1.00
17	I	1.06	16.94	12.628	12.480	34.82	0.5284	17.47	1.108	10.94	1.00
18	J	0.50	18.00	12.480	12.410	16.30	0.2498	18.25	0.519	5.12	1.00
19	I	0.50	18.50	12.410	12.340	16.20	0.2498	18.75	0.516	5.10	1.00
20	I	0.50	19.00	12.340	12.270	16.11	0.2498	19.25	0.513	5.07	1.00
						698					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in^4)	314.89	179.50	0.00	170.41
Section Modulus (in^3)	42.70	29.35	0.00	
Cross-Section Area (in^2)	11.58	9.60	0.00	
Width-Thickness Ratio	60.00	49.92	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	13.845	13.845	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

Shaft Deflection From Arm#1 GP I Load (in)	1.222
Shaft Deflection From Arm#2 GP I Load (in)	0.000

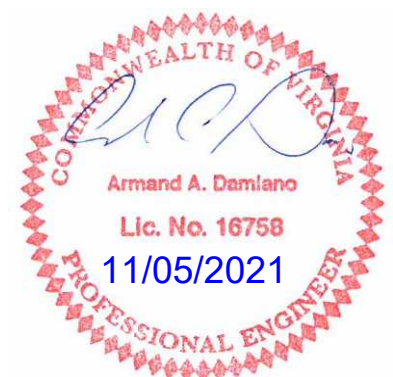




16362-1-1 - VA - 70 MPH - MP-3 Standard Loads - Type A - 49' Arm

## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	10.06	0.000	16.46	1.100	0.000	0.00
2	0.450	7.64	9.96	0.000	16.30	1.100	0.000	0.00
3	0.450	7.64	9.86	0.000	16.14	1.100	0.000	0.00
4	0.450	7.64	9.76	0.000	15.97	1.100	0.000	0.00
5	0.450	7.64	9.66	0.000	15.81	1.100	0.000	0.00
6	0.450	7.64	9.56	0.001	15.64	1.100	0.000	0.00
7	0.450	7.64	9.46	0.001	15.48	1.100	0.000	0.00
8	0.450	7.64	9.36	0.001	15.32	1.100	0.000	0.00
9	0.450	7.64	9.26	0.001	15.15	1.100	0.000	0.00
10	0.450	7.64	9.16	0.002	14.99	1.100	0.000	0.00
11	0.450	7.64	9.06	0.002	14.83	1.100	0.000	0.00
12	0.450	7.64	8.96	0.002	14.66	1.100	0.000	0.00
13	0.450	9.54	11.07	0.003	14.50	1.100	0.000	0.00
14	0.450	9.54	10.94	0.004	14.34	1.100	0.000	0.00
15	0.450	9.54	10.82	0.004	14.17	1.100	0.000	0.00
16	0.450	9.54	10.69	0.004	14.01	1.100	0.000	0.00
17	0.450	9.54	10.57	0.005	13.85	1.100	0.000	0.00
18	0.450	9.54	4.95	0.002	6.48	1.100	0.000	0.00
19	0.450	9.54	4.92	0.003	6.45	1.100	0.000	0.00
20	0.450	9.54	4.89	0.003	6.41	1.100	0.000	0.00
Fix. #1	1.200	20.36	48.86	0.009	30.00	1.200	0.000	0.00
Fix. #2	1.200	20.36	48.86	0.009	30.00	1.200	0.000	0.00
Fix. #3	1.200	25.44	349.80	0.123	174.90	1.200	0.000	0.00
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-1 - VA - 70 MPH - MP-3 Standard Loads - Type A - 49' Arm

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	2.45	0.00	13.000	12.657	59.4	1.2195	1.22	2.619	2.619	25.84
2	I	2.45	2.45	12.657	12.314	57.8	1.2194	3.67	2.549	2.549	25.18
3	I	2.45	4.90	12.314	11.971	56.2	1.2192	6.12	2.479	2.479	24.52
4	I	2.45	7.35	11.971	11.628	54.6	1.2191	8.57	2.409	2.409	23.86
5	I	2.45	9.80	11.628	11.285	53.0	1.2189	11.02	2.339	2.339	23.20
6	I	2.45	12.25	11.285	10.942	51.3	1.2187	13.47	2.269	2.269	22.54
7	I	2.45	14.70	10.942	10.599	49.7	1.2185	15.92	2.199	2.199	21.88
8	I	2.45	17.15	10.599	10.256	48.1	1.2183	18.37	2.129	2.129	21.22
9	I	2.45	19.60	10.256	9.913	46.5	1.2181	20.82	2.059	2.059	20.56
10	I	2.45	22.05	9.913	9.570	44.9	1.2178	23.27	1.989	1.989	19.90
11	I	2.45	24.50	9.570	9.227	43.3	1.2175	25.72	1.919	1.919	19.24
12	I	2.45	26.95	9.227	8.884	41.7	1.2173	28.17	1.849	1.849	18.58
13	I	2.45	29.40	8.884	8.541	40.1	1.2170	30.62	1.779	1.779	17.92
14	I	2.45	31.85	8.541	8.198	38.5	1.2166	33.07	1.709	1.709	17.26
15	I	2.45	34.30	8.198	7.855	36.9	1.2163	35.52	1.639	1.639	16.60
16	I	2.45	36.75	7.855	7.512	35.2	1.2159	37.97	1.569	1.569	15.94
17	I	2.45	39.20	7.512	7.169	33.6	1.2155	40.42	1.499	1.499	15.28
18	I	2.45	41.65	7.169	6.826	32.0	1.2150	42.86	1.429	1.429	14.62
19	I	2.45	44.10	6.826	6.483	30.4	1.2145	45.31	1.359	1.359	13.96
20	I	2.45	46.55	6.483	6.140	28.8	1.2139	47.76	1.289	1.289	13.30
		<u>49.00</u>				<u>882</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	66	7.50	30.000	1.000	90.00
Fix. #3	105	16.00	13.750	2.000	126.00
Fix. #4	22.5	23.00	7.500	1.000	22.50
Fix. #5	22	24.00	1.000	1.000	9.00
Fix. #6	65	26.00	8.700	1.000	78.00
Fix. #7	22.5	34.00	7.500	1.000	22.50
Fix. #8	65	37.00	8.700	1.000	78.00
Fix. #9	22	39.00	1.000	1.000	9.00
Fix. #10	26.7	45.00	10.500	1.000	31.50
Fix. #11	80	48.00	11.000	1.000	102.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	23.135	0.000
Cross-Section Area (in^2)	7.218	0.000
Width-Thickness Ratio	72.50	0.00
Compact Limit	68.55	0.00
Non-Compact Limit	137.09	0.00
Maximum Limit	237.27	0.00
Allow. Bending Stress (ksi)	35.489	0.000
Allow. Shear Stress (ksi)	18.150	0.000



16362-1-1 - VA - 70 MPH - MP-3 Standard Loads - Type A - 49' Arm

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000 Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	24.99	32.74	1.100	0.000	0.00	0	0.710	0.00	0.00	
2	1.00	0.450	9.54	24.32	31.86	1.100	0.000	0.00	0	0.736	0.00	0.00	
3	1.00	0.450	9.54	23.65	30.99	1.100	0.000	0.00	0	0.763	0.00	0.00	
4	1.00	0.450	9.54	22.98	30.11	1.100	0.000	0.00	0	0.792	0.00	0.00	
5	1.00	0.450	9.54	22.31	29.24	1.100	0.000	0.00	0	0.823	0.00	0.00	
6	1.00	0.450	9.54	21.65	28.36	1.100	0.000	0.00	0	0.856	0.00	0.00	
7	1.00	0.460	9.75	21.44	27.49	1.100	0.000	0.00	0	0.891	0.00	0.00	
8	1.00	0.479	10.17	21.65	26.61	1.100	0.000	0.00	0	0.930	0.00	0.00	
9	1.00	0.501	10.62	21.87	25.74	1.100	0.000	0.00	0	0.971	0.00	0.00	
10	1.00	0.524	11.11	22.10	24.86	1.100	0.000	0.00	0	1.016	0.00	0.00	
11	1.00	0.549	11.64	22.34	23.99	1.100	0.000	0.00	0	1.064	0.00	0.00	
12	1.00	0.576	12.21	22.57	23.11	1.100	0.000	0.00	0	1.100	0.00	0.00	
13	1.00	0.606	12.84	22.84	22.24	1.100	0.000	0.00	0	1.100	0.00	0.00	
14	1.00	0.638	13.53	23.12	21.36	1.100	0.000	0.00	0	1.100	0.00	0.00	
15	1.00	0.674	14.29	23.42	20.48	1.100	0.000	0.00	1	1.100	0.00	0.00	
16	1.00	0.713	15.12	23.72	19.61	1.100	0.000	0.00	1	1.100	0.00	0.00	
17	1.00	0.757	16.04	24.04	18.73	1.100	0.000	0.00	1	1.100	0.00	0.00	
18	1.00	0.805	17.07	24.39	17.86	1.100	0.000	0.00	1	1.100	0.00	0.00	
19	1.00	0.860	18.23	24.77	16.98	1.100	0.000	0.00	1	1.100	0.00	0.00	
20	1.00	0.921	19.52	25.15	16.11	1.100	0.000	0.00	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.199	25.43	762.90	381.45	1.199	0.000	0.00	0	1.199	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	0.000	0.00	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	221.33	110.66	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	0.000	0.00	1	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.132	24.00	252.00	131.25	1.132	0.000	0.00	1	1.132	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	279.84	139.92	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



16362-1-1 - VA - 70 MPH - MP-3 Standard Loads - Type A - 49' Arm

Flange Analysis - Arm #1

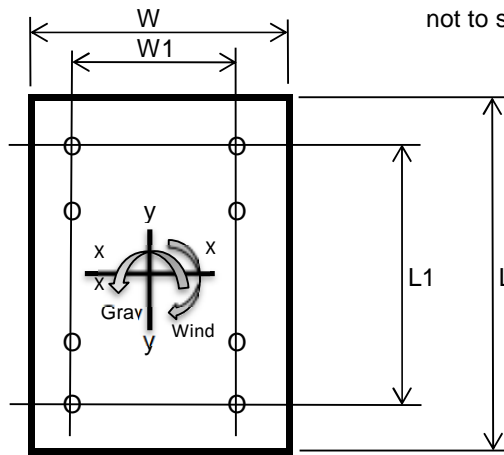
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Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	1401	2370	-	lbs
Shear (Wind)	2988	1763	-	lbs
Torsion (Arm Rise)	7671	4527	-	ft-lbs
Moment (Gravity)	33046	57360	-	ft-lbs
Moment (Wind)	73474	41987	-	ft-lbs
Nat. Wind Moment	-	-	-	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	13.00	in
Tube Wall Thick.	0.1793	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.00
W	24
W1	19.50
L	24
L1	19.50
L2 - Dist. between bolts (Typ.)	6.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	596.99	596.99	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1073.57	1073.57	in <sup>4</sup>
Bolt Tensile Stress - ft	10.30	12.14	ksi
Bolt Shear Stress - fv	1.14	0.78	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.24	0.28	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	0	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	8.12	14.09	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	18.37	10.50	ksi
Combined applied stress for interaction (SRSS)	20.08	17.57	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



16362-1-1 - VA - 70 MPH - MP-3 Standard Loads - Type A - 49' Arm

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

<b>Arm#1 Base</b>											
Gp I	1401		1401	33046		33046		389	17141		0.49
Gp II	1401	2988	3300	33046	73474	80564	7671	915	41788	1990	0.90
Gp III	2370	1763	2954	57360	41987	71086	4527	819	36872	1175	0.79
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Arm#1 Joint</b>											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Arm#2 Base</b>											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Arm#2 Joint</b>											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Lum#1 Base</b>											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Lum#2 Base</b>											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



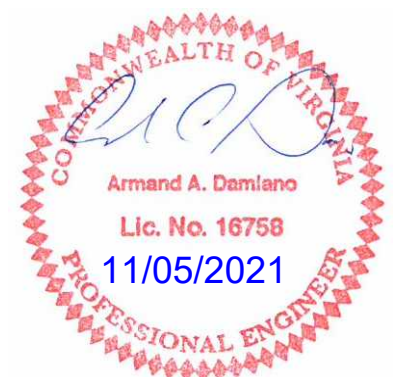
16362-1-1 - VA - 70 MPH - MP-3 Standard Loads - Type A - 49' Arm

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	2263		33046	0	33046		195		9288		0.27
Gp II	2263	3690	45335	69536	83009	73474	195	638	23330	10325	0.70
Gp III	3612	2320	36261	70476	79257	41987	312	401	22275	5900	0.54
Gp IV Natural			0	0	0				0		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9959										

<b>Shaft At Arm</b>											
Gp I	1449		33046	0	33046		151		13509		0.38
Gp II	1449	3002	7671	33057	33935	73474	151	626	13873	15018	0.72
Gp III	2418	1782	4527	57375	57553	41987	252	372	23528	8582	0.64
Gp IV Natural			0	0	0				0		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9959										



**Gusset Box Stress Check  
For Flange Style F1  
Used On Shaft Types A & D  
Wind Velocity of 70 mph  
Using Governing Load: 49'**

**Input Information**

Gusset Plate Thickness	0.375	in.	
Gusset Yield Strength Fy	50000	psi	A572 Gr 50
Shaft Base Diameter	15.00	in.	
Height To C.L. of Arm Attach.	18.00	ft.	
Shaft Dia. C.L. of Arm Attach.	12.48	in.	Width Between Gussets
Flange Plate Height	24.0	in.	
Flange Plate Width	24.0	in.	
Box Cross-Sectional Area	27.36	sq.in.	

**Applied Loads Onto Flange Box Taken From Pole Analysis - 49'**

Gravity Moment	33,046	ft-lbs
Wind Moment	73,474	ft-lbs
Torsion Moment	7671	ft-lbs
Direct Shear	3300	lbs

**Computing Moments of Inertia**

For Gravity			For Wind		
d	24	in	d	13.23	in
b	13.23	in	b	24	in
d'	23.25	in	d'	12.48	in
b'	12.48	in	b'	23.25	in
Inertia	2170.16	in <sup>4</sup>	Inertia	865.33	in <sup>4</sup>

**Computing Stress**

Gravity = $Mc/I =$	2193	psi	
Wind = $Mc/I =$	6741	psi	
Torsion = $M/[2t(a-b)(b-t)] =$	404	psi	Roark's Table 10.1 #16
Shear = $2.25 * V / A =$	272	psi	

**Allowables**

Bending = $0.66 F_y 1.33 =$	43890	psi
Torsion Limited by b/t ratio	15,430	psi
b/t =	64.0	
$12000 / F_y^{0.5} =$	54.0	

**Result**

CSR = 0.25 Which is  $\leq 1$  Therefore OK  
To be conservative bending stresses were added not SRSS





16362-1-1 - VA - 70 MPH - MP-3 Std. Loads - Type A - 49' Arm  
Weld Analysis

Page S4

**INPUTS**

	<b>Gp II</b>	<b>GpIII</b>		<b>Arm Dimensions</b>	
<b>Applied Loads To Flange Connection</b>					
Vert. Shr	1401	2370	lbs	Diameter (d)	13.0 in
Horz. Shr	2988	1763	lbs	Tube Wall Thk	0.1793 in
Torsion Moment	7671	4527	ft-lbs	Plate Thk (D)	2 in
Gravity Moment	33046	57360	ft-lbs	Plate Yield (Fy)	50 ksi
Wind Moment	73474	41987	ft-lbs		
<b>Applied Loads To Base Plate Connection</b>				<b>Shaft Dimensions</b>	
Axial	0	0	lbs	Diameter (d)	15.0 in
Shear	0	0	lbs	Tube Wall Thk	<b>0.25</b> in
Shear	0	0	lbs	Plate Thk (D)	2 in
Bending Moment	0	0	ft-lbs	Plate Yield (Fy)	36 ksi
Bending Moment	0	0	ft-lbs	Arm Attach. Elev.	<b>18.0</b> ft
Torsion Moment	0	0	ft-lbs		

Additional Load Factor To Apply As Per Signal Plans & Specifications = 1.00

**Electrodes**

**AASHTO Gp II & III Factor** = 1.33

**E70 Electrodes (Used with plates having Fy = 36 ksi)**

$F_v = 0.27 F_u$  (AASHTO Bridge Spec 10.32.2)

$F_v = 0.27 \times 58000 = 15660$  psi

Allowable =  $F_v \times \text{Gp Factor} = 20828$  psi

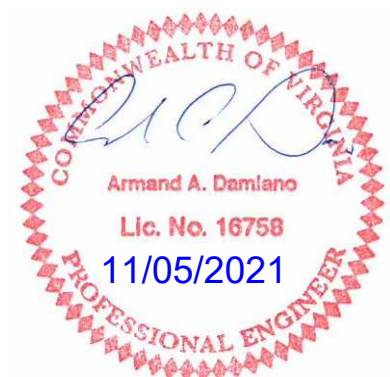
**E70 Electrodes (Used with plates having Fy = 50 ksi)**

$F_v = 0.27 \times 65000 = 17550$  psi

Allowable =  $F_v \times \text{Gp Factor} = 23342$  psi

Reference: *Design of Welded Structures*, Omer W. Blodgett

Method: Weld As A Line

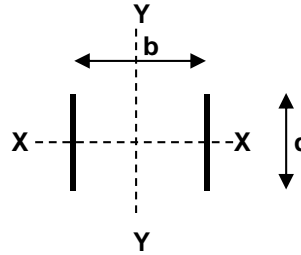


16362-1-1 - VA - 70 MPH - MP-3 Std. Loads - Type A - 49' Arm  
Weld Analysis - Continued

**ARM CONNECTING PLATES**

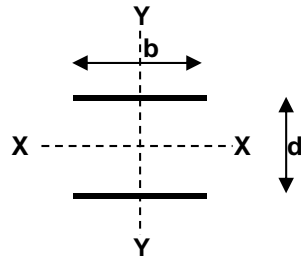
**Side Plates**

Vertical Length (d)	22.00	in	
Horz. Dist Between Plates (b)	12.48	in	
Thickness	<b>0.375</b>	in	
Weld Size	<b>0.25</b>	in	
Weld Throat (t <sub>1</sub> )	0.177	in	
$A_1 = A_{w1} * t_1 = 2 * d * t_1$	=	7.78	in <sup>2</sup>
$S_{x1} = S_{wx1} * t_1 = (d^2 / 3) * t_1$	=	28.52	in <sup>3</sup>
$S_{y1} = S_{wy1} * t_1 = b * d * t_1$	=	48.53	in <sup>3</sup>
$J_1 = J_{w1} * t_1 = t_1 * d(3b^2 + d^2) / 6$	=	616.50	in <sup>4</sup>



**Top & Bottom Plates**

Vert. Dist Between Plates (d)	22.00	in	
Horz. Length (b)	19.60	in	
Thickness	<b>0.375</b>	in	
Weld Size	<b>0.25</b>	in	
Weld Throat (t <sub>2</sub> )	0.177	in	
$A_2 = A_{w2} * t_2 = t_2 * 2 * b$	=	6.9	in <sup>2</sup>
$S_{x2} = S_{wx2} * t_2 = t_2 * b * d$	=	76.2	in <sup>3</sup>
$S_{y2} = S_{wy2} * t_2 = t_2 * (b^2 / 3)$	=	22.6	in <sup>3</sup>
$J_2 = J_{w2} * t_2 = t_2 * (b^3 + 3bd^2) / 6$	=	1060.4	in <sup>4</sup>



**Combined Analysis**

$\sigma_1 = \text{Gravity Mom} / (S_{x1} + S_{x2})$	=	3786.0	Gp II	6572.0	psi
$\sigma_2 = \text{Wind Mom} / (S_{y1} + S_{y2})$	=	12389.0	Gp III	7080.0	psi
$\sigma_2 = [\text{Tor. Mom} * C / (J_1 + J_2)] + [\text{Res. Shr} / (A_1 + A_2)]$	=	919.0		611.0	psi
Res. Weld Stress = $\sigma_r = \text{Sqrt}[(\sigma_1 + \sigma_2)^2 + \sigma_3^2]$	=	16202		13666	psi
Allowable: E70 Electrodes * AASHTO Gp Factor	=	23341.5		23341.5	psi
<b>Actual Weld Stress vs. Allowable</b>		<b>Passes</b>		<b>Passes</b>	



16362-1-1 - VA - 70 MPH - MP-3 Standard Loads - Type A - 49' Arm

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	3690 lbs
Bending Moment	83009 ft-lbs
Torsion Moment	73474 ft-lbs
Num. Anchor Bolts	6
Bolt Circle	24 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	30 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	15.00 in

**ANALYSIS - ANCHOR BOLTS**

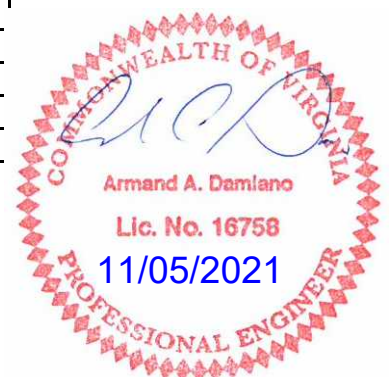
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1082.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	12.00 in
Bolt Tensile Stress	11.038 ksi
Bolt Direct Shear Stress	0.268 ksi
Bolt Torsion Shear Stress	5.325 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	11.038 ksi
$f_v =$	5.593 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.4 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	12.701 in
Dist. Shaft Face To Bolt Center	4.5 in
Design Moment	125 in-kip
Section Modulus of Failure Plane	8.46 in <sup>3</sup>
Applied Plate Stress	14.78 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	12.052 in
Dist From Shaft To Nut Face	2.938 in
Design Moment	82 in-kip
Section Modulus of Failure Plane	8.03 in <sup>3</sup>
Applied Plate Stress	10.22 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-1 - VA - 70 MPH - MP-3 Standard Loads - Type A - 49' Arm

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	0 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1082.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	12.00 in
Bolt Tensile Stress	0 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

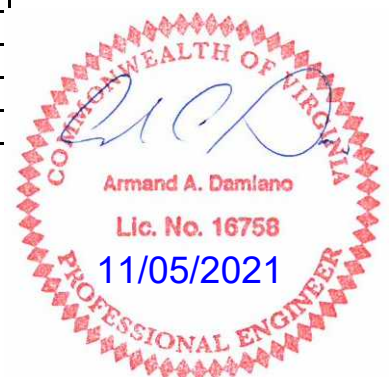
Anchor Bolt Length	60.0 in
Anchor Bolt Max. Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	127540 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	11 in
T Reduced For Group Action	63770 lbs
Maximum Applied Tensile Load	27595 lbs
Computed Factor-of Safety	2.31 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	27595 lbs
Total Tensile Load	165570 lbs
Concrete Failure Surface Area	4002.39 in <sup>2</sup>
Concrete Shear Strength	438440 psi
Computed Factor-of Safety	2.64 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	27595 lbs
Total Tensile Load	165570 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	45.36 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	4 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-2 - VA - 70 MPH - MP-3 Standard Loads - Type B1 - 75' Arm

11/04/21

**General**

Wind Vel. - mph	70	No	Roadway - mph	55	<i>Fatigue Importance Factors</i>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	0		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.50	19.50	-	-	-	0	55	29000	-
Traffic Arm #1	0.2500	0.14	18.00	28.00	18.00	-	3.93	0	55	29000	180
	0.1880	0.14	14.87	49.93	-	2.93		0	55	29000	
Traffic Arm #2								0	55	29000	90
								0	55	29000	
Lum Arm #1								0	36	29000	180
Lum Arm #2								0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8		Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	in	Double Top Nuts	Yes	
A.B. Bolt Circle	26.00	in	Foundation Diameter	48	in
Baseplate Dia.	32.00	in	Concrete Cover	4	in
Baseplate Thk.	2.00	in	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	14.25	in	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.		Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1		Arm #2	
Flange Bolt Qty.	8		NA	
Bolt Diameter	1.50	in		in
Flange Plate Length (V)	27.00	in		in
Flange Plate Width (H)	27.00	in		in
Spac. Between Bolt (V)	22.50	in		in
Spac. Between Bolt (H)	22.50	in		in
Flange Plate Thk.	2.25	in		in
Flange Plate Yield (Fy)	50	ksi		ksi
Gusset Thk.	0.500	in		in
Plate Center Hole	6.00	in		in
Weld Type	Full Pen.			

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.37	0.48	0.54	0.43							35.42	0.00
GP II CSR	0.62	0.69	0.75	0.66								
GP III CSR	0.60	0.71	0.76	0.65							57.85	
Nat.Wind (psi)	3336	713	6999	6008								

Arm #1 Flange Bolt (Max.) CSR	0.64
Arm #1 Flange Bolt Fatigue CSR	0.49
Arm #1 Flange Plate (Max.) CSR	0.67
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.78
Handhole at Toe (Fatigue) CSR	0.50
Minimum Qty of Vertical Reinf. Bars	8

Fatigue Allowable - Shaft to Baseplate	4.5 ksi
Fatigue Allowable - Arm#1 to Flange	7 ksi
Fatigue Allowable - Arm#2 to Flange	-
Anchor Bolt Max. CSR	0.59
Anchor Bolt Max. Fatigue Stress Ratio	0.34
Base Plate Max. CSR	0.66
Anchorage Capacity S.F.	1.46
Concrete Pull Out Capacity S.F.	1.39

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
6353	4942	183842	149585



16362-1-2 - VA - 70 MPH - MP-3 Standard Loads - Type B1 - 75' Arm

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd	
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20	
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20	
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20	
	#4											
Lum #1	#1											
Lum #2	#1											
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20	
	#2	15'x2.5' Sign	9			15	2.5	1	37.5	88.5	1.21	
	#3	5 Section Head w/BP	19	13.75	4			2	42	105	1.20	
	#4	2.5'x3' Sign	23			2.5	3	1	7.5	22.5	1.13	
	#5	3 Section Head w/BP	30	8.7	4			1	26	65	1.20	
	#6	3 Section Head w/BP	41	8.7	4			1	26	65	1.20	
	#7	Camera	45	1	1			1	3	22	1.20	
	#8	2.5'x3' Sign	49			2.5	3	1	7.5	22.5	1.13	
	#9	3 Section Head w/BP	52	8.7	4			1	26	65	1.20	
	#10	2.5'x3' Sign	60			2.5	3	1	7.5	22.5	1.13	
	#11	3 Section Head w/BP	63	8.7	4			1	26	65	1.20	
	#12	Camera	67	1	1			1	3	22	1.20	
	#13	3'x3.5' Sign	71			3	3.5	1	10.5	26.7	1.13	
	#14	4 Section Head w/BP	74	11	5			1	34	80	1.20	
	#15											
	#16											
	#17											
	#18											
	#19											
	#20											
For Arm #2	#1											
	#2											
	#3											
	#4											
	#5											
	#6											
	#7											
	#8											
	#9											
	#10											
	#11											
	#12											
	#13											
	#14											
	#15											
	#16											
	#17											
	#18											
	#19											
	#20											



16362-1-2 - VA - 70 MPH - MP-3 Standard Loads - Type B1 - 75' Arm

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.500	19.352	67.61	0.5287	0.53	1.714	16.65	0.80
2	I	1.06	1.06	19.352	19.204	67.08	0.5287	1.59	1.701	16.53	0.80
3	I	1.06	2.12	19.204	19.055	66.56	0.5287	2.65	1.688	16.41	0.80
4	I	1.06	3.18	19.055	18.907	66.03	0.5287	3.71	1.675	16.28	0.80
5	I	1.06	4.24	18.907	18.759	65.51	0.5287	4.76	1.662	16.16	0.80
6	I	1.06	5.29	18.759	18.611	64.99	0.5287	5.82	1.649	16.04	0.80
7	I	1.06	6.35	18.611	18.462	64.46	0.5287	6.88	1.636	15.91	0.80
8	I	1.06	7.41	18.462	18.314	63.94	0.5287	7.94	1.622	15.79	0.80
9	I	1.06	8.47	18.314	18.166	63.41	0.5287	9.00	1.609	15.67	0.80
10	I	1.06	9.53	18.166	18.018	62.89	0.5287	10.06	1.596	15.54	0.80
11	I	1.06	10.59	18.018	17.869	62.36	0.5287	11.12	1.583	15.42	0.80
12	I	1.06	11.65	17.869	17.721	61.84	0.5287	12.18	1.570	15.30	0.80
13	I	1.06	12.71	17.721	17.573	61.31	0.5287	13.23	1.557	15.17	1.00
14	I	1.06	13.76	17.573	17.425	60.79	0.5287	14.29	1.544	15.05	1.00
15	I	1.06	14.82	17.425	17.276	60.27	0.5287	15.35	1.531	14.93	1.00
16	I	1.06	15.88	17.276	17.128	59.74	0.5287	16.41	1.518	14.80	1.00
17	I	1.06	16.94	17.128	16.980	59.22	0.5286	17.47	1.505	14.68	1.00
18	J	0.50	18.00	16.980	16.910	27.78	0.2498	18.25	0.706	6.89	1.00
19	I	0.50	18.50	16.910	16.840	27.66	0.2498	18.75	0.703	6.86	1.00
20	I	0.50	19.00	16.840	16.770	27.55	0.2498	19.25	0.700	6.83	1.00
						1161					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in^4)	866.45	567.94	0.00	546.74
Section Modulus (in^3)	90.31	68.15	0.00	
Cross-Section Area (in^2)	18.83	16.35	0.00	
Width-Thickness Ratio	62.40	54.34	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	20.514	20.514	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

Shaft Deflection From Arm#1 GP I Load (in)	1.248
Shaft Deflection From Arm#2 GP I Load (in)	0.000

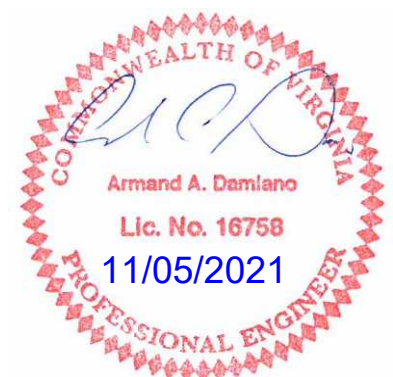




16362-1-2 - VA - 70 MPH - MP-3 Standard Loads - Type B1 - 75' Arm

## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	13.10	0.000	21.43	1.100	4.576	7.84
2	0.450	7.64	13.00	0.000	21.26	1.100	4.576	7.78
3	0.450	7.64	12.90	0.000	21.10	1.100	4.576	7.72
4	0.450	7.64	12.80	0.000	20.94	1.100	4.576	7.66
5	0.450	7.64	12.70	0.000	20.77	1.100	4.576	7.60
6	0.450	7.64	12.60	0.000	20.61	1.100	4.576	7.54
7	0.450	7.64	12.50	0.000	20.44	1.100	4.576	7.48
8	0.450	7.64	12.40	0.000	20.28	1.100	4.576	7.42
9	0.450	7.64	12.30	0.001	20.12	1.100	4.576	7.36
10	0.450	7.64	12.20	0.001	19.95	1.100	4.576	7.30
11	0.450	7.64	12.10	0.001	19.79	1.100	4.576	7.24
12	0.450	7.64	12.00	0.001	19.63	1.100	4.576	7.19
13	0.450	9.54	14.85	0.001	19.46	1.100	4.576	7.13
14	0.450	9.54	14.73	0.002	19.30	1.100	4.576	7.07
15	0.450	9.54	14.61	0.002	19.14	1.100	4.576	7.01
16	0.450	9.54	14.48	0.002	18.97	1.100	4.576	6.95
17	0.450	9.54	14.36	0.002	18.81	1.100	4.576	6.89
18	0.450	9.54	6.74	0.001	8.83	1.100	4.576	3.23
19	0.450	9.54	6.71	0.001	8.79	1.100	4.576	3.22
20	0.450	9.54	6.68	0.001	8.75	1.100	4.576	3.20
Fix. #1	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.043	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-2 - VA - 70 MPH - MP-3 Standard Loads - Type B1 - 75' Arm

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	4.18	0.00	18.000	17.415	194.9	2.0777	2.08	6.166	6.166	60.08
2	I	4.18	4.18	17.415	16.830	188.4	2.0773	6.26	5.962	5.962	58.16
3	I	4.18	8.36	16.830	16.245	181.9	2.0769	10.43	5.758	5.758	56.24
4	I	4.18	12.54	16.245	15.660	175.3	2.0764	14.61	5.555	5.555	54.32
5	I	4.18	16.71	15.660	15.075	168.8	2.0759	18.79	5.351	5.351	52.40
6	I	4.18	20.89	15.075	14.490	162.3	2.0754	22.97	5.147	5.147	50.48
7	J	2.93	25.07	14.870	14.460	195.2	1.4582	26.53	3.581	3.581	35.13
8	O	3.62	28.00	14.460	13.954	101.9	1.7970	29.80	4.280	4.280	42.04
9	O	3.62	31.62	13.954	13.447	98.2	1.7966	33.41	4.128	4.128	40.61
10	O	3.62	35.23	13.447	12.941	94.5	1.7961	37.03	3.975	3.975	39.17
11	O	3.62	38.85	12.941	12.435	90.8	1.7957	40.64	3.823	3.823	37.73
12	O	3.62	42.46	12.435	11.929	87.1	1.7952	44.26	3.670	3.670	36.29
13	O	3.62	46.08	11.929	11.423	83.5	1.7946	47.87	3.518	3.518	34.86
14	O	3.62	49.69	11.423	10.917	79.8	1.7940	51.49	3.365	3.365	33.42
15	O	3.62	53.31	10.917	10.411	76.1	1.7934	55.10	3.213	3.213	31.98
16	O	3.62	56.92	10.411	9.904	72.4	1.7927	58.72	3.060	3.060	30.55
17	O	3.62	60.54	9.904	9.398	68.8	1.7919	62.33	2.908	2.908	29.11
18	O	3.62	64.15	9.398	8.892	65.1	1.7910	65.94	2.755	2.755	27.67
19	O	3.62	67.77	8.892	8.386	61.4	1.7900	69.56	2.603	2.603	26.23
20	O	3.62	71.38	8.386	7.880	57.7	1.7889	73.17	2.450	2.450	24.80
		<u>75.00</u>				<u>2304</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	9.00	37.500	1.000	112.50
Fix. #3	105	19.00	13.750	2.000	126.00
Fix. #4	22.5	23.00	7.500	1.000	22.50
Fix. #5	65	30.00	8.700	1.000	78.00
Fix. #6	65	41.00	8.700	1.000	78.00
Fix. #7	22	45.00	1.000	1.000	9.00
Fix. #8	22.5	49.00	7.500	1.000	22.50
Fix. #9	65	52.00	8.700	1.000	78.00
Fix. #10	22.5	60.00	7.500	1.000	22.50
Fix. #11	65	63.00	8.700	1.000	78.00
Fix. #12	22	67.00	1.000	1.000	9.00
Fix. #13	26.7	71.00	10.500	1.000	31.50
Fix. #14	80	74.00	11.000	1.000	102.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	61.831	31.813
Cross-Section Area (in^2)	13.934	8.667
Width-Thickness Ratio	72.00	79.10
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	35.588	34.319
Allow. Shear Stress (ksi)	18.150	16.903



16362-1-2 - VA - 70 MPH - MP-3 Standard Loads - Type B1 - 75' Arm

Arm #1 Analysis Continued

Sec. Num.	Kz	Truck Induced Gust											
		Group 2			Group 3	Natural Wind Gust			Hght Corr. Factor = 1.000				Gallop
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	Loads (lbs)
1	1.00	0.450	9.54	58.82	77.07	1.100	4.576	28.21	0	0.467	0.00	0.00	
2	1.00	0.450	9.54	56.88	74.52	1.100	4.576	27.28	0	0.488	0.00	0.00	
3	1.00	0.450	9.54	54.93	71.98	1.100	4.576	26.35	0	0.511	0.00	0.00	
4	1.00	0.450	9.54	52.99	69.43	1.100	4.576	25.42	0	0.535	0.00	0.00	
5	1.00	0.450	9.54	51.05	66.89	1.100	4.576	24.49	0	0.562	0.00	0.00	
6	1.00	0.450	9.54	49.10	64.34	1.100	4.576	23.55	0	0.591	0.00	0.00	
7	1.00	0.450	9.54	34.16	44.76	1.100	4.576	16.39	0	0.597	0.00	0.00	
8	1.00	0.450	9.54	40.83	53.50	1.100	4.576	19.59	0	0.622	0.00	0.00	
9	1.00	0.450	9.54	39.38	51.60	1.100	4.576	18.89	0	0.652	0.00	0.00	
10	1.00	0.450	9.54	37.92	49.69	1.100	4.576	18.19	0	0.685	0.00	0.00	
11	1.00	0.450	9.54	36.47	47.78	1.100	4.576	17.49	0	0.720	0.00	0.00	
12	1.00	0.450	9.54	35.01	45.88	1.100	4.576	16.80	0	0.760	0.00	0.00	
13	1.00	0.450	9.54	33.56	43.97	1.100	4.576	16.10	0	0.803	0.00	0.00	
14	1.00	0.450	9.54	32.10	42.07	1.100	4.576	15.40	0	0.850	0.00	0.00	
15	1.00	0.466	9.88	31.74	40.16	1.100	4.576	14.70	0	0.903	0.00	0.00	
16	1.00	0.496	10.52	32.19	38.25	1.100	4.576	14.00	0	0.962	0.00	0.00	
17	1.00	0.530	11.24	32.68	36.35	1.100	4.576	13.31	1	1.028	0.00	0.00	
18	1.00	0.569	12.06	33.23	34.44	1.100	4.576	12.61	1	1.100	0.00	0.00	
19	1.00	0.612	12.98	33.78	32.53	1.100	4.576	11.91	1	1.100	0.00	0.00	
20	1.00	0.662	14.04	34.40	30.63	1.100	4.576	11.21	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #8	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #13	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #14	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



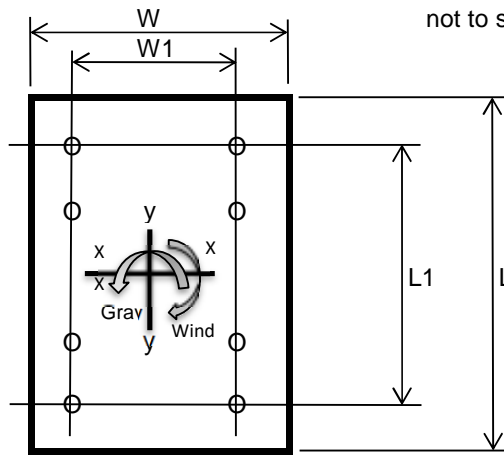
Flange Analysis - Arm #1

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	2998	4578	-	lbs
Shear (Wind)	4155	2703	-	lbs
Torsion (Arm Rise)	16328	10625	-	ft-lbs
Moment (Gravity)	97327	155408	-	ft-lbs
Moment (Wind)	149585	94960	-	ft-lbs
Nat. Wind Moment	-	-	36058	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	18.00	in
Tube Wall Thick.	0.25	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	21.76	27.90	ksi
Bolt Shear Stress - fv	2.03	1.51	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.51	0.64	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	3.41	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.49	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	15.55	24.83	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	24.31	15.44	ksi
Combined applied stress for interaction (SRSS)	28.86	29.24	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



## 16362-1-2 - VA - 70 MPH - MP-3 Standard Loads - Type B1 - 75' Arm

## Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.50	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.333333	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.730769	
Kf - Fatigue stress concentration factor for finite life	2.31	
Ki - Fatigue stress concentration factor for infinite life	5.05	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.25	in
Dt - Arm base diameter	18.00	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	1.77	
Dop - Baseplate center hole diameter	6	in
Cop - Center hole to arm diameter ratio	0.333333	
Kf - Fatigue stress concentration factor for finite life	1.75	
Ki - Fatigue stress concentration factor for infinite life	3.28	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle



## 16362-1-2 - VA - 70 MPH - MP-3 Standard Loads - Type B1 - 75' Arm

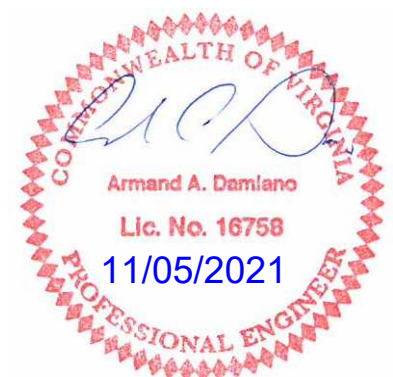
## Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	19.07	in
Shaft Thickness	0.313	in
Total Area	23.571	in <sup>2</sup>
Ix	911	in <sup>4</sup>
Iy	1023	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	25104	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	12.41	ksi
CSR	0.78	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	3.49	ksi
CSR	0.50	
Therefore	<b>OK</b>	



16362-1-2 - VA - 70 MPH - MP-3 Standard Loads - Type B1 - 75' Arm

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	2998		2998	97327		97327		431	18889		0.54
Gp II	2998	4155	5124	97327	149585	178461	16328	736	34636	1585	0.75
Gp III	4578	2703	5317	155408	94960	182124	10625	764	35347	1032	0.76
Gp IV Natural		1028	1028		36058	36058	4040	148	6999	393	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	1688		1688	38664		38665		390	14585		0.43
Gp II	1688	2316	2867	38664	68078	78292	9103	662	29533	1717	0.66
Gp III	2666	1518	3069	64252	41923	76719	5968	709	28940	1126	0.65
Gp IV Natural		575	575		15925	15925	2262	133	6008	427	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Lum#1 Base											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Lum#2 Base											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-





16362-1-2 - VA - 70 MPH - MP-3 Standard Loads - Type B1 - 75' Arm

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	4324		97327	0	97327		230		12932		0.37
Gp II	4324	4942	91109	124260	154082	149585	230	525	20473	9938	0.62
Gp III	6353	3372	59287	174020	183842	94960	337	359	24427	6309	0.60
Gp IV Natural			25104	0	25104				3336		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9971										

<b>Shaft At Arm</b>											
Gp I	3081		97327	0	97327		188		17138		0.48
Gp II	3081	4175	16328	97342	98702	149585	188	511	17380	13170	0.69
Gp III	4661	2730	10625	155427	155790	94960	285	334	27432	8360	0.71
Gp IV Natural			4047	0	4047				713		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9971										



**Gusset Box Stress Check  
For Flange Style F2  
Used On Shaft Types B1 & E1  
Wind Velocity of 70 mph  
Using Governing Load: 75' Case 1**

**Input Information**

Gusset Plate Thickness	0.50	in.	
Gusset Yield Strength Fy	50000	psi	A572 Gr 50
Shaft Base Diameter	19.50	in.	
Height To C.L. of Arm Attach.	18.00	ft.	
Shaft Dia. C.L. of Arm Attach.	16.98	in.	Width Between Gussets
Flange Plate Height	27.0	in.	
Flange Plate Width	27.0	in.	
Box Cross-Sectional Area	43.98	sq.in.	

**Applied Loads Onto Flange Box Taken From Pole Analysis - 75' Case 1**

Gravity Moment	97,327	ft-lbs
Wind Moment	149,585	ft-lbs
Torsion Moment	16328	ft-lbs
Direct Shear	5124	lbs

**Computing Moments of Inertia**

For Gravity			For Wind		
d	27	in	d	17.98	in
b	17.98	in	b	27	in
d'	26	in	d'	16.98	in
b'	16.98	in	b'	26	in
Inertia	4621.66	in <sup>4</sup>	Inertia	2471.00	in <sup>4</sup>

**Computing Stress**

Gravity = $Mc/I =$	3412	psi	
Wind = $Mc/I =$	6531	psi	
Torsion = $M/[2t(a-b)(b-t)] =$	423	psi	Roark's Table 10.1 #16
Shear = $2.25 * V / A =$	263	psi	

**Allowables**

Bending = $0.66 F_y 1.33 =$	43890	psi
Torsion Limited by b/t ratio	21,945	psi
b/t = 54.0		
$12000 / F_y^{0.5} =$	54.0	

**Result**

CSR = 0.26 Which is  $\leq 1$  Therefore OK  
To be conservative bending stresses were added not SRSS



16362-1-2 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 75' Arm  
Weld Analysis

Page S4

**INPUTS**

	<b>Gp II</b>	<b>GpIII</b>			
<b>Applied Loads To Flange Connection</b>			<b>Arm Dimensions</b>		
Vert. Shr	2998	4578	lbs	Diameter (d)	18.0 in
Horz. Shr	4155	2703	lbs	Tube Wall Thk	0.25 in
Torsion Moment	16328	10625	ft-lbs	Plate Thk (D)	2.25 in
Gravity Moment	97327	155408	ft-lbs	Plate Yield (Fy)	50 ksi
Wind Moment	149585	94960	ft-lbs		
<b>Applied Loads To Base Plate Connection</b>			<b>Shaft Dimensions</b>		
Axial	0	0	lbs	Diameter (d)	19.5 in
Shear	0	0	lbs	Tube Wall Thk	<b>0.3125</b> in
Shear	0	0	lbs	Plate Thk (D)	2 in
Bending Moment	0	0	ft-lbs	Plate Yield (Fy)	36 ksi
Bending Moment	0	0	ft-lbs	Arm Attach. Elev.	<b>18.0</b> ft
Torsion Moment	0	0	ft-lbs		

Additional Load Factor To Apply As Per Signal Plans & Specifications = 1.00

**Electrodes**

**AASHTO Gp II & III Factor** = 1.33

**E70 Electrodes (Used with plates having Fy = 36 ksi)**

$F_v = 0.27 F_u$  (AASHTO Bridge Spec 10.32.2)

$F_v = 0.27 \times 58000 = 15660$  psi

Allowable =  $F_v \times \text{Gp Factor} = 20828$  psi

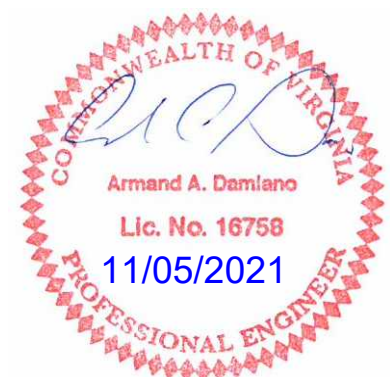
**E70 Electrodes (Used with plates having Fy = 50 ksi)**

$F_v = 0.27 \times 65000 = 17550$  psi

Allowable =  $F_v \times \text{Gp Factor} = 23342$  psi

Reference: *Design of Welded Structures*, Omer W. Blodgett

Method: Weld As A Line

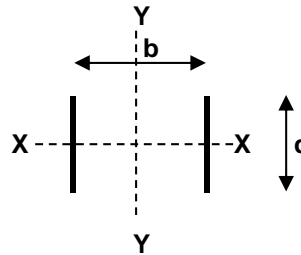


16362-1-2 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 75' Arm  
Weld Analysis - Continued

**ARM CONNECTING PLATES**

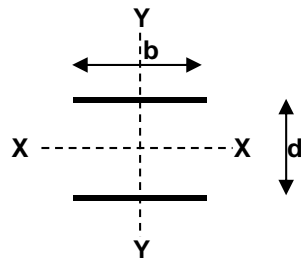
**Side Plates**

Vertical Length (d)	26.50	in
Horz. Dist Between Plates (b)	16.98	in
Thickness	<b>0.5</b>	in
Weld Size	<b>0.313</b>	in
Weld Throat (t <sub>1</sub> )	0.221	in
$A_1 = A_{w1} * t_1 = 2 * d * t_1$	=	11.73 in <sup>2</sup>
$S_{x1} = S_{wx1} * t_1 = (d^2 / 3) * t_1$	=	51.80 in <sup>3</sup>
$S_{y1} = S_{wy1} * t_1 = b * d * t_1$	=	99.57 in <sup>3</sup>
$J_1 = J_{w1} * t_1 = t_1 * d(3b^2 + d^2) / 6$	=	1531.70 in <sup>4</sup>



**Top & Bottom Plates**

Vert. Dist Between Plates (d)	26.50	in
Horz. Length (b)	26.67	in
Thickness	<b>0.5</b>	in
Weld Size	<b>0.313</b>	in
Weld Throat (t <sub>2</sub> )	0.221	in
$A_2 = A_{w2} * t_2 = t_2 * 2 * b$	=	11.8 in <sup>2</sup>
$S_{x2} = S_{wx2} * t_2 = t_2 * b * d$	=	156.4 in <sup>3</sup>
$S_{y2} = S_{wy2} * t_2 = t_2 * (b^2 / 3)$	=	52.5 in <sup>3</sup>
$J_2 = J_{w2} * t_2 = t_2 * (b^3 + 3bd^2) / 6$	=	2772.3 in <sup>4</sup>



**Combined Analysis**

$\sigma_1 = \text{Gravity Mom} / (S_{x1} + S_{x2})$	=	5610.0	Gp II	8957.0	psi
$\sigma_2 = \text{Wind Mom} / (S_{y1} + S_{y2})$	=	11806.0	Gp III	7495.0	psi
$\sigma_3 = [\text{Tor. Mom} * C / (J_1 + J_2)] + [\text{Res. Shr} / (A_1 + A_2)]$	=	935.0		693.0	psi
Res. Weld Stress = $\sigma_r = \text{Sqrt}[(\sigma_1 + \sigma_2)^2 + \sigma_3^2]$	=	17442		16467	psi
Allowable: E70 Electrodes * AASHTO Gp Factor	=	23341.5		23341.5	psi
<b>Actual Weld Stress vs. Allowable</b>		<b>Passes</b>		<b>Passes</b>	



16362-1-2 - VA - 70 MPH - MP-3 Standard Loads - Type B1 - 75' Arm

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	4942 lbs
Bending Moment	183842 ft-lbs
Torsion Moment	149585 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.50 in

**ANALYSIS - ANCHOR BOLTS**

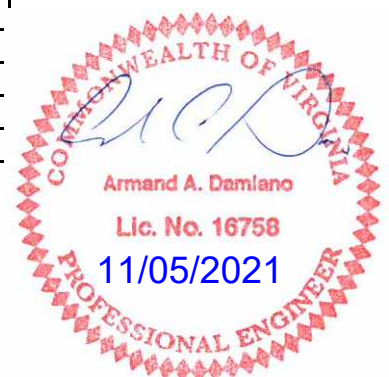
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	16.931 ksi
Bolt Direct Shear Stress	0.269 ksi
Bolt Torsion Shear Stress	7.505 ksi
Combined Bolt Stress	
$F_v = .3 F_y$ * Allowable Increase Factor	21.945 ksi
$F_t = .5 F_y$ * Allowable Increase Factor	36.575 ksi
$f_t =$	16.931 ksi
$f_v =$	7.774 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.59 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.25 in
Design Moment	138 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	20.85 ksi
Allowable Plate Stress = $.66 F_y$ * Allow. Incr.	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.688 in
Design Moment	72 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	11.42 ksi
Allowable Plate Stress = $.66 F_y$ * Allow. Incr.	31.6 ksi
Therefore	<b>OK</b>



16362-1-2 - VA - 70 MPH - MP-3 Standard Loads - Type B1 - 75' Arm

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	25104 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	2.32 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.34
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

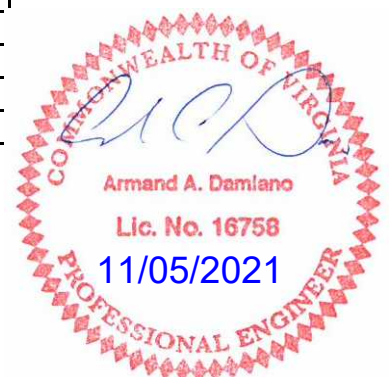
Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	42328 lbs
Computed Factor-of Safety	1.46 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	42328 lbs
Total Tensile Load	338624 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	1.39 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	42328 lbs
Total Tensile Load	338624 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	8 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-3 - VA - 70 MPH - MP-3 Standard Loads - Type B2 - 75' Arm

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<b>Fatigue Importance Factors</b>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	0		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	20.50	19.50	-	-	-	0	55	29000	-
Traffic Arm #1	0.3125	0.14	19.00	30.00	18.00	-	3.93	0	55	29000	180
	0.1880	0.14	15.66	48.02	-	3.02		0	55	29000	
Traffic Arm #2								0	55	29000	90
								0	55	29000	
Lum Arm #1								0	36	29000	180
Lum Arm #2								0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8		Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	in	Double Top Nuts	Yes	
A.B. Bolt Circle	26.00	in	Foundation Diameter	48	in
Baseplate Dia.	32.00	in	Concrete Cover	4	in
Baseplate Thk.	2.00	in	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	15.75	in	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.		Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50 in	in
Flange Plate Length (V)	29.50 in	in
Flange Plate Width (H)	29.50 in	in
Spac. Between Bolt (V)	25.00 in	in
Spac. Between Bolt (H)	25.00 in	in
Flange Plate Thk.	2.75 in	in
Flange Plate Yield (Fy)	50 ksi	ksi
Gusset Thk.	0.500 in	in
Plate Center Hole	6.00 in	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.42	0.54	0.48	0.48							34.23	0.00
GP II CSR	0.74	0.90	0.71	0.89								
GP III CSR	0.69	0.84	0.69	0.79							57.64	
Nat.Wind (psi)	3086	649	6787	7794								

Arm #1 Flange Bolt (Max.) CSR	0.74
Arm #1 Flange Bolt Fatigue CSR	0.59
Arm #1 Flange Plate (Max.) CSR	0.56
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.73
Handhole at Toe (Fatigue) CSR	0.46
Minimum Qty of Vertical Reinf. Bars	9

Fatigue Allowable - Shaft to Baseplate	4.5 ksi
Fatigue Allowable - Arm#1 to Flange	7 ksi
Fatigue Allowable - Arm#2 to Flange	-
Anchor Bolt Max. CSR	0.76
Anchor Bolt Max. Fatigue Stress Ratio	0.34
Base Plate Max. CSR	0.69
Anchorage Capacity S.F.	1.18
Concrete Pull Out Capacity S.F.	1.13

**Ground Line Reactions**

	Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
	7248	4971	226786	208022





16362-1-3 - VA - 70 MPH - MP-3 Standard Loads - Type B2 - 75' Arm  
Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft.)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1										
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	3 Section Head w/BP	20	8.7	4			1	26	65	1.20
	#3	3 Section Head w/BP	32	8.7	4			1	26	65	1.20
	#4	2.5'x3' Sign	41			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	44	8.7	4			1	26	65	1.20
	#6	2.5'x3' Sign	47			2.5	3	1	7.5	22.5	1.13
	#7	3 Section Head w/BP	50	8.7	4			1	26	65	1.20
	#8	2.5'x3' Sign	52			2.5	3	1	7.5	22.5	1.13
	#9	Camera	54	1	1			1	3	22	1.20
	#10	3 Section Head w/BP	56	8.7	4			1	26	65	1.20
	#11	2.5'x3' Sign	58			2.5	3	1	7.5	22.5	1.13
	#12	5 Section Head w/BP	62	13.75	4			2	42	105	1.20
	#13	3'x3.5' Sign	65			3	3.5	1	10.5	26.7	1.13
	#14	Camera	66	1	1			1	3	22	1.20
	#15	4 Section Head w/BP	68	11	5			1	34	80	1.20
	#16	3'x3.5' Sign	71			3	3.5	1	10.5	26.7	1.13
	#17	4 Section Head w/BP	74	11	5			1	34	80	1.20
	For Arm #2	#18									
#19											
#20											
#1											
#2											
#3											
#4											
#5											
#6											
#7											
#8											
#9											
#10											
#11											
#12											
#13											
#14											
#15											
#16											
#17											
#18											
#19											
#20											



16362-1-3 - VA - 70 MPH - MP-3 Standard Loads - Type B2 - 75' Arm

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	20.500	20.352	71.14	0.5288	0.53	1.802	17.48	0.80
2	I	1.06	1.06	20.352	20.204	70.62	0.5288	1.59	1.789	17.36	0.80
3	I	1.06	2.12	20.204	20.055	70.10	0.5288	2.65	1.776	17.24	0.80
4	I	1.06	3.18	20.055	19.907	69.57	0.5288	3.71	1.763	17.12	0.80
5	I	1.06	4.24	19.907	19.759	69.05	0.5288	4.76	1.750	16.99	0.80
6	I	1.06	5.29	19.759	19.611	68.52	0.5287	5.82	1.737	16.87	0.80
7	I	1.06	6.35	19.611	19.462	68.00	0.5287	6.88	1.724	16.75	0.80
8	I	1.06	7.41	19.462	19.314	67.47	0.5287	7.94	1.711	16.62	0.80
9	I	1.06	8.47	19.314	19.166	66.95	0.5287	9.00	1.698	16.50	0.80
10	I	1.06	9.53	19.166	19.018	66.42	0.5287	10.06	1.685	16.38	0.80
11	I	1.06	10.59	19.018	18.869	65.90	0.5287	11.12	1.671	16.25	0.80
12	I	1.06	11.65	18.869	18.721	65.38	0.5287	12.18	1.658	16.13	0.80
13	I	1.06	12.71	18.721	18.573	64.85	0.5287	13.23	1.645	16.01	1.00
14	I	1.06	13.76	18.573	18.425	64.33	0.5287	14.29	1.632	15.88	1.00
15	I	1.06	14.82	18.425	18.276	63.80	0.5287	15.35	1.619	15.76	1.00
16	I	1.06	15.88	18.276	18.128	63.28	0.5287	16.41	1.606	15.64	1.00
17	I	1.06	16.94	18.128	17.980	62.75	0.5287	17.47	1.593	15.51	1.00
18	J	0.50	18.00	17.980	17.910	29.45	0.2498	18.25	0.748	7.28	1.00
19	I	0.50	18.50	17.910	17.840	29.33	0.2498	18.75	0.745	7.26	1.00
20	I	0.50	19.00	17.840	17.770	29.22	0.2498	19.25	0.742	7.23	1.00
						1227					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in <sup>4</sup> )	1009.11	676.42	0.00	652.58
Section Modulus (in <sup>3</sup> )	99.97	76.57	0.00	
Cross-Section Area (in <sup>2</sup> )	19.81	17.34	0.00	
Width-Thickness Ratio	65.60	57.54	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	21.467	21.467	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

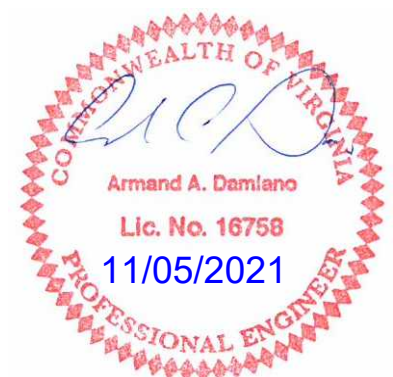
Shaft Deflection From Arm#1 GP I Load (in)	1.341
Shaft Deflection From Arm#2 GP I Load (in)	0.000



16362-1-3 - VA - 70 MPH - MP-3 Standard Loads - Type B2 - 75' Arm

## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	13.77	0.000	22.53	1.100	4.576	8.25
2	0.450	7.64	13.67	0.000	22.37	1.100	4.576	8.19
3	0.450	7.64	13.57	0.000	22.20	1.100	4.576	8.13
4	0.450	7.64	13.47	0.000	22.04	1.100	4.576	8.07
5	0.450	7.64	13.37	0.000	21.87	1.100	4.576	8.01
6	0.450	7.64	13.27	0.000	21.71	1.100	4.576	7.95
7	0.450	7.64	13.17	0.000	21.55	1.100	4.576	7.89
8	0.450	7.64	13.07	0.000	21.38	1.100	4.576	7.83
9	0.450	7.64	12.97	0.001	21.22	1.100	4.576	7.77
10	0.450	7.64	12.87	0.001	21.06	1.100	4.576	7.71
11	0.450	7.64	12.77	0.001	20.89	1.100	4.576	7.65
12	0.450	7.64	12.67	0.001	20.73	1.100	4.576	7.59
13	0.450	9.54	15.70	0.001	20.57	1.100	4.576	7.53
14	0.450	9.54	15.57	0.002	20.40	1.100	4.576	7.47
15	0.450	9.54	15.45	0.002	20.24	1.100	4.576	7.41
16	0.450	9.54	15.32	0.002	20.08	1.100	4.576	7.35
17	0.450	9.54	15.20	0.002	19.91	1.100	4.576	7.29
18	0.450	9.54	7.13	0.001	9.35	1.100	4.576	3.42
19	0.450	9.54	7.11	0.001	9.31	1.100	4.576	3.41
20	0.450	9.54	7.08	0.001	9.27	1.100	4.576	3.39
Fix. #1	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.037	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-3 - VA - 70 MPH - MP-3 Standard Loads - Type B2 - 75' Arm

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	3.85	0.00	19.000	18.460	237.1	1.9179	1.92	6.016	6.016	58.51
2	I	3.85	3.85	18.460	17.921	230.2	1.9176	5.77	5.843	5.843	56.88
3	I	3.85	7.71	17.921	17.381	223.2	1.9173	9.63	5.669	5.669	55.25
4	I	3.85	11.56	17.381	16.842	216.3	1.9170	13.48	5.496	5.496	53.61
5	I	3.85	15.42	16.842	16.302	209.4	1.9167	17.33	5.323	5.323	51.98
6	I	3.85	19.27	16.302	15.762	202.4	1.9163	21.19	5.149	5.149	50.35
7	I	3.85	23.13	15.762	15.223	195.5	1.9160	25.04	4.976	4.976	48.71
8	J	3.02	26.98	15.660	15.237	241.5	1.5031	28.48	3.888	3.888	38.07
9	O	3.75	30.00	15.237	14.712	111.4	1.8640	31.86	4.680	4.680	45.87
10	O	3.75	33.75	14.712	14.187	107.5	1.8636	35.61	4.516	4.516	44.32
11	O	3.75	37.50	14.187	13.662	103.5	1.8632	39.36	4.351	4.351	42.78
12	O	3.75	41.25	13.662	13.137	99.6	1.8628	43.11	4.187	4.187	41.23
13	O	3.75	45.00	13.137	12.612	95.6	1.8623	46.86	4.023	4.023	39.69
14	O	3.75	48.75	12.612	12.087	91.7	1.8617	50.61	3.859	3.859	38.14
15	O	3.75	52.50	12.087	11.562	87.7	1.8611	54.36	3.695	3.695	36.59
16	O	3.75	56.25	11.562	11.037	83.7	1.8605	58.11	3.531	3.531	35.05
17	O	3.75	60.00	11.037	10.512	79.8	1.8598	61.86	3.367	3.367	33.50
18	O	3.75	63.75	10.512	9.987	75.8	1.8590	65.61	3.203	3.203	31.95
19	O	3.75	67.50	9.987	9.462	71.9	1.8581	69.36	3.039	3.039	30.41
20	O	3.75	71.25	9.462	8.937	67.9	1.8572	73.11	2.875	2.875	28.86
		<u>75.00</u>				<u>2832</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	65	20.00	8.700	1.000	78.00
Fix. #3	65	32.00	8.700	1.000	78.00
Fix. #4	22.5	41.00	7.500	1.000	22.50
Fix. #5	65	44.00	8.700	1.000	78.00
Fix. #6	22.5	47.00	7.500	1.000	22.50
Fix. #7	65	50.00	8.700	1.000	78.00
Fix. #8	22.5	52.00	7.500	1.000	22.50
Fix. #9	22	54.00	1.000	1.000	9.00
Fix. #10	65	56.00	8.700	1.000	78.00
Fix. #11	22.5	58.00	7.500	1.000	22.50
Fix. #12	105	62.00	13.750	2.000	126.00
Fix. #13	26.7	65.00	10.500	1.000	31.50
Fix. #14	22	66.00	1.000	1.000	9.00
Fix. #15	80	68.00	11.000	1.000	102.00
Fix. #16	26.7	71.00	10.500	1.000	31.50
Fix. #17	80	74.00	11.000	1.000	102.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	85.669	35.328
Cross-Section Area (in^2)	18.337	9.133
Width-Thickness Ratio	60.80	83.30
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	36.300	33.670
Allow. Shear Stress (ksi)	18.150	15.640



16362-1-3 - VA - 70 MPH - MP-3 Standard Loads - Type B2 - 75' Arm

Arm #1 Analysis Continued

Sec. Num.	Kz	Truck Induced Gust											
		Group 2			Group 3	Natural Wind Gust			Hght Corr. Factor = 1.000				Gallop
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	Loads (lbs)
1	1.00	0.450	9.54	57.39	75.20	1.100	4.576	27.53	0	0.450	0.00	0.00	
2	1.00	0.450	9.54	55.74	73.03	1.100	4.576	26.74	0	0.451	0.00	0.00	
3	1.00	0.450	9.54	54.09	70.87	1.100	4.576	25.94	0	0.469	0.00	0.00	
4	1.00	0.450	9.54	52.43	68.70	1.100	4.576	25.15	0	0.488	0.00	0.00	
5	1.00	0.450	9.54	50.78	66.53	1.100	4.576	24.36	0	0.509	0.00	0.00	
6	1.00	0.450	9.54	49.13	64.37	1.100	4.576	23.56	0	0.532	0.00	0.00	
7	1.00	0.450	9.54	47.47	62.20	1.100	4.576	22.77	0	0.556	0.00	0.00	
8	1.00	0.450	9.54	37.09	48.60	1.100	4.576	17.79	0	0.558	0.00	0.00	
9	1.00	0.450	9.54	44.64	58.49	1.100	4.576	21.41	0	0.581	0.00	0.00	
10	1.00	0.450	9.54	43.08	56.44	1.100	4.576	20.66	0	0.608	0.00	0.00	
11	1.00	0.450	9.54	41.51	54.39	1.100	4.576	19.91	0	0.638	0.00	0.00	
12	1.00	0.450	9.54	39.95	52.34	1.100	4.576	19.16	0	0.671	0.00	0.00	
13	1.00	0.450	9.54	38.38	50.29	1.100	4.576	18.41	0	0.707	0.00	0.00	
14	1.00	0.450	9.54	36.82	48.24	1.100	4.576	17.66	0	0.746	0.00	0.00	
15	1.00	0.450	9.54	35.25	46.19	1.100	4.576	16.91	0	0.790	0.00	0.00	
16	1.00	0.450	9.54	33.69	44.14	1.100	4.576	16.16	0	0.838	0.00	0.00	
17	1.00	0.459	9.74	32.80	42.09	1.100	4.576	15.41	1	0.891	0.00	0.00	
18	1.00	0.490	10.4	33.31	40.04	1.100	4.576	14.66	1	0.951	0.00	0.00	
19	1.00	0.525	11.13	33.82	37.99	1.100	4.576	13.91	1	1.018	0.00	0.00	
20	1.00	0.564	11.96	34.38	35.94	1.100	4.576	13.16	1	1.094	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #7	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #8	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #11	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #12	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	1	1.200	0.00	0.00	0.00
Fix. #13	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #14	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #15	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #16	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #17	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



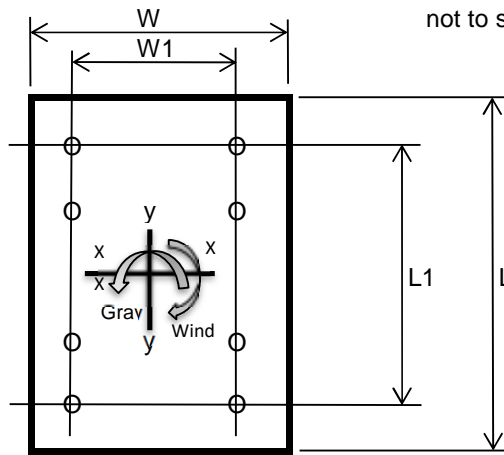
Flange Analysis - Arm #1

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	3631	5393	-	lbs
Shear (Wind)	4170	2780	-	lbs
Torsion (Arm Rise)	16387	10925	-	ft-lbs
Moment (Gravity)	122715	199294	-	ft-lbs
Moment (Wind)	208022	127328	-	ft-lbs
Nat. Wind Moment	-	-	48453	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	19.00	in
Tube Wall Thick.	0.3125	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.75
W	29.5
W1	25.00
L	29.5
L1	25.00
L2 - Dist. between bolts (Typ.)	8.33



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	979.65	979.65	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1763.77	1763.77	in <sup>4</sup>
Bolt Tensile Stress - ft	25.81	32.38	ksi
Bolt Shear Stress - fv	1.93	1.5	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Fv =	44.22	44.22	ksi
Allowable Shear Stress = Ft =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.6	0.74	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	4.13	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.59	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	12.26	19.91	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	21.12	12.93	ksi
Combined applied stress for interaction (SRSS)	24.42	23.74	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



## 16362-1-3 - VA - 70 MPH - MP-3 Standard Loads - Type B2 - 75' Arm

## Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	20.50	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.268293	
Dop - Baseplate center hole diameter	15.75	in
Cop - Center hole to shaft diameter ratio	0.768293	
Kf - Fatigue stress concentration factor for finite life	2.28	
Ki - Fatigue stress concentration factor for infinite life	4.97	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.3125	in
Dt - Arm base diameter	19.00	in
Ttp - Thickness of baseplate	2.75	in
Dbc - Bolt circle diameter	35.36	in
Cbc - Bolt circle ratio	1.86	
Dop - Baseplate center hole diameter	6	in
Cop - Center hole to arm diameter ratio	0.315789	
Kf - Fatigue stress concentration factor for finite life	1.70	
Ki - Fatigue stress concentration factor for infinite life	3.36	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle





## 16362-1-3 - VA - 70 MPH - MP-3 Standard Loads - Type B2 - 75' Arm

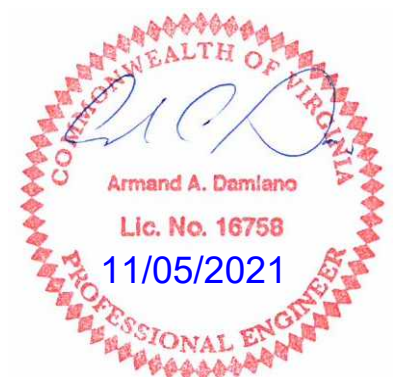
## Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	20.07	in
Shaft Thickness	0.313	in
Total Area	24.5588	in <sup>2</sup>
Ix	1048	in <sup>4</sup>
Iy	1194	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	25711	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	11.63	ksi
CSR	0.73	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	3.22	ksi
CSR	0.46	
Therefore	<b>OK</b>	



16362-1-3 - VA - 70 MPH - MP-3 Standard Loads - Type B2 - 75' Arm

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

<b>Arm#1 Base</b>											
Gp I	3631		3631	122715		122715		397	17190		0.48
Gp II	3631	4170	5530	122715	208022	241521	16387	604	33831	1148	0.71
Gp III	5393	2780	6068	199294	127328	236497	10925	662	33128	766	0.69
Gp IV Natural		1052	1052		48453	48453	4136	115	6787	290	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Arm#1 Joint</b>											
Gp I	2030		2030	46895		46896		445	15930		0.48
Gp II	2030	3556	4095	46895	102787	112980	13975	897	38376	2374	0.89
Gp III	3330	2176	3978	81937	60119	101627	8550	872	34520	1453	0.79
Gp IV Natural		828	828		22943	22943	3254	182	7794	553	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Arm#2 Base</b>											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Arm#2 Joint</b>											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Lum#1 Base</b>											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Lum#2 Base</b>											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-3 - VA - 70 MPH - MP-3 Standard Loads - Type B2 - 75' Arm

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	5022		122715	0	122715		254		14730		0.42
Gp II	5022	4971	91441	149853	175549	208022	254	502	21071	12485	0.74
Gp III	7248	3471	60962	218439	226786	127328	366	351	27222	7642	0.69
Gp IV Natural			25711	0	25711				3086		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9970										

<b>Shaft At Arm</b>											
Gp I	3719		122715	0	122715		215		19231		0.54
Gp II	3719	4191	16387	122730	123819	208022	215	484	19404	16300	0.90
Gp III	5481	2808	10925	199315	199614	127328	316	324	31283	9977	0.84
Gp IV Natural			4143	0	4143				649		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9970										



**Gusset Box Stress Check**  
**For Flange Style F3**  
**Used On Shaft Types B2 & E2**  
**Wind Velocity of 70 mph**  
**Using Governing Load: 75' Case 2**

**Input Information**

Gusset Plate Thickness	0.50	in.	
Gusset Yield Strength Fy	50000	psi	A572 Gr 50
Shaft Base Diameter	20.50	in.	
Height To C.L. of Arm Attach.	18.00	ft.	
Shaft Dia. C.L. of Arm Attach.	17.98	in.	Width Between Gussets
Flange Plate Height	29.5	in.	
Flange Plate Width	29.5	in.	
Box Cross-Sectional Area	47.48	sq.in.	

**Applied Loads Onto Flange Box Taken From Pole Analysis - 75' Case 2**

Gravity Moment	122,715	ft-lbs
Wind Moment	208,022	ft-lbs
Torsion Moment	16387	ft-lbs
Direct Shear	5530	lbs

**Computing Moments of Inertia**

For Gravity			For Wind		
d	29.5	in	d	18.98	in
b	18.98	in	b	29.5	in
d'	28.5	in	d'	17.98	in
b'	17.98	in	b'	28.5	in
Inertia	5920.03	in <sup>4</sup>	Inertia	3003.64	in <sup>4</sup>

**Computing Stress**

Gravity = $Mc/I =$	3669	psi	
Wind = $Mc/I =$	7887	psi	
Torsion = $M/[2t(a-b)(b-t)] =$	367	psi	Roark's Table 10.1 #16
Shear = $2.25 * V / A =$	263	psi	

**Allowables**

Bending = $0.66 F_y 1.33 =$	43890	psi
Torsion Limited by b/t ratio	18,156	psi
b/t =	59.0	
$12000 / F_y^{0.5} =$	54.0	

**Result**

**CSR =** 0.30 Which is  $\leq 1$  Therefore OK  
 To be conservative bending stresses were added not SRSS



16362-1-3 - VA - 70 MPH - MP-3 Std. Loads - Type B2 - 75' Arm  
Weld Analysis

Page S4

**INPUTS**

	<b>Gp II</b>	<b>GpIII</b>		<b>Arm Dimensions</b>		
<b>Applied Loads To Flange Connection</b>						
Vert. Shr	3631	5393	lbs	Diameter (d)	19.0	in
Horz. Shr	4170	2780	lbs	Tube Wall Thk	0.25	in
Torsion Moment	16387	10925	ft-lbs	Plate Thk (D)	2.75	in
Gravity Moment	122715	199294	ft-lbs	Plate Yield (Fy)	50	ksi
Wind Moment	208022	127328	ft-lbs			
<b>Applied Loads To Base Plate Connection</b>				<b>Shaft Dimensions</b>		
Axial	0	0	lbs	Diameter (d)	20.5	in
Shear	0	0	lbs	Tube Wall Thk	<b>0.3125</b>	in
Shear	0	0	lbs	Plate Thk (D)	2	in
Bending Moment	0	0	ft-lbs	Plate Yield (Fy)	36	ksi
Bending Moment	0	0	ft-lbs	Arm Attach. Elev.	<b>18.0</b>	ft
Torsion Moment	0	0	ft-lbs			

**Additional Load Factor To Apply As Per Signal Plans & Specifications = 1.00**

**Electrodes**

**AASHTO Gp II & III Factor = 1.33**

**E70 Electrodes (Used with plates having Fy = 36 ksi)**

$F_v = 0.27 F_u$  (AASHTO Bridge Spec 10.32.2)

$F_v = 0.27 \times 58000 = 15660$  psi

Allowable =  $F_v \times \text{Gp Factor} = 20828$  psi

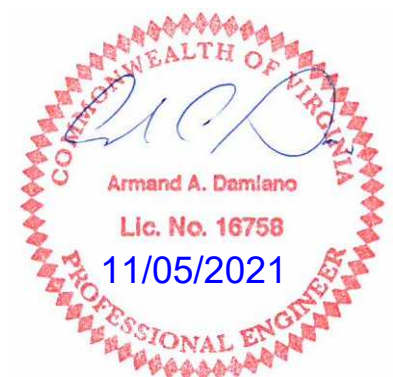
**E70 Electrodes (Used with plates having Fy = 50 ksi)**

$F_v = 0.27 \times 65000 = 17550$  psi

Allowable =  $F_v \times \text{Gp Factor} = 23342$  psi

Reference: *Design of Welded Structures*, Omer W. Blodgett

Method: Weld As A Line

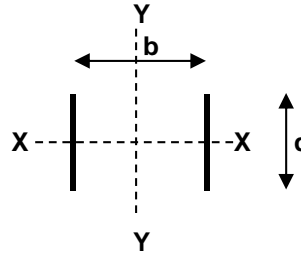


16362-1-3 - VA - 70 MPH - MP-3 Std. Loads - Type B2 - 75' Arm  
Weld Analysis - Continued

**ARM CONNECTING PLATES**

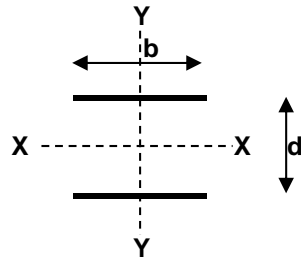
**Side Plates**

Vertical Length (d)	28.00	in
Horz. Dist Between Plates (b)	17.98	in
Thickness	<b>0.5</b>	in
Weld Size	<b>0.313</b>	in
Weld Throat (t <sub>1</sub> )	0.221	in
$A_1 = A_{w1} * t_1 = 2 * d * t_1$	=	12.39 in <sup>2</sup>
$S_{x1} = S_{wx1} * t_1 = (d^2 / 3) * t_1$	=	57.83 in <sup>3</sup>
$S_{y1} = S_{wy1} * t_1 = b * d * t_1$	=	111.41 in <sup>3</sup>
$J_1 = J_{w1} * t_1 = t_1 * d(3b^2 + d^2) / 6$	=	1811.20 in <sup>4</sup>



**Top & Bottom Plates**

Vert. Dist Between Plates (d)	28.00	in
Horz. Length (b)	28.24	in
Thickness	<b>0.5</b>	in
Weld Size	<b>0.313</b>	in
Weld Throat (t <sub>2</sub> )	0.221	in
$A_2 = A_{w2} * t_2 = t_2 * 2 * b$	=	12.5 in <sup>2</sup>
$S_{x2} = S_{wx2} * t_2 = t_2 * b * d$	=	175.0 in <sup>3</sup>
$S_{y2} = S_{wy2} * t_2 = t_2 * (b^2 / 3)$	=	58.8 in <sup>3</sup>
$J_2 = J_{w2} * t_2 = t_2 * (b^3 + 3bd^2) / 6$	=	3280.9 in <sup>4</sup>



**Combined Analysis**

$\sigma_1 = \text{Gravity Mom} / (S_{x1} + S_{x2})$	=	6325.0	Gp II	10272.0	psi
$\sigma_2 = \text{Wind Mom} / (S_{y1} + S_{y2})$	=	14663.0	Gp III	8975.0	psi
$\sigma_2 = [\text{Tor. Mom} * C / (J_1 + J_2)] + [\text{Res. Shr} / (A_1 + A_2)]$	=	865.0		673.0	psi
Res. Weld Stress = $\sigma_r = \text{Sqrt}[(\sigma_1 + \sigma_2)^2 + \sigma_3^2]$	=	21006		19259	psi
Allowable: E70 Electrodes * AASHTO Gp Factor	=	23341.5		23341.5	psi
<b>Actual Weld Stress vs. Allowable</b>		<b>Passes</b>		<b>Passes</b>	



16362-1-3 - VA - 70 MPH - MP-3 Standard Loads - Type B2 - 75' Arm

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	4971 lbs
Bending Moment	226786 ft-lbs
Torsion Moment	208022 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	20.50 in

**ANALYSIS - ANCHOR BOLTS**

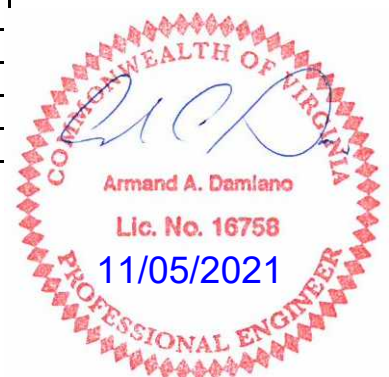
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	20.885 ksi
Bolt Direct Shear Stress	0.271 ksi
Bolt Torsion Shear Stress	10.436 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	20.885 ksi
$f_v =$	10.707 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.76 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	2.75 in
Design Moment	144 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	21.76 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.188 in
Design Moment	63 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	9.99 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>





16362-1-3 - VA - 70 MPH - MP-3 Standard Loads - Type B2 - 75' Arm

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	25711 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	2.37 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.34
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

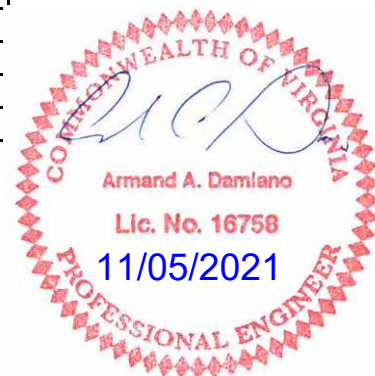
Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	52213 lbs
Computed Factor-of Safety	1.18 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	52213 lbs
Total Tensile Load	417704 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	1.13 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	52213 lbs
Total Tensile Load	417704 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	<b>9</b> Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-4 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/60' Arms

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<b>Fatigue Importance Factors</b>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	2		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	0		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

**Pole Variables**

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.00	19.50	-	-	-	0	55	29000	-
Traffic Arm #1	0.2500	0.14	17.50	25.00	18.00	-	3.67	0	55	29000	180
	0.1880	0.14	14.79	47.92	-	2.92		0	55	29000	
Traffic Arm #2	0.2500	0.14	15.58	23.69	18.00	-	3.14	0	55	29000	270
	0.1793	0.14	13.00	39.00	-	2.69		0	55	29000	
Lum Arm #1								0	36	29000	180
Lum Arm #2								0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	in	Double Top Nuts	Yes
A.B. Bolt Circle	26.00	in	Foundation Diameter	48
Baseplate Dia.	32.00	in	Concrete Cover	4
Baseplate Thk.	2.00	in	f'c = 28 Day Concrete Comp. Strength	3000
B.P. Center Hole	14.25	in	Vertical Reinforcing Bar Size #	8
Weld Type	Full Pen.		Rebar Yield Strength fy	60
				ksi

**Flange Simplex**

**Arm #1**      **Arm #2**

**Hand Hole**

Flange Bolt Qty.	8	8	Handhole Width	6.00	in		
Bolt Diameter	1.50	in	1.50	in	Handhole Height	24.50	in
Flange Plate Length (V)	27.00	in	27.00	in	Height To C.L.	37	in
Flange Plate Width (H)	27.00	in	27.00	in	Radial Orientation	0	Deg.
Spac. Between Bolt (V)	22.50	in	22.50	in	Rim Thickness	0.75	in
Spac. Between Bolt (H)	22.50	in	22.50	in	Rim Depth	5.00	in
Flange Plate Thk.	2.25	in	2.25	in	Rim Projection	1.00	in
Flange Plate Yield (Fy)	50.00	ksi	50.00	ksi			
Gusset Thk.	0.500	in	0.500	in			
Plate Center Hole	6.00	in	6.00	in			
Weld Type	Full Pen.	Full Pen.					

**Results**

	<b>Shaft At</b>		<b>Arm#1</b>		<b>Arm#2</b>		<b>Lum#1</b>		<b>Lum#2</b>		<b>Tip Deflection (in)</b>	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.42	0.55	0.49	0.41	0.43	0.34					29.76	20.19
GP II CSR	0.83	0.94	0.71	0.64	0.66	0.58						
GP III CSR	0.76	0.88	0.70	0.62	0.63	0.54					48.75	33.79
Nat.Wind (psi)	4025	808	6735	5792	6306	5372						

Arm #1 Flange Bolt (Max.) CSR	0.56
Arm #1 Flange Bolt Fatigue CSR	0.45
Arm #1 Flange Plate (Max.) CSR	0.60
Arm #2 Flange Bolt (Max.) CSR	0.40
Arm #2 Flange Bolt Fatigue CSR	0.33
Arm #2 Flange Plate (Max.) CSR	0.47
Handhole at Root (Fatigue) CSR	0.93
Handhole at Toe (Fatigue) CSR	0.60
Minimum Qty of Vertical Reinf. Bars	9

Fatigue Allowable - Shaft to Baseplate	4.5	ksi
Fatigue Allowable - Arm#1 to Flange	7	ksi
Fatigue Allowable - Arm#2 to Flange	7	ksi
Anchor Bolt Max. CSR	0.69	
Anchor Bolt Max. Fatigue Stress Ratio	0.38	
Base Plate Max. CSR	0.85	
Anchorage Capacity S.F.	1.22	
Concrete Pull Out Capacity S.F.	1.16	

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
9259	4553	220352	172464



16362-1-4 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/60' Arms  
Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft.)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1										
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	15'x2.5' Sign	12			15	2.5	1	37.5	88.5	1.21
	#3	5 Section Head w/BP	25	13.75	4			2	42	105	1.20
	#4	2.5'x3' Sign	29			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	36	8.7	4			1	26	65	1.20
	#6	Camera	40	1	1			1	3	22	1.20
	#7	2.5'x3' Sign	44			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	47	8.7	4			1	26	65	1.20
	#9	2.5'x3' Sign	55			2.5	3	1	7.5	22.5	1.13
	#10	3 Section Head w/BP	58	8.7	4			1	26	65	1.20
	#11	Camera	62	1	1			1	3	22	1.20
	#12	3'x3.5' Sign	66			3	3.5	1	10.5	26.7	1.13
	#13	4 Section Head w/BP	69	11	5			1	34	80	1.20
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1	Camera	4	1	1			1	3	22	1.20
	#2	15'x2.5' Sign	12.5			15	2.5	1	37.5	88.5	1.21
	#3	5 Section Head w/BP	26	13.75	4			2	42	105	1.20
	#4	2.5'x3' Sign	34			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	37	8.7	4			1	26	65	1.20
	#6	Camera	46	1	1			1	3	22	1.20
	#7	2.5'x3' Sign	45			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	48	8.7	4			1	26	65	1.20
	#9	Camera	57	1	1			1	3	22	1.20
	#10	3'x3.5' Sign	56			3	3.5	1	10.5	26.7	1.13
	#11	4 Section Head w/BP	59	11	5			1	34	80	1.20
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										



16362-1-4 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/60' Arms

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.000	18.852	65.84	0.5287	0.53	1.670	16.24	0.80
2	I	1.06	1.06	18.852	18.704	65.31	0.5287	1.59	1.657	16.11	0.80
3	I	1.06	2.12	18.704	18.555	64.79	0.5287	2.65	1.644	15.99	0.80
4	I	1.06	3.18	18.555	18.407	64.27	0.5287	3.71	1.631	15.87	0.80
5	I	1.06	4.24	18.407	18.259	63.74	0.5287	4.76	1.618	15.74	0.80
6	I	1.06	5.29	18.259	18.111	63.22	0.5287	5.82	1.605	15.62	0.80
7	I	1.06	6.35	18.111	17.962	62.69	0.5287	6.88	1.591	15.50	0.80
8	I	1.06	7.41	17.962	17.814	62.17	0.5287	7.94	1.578	15.37	0.80
9	I	1.06	8.47	17.814	17.666	61.64	0.5287	9.00	1.565	15.25	0.80
10	I	1.06	9.53	17.666	17.518	61.12	0.5287	10.06	1.552	15.13	0.80
11	I	1.06	10.59	17.518	17.369	60.59	0.5287	11.12	1.539	15.00	0.80
12	I	1.06	11.65	17.369	17.221	60.07	0.5287	12.18	1.526	14.88	0.80
13	I	1.06	12.71	17.221	17.073	59.55	0.5286	13.23	1.513	14.76	1.00
14	I	1.06	13.76	17.073	16.925	59.02	0.5286	14.29	1.500	14.63	1.00
15	I	1.06	14.82	16.925	16.776	58.50	0.5286	15.35	1.487	14.51	1.00
16	I	1.06	15.88	16.776	16.628	57.97	0.5286	16.41	1.474	14.39	1.00
17	I	1.06	16.94	16.628	16.480	57.45	0.5286	17.47	1.461	14.27	1.00
18	J	0.50	18.00	16.480	16.410	26.95	0.2498	18.25	0.685	6.69	1.00
19	I	0.50	18.50	16.410	16.340	26.83	0.2498	18.75	0.682	6.67	1.00
20	I	0.50	19.00	16.340	16.270	26.71	0.2498	19.25	0.679	6.64	1.00
						1129					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in <sup>4</sup> )	800.47	518.34	518.34	498.41
Section Modulus (in <sup>3</sup> )	85.67	64.12	64.12	
Cross-Section Area (in <sup>2</sup> )	18.34	15.86	15.86	
Width-Thickness Ratio	60.80	52.74	52.74	
Compact Limit	68.55	68.55	68.55	
Non-Compact Limit	137.09	137.09	137.09	
Maximum Limit	237.27	237.27	237.27	
Allow. Bending Stress (ksi)	36.300	36.300	36.300	
Allow. Compressive Str (ksi)	19.983	19.983	19.983	
Allow. Shear Stress (ksi)	18.150	18.150	18.150	

Shaft Deflection From Arm#1 GP I Load (in)	1.186
Shaft Deflection From Arm#2 GP I Load (in)	0.819



16362-1-4 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/60' Arms

## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	12.76	0.000	20.87	1.100	4.576	7.64
2	0.450	7.64	12.66	0.000	20.71	1.100	4.576	7.58
3	0.450	7.64	12.56	0.000	20.55	1.100	4.576	7.52
4	0.450	7.64	12.46	0.000	20.38	1.100	4.576	7.46
5	0.450	7.64	12.36	0.000	20.22	1.100	4.576	7.40
6	0.450	7.64	12.26	0.000	20.06	1.100	4.576	7.34
7	0.450	7.64	12.16	0.000	19.89	1.100	4.576	7.28
8	0.450	7.64	12.06	0.001	19.73	1.100	4.576	7.22
9	0.450	7.64	11.96	0.001	19.57	1.100	4.576	7.16
10	0.450	7.64	11.86	0.001	19.40	1.100	4.576	7.10
11	0.450	7.64	11.76	0.001	19.24	1.100	4.576	7.04
12	0.450	7.64	11.66	0.001	19.08	1.100	4.576	6.98
13	0.450	9.54	14.43	0.002	18.91	1.100	4.576	6.92
14	0.450	9.54	14.31	0.002	18.75	1.100	4.576	6.86
15	0.450	9.54	14.18	0.002	18.59	1.100	4.576	6.80
16	0.450	9.54	14.06	0.002	18.42	1.100	4.576	6.74
17	0.450	9.54	13.93	0.002	18.26	1.100	4.576	6.68
18	0.450	9.54	6.54	0.001	8.57	1.100	4.576	3.14
19	0.450	9.54	6.51	0.001	8.53	1.100	4.576	3.12
20	0.450	9.54	6.48	0.001	8.49	1.100	4.576	3.11
Fix. #1	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.047	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-4 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/60' Arms

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	3.68	0.00	17.500	16.985	167.1	1.8308	1.83	5.288	5.288	51.57
2	I	3.68	3.68	16.985	16.470	162.1	1.8306	5.51	5.130	5.130	50.08
3	I	3.68	7.36	16.470	15.954	157.0	1.8303	9.19	4.972	4.972	48.59
4	I	3.68	11.04	15.954	15.439	151.9	1.8299	12.87	4.814	4.814	47.10
5	I	3.68	14.72	15.439	14.924	146.8	1.8296	16.55	4.656	4.656	45.61
6	I	3.68	18.40	14.924	14.409	141.8	1.8292	20.23	4.498	4.498	44.12
7	J	2.92	22.08	14.790	14.381	193.4	1.4532	23.53	3.549	3.549	34.83
8	O	3.46	25.00	14.381	13.897	97.1	1.7209	26.72	4.079	4.079	40.07
9	O	3.46	28.46	13.897	13.412	93.7	1.7205	30.18	3.939	3.939	38.75
10	O	3.46	31.92	13.412	12.927	90.3	1.7202	33.64	3.799	3.799	37.43
11	O	3.46	35.38	12.927	12.443	86.9	1.7197	37.10	3.659	3.659	36.12
12	O	3.46	38.85	12.443	11.958	83.6	1.7193	40.57	3.519	3.519	34.80
13	O	3.46	42.31	11.958	11.474	80.2	1.7188	44.03	3.380	3.380	33.48
14	O	3.46	45.77	11.474	10.989	76.8	1.7183	47.49	3.240	3.240	32.16
15	O	3.46	49.23	10.989	10.504	73.5	1.7178	50.95	3.100	3.100	30.85
16	O	3.46	52.69	10.504	10.020	70.1	1.7171	54.41	2.960	2.960	29.53
17	O	3.46	56.15	10.020	9.535	66.7	1.7165	57.87	2.820	2.820	28.21
18	O	3.46	59.62	9.535	9.050	63.3	1.7157	61.33	2.681	2.681	26.89
19	O	3.46	63.08	9.050	8.566	60.0	1.7149	64.79	2.541	2.541	25.58
20	O	3.46	66.54	8.566	8.081	56.6	1.7140	68.25	2.401	2.401	24.26
		<u>70.00</u>				<u>2119</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	12.00	37.500	1.000	112.50
Fix. #3	105	25.00	13.750	2.000	126.00
Fix. #4	22.5	29.00	7.500	1.000	22.50
Fix. #5	65	36.00	8.700	1.000	78.00
Fix. #6	22	40.00	1.000	1.000	9.00
Fix. #7	22.5	44.00	7.500	1.000	22.50
Fix. #8	65	47.00	8.700	1.000	78.00
Fix. #9	22.5	55.00	7.500	1.000	22.50
Fix. #10	65	58.00	8.700	1.000	78.00
Fix. #11	22	62.00	1.000	1.000	9.00
Fix. #12	26.7	66.00	10.500	1.000	31.50
Fix. #13	80	69.00	11.000	1.000	102.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	58.397	31.467
Cross-Section Area (in^2)	13.541	8.620
Width-Thickness Ratio	70.00	78.67
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	35.991	34.389
Allow. Shear Stress (ksi)	18.150	17.040





16362-1-4 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/60' Arms

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000 Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	50.44	66.10	1.100	4.576	24.20	0	0.484	0.00	0.00	
2	1.00	0.450	9.54	48.94	64.12	1.100	4.576	23.47	0	0.503	0.00	0.00	
3	1.00	0.450	9.54	47.43	62.15	1.100	4.576	22.75	0	0.524	0.00	0.00	
4	1.00	0.450	9.54	45.92	60.17	1.100	4.576	22.03	0	0.546	0.00	0.00	
5	1.00	0.450	9.54	44.42	58.20	1.100	4.576	21.30	0	0.571	0.00	0.00	
6	1.00	0.450	9.54	42.91	56.22	1.100	4.576	20.58	0	0.597	0.00	0.00	
7	1.00	0.450	9.54	33.86	44.36	1.100	4.576	16.24	0	0.601	0.00	0.00	
8	1.00	0.450	9.54	38.91	50.98	1.100	4.576	18.66	0	0.626	0.00	0.00	
9	1.00	0.450	9.54	37.58	49.23	1.100	4.576	18.02	0	0.655	0.00	0.00	
10	1.00	0.450	9.54	36.24	47.49	1.100	4.576	17.38	0	0.686	0.00	0.00	
11	1.00	0.450	9.54	34.91	45.74	1.100	4.576	16.74	0	0.721	0.00	0.00	
12	1.00	0.450	9.54	33.57	43.99	1.100	4.576	16.10	0	0.758	0.00	0.00	
13	1.00	0.450	9.54	32.24	42.24	1.100	4.576	15.46	0	0.799	0.00	0.00	
14	1.00	0.450	9.54	30.91	40.50	1.100	4.576	14.83	0	0.844	0.00	0.00	
15	1.00	0.461	9.78	30.32	38.75	1.100	4.576	14.19	0	0.894	0.00	0.00	
16	1.00	0.489	10.38	30.73	37.00	1.100	4.576	13.55	0	0.949	0.00	0.00	
17	1.00	0.521	11.05	31.17	35.25	1.100	4.576	12.91	1	1.011	0.00	0.00	
18	1.00	0.557	11.81	31.66	33.51	1.100	4.576	12.27	1	1.080	0.00	0.00	
19	1.00	0.597	12.66	32.17	31.76	1.100	4.576	11.63	1	1.100	0.00	0.00	
20	1.00	0.643	13.63	32.73	30.01	1.100	4.576	10.99	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #10	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #13	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00





Flange Analysis - Arm #1

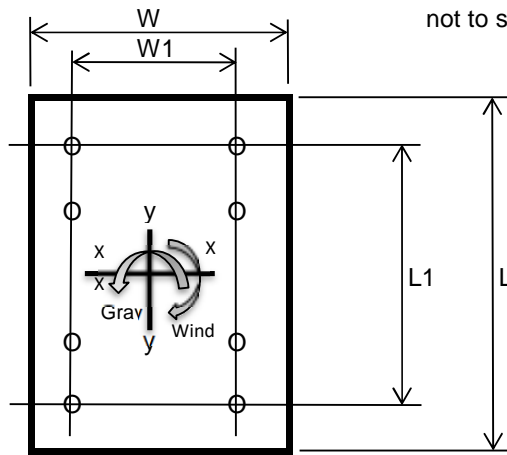
Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	2748	4188	-	lbs
Shear (Wind)	3869	2515	-	lbs
Torsion (Arm Rise)	14192	9224	-	ft-lbs
Moment (Gravity)	85096	136462	-	ft-lbs
Moment (Wind)	137190	86259	-	ft-lbs
Nat. Wind Moment	-	-	32774	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs

Diameter of tube	17.50	in
Tube Wall Thick.	0.25	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)

	Results GpII	Results GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	19.42	24.59	ksi
Bolt Shear Stress - fv	1.79	1.34	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.45	0.56	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	3.1	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.45	<b>OK</b>	

Plate Analysis

Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	13.77	22.08	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	22.58	14.20	ksi
Combined applied stress for interaction (SRSS)	26.45	26.25	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



16362-1-4 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/60' Arms

Arm #2 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	3.00	0.00	15.580	15.160	121.2	1.4932	1.49	3.843	3.843	37.63
2	I	3.00	3.00	15.160	14.740	117.9	1.4930	4.49	3.738	3.738	36.64
3	I	3.00	6.00	14.740	14.320	114.5	1.4928	7.49	3.633	3.633	35.65
4	I	3.00	9.00	14.320	13.900	111.1	1.4926	10.49	3.528	3.528	34.66
5	I	3.00	12.00	13.900	13.480	107.8	1.4923	13.49	3.423	3.423	33.67
6	I	3.00	15.00	13.480	13.060	104.4	1.4921	16.49	3.318	3.318	32.68
7	I	3.00	18.00	13.060	12.640	101.0	1.4918	19.49	3.213	3.213	31.69
8	J	2.69	21.00	13.000	12.623	152.9	1.3384	22.34	2.872	2.872	28.33
9	O	3.03	23.69	12.623	12.200	70.9	1.5043	25.19	3.130	3.130	30.92
10	O	3.03	26.72	12.200	11.776	68.5	1.5040	28.22	3.023	3.023	29.91
11	O	3.03	29.74	11.776	11.353	66.0	1.5037	31.25	2.916	2.916	28.91
12	O	3.03	32.77	11.353	10.929	63.6	1.5033	34.27	2.809	2.809	27.90
13	O	3.03	35.79	10.929	10.505	61.1	1.5029	37.30	2.702	2.702	26.89
14	O	3.03	38.82	10.505	10.082	58.7	1.5025	40.32	2.596	2.596	25.89
15	O	3.03	41.85	10.082	9.658	56.2	1.5021	43.35	2.489	2.489	24.88
16	O	3.03	44.87	9.658	9.234	53.7	1.5016	46.37	2.382	2.382	23.87
17	O	3.03	47.90	9.234	8.811	51.3	1.5011	49.40	2.275	2.275	22.87
18	O	3.03	50.92	8.811	8.387	48.8	1.5005	52.42	2.168	2.168	21.86
19	O	3.03	53.95	8.387	7.964	46.4	1.4999	55.45	2.061	2.061	20.85
20	O	3.03	56.97	7.964	7.540	43.9	1.4991	58.47	1.955	1.955	19.85
		60.00				1620					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	12.50	37.500	1.000	112.50
Fix. #3	105	26.00	13.750	2.000	126.00
Fix. #4	22.5	34.00	7.500	1.000	22.50
Fix. #5	65	37.00	8.700	1.000	78.00
Fix. #6	22	46.00	1.000	1.000	9.00
Fix. #7	22.5	45.00	7.500	1.000	22.50
Fix. #8	65	48.00	8.700	1.000	78.00
Fix. #9	22	57.00	1.000	1.000	9.00
Fix. #10	26.7	56.00	10.500	1.000	31.50
Fix. #11	80	59.00	11.000	1.000	102.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#2 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	46.120	23.135
Cross-Section Area (in^2)	12.034	7.218
Width-Thickness Ratio	62.32	72.50
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	36.300	35.489
Allow. Shear Stress (ksi)	18.150	18.150



16362-1-4 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/60' Arms

Arm #2 Analysis Continued

Sec. Num.	Kz	Truck Induced Gust											Gallop Loads (lbs)
		Group 2			Group 3	Natural Wind Gust			Hght Corr. Factor = 1.00				
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	36.66	48.03	1.100	4.576	17.58	0	0.562	0.00	0.00	
2	1.00	0.450	9.54	35.66	46.72	1.100	4.576	17.10	0	0.582	0.00	0.00	
3	1.00	0.450	9.54	34.65	45.41	1.100	4.576	16.62	0	0.604	0.00	0.00	
4	1.00	0.450	9.54	33.65	44.09	1.100	4.576	16.14	0	0.628	0.00	0.00	
5	1.00	0.450	9.54	32.65	42.78	1.100	4.576	15.66	0	0.653	0.00	0.00	
6	1.00	0.450	9.54	31.65	41.47	1.100	4.576	15.18	0	0.680	0.00	0.00	
7	1.00	0.450	9.54	30.65	40.16	1.100	4.576	14.70	0	0.709	0.00	0.00	
8	1.00	0.450	9.54	27.40	35.90	1.100	4.576	13.14	0	0.711	0.00	0.00	
9	1.00	0.450	9.54	29.86	39.12	1.100	4.576	14.32	0	0.741	0.00	0.00	
10	1.00	0.450	9.54	28.84	37.79	1.100	4.576	13.83	0	0.776	0.00	0.00	
11	1.00	0.450	9.54	27.82	36.45	1.100	4.576	13.34	0	0.813	0.00	0.00	
12	1.00	0.450	9.54	26.80	35.11	1.100	4.576	12.85	0	0.853	0.00	0.00	
13	1.00	0.463	9.81	26.51	33.78	1.100	4.576	12.37	0	0.897	0.00	0.00	
14	1.00	0.488	10.34	26.84	32.44	1.100	4.576	11.88	0	0.946	0.00	0.00	
15	1.00	0.515	10.92	27.18	31.11	1.100	4.576	11.39	0	0.999	0.00	0.00	
16	1.00	0.545	11.56	27.53	29.77	1.100	4.576	10.90	1	1.057	0.00	0.00	
17	1.00	0.579	12.27	27.92	28.44	1.100	4.576	10.41	1	1.100	0.00	0.00	
18	1.00	0.616	13.06	28.32	27.10	1.100	4.576	9.92	1	1.100	0.00	0.00	
19	1.00	0.658	13.95	28.76	25.77	1.100	4.576	9.43	1	1.100	0.00	0.00	
20	1.00	0.705	14.95	29.22	24.43	1.100	4.576	8.94	1	1.100	0.00	0.00	
Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



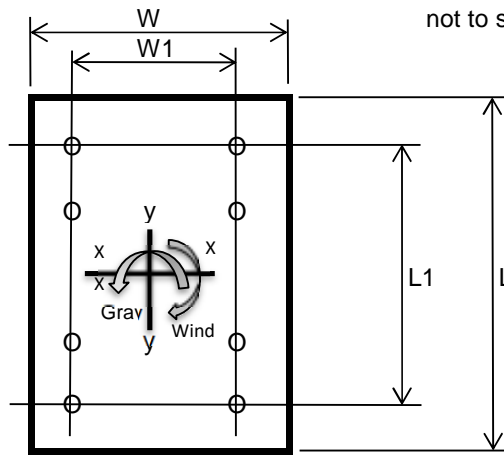
Flange Analysis - Arm #2

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	2161	3337	-	lbs
Shear (Wind)	3319	2098	-	lbs
Torsion (Arm Rise)	10435	6598	-	ft-lbs
Moment (Gravity)	58769	96007	-	ft-lbs
Moment (Wind)	104534	63624	-	ft-lbs
Nat. Wind Moment	-	-	24233	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	15.58	in
Tube Wall Thick.	0.25	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	14.05	17.39	ksi
Bolt Shear Stress - fv	1.36	1	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.33	0.40	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	2.29	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.33	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	9.97	16.28	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	18.03	10.98	ksi
Combined applied stress for interaction (SRSS)	20.60	19.64	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



## 16362-1-4 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/60' Arms

## Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.00	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.368421	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.75	
Kf - Fatigue stress concentration factor for finite life	2.41	
Ki - Fatigue stress concentration factor for infinite life	5.32	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.25	in
Dt - Arm base diameter	17.50	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	1.82	
Dop - Baseplate center hole diameter	6.00	in
Cop - Center hole to arm diameter ratio	0.342857	
Kf - Fatigue stress concentration factor for finite life	1.76	
Ki - Fatigue stress concentration factor for infinite life	3.33	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle

**ARM 2 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.25	in
Dt - Arm base diameter	15.58	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	2.042349	
Dop - Baseplate center hole diameter	6	in
Cop - Center hole to arm diameter ratio	0.385109	
Kf - Fatigue stress concentration factor for finite life	1.83	
Ki - Fatigue stress concentration factor for infinite life	3.50	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle



16362-1-4 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/60' Arms

Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	18.57	in
Shaft Thickness	0.313	in
Total Area	23.0768	in^2
Ix	848	in^4
Iy	944	in^4
Controlling Moment - Natural Wind Gust	28736	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	14.85	ksi
CSR	0.93	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	4.22	ksi
CSR	0.60	
Therefore	<b>OK</b>	



16362-1-4 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/60' Arms

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear	Shear	Bending	Torsion	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	2748		2748	85096		85097		406	17487		0.49
Gp II	2748	3869	4746	85096	137190	161439	14192	701	33175	1459	0.71
Gp III	4188	2515	4886	136462	86259	161439	9224	722	33175	948	0.70
Gp IV Natural		956	956		32774	32774	3507	142	6735	361	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	1710		1710	36287		36287		397	13839		0.41
Gp II	1710	2605	3116	36287	65080	74513	9554	723	28416	1822	0.64
Gp III	2742	1656	3204	60410	39979	72441	6073	744	27626	1158	0.62
Gp IV Natural		628	628		15186	15186	2305	146	5792	440	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	2161		2161	58769		58770		360	15292		0.43
Gp II	2161	3319	3961	58769	104534	119922	10435	659	31203	1358	0.66
Gp III	3337	2098	3942	96007	63624	115176	6598	656	29968	859	0.63
Gp IV Natural		799	799		24233	24233	2514	133	6306	328	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	1273		1273	22969		22969		353	11914		0.34
Gp II	1273	2099	2455	22969	45981	51399	6599	681	26661	1712	0.58
Gp III	2084	1298	2456	39262	27203	47766	4080	681	24776	1059	0.54
Gp IV Natural		493	493		10356	10356	1552	137	5372	403	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Lum#1 Base											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Lum#2 Base											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-





16362-1-4 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/60' Arms

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	6202		85096	58769	103418		338		14486		0.42
Gp II	6202	4553	117005	144217	185711	172464	338	497	26013	12079	0.83
Gp III	9259	3108	132467	176090	220352	107182	505	339	30866	7507	0.76
Gp IV Natural			23238	16904	28736				4025		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9950										

<b>Shaft At Arm</b>											
Gp I	4989		85096	58769	103418		314		19354		0.55
Gp II	4989	3889	68978	92360	115275	172464	314	491	21573	16138	0.94
Gp III	7605	2540	102643	141065	174456	107182	479	321	32648	10029	0.88
Gp IV Natural			3513	2513	4320				808		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9950										



**Gusset Box Stress Check  
For Flange Style F2  
Used On Shaft Type C & F  
Wind Velocity of 70 mph  
Using Governing Load: 70'**

**Input Information**

Gusset Plate Thickness	0.50	in.	
Gusset Yield Strength Fy	50000	psi	A572 Gr 50
Shaft Base Diameter	19.00	in.	
Height To C.L. of Arm Attach.	18.00	ft.	
Shaft Dia. C.L. of Arm Attach.	16.48	in.	Width Between Gussets
Flange Plate Height	27.0	in.	
Flange Plate Width	27.0	in.	
Box Cross-Sectional Area	43.48	sq.in.	

**Applied Loads Onto Flange Box Taken From Pole Analysis - 70'**

Gravity Moment	85,096	ft-lbs
Wind Moment	137,190	ft-lbs
Torsion Moment	14192	ft-lbs
Direct Shear	4746	lbs

**Computing Moments of Inertia**

For Gravity			For Wind		
d	27	in	d	17.48	in
b	17.48	in	b	27	in
d'	26	in	d'	16.48	in
b'	16.48	in	b'	26	in
Inertia	4533.86	in <sup>4</sup>	Inertia	2319.71	in <sup>4</sup>

**Computing Stress**

Gravity = $Mc/I =$	3041	psi	
Wind = $Mc/I =$	6203	psi	
Torsion = $M/[2t(a-b)(b-t)] =$	378	psi	Roark's Table 10.1 #16
Shear = $2.25 * V / A =$	246	psi	

**Allowables**

Bending = $0.66 F_y 1.33 =$	43890	psi
Torsion Limited by b/t ratio	21,945	psi
b/t = 54.0		
$12000 / F_y^{0.5} =$	54.0	

**Result**

CSR = 0.24 Which is  $\leq 1$  Therefore OK  
To be conservative bending stresses were added not SRSS



16362-1-2 - VA - 70 MPH - MP-3 Std. Loads-Type C-70'/60' Arms  
Weld Analysis

Page S4

**INPUTS**

	<b>Gp II</b>	<b>GpIII</b>		<b>Arm Dimensions</b>		
<b>Applied Loads To Flange Connection</b>						
Vert. Shr	2748	4188	lbs	Diameter (d)	17.5	in
Horz. Shr	3869	2515	lbs	Tube Wall Thk	0.25	in
Torsion Moment	14192	9224	ft-lbs	Plate Thk (D)	2.25	in
Gravity Moment	85096	136462	ft-lbs	Plate Yield (Fy)	50	ksi
Wind Moment	137190	86259	ft-lbs			
<b>Applied Loads To Base Plate Connection</b>				<b>Shaft Dimensions</b>		
Axial	0	0	lbs	Diameter (d)	19.0	in
Shear	0	0	lbs	Tube Wall Thk	<b>0.3125</b>	in
Shear	0	0	lbs	Plate Thk (D)	2	in
Bending Moment	0	0	ft-lbs	Plate Yield (Fy)	36	ksi
Bending Moment	0	0	ft-lbs	Arm Attach. Elev.	<b>18.0</b>	ft
Torsion Moment	0	0	ft-lbs			

Additional Load Factor To Apply As Per Signal Plans & Specifications = 1.00

**Electrodes**

**AASHTO Gp II & III Factor = 1.33**

**E70 Electrodes (Used with plates having Fy = 36 ksi)**

$F_v = 0.27 F_u$  (AASHTO Bridge Spec 10.32.2)

$F_v = 0.27 \times 58000 = 15660$  psi

Allowable =  $F_v \times \text{Gp Factor} = 20828$  psi

**E70 Electrodes (Used with plates having Fy = 50 ksi)**

$F_v = 0.27 \times 65000 = 17550$  psi

Allowable =  $F_v \times \text{Gp Factor} = 23342$  psi

Reference: *Design of Welded Structures*, Omer W. Blodgett

Method: Weld As A Line

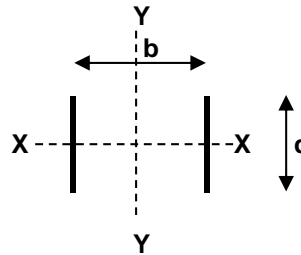


16362-1-2 - VA - 70 MPH - MP-3 Std. Loads-Type C-70'/60' Arms  
 Weld Analysis - Continued

**ARM CONNECTING PLATES**

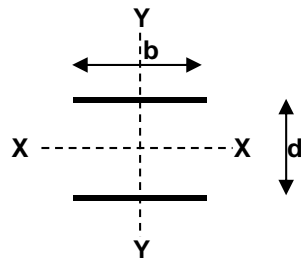
**Side Plates**

Vertical Length (d)	26.50	in
Horz. Dist Between Plates (b)	16.48	in
Thickness	<b>0.5</b>	in
Weld Size	<b>0.313</b>	in
Weld Throat (t <sub>1</sub> )	0.221	in
$A_1 = A_{w1} * t_1 = 2 * d * t_1$	=	11.73 in <sup>2</sup>
$S_{x1} = S_{wx1} * t_1 = (d^2 / 3) * t_1$	=	51.80 in <sup>3</sup>
$S_{y1} = S_{wy1} * t_1 = b * d * t_1$	=	96.64 in <sup>3</sup>
$J_1 = J_{w1} * t_1 = t_1 * d(3b^2 + d^2) / 6$	=	1482.70 in <sup>4</sup>



**Top & Bottom Plates**

Vert. Dist Between Plates (d)	26.50	in
Horz. Length (b)	25.89	in
Thickness	<b>0.5</b>	in
Weld Size	<b>0.313</b>	in
Weld Throat (t <sub>2</sub> )	0.221	in
$A_2 = A_{w2} * t_2 = t_2 * 2 * b$	=	11.5 in <sup>2</sup>
$S_{x2} = S_{wx2} * t_2 = t_2 * b * d$	=	151.8 in <sup>3</sup>
$S_{y2} = S_{wy2} * t_2 = t_2 * (b^2 / 3)$	=	49.4 in <sup>3</sup>
$J_2 = J_{w2} * t_2 = t_2 * (b^3 + 3bd^2) / 6$	=	2651.2 in <sup>4</sup>



**Combined Analysis**

$\sigma_1 = \text{Gravity Mom} / (S_{x1} + S_{x2})$	=	5016.0	Gp II	8043.0	psi
$\sigma_2 = \text{Wind Mom} / (S_{y1} + S_{y2})$	=	11271.0	Gp III	7087.0	psi
$\sigma_2 = [\text{Tor. Mom} * C / (J_1 + J_2)] + [\text{Res. Shr} / (A_1 + A_2)]$	=	848.0		629.0	psi
Res. Weld Stress = $\sigma_r = \text{Sqrt}[(\sigma_1 + \sigma_2)^2 + \sigma_3^2]$	=	16310		15144	psi
Allowable: E70 Electrodes * AASHTO Gp Factor	=	23341.5		23341.5	psi
<b>Actual Weld Stress vs. Allowable</b>		<b>Passes</b>		<b>Passes</b>	



16362-1-4 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/60' Arms

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	4553 lbs
Bending Moment	220352 ft-lbs
Torsion Moment	172464 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.00 in

**ANALYSIS - ANCHOR BOLTS**

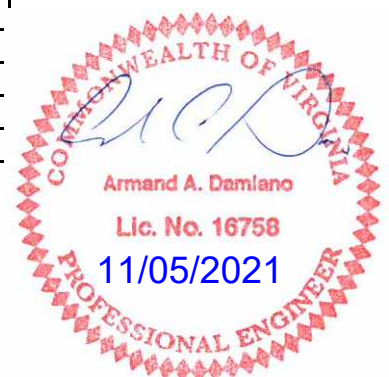
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	20.293 ksi
Bolt Direct Shear Stress	0.248 ksi
Bolt Torsion Shear Stress	8.653 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	20.293 ksi
$f_v =$	8.901 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.69 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.5 in
Design Moment	178 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	26.89 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.938 in
Design Moment	99 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	15.69 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-4 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/60' Arms

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	28736 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	2.65 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.38
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

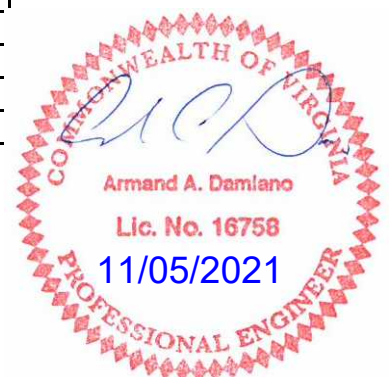
Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	50733 lbs
Computed Factor-of Safety	1.22 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	50733 lbs
Total Tensile Load	405864 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	1.16 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	50733 lbs
Total Tensile Load	405864 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	<b>9</b> Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-5 - VA - 70 MPH - MP-3 Std. Loads - Type D - 49' Arm w/24' Lum.

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<b>Fatigue Importance Factors</b>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.00
Fatigue Cat.	0		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.00
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.00
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	1		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.2500	0.14	15.00	25.00	-	-	-	0	55	29000	-
Traffic Arm #1	0.1793	0.14	13.00	49.00	18.00	-	2.57	0	55	29000	180
Traffic Arm #2					-	-		0	55	29000	90
Lum Arm #1	0.2760		2.88	24.00	24.00	-	5	0	36	29000	180
Lum Arm #2					-	-		0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	6	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	Double Top Nuts	Yes	
A.B. Bolt Circle	24.00	Foundation Diameter	48	in
Baseplate Dia.	30.00	Concrete Cover	4	in
Baseplate Thk.	2.00	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	10.50	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.	Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50	in
Flange Plate Length (V)	24.00	in
Flange Plate Width (H)	24.00	in
Spac. Between Bolt (V)	19.50	in
Spac. Between Bolt (H)	19.50	in
Flange Plate Thk.	2.00	in
Flange Plate Yield (Fy)	50	ksi
Gusset Thk.	0.375	in
Plate Center Hole	5.00	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.27	0.39	0.49								19.43	0.00
GP II CSR	0.77	0.78	0.90				0.78					
GP III CSR	0.59	0.67	0.79				0.63				34.09	

Arm #1 Flange Bolt (Max.) CSR	0.28
Arm #1 Flange Bolt Fatigue CSR	0.00
Arm #1 Flange Plate (Max.) CSR	0.46
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.00
Handhole at Toe (Fatigue) CSR	0.00
Minimum Qty of Vertical Reinf. Bars	4

Fatigue Allowable - Shaft to Baseplate	
Fatigue Allowable - Arm#1 to Flange	
Fatigue Allowable - Arm#2 to Flange	
Anchor Bolt Max. CSR	0.43
Anchor Bolt Max. Fatigue Stress Ratio	0.00
Base Plate Max. CSR	0.52
Anchorage Capacity S.F.	2.05
Concrete Pull Out Capacity S.F.	2.35

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
4316	4049	93432	74600





16362-1-5 - VA - 70 MPH - MP-3 Std. Loads - Type D - 49' Arm w/24' Lum.

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.2
	#2	Ped Head	10.5	2.4	1			1	6	30	1.2
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.2
	#4										
Lum #1	#1	Cobra Head w/Camera	24	2	1			4.54	9	57	1
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	12'x2.5' Sign	7.5			12	2.5	1	30	66	1.20
	#3	5 Section Head w/BP	16	13.75	4			2	42	105	1.20
	#4		2.5'x3' Sign	23			2.5	3	1	7.5	22.5
	#5	Camera	24	1	1			1	3	22	1.20
	#6	3 Section Head w/BP	26	8.7	4			1	26	65	1.20
	#7	2.5'x3' Sign	34			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	37	8.7	4			1	26	65	1.20
	#9	Camera	39	1	1			1	3	22	1.20
	#10	3'x3.5' Sign	45			3	3.5	1	10.5	26.7	1.13
	#11	4 Section Head w/BP	48	11	5			1	34	80	1.20
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
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	#18										
	#19										
	#20										



16362-1-5 - VA - 70 MPH - MP-3 Std. Loads - Type D - 49' Arm w/24' Lum.

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	15.000	14.852	41.53	0.5285	0.53	1.317	12.91	0.80
2	I	1.06	1.06	14.852	14.704	41.11	0.5285	1.59	1.304	12.79	0.80
3	I	1.06	2.12	14.704	14.555	40.69	0.5285	2.65	1.291	12.66	0.80
4	I	1.06	3.18	14.555	14.407	40.27	0.5285	3.70	1.278	12.54	0.80
5	I	1.06	4.24	14.407	14.259	39.85	0.5285	4.76	1.265	12.42	0.80
6	I	1.06	5.29	14.259	14.111	39.43	0.5285	5.82	1.252	12.29	0.80
7	I	1.06	6.35	14.111	13.962	39.01	0.5285	6.88	1.239	12.17	0.80
8	I	1.06	7.41	13.962	13.814	38.59	0.5285	7.94	1.225	12.05	0.80
9	I	1.06	8.47	13.814	13.666	38.17	0.5285	9.00	1.212	11.92	0.80
10	I	1.06	9.53	13.666	13.518	37.75	0.5284	10.06	1.199	11.80	0.80
11	I	1.06	10.59	13.518	13.369	37.33	0.5284	11.12	1.186	11.68	0.80
12	I	1.06	11.65	13.369	13.221	36.91	0.5284	12.18	1.173	11.56	0.80
13	I	1.06	12.71	13.221	13.073	36.49	0.5284	13.23	1.160	11.43	1.00
14	I	1.06	13.76	13.073	12.925	36.08	0.5284	14.29	1.147	11.31	1.00
15	I	1.06	14.82	12.925	12.776	35.66	0.5284	15.35	1.134	11.19	1.00
16	I	1.06	15.88	12.776	12.628	35.24	0.5284	16.41	1.121	11.06	1.00
17	I	1.06	16.94	12.628	12.480	34.82	0.5284	17.47	1.108	10.94	1.00
18	J	3.00	18.00	12.480	12.060	96.37	1.4914	19.49	3.068	30.32	1.00
19	I	3.00	21.00	12.060	11.640	93.00	1.4911	22.49	2.963	29.33	1.00
20	J	1.00	24.00	11.640	11.500	30.25	0.4990	24.50	0.964	9.56	1.00
						869					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in^4)	314.89	179.50	0.00	139.71
Section Modulus (in^3)	42.70	29.35	0.00	
Cross-Section Area (in^2)	11.58	9.60	0.00	
Width-Thickness Ratio	60.00	49.92	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	7.946	7.946	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

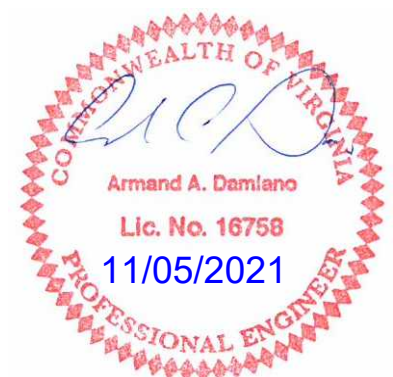
Shaft Deflection From Arm#1 GP I Load (in)	1.222
Shaft Deflection From Arm#2 GP I Load (in)	0.000



16362-1-5 - VA - 70 MPH - MP-3 Std. Loads - Type D - 49' Arm w/24' Lum.

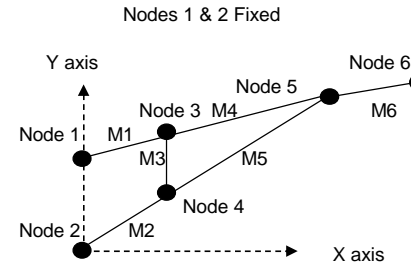
## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	10.06	0.000	16.46	1.100	0.000	0.00
2	0.450	7.64	9.96	0.000	16.30	1.100	0.000	0.00
3	0.450	7.64	9.86	0.000	16.14	1.100	0.000	0.00
4	0.450	7.64	9.76	0.000	15.97	1.100	0.000	0.00
5	0.450	7.64	9.66	0.001	15.81	1.100	0.000	0.00
6	0.450	7.64	9.56	0.001	15.64	1.100	0.000	0.00
7	0.450	7.64	9.46	0.001	15.48	1.100	0.000	0.00
8	0.450	7.64	9.36	0.001	15.32	1.100	0.000	0.00
9	0.450	7.64	9.26	0.002	15.15	1.100	0.000	0.00
10	0.450	7.64	9.16	0.002	14.99	1.100	0.000	0.00
11	0.450	7.64	9.06	0.003	14.83	1.100	0.000	0.00
12	0.450	7.64	8.96	0.003	14.66	1.100	0.000	0.00
13	0.450	9.54	11.07	0.004	14.50	1.100	0.000	0.00
14	0.450	9.54	10.94	0.005	14.34	1.100	0.000	0.00
15	0.450	9.54	10.82	0.006	14.17	1.100	0.000	0.00
16	0.450	9.54	10.69	0.006	14.01	1.100	0.000	0.00
17	0.450	9.54	10.57	0.007	13.85	1.100	0.000	0.00
18	0.450	9.54	29.26	0.023	38.34	1.100	0.000	0.00
19	0.450	9.54	28.26	0.029	37.03	1.100	0.000	0.00
20	0.450	9.54	9.20	0.011	12.05	1.100	0.000	0.00
Fix. #1	1.200	20.36	48.86	0.012	30.00	1.200	0.000	0.00
Fix. #2	1.200	20.36	48.86	0.012	30.00	1.200	0.000	0.00
Fix. #3	1.200	25.44	349.80	0.172	174.90	1.200	0.000	0.00
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-5 - VA - 70 MPH - MP-3 Std. Loads - Type D - 49' Arm w/24' Lum. - Luminaire Arm - Group II

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-33.67	-24.6	0	0	0
Node #2	0	0	0	0	-35.63	-26	0	0	0
Node #3	100	59.5	0	0	-66.63	-51.3	0	0	0
Node #4	100	48.8	0	0	-69.41	-53.4	0	0	0
Node #5	200	79	0	0	-94.35	-75.6	0	0	0
Node #6	288	87	0	0	-85.29	-69.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-67.33	1.1	1	-49.04	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-71.25	1.1	1	-51.90	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-0.68	1.1	1	-1.18	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-65.23	1.1	1.1	-52.27	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-66.89	1.1	1.1	-53.59	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-56.58	1.1	1.1	-45.33	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-57.00	1	1.1	-46.64					

AASHTO Gp	2
Mntg Hght =	29.00
Datum =	1

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2180.2	lbs
P1y	-694.6	lbs
P1z	178.8	lbs
M1x	6661.9	in-lbs
M1y	-25162.7	in-lbs
M1z	-898.1	in-lbs
P2x	2180.2	lbs
P2y	1079.6	lbs
P2z	121.5	lbs
M2x	6843.3	in-lbs
M2y	-20414.5	in-lbs
M2z	-928.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1018	138	19343	-491	0.55
#2	1071	87	15894	-954	0.78
#3	1489	431	8552	-392	0.35
#4	-1001	64	7424	-23	0.2
#5	1020	75	8261	-288	0.5
#6	4	98	7210	1	0.22

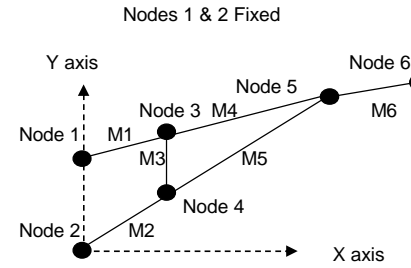
Arm Tip Displacement At Node 6	
X dir	0.103 (in)
Y dir	-0.898 (in)
Z dir	-10.462 (in)

V09.19.15



16362-1-5 - VA - 70 MPH - MP-3 Std. Loads - Type D - 49' Arm w/24' Lum. - Luminaire Arm - Group III

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-40.85	-13.2	0	0	0
Node #2	0	0	0	0	-43.23	-14	0	0	0
Node #3	100	59.5	0	0	-81.04	-26.6	0	0	0
Node #4	100	48.8	0	0	-84.42	-27.7	0	0	0
Node #5	200	79	0	0	-114.49	-37.8	0	0	0
Node #6	288	87	0	0	-115.33	-36.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-81.69	1.1	1	-26.29	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-86.45	1.1	1	-27.82	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-1.22	1.1	1	-0.63	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-79.16	1.1	1.1	-26.13	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-81.16	1.1	1.1	-26.80	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-68.65	1.1	1.1	-22.67	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-81.00	1	1.1	-25.00					

AASHTO Gp	3
Mntg Hght =	29.00
Datum =	1

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2797.7	lbs
P1y	-898.7	lbs
P1z	92.5	lbs
M1x	3425.6	in-lbs
M1y	-12957.4	in-lbs
M1z	-1426.8	in-lbs
P2x	2797.7	lbs
P2y	1378.1	lbs
P2z	63.2	lbs
M2x	3519.9	in-lbs
M2y	-10515.8	in-lbs
M2z	-1452.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1307	75	10010	-255	0.26
#2	1373	50	8249	-493	0.63
#3	1905	442	8972	-201	0.38
#4	-1287	45	3944	-13	0.08
#5	1311	48	4359	-150	0.46
#6	5	107	7919	1	0.24

Arm Tip Displacement At Node 6	
X dir	0.137 (in)
Y dir	-1.214 (in)
Z dir	-5.396 (in)

V09.19.15



16362-1-5 - VA - 70 MPH - MP-3 Std. Loads - Type D - 49' Arm w/24' Lum.

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	2.45	0.00	13.000	12.657	59.4	1.2195	1.22	2.619	2.619	25.84
2	I	2.45	2.45	12.657	12.314	57.8	1.2194	3.67	2.549	2.549	25.18
3	I	2.45	4.90	12.314	11.971	56.2	1.2192	6.12	2.479	2.479	24.52
4	I	2.45	7.35	11.971	11.628	54.6	1.2191	8.57	2.409	2.409	23.86
5	I	2.45	9.80	11.628	11.285	53.0	1.2189	11.02	2.339	2.339	23.20
6	I	2.45	12.25	11.285	10.942	51.3	1.2187	13.47	2.269	2.269	22.54
7	I	2.45	14.70	10.942	10.599	49.7	1.2185	15.92	2.199	2.199	21.88
8	I	2.45	17.15	10.599	10.256	48.1	1.2183	18.37	2.129	2.129	21.22
9	I	2.45	19.60	10.256	9.913	46.5	1.2181	20.82	2.059	2.059	20.56
10	I	2.45	22.05	9.913	9.570	44.9	1.2178	23.27	1.989	1.989	19.90
11	I	2.45	24.50	9.570	9.227	43.3	1.2175	25.72	1.919	1.919	19.24
12	I	2.45	26.95	9.227	8.884	41.7	1.2173	28.17	1.849	1.849	18.58
13	I	2.45	29.40	8.884	8.541	40.1	1.2170	30.62	1.779	1.779	17.92
14	I	2.45	31.85	8.541	8.198	38.5	1.2166	33.07	1.709	1.709	17.26
15	I	2.45	34.30	8.198	7.855	36.9	1.2163	35.52	1.639	1.639	16.60
16	I	2.45	36.75	7.855	7.512	35.2	1.2159	37.97	1.569	1.569	15.94
17	I	2.45	39.20	7.512	7.169	33.6	1.2155	40.42	1.499	1.499	15.28
18	I	2.45	41.65	7.169	6.826	32.0	1.2150	42.86	1.429	1.429	14.62
19	I	2.45	44.10	6.826	6.483	30.4	1.2145	45.31	1.359	1.359	13.96
20	I	2.45	46.55	6.483	6.140	28.8	1.2139	47.76	1.289	1.289	13.30
		<u>49.00</u>				<u>882</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	66	7.50	30.000	1.000	90.00
Fix. #3	105	16.00	13.750	2.000	126.00
Fix. #4	22.5	23.00	7.500	1.000	22.50
Fix. #5	22	24.00	1.000	1.000	9.00
Fix. #6	65	26.00	8.700	1.000	78.00
Fix. #7	22.5	34.00	7.500	1.000	22.50
Fix. #8	65	37.00	8.700	1.000	78.00
Fix. #9	22	39.00	1.000	1.000	9.00
Fix. #10	26.7	45.00	10.500	1.000	31.50
Fix. #11	80	48.00	11.000	1.000	102.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	23.135	0.000
Cross-Section Area (in^2)	7.218	0.000
Width-Thickness Ratio	72.50	0.00
Compact Limit	68.55	0.00
Non-Compact Limit	137.09	0.00
Maximum Limit	237.27	0.00
Allow. Bending Stress (ksi)	35.489	0.000
Allow. Shear Stress (ksi)	18.150	0.000



16362-1-5 - VA - 70 MPH - MP-3 Std. Loads - Type D - 49' Arm w/24' Lum.

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	
1	1.00	0.450	9.54	24.99	32.74	1.100	0.000	0.00	0	0.710	0.00	0.00	0.00
2	1.00	0.450	9.54	24.32	31.86	1.100	0.000	0.00	0	0.736	0.00	0.00	0.00
3	1.00	0.450	9.54	23.65	30.99	1.100	0.000	0.00	0	0.763	0.00	0.00	0.00
4	1.00	0.450	9.54	22.98	30.11	1.100	0.000	0.00	0	0.792	0.00	0.00	0.00
5	1.00	0.450	9.54	22.31	29.24	1.100	0.000	0.00	0	0.823	0.00	0.00	0.00
6	1.00	0.450	9.54	21.65	28.36	1.100	0.000	0.00	0	0.856	0.00	0.00	0.00
7	1.00	0.460	9.75	21.44	27.49	1.100	0.000	0.00	0	0.891	0.00	0.00	0.00
8	1.00	0.479	10.17	21.65	26.61	1.100	0.000	0.00	0	0.930	0.00	0.00	0.00
9	1.00	0.501	10.62	21.87	25.74	1.100	0.000	0.00	0	0.971	0.00	0.00	0.00
10	1.00	0.524	11.11	22.10	24.86	1.100	0.000	0.00	0	1.016	0.00	0.00	0.00
11	1.00	0.549	11.64	22.34	23.99	1.100	0.000	0.00	0	1.064	0.00	0.00	0.00
12	1.00	0.576	12.21	22.57	23.11	1.100	0.000	0.00	0	1.100	0.00	0.00	0.00
13	1.00	0.606	12.84	22.84	22.24	1.100	0.000	0.00	0	1.100	0.00	0.00	0.00
14	1.00	0.638	13.53	23.12	21.36	1.100	0.000	0.00	0	1.100	0.00	0.00	0.00
15	1.00	0.674	14.29	23.42	20.48	1.100	0.000	0.00	1	1.100	0.00	0.00	0.00
16	1.00	0.713	15.12	23.72	19.61	1.100	0.000	0.00	1	1.100	0.00	0.00	0.00
17	1.00	0.757	16.04	24.04	18.73	1.100	0.000	0.00	1	1.100	0.00	0.00	0.00
18	1.00	0.805	17.07	24.39	17.86	1.100	0.000	0.00	1	1.100	0.00	0.00	0.00
19	1.00	0.860	18.23	24.77	16.98	1.100	0.000	0.00	1	1.100	0.00	0.00	0.00
20	1.00	0.921	19.52	25.15	16.11	1.100	0.000	0.00	1	1.100	0.00	0.00	0.00

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.199	25.43	762.90	381.45	1.199	0.000	0.00	0	1.199	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	0.000	0.00	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	221.33	110.66	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	0.000	0.00	1	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.132	24.00	252.00	131.25	1.132	0.000	0.00	1	1.132	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	279.84	139.92	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00





16362-1-5 - VA - 70 MPH - MP-3 Std. Loads - Type D - 49' Arm w/24' Lum.

Flange Analysis - Arm #1

V06-21-16

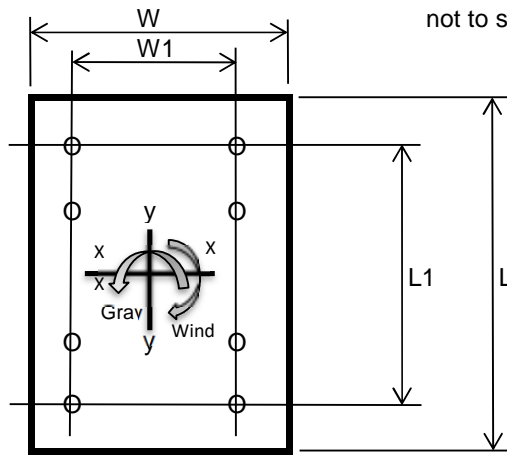
Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	1401	2370	-	lbs
Shear (Wind)	2988	1763	-	lbs
Torsion (Arm Rise)	7671	4527	-	ft-lbs
Moment (Gravity)	33046	57360	-	ft-lbs
Moment (Wind)	73474	41987	-	ft-lbs
Nat. Wind Moment	-	-	-	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs

Diameter of tube	13.00	in
Tube Wall Thick.	0.1793	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.00
W	24
W1	19.50
L	24
L1	19.50
L2 - Dist. between bolts (Typ.)	6.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	596.99	596.99	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1073.57	1073.57	in <sup>4</sup>
Bolt Tensile Stress - ft	10.30	12.14	ksi
Bolt Shear Stress - fv	1.14	0.78	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.24	0.28	CSR
Therefore	OK	OK	
Natural Wind Bolt Tensile Stress	0	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0	OK	

Plate Analysis

Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	8.12	14.09	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	18.37	10.50	ksi
Combined applied stress for interaction (SRSS)	20.08	17.57	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	OK	OK	



16362-1-5 - VA - 70 MPH - MP-3 Std. Loads - Type D - 49' Arm w/24' Lum.

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	1401		1401	33046		33046		389	17141		0.49
Gp II	1401	2988	3300	33046	73474	80564	7671	915	41788	1990	0.90
Gp III	2370	1763	2954	57360	41987	71086	4527	819	36872	1175	0.79
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-5 - VA - 70 MPH - MP-3 Std. Loads - Type D - 49' Arm w/24' Lum.

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	2819		33046	0	33046		243		9288		0.27
Gp II	2819	4049	45335	81696	93432	74600	243	700	26259	10483	0.77
Gp III	4316	2548	36261	77682	85728	42566	373	441	24094	5982	0.59
Gp IV Natural			0	0	0				0		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9952										

<b>Shaft At Arm</b>											
Gp I	2005		33046	0	33046		209		13509		0.39
Gp II	2005	3355	7671	38876	39626	74600	209	699	16199	15248	0.78
Gp III	3069	2006	4527	60552	60721	42566	320	418	24823	8701	0.67
Gp IV Natural			0	0	0				0		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9952										



16362-1-5 - VA - 70 MPH - MP-3 Std. Loads - Type D - 49' Arm w/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	4049 lbs
Bending Moment	93432 ft-lbs
Torsion Moment	74600 ft-lbs
Num. Anchor Bolts	6
Bolt Circle	24 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	30 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	15.00 in

**ANALYSIS - ANCHOR BOLTS**

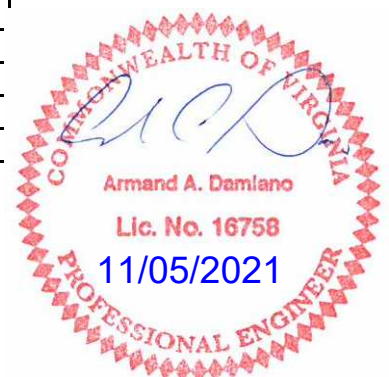
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1082.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	12.00 in
Bolt Tensile Stress	12.424 ksi
Bolt Direct Shear Stress	0.294 ksi
Bolt Torsion Shear Stress	5.406 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	12.424 ksi
$f_v =$	5.7 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.43 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	12.701 in
Dist. Shaft Face To Bolt Center	4.5 in
Design Moment	140 in-kip
Section Modulus of Failure Plane	8.46 in <sup>3</sup>
Applied Plate Stress	16.55 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	12.052 in
Dist From Shaft To Nut Face	2.938 in
Design Moment	92 in-kip
Section Modulus of Failure Plane	8.03 in <sup>3</sup>
Applied Plate Stress	11.46 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-5 - VA - 70 MPH - MP-3 Std. Loads - Type D - 49' Arm w/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	0 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1082.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	12.00 in
Bolt Tensile Stress	0 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

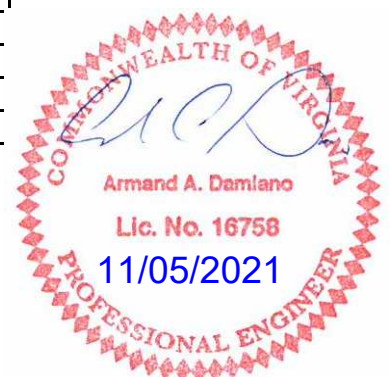
Anchor Bolt Length	60.0 in
Anchor Bolt Max. Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	127540 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	11 in
T Reduced For Group Action	63770 lbs
Maximum Applied Tensile Load	31060 lbs
Computed Factor-of Safety	2.05 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	31060 lbs
Total Tensile Load	186360 lbs
Concrete Failure Surface Area	4002.39 in <sup>2</sup>
Concrete Shear Strength	438440 psi
Computed Factor-of Safety	2.35 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	31060 lbs
Total Tensile Load	186360 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	45.36 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	4 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum.

11/04/21

**General**

Wind Vel. - mph	70	No	Roadway - mph	55	<i>Fatigue Importance Factors</i>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	1		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.50	25.00	-	-	-	0	55	29000	-
Traffic Arm #1	0.2500	0.14	18.00	28.00	18.00	-	3.93	0	55	29000	180
	0.1880	0.14	14.87	49.93	-	2.93		0	55	29000	
Traffic Arm #2								0	55	29000	90
								0	55	29000	
Lum Arm #1	0.2760	0.14	2.88	24.00	24.00	-	5	0	36	29000	180
Lum Arm #2								0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8		Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	in	Double Top Nuts	Yes	
A.B. Bolt Circle	26.00	in	Foundation Diameter	48	in
Baseplate Dia.	32.00	in	Concrete Cover	4	in
Baseplate Thk.	2.00	in	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	14.25	in	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.		Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50 in	in
Flange Plate Length (V)	27.00 in	in
Flange Plate Width (H)	27.00 in	in
Spac. Between Bolt (V)	22.50 in	in
Spac. Between Bolt (H)	22.50 in	in
Flange Plate Thk.	2.25 in	in
Flange Plate Yield (Fy)	50 ksi	ksi
Gusset Thk.	0.500 in	in
Plate Center Hole	6.00 in	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.37	0.49	0.54	0.43							35.42	0.00
GP II CSR	0.66	0.72	0.75	0.66			0.78					
GP III CSR	0.62	0.73	0.76	0.65			0.63				57.85	
Nat.Wind (psi)	3437	738	6999	6008								

Arm #1 Flange Bolt (Max.) CSR	0.64
Arm #1 Flange Bolt Fatigue CSR	0.49
Arm #1 Flange Plate (Max.) CSR	0.67
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.80
Handhole at Toe (Fatigue) CSR	0.51
Minimum Qty of Vertical Reinf. Bars	8

Fatigue Allowable - Shaft to Baseplate	4.5 ksi
Fatigue Allowable - Arm#1 to Flange	7 ksi
Fatigue Allowable - Arm#2 to Flange	-
Anchor Bolt Max. CSR	0.60
Anchor Bolt Max. Fatigue Stress Ratio	0.35
Base Plate Max. CSR	0.69
Anchorage Capacity S.F.	1.41
Concrete Pull Out Capacity S.F.	1.34

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
7201	5321	191222	150711



16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum.

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1	Cobra Head w/Camera	24	2	1			4.54	9	57	1.00
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	15'x2.5' Sign	9			15	2.5	1	37.5	88.5	1.21
	#3	5 Section Head w/BP	19	13.75	4			2	42	105	1.20
	#4	2.5'x3' Sign	23			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	30	8.7	4			1	26	65	1.20
	#6	3 Section Head w/BP	41	8.7	4			1	26	65	1.20
	#7	Camera	45	1	1			1	3	22	1.20
	#8	2.5'x3' Sign	49			2.5	3	1	7.5	22.5	1.13
	#9	3 Section Head w/BP	52	8.7	4			1	26	65	1.20
	#10	2.5'x3' Sign	60			2.5	3	1	7.5	22.5	1.13
	#11	3 Section Head w/BP	63	8.7	4			1	26	65	1.20
	#12	Camera	67	1	1			1	3	22	1.20
	#13	3'x3.5' Sign	71			3	3.5	1	10.5	26.7	1.13
	#14	4 Section Head w/BP	74	11	5			1	34	80	1.20
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
	#8										
	#9										
	#10										
	#11										
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										





16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum.

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.500	19.352	67.61	0.5287	0.53	1.714	16.65	0.80
2	I	1.06	1.06	19.352	19.204	67.08	0.5287	1.59	1.701	16.53	0.80
3	I	1.06	2.12	19.204	19.055	66.56	0.5287	2.65	1.688	16.41	0.80
4	I	1.06	3.18	19.055	18.907	66.03	0.5287	3.71	1.675	16.28	0.80
5	I	1.06	4.24	18.907	18.759	65.51	0.5287	4.76	1.662	16.16	0.80
6	I	1.06	5.29	18.759	18.611	64.99	0.5287	5.82	1.649	16.04	0.80
7	I	1.06	6.35	18.611	18.462	64.46	0.5287	6.88	1.636	15.91	0.80
8	I	1.06	7.41	18.462	18.314	63.94	0.5287	7.94	1.622	15.79	0.80
9	I	1.06	8.47	18.314	18.166	63.41	0.5287	9.00	1.609	15.67	0.80
10	I	1.06	9.53	18.166	18.018	62.89	0.5287	10.06	1.596	15.54	0.80
11	I	1.06	10.59	18.018	17.869	62.36	0.5287	11.12	1.583	15.42	0.80
12	I	1.06	11.65	17.869	17.721	61.84	0.5287	12.18	1.570	15.30	0.80
13	I	1.06	12.71	17.721	17.573	61.31	0.5287	13.23	1.557	15.17	1.00
14	I	1.06	13.76	17.573	17.425	60.79	0.5287	14.29	1.544	15.05	1.00
15	I	1.06	14.82	17.425	17.276	60.27	0.5287	15.35	1.531	14.93	1.00
16	I	1.06	15.88	17.276	17.128	59.74	0.5287	16.41	1.518	14.80	1.00
17	I	1.06	16.94	17.128	16.980	59.22	0.5286	17.47	1.505	14.68	1.00
18	J	3.00	18.00	16.980	16.560	164.94	1.4937	19.49	4.193	40.93	1.00
19	I	3.00	21.00	16.560	16.140	160.73	1.4936	22.49	4.088	39.94	1.00
20	J	1.00	24.00	16.140	16.000	52.64	0.4993	24.50	1.339	13.09	1.00
						1457					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in^4)	866.45	567.94	0.00	473.53
Section Modulus (in^3)	90.31	68.15	0.00	
Cross-Section Area (in^2)	18.83	16.35	0.00	
Width-Thickness Ratio	62.40	54.34	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	14.296	14.296	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

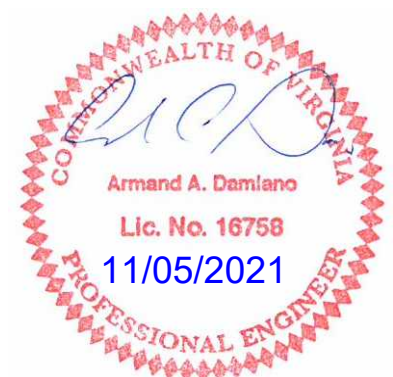
Shaft Deflection From Arm#1 GP I Load (in)	1.248
Shaft Deflection From Arm#2 GP I Load (in)	0.000



16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum.

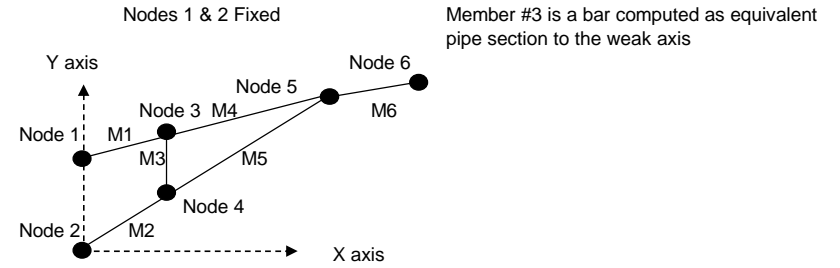
## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	13.10	0.000	21.43	1.100	4.576	7.84
2	0.450	7.64	13.00	0.000	21.26	1.100	4.576	7.78
3	0.450	7.64	12.90	0.000	21.10	1.100	4.576	7.72
4	0.450	7.64	12.80	0.000	20.94	1.100	4.576	7.66
5	0.450	7.64	12.70	0.000	20.77	1.100	4.576	7.60
6	0.450	7.64	12.60	0.000	20.61	1.100	4.576	7.54
7	0.450	7.64	12.50	0.000	20.44	1.100	4.576	7.48
8	0.450	7.64	12.40	0.001	20.28	1.100	4.576	7.42
9	0.450	7.64	12.30	0.001	20.12	1.100	4.576	7.36
10	0.450	7.64	12.20	0.001	19.95	1.100	4.576	7.30
11	0.450	7.64	12.10	0.001	19.79	1.100	4.576	7.24
12	0.450	7.64	12.00	0.001	19.63	1.100	4.576	7.19
13	0.450	9.54	14.85	0.002	19.46	1.100	4.576	7.13
14	0.450	9.54	14.73	0.002	19.30	1.100	4.576	7.07
15	0.450	9.54	14.61	0.003	19.14	1.100	4.576	7.01
16	0.450	9.54	14.48	0.003	18.97	1.100	4.576	6.95
17	0.450	9.54	14.36	0.003	18.81	1.100	4.576	6.89
18	0.450	9.54	40.00	0.011	52.41	1.100	4.576	19.18
19	0.450	9.54	38.99	0.014	51.09	1.100	4.576	18.70
20	0.450	9.54	12.78	0.005	16.74	1.100	4.576	6.13
Fix. #1	1.200	20.36	48.86	0.004	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.004	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.060	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum. - Luminaire Arm - Group II

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-33.67	-24.6	0	0	0
Node #2	0	0	0	0	-35.63	-26	0	0	0
Node #3	100	59.5	0	0	-66.63	-51.3	0	0	0
Node #4	100	48.8	0	0	-69.41	-53.4	0	0	0
Node #5	200	79	0	0	-94.35	-75.6	0	0	0
Node #6	288	87	0	0	-85.29	-69.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-67.33	1.1	1	-49.04	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-71.25	1.1	1	-51.90	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-0.68	1.1	1	-1.18	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-65.23	1.1	1.1	-52.27	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-66.89	1.1	1.1	-53.59	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-56.58	1.1	1.1	-45.33	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-57.00	1	1.1	-46.64					

AASHTO Gp	2
Mntg Hght =	29.00
Datum =	1

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2180.2	lbs
P1y	-694.6	lbs
P1z	178.8	lbs
M1x	6661.9	in-lbs
M1y	-25162.7	in-lbs
M1z	-898.1	in-lbs
P2x	2180.2	lbs
P2y	1079.6	lbs
P2z	121.5	lbs
M2x	6843.3	in-lbs
M2y	-20414.5	in-lbs
M2z	-928.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1018	138	19343	-491	0.55
#2	1071	87	15894	-954	0.78
#3	1489	431	8552	-392	0.35
#4	-1001	64	7424	-23	0.2
#5	1020	75	8261	-288	0.5
#6	4	98	7210	1	0.22

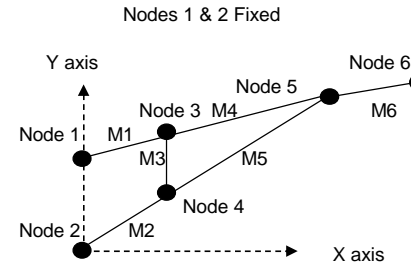
Arm Tip Displacement At Node 6	
X dir	0.103 (in)
Y dir	-0.898 (in)
Z dir	-10.462 (in)

V09.19.15



16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum. - Luminaire Arm - Group III

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-40.85	-13.2	0	0	0
Node #2	0	0	0	0	-43.23	-14	0	0	0
Node #3	100	59.5	0	0	-81.04	-26.6	0	0	0
Node #4	100	48.8	0	0	-84.42	-27.7	0	0	0
Node #5	200	79	0	0	-114.49	-37.8	0	0	0
Node #6	288	87	0	0	-115.33	-36.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-81.69	1.1	1	-26.29	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-86.45	1.1	1	-27.82	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-1.22	1.1	1	-0.63	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-79.16	1.1	1.1	-26.13	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-81.16	1.1	1.1	-26.80	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-68.65	1.1	1.1	-22.67	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-81.00	1	1.1	-25.00					

AASHTO Gp	3
Mntg Hght =	29.00
Datum =	1

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2797.7	lbs
P1y	-898.7	lbs
P1z	92.5	lbs
M1x	3425.6	in-lbs
M1y	-12957.4	in-lbs
M1z	-1426.8	in-lbs
P2x	2797.7	lbs
P2y	1378.1	lbs
P2z	63.2	lbs
M2x	3519.9	in-lbs
M2y	-10515.8	in-lbs
M2z	-1452.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1307	75	10010	-255	0.26
#2	1373	50	8249	-493	0.63
#3	1905	442	8972	-201	0.38
#4	-1287	45	3944	-13	0.08
#5	1311	48	4359	-150	0.46
#6	5	107	7919	1	0.24

Arm Tip Displacement At Node 6	
X dir	0.137 (in)
Y dir	-1.214 (in)
Z dir	-5.396 (in)

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16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum.

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	4.18	0.00	18.000	17.415	194.9	2.0777	2.08	6.166	6.166	60.08
2	I	4.18	4.18	17.415	16.830	188.4	2.0773	6.26	5.962	5.962	58.16
3	I	4.18	8.36	16.830	16.245	181.9	2.0769	10.43	5.758	5.758	56.24
4	I	4.18	12.54	16.245	15.660	175.3	2.0764	14.61	5.555	5.555	54.32
5	I	4.18	16.71	15.660	15.075	168.8	2.0759	18.79	5.351	5.351	52.40
6	I	4.18	20.89	15.075	14.490	162.3	2.0754	22.97	5.147	5.147	50.48
7	J	2.93	25.07	14.870	14.460	195.2	1.4582	26.53	3.581	3.581	35.13
8	O	3.62	28.00	14.460	13.954	101.9	1.7970	29.80	4.280	4.280	42.04
9	O	3.62	31.62	13.954	13.447	98.2	1.7966	33.41	4.128	4.128	40.61
10	O	3.62	35.23	13.447	12.941	94.5	1.7961	37.03	3.975	3.975	39.17
11	O	3.62	38.85	12.941	12.435	90.8	1.7957	40.64	3.823	3.823	37.73
12	O	3.62	42.46	12.435	11.929	87.1	1.7952	44.26	3.670	3.670	36.29
13	O	3.62	46.08	11.929	11.423	83.5	1.7946	47.87	3.518	3.518	34.86
14	O	3.62	49.69	11.423	10.917	79.8	1.7940	51.49	3.365	3.365	33.42
15	O	3.62	53.31	10.917	10.411	76.1	1.7934	55.10	3.213	3.213	31.98
16	O	3.62	56.92	10.411	9.904	72.4	1.7927	58.72	3.060	3.060	30.55
17	O	3.62	60.54	9.904	9.398	68.8	1.7919	62.33	2.908	2.908	29.11
18	O	3.62	64.15	9.398	8.892	65.1	1.7910	65.94	2.755	2.755	27.67
19	O	3.62	67.77	8.892	8.386	61.4	1.7900	69.56	2.603	2.603	26.23
20	O	3.62	71.38	8.386	7.880	57.7	1.7889	73.17	2.450	2.450	24.80
		<u>75.00</u>				<u>2304</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	9.00	37.500	1.000	112.50
Fix. #3	105	19.00	13.750	2.000	126.00
Fix. #4	22.5	23.00	7.500	1.000	22.50
Fix. #5	65	30.00	8.700	1.000	78.00
Fix. #6	65	41.00	8.700	1.000	78.00
Fix. #7	22	45.00	1.000	1.000	9.00
Fix. #8	22.5	49.00	7.500	1.000	22.50
Fix. #9	65	52.00	8.700	1.000	78.00
Fix. #10	22.5	60.00	7.500	1.000	22.50
Fix. #11	65	63.00	8.700	1.000	78.00
Fix. #12	22	67.00	1.000	1.000	9.00
Fix. #13	26.7	71.00	10.500	1.000	31.50
Fix. #14	80	74.00	11.000	1.000	102.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	61.831	31.813
Cross-Section Area (in^2)	13.934	8.667
Width-Thickness Ratio	72.00	79.10
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	35.588	34.319
Allow. Shear Stress (ksi)	18.150	16.903



16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum.

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000 Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	58.82	77.07	1.100	4.576	28.21	0	0.467	0.00	0.00	
2	1.00	0.450	9.54	56.88	74.52	1.100	4.576	27.28	0	0.488	0.00	0.00	
3	1.00	0.450	9.54	54.93	71.98	1.100	4.576	26.35	0	0.511	0.00	0.00	
4	1.00	0.450	9.54	52.99	69.43	1.100	4.576	25.42	0	0.535	0.00	0.00	
5	1.00	0.450	9.54	51.05	66.89	1.100	4.576	24.49	0	0.562	0.00	0.00	
6	1.00	0.450	9.54	49.10	64.34	1.100	4.576	23.55	0	0.591	0.00	0.00	
7	1.00	0.450	9.54	34.16	44.76	1.100	4.576	16.39	0	0.597	0.00	0.00	
8	1.00	0.450	9.54	40.83	53.50	1.100	4.576	19.59	0	0.622	0.00	0.00	
9	1.00	0.450	9.54	39.38	51.60	1.100	4.576	18.89	0	0.652	0.00	0.00	
10	1.00	0.450	9.54	37.92	49.69	1.100	4.576	18.19	0	0.685	0.00	0.00	
11	1.00	0.450	9.54	36.47	47.78	1.100	4.576	17.49	0	0.720	0.00	0.00	
12	1.00	0.450	9.54	35.01	45.88	1.100	4.576	16.80	0	0.760	0.00	0.00	
13	1.00	0.450	9.54	33.56	43.97	1.100	4.576	16.10	0	0.803	0.00	0.00	
14	1.00	0.450	9.54	32.10	42.07	1.100	4.576	15.40	0	0.850	0.00	0.00	
15	1.00	0.466	9.88	31.74	40.16	1.100	4.576	14.70	0	0.903	0.00	0.00	
16	1.00	0.496	10.52	32.19	38.25	1.100	4.576	14.00	0	0.962	0.00	0.00	
17	1.00	0.530	11.24	32.68	36.35	1.100	4.576	13.31	1	1.028	0.00	0.00	
18	1.00	0.569	12.06	33.23	34.44	1.100	4.576	12.61	1	1.100	0.00	0.00	
19	1.00	0.612	12.98	33.78	32.53	1.100	4.576	11.91	1	1.100	0.00	0.00	
20	1.00	0.662	14.04	34.40	30.63	1.100	4.576	11.21	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #8	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #13	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #14	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00





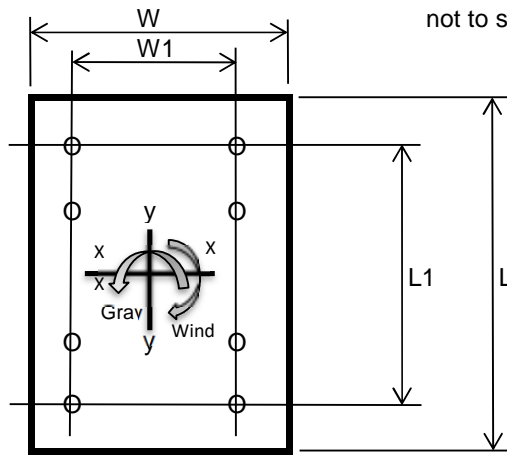
Flange Analysis - Arm #1

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	2998	4578	-	lbs
Shear (Wind)	4155	2703	-	lbs
Torsion (Arm Rise)	16328	10625	-	ft-lbs
Moment (Gravity)	97327	155408	-	ft-lbs
Moment (Wind)	149585	94960	-	ft-lbs
Nat. Wind Moment	-	-	36058	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	18.00	in
Tube Wall Thick.	0.25	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	21.76	27.90	ksi
Bolt Shear Stress - fv	2.03	1.51	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.51	0.64	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	3.41	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.49	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	15.55	24.83	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	24.31	15.44	ksi
Combined applied stress for interaction (SRSS)	28.86	29.24	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	





16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum.

Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.50	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.333333	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.730769	
Kf - Fatigue stress concentration factor for finite life	2.31	
Ki - Fatigue stress concentration factor for infinite life	5.05	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.25	in
Dt - Arm base diameter	18.00	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	1.77	
Dop - Baseplate center hole diameter	6	in
Cop - Center hole to arm diameter ratio	0.333333	
Kf - Fatigue stress concentration factor for finite life	1.75	
Ki - Fatigue stress concentration factor for infinite life	3.28	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle



16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum.

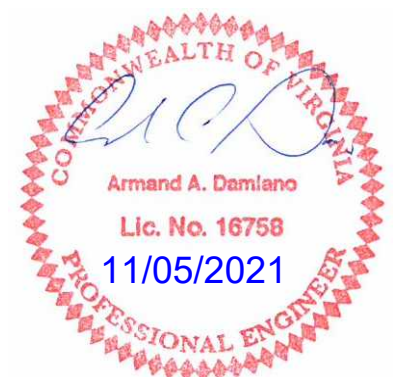
## Lower Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	19.07	in
Shaft Thickness	0.313	in
Total Area	23.571	in <sup>2</sup>
Ix	911	in <sup>4</sup>
Iy	1023	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	25868	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	12.78	ksi
CSR	0.80	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	3.60	ksi
CSR	0.51	
Therefore	<b>OK</b>	



16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum.

Upper Hand Hole Stresses

**INPUTS**

Handhole Width	3.00	in
Handhole Height	5.00	in
Distance From Base Plate To Hand Hole Center Line	216	in
Radial Orientation	0	Degrees
Rim Thickness	0.50	in
Rim Depth	3.50	in
Rim Projection	0.31	in
Shaft Diameter (At hand hole location)	16.98	in
Shaft Thickness	0.313	in
Total Area	18.6471	in^2
Ix	583	in^4
Iy	645	in^4
Controlling Moment - Galloping	4192	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	2.88	ksi
CSR	0.18	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	0.75	ksi
CSR	0.11	
Therefore	<b>OK</b>	



16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum.

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	2998		2998	97327		97327		431	18889		0.54
Gp II	2998	4155	5124	97327	149585	178461	16328	736	34636	1585	0.75
Gp III	4578	2703	5317	155408	94960	182124	10625	764	35347	1032	0.76
Gp IV Natural		1028	1028		36058	36058	4040	148	6999	393	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	1688		1688	38664		38665		390	14585		0.43
Gp II	1688	2316	2867	38664	68078	78292	9103	662	29533	1717	0.66
Gp III	2666	1518	3069	64252	41923	76719	5968	709	28940	1126	0.65
Gp IV Natural		575	575		15925	15925	2262	133	6008	427	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum.

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	5004		97327	0	97327		266		12932		0.37
Gp II	5004	5321	91109	136858	164411	150711	266	566	21845	10012	0.66
Gp III	7201	3627	59287	181799	191222	95539	382	386	25408	6347	0.62
Gp IV Natural			25868	0	25868				3437		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9969										

<b>Shaft At Arm</b>											
Gp I	3761		97327	0	97327		230		17138		0.49
Gp II	3761	4547	16328	103244	104527	150711	230	556	18406	13269	0.72
Gp III	5435	2979	10625	158715	159070	95539	332	365	28010	8411	0.73
Gp IV Natural			4192	0	4192				738		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9969										



16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	5321 lbs
Bending Moment	191222 ft-lbs
Torsion Moment	150711 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.50 in

**ANALYSIS - ANCHOR BOLTS**

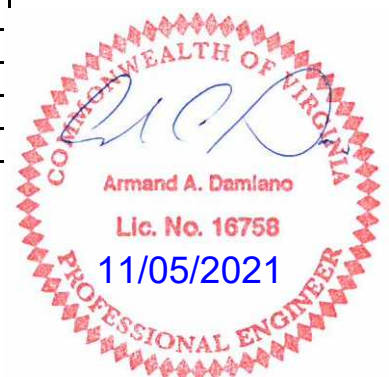
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	17.61 ksi
Bolt Direct Shear Stress	0.29 ksi
Bolt Torsion Shear Stress	7.561 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	17.61 ksi
$f_v =$	7.851 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.6 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.25 in
Design Moment	144 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	21.76 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.688 in
Design Moment	75 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	11.89 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-6 - VA - 70 MPH - MP-3 Std. Loads - Type E1 - 75' Arm w/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	25868 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	2.39 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.35
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

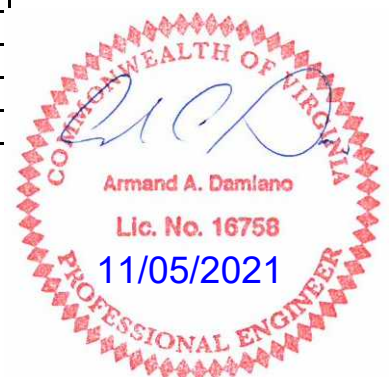
Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	44025 lbs
Computed Factor-of Safety	1.41 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	44025 lbs
Total Tensile Load	352200 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	1.34 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	44025 lbs
Total Tensile Load	352200 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	<b>8</b> Qty.





**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum.

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<b>Fatigue Importance Factors</b>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	1		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	20.50	25.00	-	-	-	0	55	29000	-
Traffic Arm #1	0.3125	0.14	19.00	30.00	18.00	-	3.93	0	55	29000	180
	0.1880	0.14	15.66	48.02	-	3.02		0	55	29000	
Traffic Arm #2								0	55	29000	90
								0	55	29000	
Lum Arm #1	0.2760		2.88	24.00	24.00	-	5	0	36	29000	180
Lum Arm #2						-		0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8		Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	in	Double Top Nuts	Yes	
A.B. Bolt Circle	26.00	in	Foundation Diameter	48	in
Baseplate Dia.	32.00	in	Concrete Cover	4	in
Baseplate Thk.	2.00	in	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	15.75	in	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.		Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50 in	in
Flange Plate Length (V)	29.50 in	in
Flange Plate Width (H)	29.50 in	in
Spac. Between Bolt (V)	25.00 in	in
Spac. Between Bolt (H)	25.00 in	in
Flange Plate Thk.	2.75 in	in
Flange Plate Yield (Fy)	50 ksi	ksi
Gusset Thk.	0.500 in	in
Plate Center Hole	6.00 in	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	<b>Shaft At</b>		<b>Arm#1</b>		<b>Arm#2</b>		<b>Lum#1</b>		<b>Lum#2</b>		<b>Tip Deflection (in)</b>	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.42	0.54	0.48	0.48							34.23	0.00
GP II CSR	0.77	0.92	0.71	0.89			0.78					
GP III CSR	0.71	0.86	0.69	0.79			0.63				57.64	
Nat.Wind (psi)	3183	673	6787	7794								

Arm #1 Flange Bolt (Max.) CSR	0.74
Arm #1 Flange Bolt Fatigue CSR	0.59
Arm #1 Flange Plate (Max.) CSR	0.56
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.75
Handhole at Toe (Fatigue) CSR	0.47
Minimum Qty of Vertical Reinf. Bars	10

Fatigue Allowable - Shaft to Baseplate	4.5 ksi
Fatigue Allowable - Arm#1 to Flange	7 ksi
Fatigue Allowable - Arm#2 to Flange	-
Anchor Bolt Max. CSR	0.77
Anchor Bolt Max. Fatigue Stress Ratio	0.35
Base Plate Max. CSR	0.71
Anchorage Capacity S.F.	1.15
Concrete Pull Out Capacity S.F.	1.09

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
8119	5355	234412	209148



16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum.

Input Loads

**Fixture Input Data**

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft.)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1	Cobra Head w/Camera	24	2	1			4.54	9	57	1.00
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	3 Section Head w/BP	20	8.7	4			1	26	65	1.20
	#3	3 Section Head w/BP	32	8.7	4			1	26	65	1.20
	#4	2.5'x3' Sign	41			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	44	8.7	4			1	26	65	1.20
	#6	2.5'x3' Sign	47			2.5	3	1	7.5	22.5	1.13
	#7	3 Section Head w/BP	50	8.7	4			1	26	65	1.20
	#8	2.5'x3' Sign	52			2.5	3	1	7.5	22.5	1.13
	#9	Camera	54	1	1			1	3	22	1.20
	#10	3 Section Head w/BP	56	8.7	4			1	26	65	1.20
	#11	2.5'x3' Sign	58			2.5	3	1	7.5	22.5	1.13
	#12	5 Section Head w/BP	62	13.75	4			2	42	105	1.20
	#13	3'x3.5' Sign	65			3	3.5	1	10.5	26.7	1.13
	#14	Camera	66	1	1			1	3	22	1.20
	#15	4 Section Head w/BP	68	11	5			1	34	80	1.20
	#16	3'x3.5' Sign	71			3	3.5	1	10.5	26.7	1.13
	#17	4 Section Head w/BP	74	11	5			1	34	80	1.20
	#18										
#19											
#20											
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
	#8										
	#9										
	#10										
	#11										
	#12										



16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum.

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	20.500	20.352	71.14	0.5288	0.53	1.802	17.48	0.80
2	I	1.06	1.06	20.352	20.204	70.62	0.5288	1.59	1.789	17.36	0.80
3	I	1.06	2.12	20.204	20.055	70.10	0.5288	2.65	1.776	17.24	0.80
4	I	1.06	3.18	20.055	19.907	69.57	0.5288	3.71	1.763	17.12	0.80
5	I	1.06	4.24	19.907	19.759	69.05	0.5288	4.76	1.750	16.99	0.80
6	I	1.06	5.29	19.759	19.611	68.52	0.5287	5.82	1.737	16.87	0.80
7	I	1.06	6.35	19.611	19.462	68.00	0.5287	6.88	1.724	16.75	0.80
8	I	1.06	7.41	19.462	19.314	67.47	0.5287	7.94	1.711	16.62	0.80
9	I	1.06	8.47	19.314	19.166	66.95	0.5287	9.00	1.698	16.50	0.80
10	I	1.06	9.53	19.166	19.018	66.42	0.5287	10.06	1.685	16.38	0.80
11	I	1.06	10.59	19.018	18.869	65.90	0.5287	11.12	1.671	16.25	0.80
12	I	1.06	11.65	18.869	18.721	65.38	0.5287	12.18	1.658	16.13	0.80
13	I	1.06	12.71	18.721	18.573	64.85	0.5287	13.23	1.645	16.01	1.00
14	I	1.06	13.76	18.573	18.425	64.33	0.5287	14.29	1.632	15.88	1.00
15	I	1.06	14.82	18.425	18.276	63.80	0.5287	15.35	1.619	15.76	1.00
16	I	1.06	15.88	18.276	18.128	63.28	0.5287	16.41	1.606	15.64	1.00
17	I	1.06	16.94	18.128	17.980	62.75	0.5287	17.47	1.593	15.51	1.00
18	J	3.00	18.00	17.980	17.560	174.96	1.4941	19.49	4.443	43.28	1.00
19	I	3.00	21.00	17.560	17.140	170.75	1.4939	22.49	4.338	42.29	1.00
20	J	1.00	24.00	17.140	17.000	55.98	0.4993	24.50	1.423	13.88	1.00
						1540					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in^4)	1009.11	676.42	0.00	569.99
Section Modulus (in^3)	99.97	76.57	0.00	
Cross-Section Area (in^2)	19.81	17.34	0.00	
Width-Thickness Ratio	65.60	57.54	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	15.824	15.824	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

Shaft Deflection From Arm#1 GP I Load (in)	1.341
Shaft Deflection From Arm#2 GP I Load (in)	0.000



16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum.

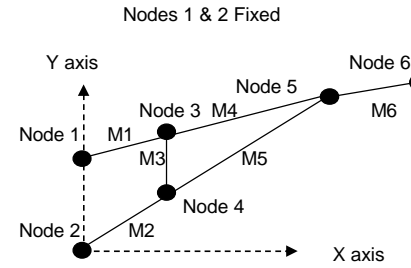
## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	13.77	0.000	22.53	1.100	4.576	8.25
2	0.450	7.64	13.67	0.000	22.37	1.100	4.576	8.19
3	0.450	7.64	13.57	0.000	22.20	1.100	4.576	8.13
4	0.450	7.64	13.47	0.000	22.04	1.100	4.576	8.07
5	0.450	7.64	13.37	0.000	21.87	1.100	4.576	8.01
6	0.450	7.64	13.27	0.000	21.71	1.100	4.576	7.95
7	0.450	7.64	13.17	0.000	21.55	1.100	4.576	7.89
8	0.450	7.64	13.07	0.001	21.38	1.100	4.576	7.83
9	0.450	7.64	12.97	0.001	21.22	1.100	4.576	7.77
10	0.450	7.64	12.87	0.001	21.06	1.100	4.576	7.71
11	0.450	7.64	12.77	0.001	20.89	1.100	4.576	7.65
12	0.450	7.64	12.67	0.001	20.73	1.100	4.576	7.59
13	0.450	9.54	15.70	0.002	20.57	1.100	4.576	7.53
14	0.450	9.54	15.57	0.002	20.40	1.100	4.576	7.47
15	0.450	9.54	15.45	0.002	20.24	1.100	4.576	7.41
16	0.450	9.54	15.32	0.003	20.08	1.100	4.576	7.35
17	0.450	9.54	15.20	0.003	19.91	1.100	4.576	7.29
18	0.450	9.54	42.38	0.010	55.53	1.100	4.576	20.33
19	0.450	9.54	41.38	0.012	54.22	1.100	4.576	19.85
20	0.450	9.54	13.57	0.005	17.78	1.100	4.576	6.51
Fix. #1	1.200	20.36	48.86	0.004	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.004	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.051	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum. - Luminaire Arm - Group II

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-33.67	-24.6	0	0	0
Node #2	0	0	0	0	-35.63	-26	0	0	0
Node #3	100	59.5	0	0	-66.63	-51.3	0	0	0
Node #4	100	48.8	0	0	-69.41	-53.4	0	0	0
Node #5	200	79	0	0	-94.35	-75.6	0	0	0
Node #6	288	87	0	0	-85.29	-69.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-67.33	1.1	1	-49.04	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-71.25	1.1	1	-51.90	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-0.68	1.1	1	-1.18	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-65.23	1.1	1.1	-52.27	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-66.89	1.1	1.1	-53.59	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-56.58	1.1	1.1	-45.33	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-57.00	1	1.1	-46.64					

AASHTO Gp	2
Mntg Hght =	29.00
Datum =	1

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2180.2	lbs
P1y	-694.6	lbs
P1z	178.8	lbs
M1x	6661.9	in-lbs
M1y	-25162.7	in-lbs
M1z	-898.1	in-lbs
P2x	2180.2	lbs
P2y	1079.6	lbs
P2z	121.5	lbs
M2x	6843.3	in-lbs
M2y	-20414.5	in-lbs
M2z	-928.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1018	138	19343	-491	0.55
#2	1071	87	15894	-954	0.78
#3	1489	431	8552	-392	0.35
#4	-1001	64	7424	-23	0.2
#5	1020	75	8261	-288	0.5
#6	4	98	7210	1	0.22

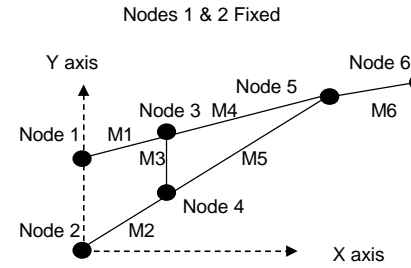
Arm Tip Displacement At Node 6	
X dir	0.103 (in)
Y dir	-0.898 (in)
Z dir	-10.462 (in)

V09.19.15



16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum. - Luminaire Arm - Group III

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-40.85	-13.2	0	0	0
Node #2	0	0	0	0	-43.23	-14	0	0	0
Node #3	100	59.5	0	0	-81.04	-26.6	0	0	0
Node #4	100	48.8	0	0	-84.42	-27.7	0	0	0
Node #5	200	79	0	0	-114.49	-37.8	0	0	0
Node #6	288	87	0	0	-115.33	-36.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



Member #3 is a bar computed as equivalent pipe section to the weak axis

	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-81.69	1.1	1	-26.29	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-86.45	1.1	1	-27.82	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-1.22	1.1	1	-0.63	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-79.16	1.1	1.1	-26.13	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-81.16	1.1	1.1	-26.80	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-68.65	1.1	1.1	-22.67	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-81.00	1	1.1	-25.00					

AASHTO Gp	3
Mntg Hght =	29.00
Datum =	1

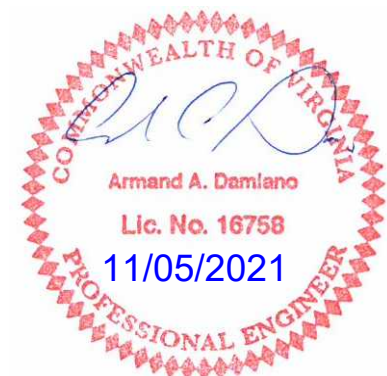
ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2797.7	lbs
P1y	-898.7	lbs
P1z	92.5	lbs
M1x	3425.6	in-lbs
M1y	-12957.4	in-lbs
M1z	-1426.8	in-lbs
P2x	2797.7	lbs
P2y	1378.1	lbs
P2z	63.2	lbs
M2x	3519.9	in-lbs
M2y	-10515.8	in-lbs
M2z	-1452.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1307	75	10010	-255	0.26
#2	1373	50	8249	-493	0.63
#3	1905	442	8972	-201	0.38
#4	-1287	45	3944	-13	0.08
#5	1311	48	4359	-150	0.46
#6	5	107	7919	1	0.24

Arm Tip Displacement At Node 6	
X dir	0.137 (in)
Y dir	-1.214 (in)
Z dir	-5.396 (in)

V09.19.15





16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum.

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	3.85	0.00	19.000	18.460	237.1	1.9179	1.92	6.016	6.016	58.51
2	I	3.85	3.85	18.460	17.921	230.2	1.9176	5.77	5.843	5.843	56.88
3	I	3.85	7.71	17.921	17.381	223.2	1.9173	9.63	5.669	5.669	55.25
4	I	3.85	11.56	17.381	16.842	216.3	1.9170	13.48	5.496	5.496	53.61
5	I	3.85	15.42	16.842	16.302	209.4	1.9167	17.33	5.323	5.323	51.98
6	I	3.85	19.27	16.302	15.762	202.4	1.9163	21.19	5.149	5.149	50.35
7	I	3.85	23.13	15.762	15.223	195.5	1.9160	25.04	4.976	4.976	48.71
8	J	3.02	26.98	15.660	15.237	241.5	1.5031	28.48	3.888	3.888	38.07
9	O	3.75	30.00	15.237	14.712	111.4	1.8640	31.86	4.680	4.680	45.87
10	O	3.75	33.75	14.712	14.187	107.5	1.8636	35.61	4.516	4.516	44.32
11	O	3.75	37.50	14.187	13.662	103.5	1.8632	39.36	4.351	4.351	42.78
12	O	3.75	41.25	13.662	13.137	99.6	1.8628	43.11	4.187	4.187	41.23
13	O	3.75	45.00	13.137	12.612	95.6	1.8623	46.86	4.023	4.023	39.69
14	O	3.75	48.75	12.612	12.087	91.7	1.8617	50.61	3.859	3.859	38.14
15	O	3.75	52.50	12.087	11.562	87.7	1.8611	54.36	3.695	3.695	36.59
16	O	3.75	56.25	11.562	11.037	83.7	1.8605	58.11	3.531	3.531	35.05
17	O	3.75	60.00	11.037	10.512	79.8	1.8598	61.86	3.367	3.367	33.50
18	O	3.75	63.75	10.512	9.987	75.8	1.8590	65.61	3.203	3.203	31.95
19	O	3.75	67.50	9.987	9.462	71.9	1.8581	69.36	3.039	3.039	30.41
20	O	3.75	71.25	9.462	8.937	67.9	1.8572	73.11	2.875	2.875	28.86
		<u>75.00</u>				<u>2832</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	65	20.00	8.700	1.000	78.00
Fix. #3	65	32.00	8.700	1.000	78.00
Fix. #4	22.5	41.00	7.500	1.000	22.50
Fix. #5	65	44.00	8.700	1.000	78.00
Fix. #6	22.5	47.00	7.500	1.000	22.50
Fix. #7	65	50.00	8.700	1.000	78.00
Fix. #8	22.5	52.00	7.500	1.000	22.50
Fix. #9	22	54.00	1.000	1.000	9.00
Fix. #10	65	56.00	8.700	1.000	78.00
Fix. #11	22.5	58.00	7.500	1.000	22.50
Fix. #12	105	62.00	13.750	2.000	126.00
Fix. #13	26.7	65.00	10.500	1.000	31.50
Fix. #14	22	66.00	1.000	1.000	9.00
Fix. #15	80	68.00	11.000	1.000	102.00
Fix. #16	26.7	71.00	10.500	1.000	31.50
Fix. #17	80	74.00	11.000	1.000	102.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	85.669	35.328
Cross-Section Area (in^2)	18.337	9.133
Width-Thickness Ratio	60.80	83.30
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	36.300	33.670
Allow. Shear Stress (ksi)	18.150	15.640





16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum.

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000 Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	57.39	75.20	1.100	4.576	27.53	0	0.450	0.00	0.00	
2	1.00	0.450	9.54	55.74	73.03	1.100	4.576	26.74	0	0.451	0.00	0.00	
3	1.00	0.450	9.54	54.09	70.87	1.100	4.576	25.94	0	0.469	0.00	0.00	
4	1.00	0.450	9.54	52.43	68.70	1.100	4.576	25.15	0	0.488	0.00	0.00	
5	1.00	0.450	9.54	50.78	66.53	1.100	4.576	24.36	0	0.509	0.00	0.00	
6	1.00	0.450	9.54	49.13	64.37	1.100	4.576	23.56	0	0.532	0.00	0.00	
7	1.00	0.450	9.54	47.47	62.20	1.100	4.576	22.77	0	0.556	0.00	0.00	
8	1.00	0.450	9.54	37.09	48.60	1.100	4.576	17.79	0	0.558	0.00	0.00	
9	1.00	0.450	9.54	44.64	58.49	1.100	4.576	21.41	0	0.581	0.00	0.00	
10	1.00	0.450	9.54	43.08	56.44	1.100	4.576	20.66	0	0.608	0.00	0.00	
11	1.00	0.450	9.54	41.51	54.39	1.100	4.576	19.91	0	0.638	0.00	0.00	
12	1.00	0.450	9.54	39.95	52.34	1.100	4.576	19.16	0	0.671	0.00	0.00	
13	1.00	0.450	9.54	38.38	50.29	1.100	4.576	18.41	0	0.707	0.00	0.00	
14	1.00	0.450	9.54	36.82	48.24	1.100	4.576	17.66	0	0.746	0.00	0.00	
15	1.00	0.450	9.54	35.25	46.19	1.100	4.576	16.91	0	0.790	0.00	0.00	
16	1.00	0.450	9.54	33.69	44.14	1.100	4.576	16.16	0	0.838	0.00	0.00	
17	1.00	0.459	9.74	32.80	42.09	1.100	4.576	15.41	1	0.891	0.00	0.00	
18	1.00	0.490	10.4	33.31	40.04	1.100	4.576	14.66	1	0.951	0.00	0.00	
19	1.00	0.525	11.13	33.82	37.99	1.100	4.576	13.91	1	1.018	0.00	0.00	
20	1.00	0.564	11.96	34.38	35.94	1.100	4.576	13.16	1	1.094	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #7	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #8	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #11	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #12	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	1	1.200	0.00	0.00	0.00
Fix. #13	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #14	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #15	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #16	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #17	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



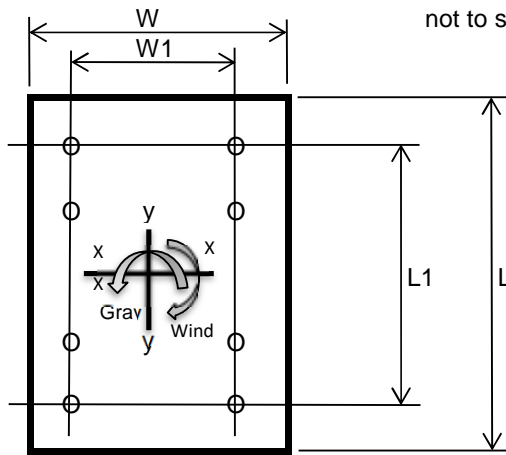
Flange Analysis - Arm #1

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	3631	5393	-	lbs
Shear (Wind)	4170	2780	-	lbs
Torsion (Arm Rise)	16387	10925	-	ft-lbs
Moment (Gravity)	122715	199294	-	ft-lbs
Moment (Wind)	208022	127328	-	ft-lbs
Nat. Wind Moment	-	-	48453	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	19.00	in
Tube Wall Thick.	0.3125	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.75
W	29.5
W1	25.00
L	29.5
L1	25.00
L2 - Dist. between bolts (Typ.)	8.33



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	979.65	979.65	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1763.77	1763.77	in <sup>4</sup>
Bolt Tensile Stress - ft	25.81	32.38	ksi
Bolt Shear Stress - fv	1.93	1.5	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Fv =	44.22	44.22	ksi
Allowable Shear Stress = Ft =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.6	0.74	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	4.13	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.59	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	12.26	19.91	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	21.12	12.93	ksi
Combined applied stress for interaction (SRSS)	24.42	23.74	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum.

Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

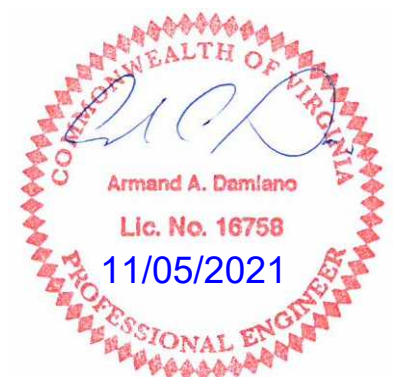
Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	20.50	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.268293	
Dop - Baseplate center hole diameter	15.75	in
Cop - Center hole to shaft diameter ratio	0.768293	
Kf - Fatigue stress concentration factor for finite life	2.28	
Ki - Fatigue stress concentration factor for infinite life	4.97	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.3125	in
Dt - Arm base diameter	19.00	in
Ttp - Thickness of baseplate	2.75	in
Dbc - Bolt circle diameter	35.36	in
Cbc - Bolt circle ratio	1.86	
Dop - Baseplate center hole diameter	6	in
Cop - Center hole to arm diameter ratio	0.315789	
Kf - Fatigue stress concentration factor for finite life	1.70	
Ki - Fatigue stress concentration factor for infinite life	3.36	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle



16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum.

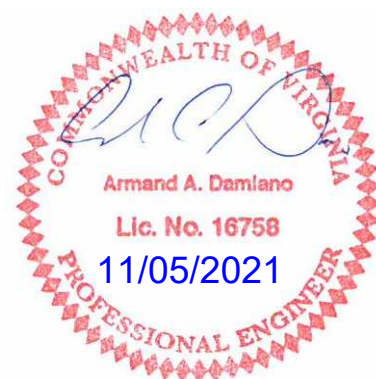
## Lower Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	20.07	in
Shaft Thickness	0.313	in
Total Area	24.5588	in <sup>2</sup>
Ix	1048	in <sup>4</sup>
Iy	1194	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	26522	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	12.00	ksi
CSR	0.75	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	3.32	ksi
CSR	0.47	
Therefore	<b>OK</b>	



16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum.

## Upper Hand Hole Stresses

**INPUTS**

Handhole Width	3.00	in
Handhole Height	5.00	in
Distance From Base Plate To Hand Hole Center Line	216	in
Radial Orientation	0	Degrees
Rim Thickness	0.50	in
Rim Depth	3.50	in
Rim Projection	0.31	in
Shaft Diameter (At hand hole location)	17.98	in
Shaft Thickness	0.313	in
Total Area	19.6302	in <sup>2</sup>
Ix	691	in <sup>4</sup>
Iy	768	in <sup>4</sup>
Controlling Moment - Galloping	4297	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	2.64	ksi
CSR	0.16	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	0.68	ksi
CSR	0.10	
Therefore	<b>OK</b>	



16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum.

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	3631		3631	122715		122715		397	17190		0.48
Gp II	3631	4170	5530	122715	208022	241521	16387	604	33831	1148	0.71
Gp III	5393	2780	6068	199294	127328	236497	10925	662	33128	766	0.69
Gp IV Natural		1052	1052		48453	48453	4136	115	6787	290	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	2030		2030	46895		46896		445	15930		0.48
Gp II	2030	3556	4095	46895	102787	112980	13975	897	38376	2374	0.89
Gp III	3330	2176	3978	81937	60119	101627	8550	872	34520	1453	0.79
Gp IV Natural		828	828		22943	22943	3254	182	7794	553	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum.

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

**Shaft Base**

Gp I	5721		122715	0	122715		289		14730		0.42
Gp II	5721	5355	91441	162548	186503	209148	289	541	22386	12552	0.77
Gp III	8119	3731	60962	226346	234412	127906	410	377	28137	7676	0.71
Gp IV Natural			26522	0	26522				3183		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9968										

**Shaft At Arm**

Gp I	4418		122715	0	122715		255		19231		0.54
Gp II	4418	4567	16387	128652	129691	209148	255	527	20325	16388	0.92
Gp III	6274	3063	10925	202627	202921	127906	362	354	31801	10022	0.86
Gp IV Natural			4297	0	4297				673		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9968										





16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	5355 lbs
Bending Moment	234412 ft-lbs
Torsion Moment	209148 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	20.50 in

**ANALYSIS - ANCHOR BOLTS**

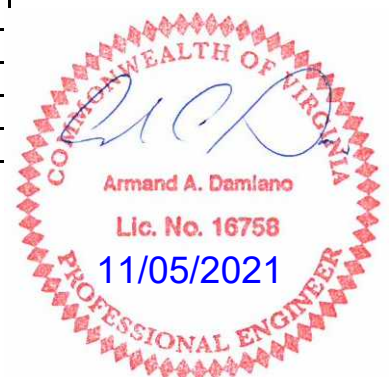
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	21.588 ksi
Bolt Direct Shear Stress	0.292 ksi
Bolt Torsion Shear Stress	10.493 ksi
Combined Bolt Stress	
$F_v = .3 F_y$ * Allowable Increase Factor	21.945 ksi
$F_t = .5 F_y$ * Allowable Increase Factor	36.575 ksi
$f_t =$	21.588 ksi
$f_v =$	10.785 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.77 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	2.75 in
Design Moment	149 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	22.51 ksi
Allowable Plate Stress = $.66 F_y$ * Allow. Incr.	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.188 in
Design Moment	65 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	10.31 ksi
Allowable Plate Stress = $.66 F_y$ * Allow. Incr.	31.6 ksi
Therefore	<b>OK</b>



16362-1-7 - VA - 70 MPH - MP-3 Std. Loads - Type E2 - 75' Arm w/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	26522 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	2.45 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.35
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

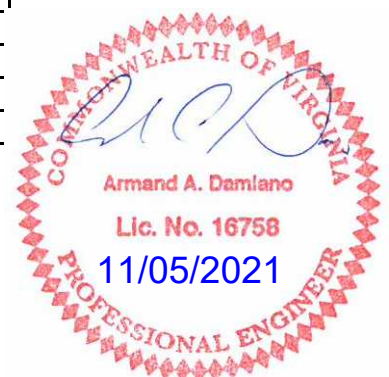
Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	53970 lbs
Computed Factor-of Safety	1.15 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	53970 lbs
Total Tensile Load	431760 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	1.09 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	53970 lbs
Total Tensile Load	431760 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	<b>10</b> Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70'/60' Arms w/24' Lum.

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<i>Fatigue Importance Factors</i>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	2		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	1		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.00	25.00	-	-	-	0	55	29000	-
Traffic Arm #1	0.2500	0.14	17.50	25.00	18.00	-	3.67	0	55	29000	180
	0.1880	0.14	14.79	47.92	-	2.92	-	0	55	29000	-
Traffic Arm #2	0.2500	0.14	15.58	23.69	18.00	-	3.14	0	55	29000	270
	0.1793	0.14	13.00	39.00	-	2.69	-	0	55	29000	-
Lum Arm #1	0.2760		2.88	24.00	24.00	-	5	0	36	29000	180
Lum Arm #2						-		0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	Double Top Nuts	Yes	
A.B. Bolt Circle	26.00	Foundation Diameter	48	in
Baseplate Dia.	32.00	Concrete Cover	4	in
Baseplate Thk.	2.00	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	14.25	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.	Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1		Arm #2	
Flange Bolt Qty.	8		8	
Bolt Diameter	1.50	in	1.50	in
Flange Plate Length (V)	27.00	in	27.00	in
Flange Plate Width (H)	27.00	in	27.00	in
Spac. Between Bolt (V)	22.50	in	22.50	in
Spac. Between Bolt (H)	22.50	in	22.50	in
Flange Plate Thk.	2.25	in	2.25	in
Flange Plate Yield (Fy)	50.00	ksi	50.00	ksi
Gusset Thk.	0.500	in	0.500	in
Plate Center Hole	6.00	in	6.00	in
Weld Type	Full Pen.		Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1	Lum#2	Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Arm #1	Arm #2
GP I CSR	0.42	0.55	0.49	0.41	0.43	0.34			29.76	20.19
GP II CSR	0.86	0.96	0.71	0.64	0.66	0.58	0.78			
GP III CSR	0.79	0.89	0.70	0.62	0.63	0.54	0.63		48.75	33.79
Nat.Wind (psi)	4110	830	6735	5792	6306	5372				

Arm #1 Flange Bolt (Max.) CSR	0.56
Arm #1 Flange Bolt Fatigue CSR	0.45
Arm #1 Flange Plate (Max.) CSR	0.60
Arm #2 Flange Bolt (Max.) CSR	0.40
Arm #2 Flange Bolt Fatigue CSR	0.33
Arm #2 Flange Plate (Max.) CSR	0.47
Handhole at Root (Fatigue) CSR	0.95
Handhole at Toe (Fatigue) CSR	0.62
Minimum Qty of Vertical Reinf. Bars	9

Fatigue Allowable - Shaft to Baseplate	4.5 ksi
Fatigue Allowable - Arm#1 to Flange	7 ksi
Fatigue Allowable - Arm#2 to Flange	7 ksi
Anchor Bolt Max. CSR	0.71
Anchor Bolt Max. Fatigue Stress Ratio	0.39
Base Plate Max. CSR	0.88
Anchorage Capacity S.F.	1.19
Concrete Pull Out Capacity S.F.	1.13

**Ground Line Reactions**

	Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
	10096	4923	226566	173590



16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70'/60' Arms w/24' Lum.

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft.)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1	Cobra Head w/Camera	24	2	1			4.54	9	57	1.00
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	15'x2.5' Sign	12			15	2.5	1	37.5	88.5	1.21
	#3	5 Section Head w/BP	25	13.75	4			2	42	105	1.20
	#4	2.5'x3' Sign	29			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	36	8.7	4			1	26	65	1.20
	#6	Camera	40	1	1			1	3	22	1.20
	#7	2.5'x3' Sign	44			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	47	8.7	4			1	26	65	1.20
	#9	2.5'x3' Sign	55			2.5	3	1	7.5	22.5	1.13
	#10	3 Section Head w/BP	58	8.7	4			1	26	65	1.20
	#11	Camera	62	1	1			1	3	22	1.20
	#12	3'x3.5' Sign	66			3	3.5	1	10.5	26.7	1.13
	#13	4 Section Head w/BP	69	11	5			1	34	80	1.20
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1	Camera	4	1	1			1	3	22	1.20
	#2	15'x2.5' Sign	12.5			15	2.5	1	37.5	88.5	1.21
	#3	5 Section Head w/BP	26	13.75	4			2	42	105	1.20
	#4	2.5'x3' Sign	34			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	37	8.7	4			1	26	65	1.20
	#6	Camera	46	1	1			1	3	22	1.20
	#7	2.5'x3' Sign	45			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	48	8.7	4			1	26	65	1.20
	#9	Camera	57	1	1			1	3	22	1.20
	#10	3'x3.5' Sign	56			3	3.5	1	10.5	26.7	1.13
	#11	4 Section Head w/BP	59	11	5			1	34	80	1.20
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										



16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70'/60' Arms w/24' Lum.

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.000	18.852	65.84	0.5287	0.53	1.670	16.24	0.80
2	I	1.06	1.06	18.852	18.704	65.31	0.5287	1.59	1.657	16.11	0.80
3	I	1.06	2.12	18.704	18.555	64.79	0.5287	2.65	1.644	15.99	0.80
4	I	1.06	3.18	18.555	18.407	64.27	0.5287	3.71	1.631	15.87	0.80
5	I	1.06	4.24	18.407	18.259	63.74	0.5287	4.76	1.618	15.74	0.80
6	I	1.06	5.29	18.259	18.111	63.22	0.5287	5.82	1.605	15.62	0.80
7	I	1.06	6.35	18.111	17.962	62.69	0.5287	6.88	1.591	15.50	0.80
8	I	1.06	7.41	17.962	17.814	62.17	0.5287	7.94	1.578	15.37	0.80
9	I	1.06	8.47	17.814	17.666	61.64	0.5287	9.00	1.565	15.25	0.80
10	I	1.06	9.53	17.666	17.518	61.12	0.5287	10.06	1.552	15.13	0.80
11	I	1.06	10.59	17.518	17.369	60.59	0.5287	11.12	1.539	15.00	0.80
12	I	1.06	11.65	17.369	17.221	60.07	0.5287	12.18	1.526	14.88	0.80
13	I	1.06	12.71	17.221	17.073	59.55	0.5286	13.23	1.513	14.76	1.00
14	I	1.06	13.76	17.073	16.925	59.02	0.5286	14.29	1.500	14.63	1.00
15	I	1.06	14.82	16.925	16.776	58.50	0.5286	15.35	1.487	14.51	1.00
16	I	1.06	15.88	16.776	16.628	57.97	0.5286	16.41	1.474	14.39	1.00
17	I	1.06	16.94	16.628	16.480	57.45	0.5286	17.47	1.461	14.27	1.00
18	J	3.00	18.00	16.480	16.060	159.92	1.4935	19.49	4.068	39.75	1.00
19	I	3.00	21.00	16.060	15.640	155.72	1.4934	22.49	3.963	38.76	1.00
20	J	1.00	24.00	15.640	15.500	50.97	0.4993	24.50	1.298	12.70	1.00
						1415					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in^4)	800.47	518.34	518.34	429.68
Section Modulus (in^3)	85.67	64.12	64.12	
Cross-Section Area (in^2)	18.34	15.86	15.86	
Width-Thickness Ratio	60.80	52.74	52.74	
Compact Limit	68.55	68.55	68.55	
Non-Compact Limit	137.09	137.09	137.09	
Maximum Limit	237.27	237.27	237.27	
Allow. Bending Stress (ksi)	36.300	36.300	36.300	
Allow. Compressive Str (ksi)	13.488	13.488	13.488	
Allow. Shear Stress (ksi)	18.150	18.150	18.150	

Shaft Deflection From Arm#1 GP I Load (in)	1.186
Shaft Deflection From Arm#2 GP I Load (in)	0.819



16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70/60' Arms w/24' Lum.

## Shaft Analysis Continued

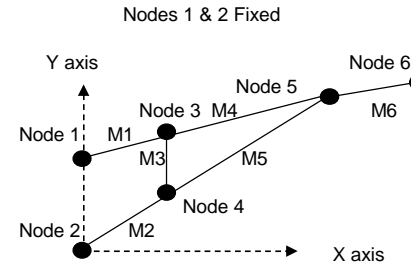
Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	12.76	0.000	20.87	1.100	4.576	7.64
2	0.450	7.64	12.66	0.000	20.71	1.100	4.576	7.58
3	0.450	7.64	12.56	0.000	20.55	1.100	4.576	7.52
4	0.450	7.64	12.46	0.000	20.38	1.100	4.576	7.46
5	0.450	7.64	12.36	0.000	20.22	1.100	4.576	7.40
6	0.450	7.64	12.26	0.000	20.06	1.100	4.576	7.34
7	0.450	7.64	12.16	0.001	19.89	1.100	4.576	7.28
8	0.450	7.64	12.06	0.001	19.73	1.100	4.576	7.22
9	0.450	7.64	11.96	0.001	19.57	1.100	4.576	7.16
10	0.450	7.64	11.86	0.001	19.40	1.100	4.576	7.10
11	0.450	7.64	11.76	0.001	19.24	1.100	4.576	7.04
12	0.450	7.64	11.66	0.001	19.08	1.100	4.576	6.98
13	0.450	9.54	14.43	0.002	18.91	1.100	4.576	6.92
14	0.450	9.54	14.31	0.002	18.75	1.100	4.576	6.86
15	0.450	9.54	14.18	0.003	18.59	1.100	4.576	6.80
16	0.450	9.54	14.06	0.003	18.42	1.100	4.576	6.74
17	0.450	9.54	13.93	0.003	18.26	1.100	4.576	6.68
18	0.450	9.54	38.80	0.012	50.84	1.100	4.576	18.61
19	0.450	9.54	37.80	0.014	49.53	1.100	4.576	18.13
20	0.450	9.54	12.38	0.005	16.22	1.100	4.576	5.94
Fix. #1	1.200	20.36	48.86	0.005	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.005	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.065	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00





16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70'/60' Arms w/24' Lum. - Luminaire Arm - Group II

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-33.67	-24.6	0	0	0
Node #2	0	0	0	0	-35.63	-26	0	0	0
Node #3	100	59.5	0	0	-66.63	-51.3	0	0	0
Node #4	100	48.8	0	0	-69.41	-53.4	0	0	0
Node #5	200	79	0	0	-94.35	-75.6	0	0	0
Node #6	288	87	0	0	-85.29	-69.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-67.33	1.1	1	-49.04	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-71.25	1.1	1	-51.90	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-0.68	1.1	1	-1.18	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-65.23	1.1	1.1	-52.27	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-66.89	1.1	1.1	-53.59	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-56.58	1.1	1.1	-45.33	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-57.00	1	1.1	-46.64					

AASHTO Gp	2
Mntg Hght =	29.00
Datum =	1

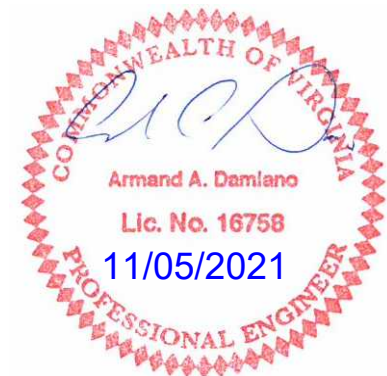
ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2180.2	lbs
P1y	-694.6	lbs
P1z	178.8	lbs
M1x	6661.9	in-lbs
M1y	-25162.7	in-lbs
M1z	-898.1	in-lbs
P2x	2180.2	lbs
P2y	1079.6	lbs
P2z	121.5	lbs
M2x	6843.3	in-lbs
M2y	-20414.5	in-lbs
M2z	-928.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1018	138	19343	-491	0.55
#2	1071	87	15894	-954	0.78
#3	1489	431	8552	-392	0.35
#4	-1001	64	7424	-23	0.2
#5	1020	75	8261	-288	0.5
#6	4	98	7210	1	0.22

Arm Tip Displacement At Node 6	
X dir	0.103 (in)
Y dir	-0.898 (in)
Z dir	-10.462 (in)

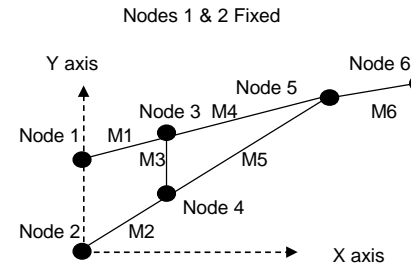
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16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70'/60' Arms w/24' Lum. - Luminaire Arm - Group III

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-40.85	-13.2	0	0	0
Node #2	0	0	0	0	-43.23	-14	0	0	0
Node #3	100	59.5	0	0	-81.04	-26.6	0	0	0
Node #4	100	48.8	0	0	-84.42	-27.7	0	0	0
Node #5	200	79	0	0	-114.49	-37.8	0	0	0
Node #6	288	87	0	0	-115.33	-36.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



Member #3 is a bar computed as equivalent pipe section to the weak axis

	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-81.69	1.1	1	-26.29	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-86.45	1.1	1	-27.82	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-1.22	1.1	1	-0.63	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-79.16	1.1	1.1	-26.13	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-81.16	1.1	1.1	-26.80	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-68.65	1.1	1.1	-22.67	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-81.00	1	1.1	-25.00					

AASHTO Gp	3
Mntg Hght =	29.00
Datum =	1

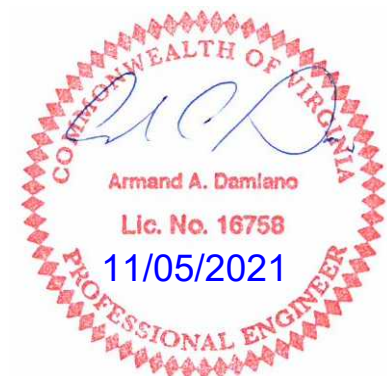
ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2797.7	lbs
P1y	-898.7	lbs
P1z	92.5	lbs
M1x	3425.6	in-lbs
M1y	-12957.4	in-lbs
M1z	-1426.8	in-lbs
P2x	2797.7	lbs
P2y	1378.1	lbs
P2z	63.2	lbs
M2x	3519.9	in-lbs
M2y	-10515.8	in-lbs
M2z	-1452.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1307	75	10010	-255	0.26
#2	1373	50	8249	-493	0.63
#3	1905	442	8972	-201	0.38
#4	-1287	45	3944	-13	0.08
#5	1311	48	4359	-150	0.46
#6	5	107	7919	1	0.24

Arm Tip Displacement At Node 6	
X dir	0.137 (in)
Y dir	-1.214 (in)
Z dir	-5.396 (in)

V09.19.15



16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70'/60' Arms w/24' Lum.

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	3.68	0.00	17.500	16.985	167.1	1.8308	1.83	5.288	5.288	51.57
2	I	3.68	3.68	16.985	16.470	162.1	1.8306	5.51	5.130	5.130	50.08
3	I	3.68	7.36	16.470	15.954	157.0	1.8303	9.19	4.972	4.972	48.59
4	I	3.68	11.04	15.954	15.439	151.9	1.8299	12.87	4.814	4.814	47.10
5	I	3.68	14.72	15.439	14.924	146.8	1.8296	16.55	4.656	4.656	45.61
6	I	3.68	18.40	14.924	14.409	141.8	1.8292	20.23	4.498	4.498	44.12
7	J	2.92	22.08	14.790	14.381	193.4	1.4532	23.53	3.549	3.549	34.83
8	O	3.46	25.00	14.381	13.897	97.1	1.7209	26.72	4.079	4.079	40.07
9	O	3.46	28.46	13.897	13.412	93.7	1.7205	30.18	3.939	3.939	38.75
10	O	3.46	31.92	13.412	12.927	90.3	1.7202	33.64	3.799	3.799	37.43
11	O	3.46	35.38	12.927	12.443	86.9	1.7197	37.10	3.659	3.659	36.12
12	O	3.46	38.85	12.443	11.958	83.6	1.7193	40.57	3.519	3.519	34.80
13	O	3.46	42.31	11.958	11.474	80.2	1.7188	44.03	3.380	3.380	33.48
14	O	3.46	45.77	11.474	10.989	76.8	1.7183	47.49	3.240	3.240	32.16
15	O	3.46	49.23	10.989	10.504	73.5	1.7178	50.95	3.100	3.100	30.85
16	O	3.46	52.69	10.504	10.020	70.1	1.7171	54.41	2.960	2.960	29.53
17	O	3.46	56.15	10.020	9.535	66.7	1.7165	57.87	2.820	2.820	28.21
18	O	3.46	59.62	9.535	9.050	63.3	1.7157	61.33	2.681	2.681	26.89
19	O	3.46	63.08	9.050	8.566	60.0	1.7149	64.79	2.541	2.541	25.58
20	O	3.46	66.54	8.566	8.081	56.6	1.7140	68.25	2.401	2.401	24.26
		<u>70.00</u>				<u>2119</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	12.00	37.500	1.000	112.50
Fix. #3	105	25.00	13.750	2.000	126.00
Fix. #4	22.5	29.00	7.500	1.000	22.50
Fix. #5	65	36.00	8.700	1.000	78.00
Fix. #6	22	40.00	1.000	1.000	9.00
Fix. #7	22.5	44.00	7.500	1.000	22.50
Fix. #8	65	47.00	8.700	1.000	78.00
Fix. #9	22.5	55.00	7.500	1.000	22.50
Fix. #10	65	58.00	8.700	1.000	78.00
Fix. #11	22	62.00	1.000	1.000	9.00
Fix. #12	26.7	66.00	10.500	1.000	31.50
Fix. #13	80	69.00	11.000	1.000	102.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	58.397	31.467
Cross-Section Area (in^2)	13.541	8.620
Width-Thickness Ratio	70.00	78.67
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	35.991	34.389
Allow. Shear Stress (ksi)	18.150	17.040



16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70'/60' Arms w/24' Lum.

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000 Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	50.44	66.10	1.100	4.576	24.20	0	0.484	0.00	0.00	
2	1.00	0.450	9.54	48.94	64.12	1.100	4.576	23.47	0	0.503	0.00	0.00	
3	1.00	0.450	9.54	47.43	62.15	1.100	4.576	22.75	0	0.524	0.00	0.00	
4	1.00	0.450	9.54	45.92	60.17	1.100	4.576	22.03	0	0.546	0.00	0.00	
5	1.00	0.450	9.54	44.42	58.20	1.100	4.576	21.30	0	0.571	0.00	0.00	
6	1.00	0.450	9.54	42.91	56.22	1.100	4.576	20.58	0	0.597	0.00	0.00	
7	1.00	0.450	9.54	33.86	44.36	1.100	4.576	16.24	0	0.601	0.00	0.00	
8	1.00	0.450	9.54	38.91	50.98	1.100	4.576	18.66	0	0.626	0.00	0.00	
9	1.00	0.450	9.54	37.58	49.23	1.100	4.576	18.02	0	0.655	0.00	0.00	
10	1.00	0.450	9.54	36.24	47.49	1.100	4.576	17.38	0	0.686	0.00	0.00	
11	1.00	0.450	9.54	34.91	45.74	1.100	4.576	16.74	0	0.721	0.00	0.00	
12	1.00	0.450	9.54	33.57	43.99	1.100	4.576	16.10	0	0.758	0.00	0.00	
13	1.00	0.450	9.54	32.24	42.24	1.100	4.576	15.46	0	0.799	0.00	0.00	
14	1.00	0.450	9.54	30.91	40.50	1.100	4.576	14.83	0	0.844	0.00	0.00	
15	1.00	0.461	9.78	30.32	38.75	1.100	4.576	14.19	0	0.894	0.00	0.00	
16	1.00	0.489	10.38	30.73	37.00	1.100	4.576	13.55	0	0.949	0.00	0.00	
17	1.00	0.521	11.05	31.17	35.25	1.100	4.576	12.91	1	1.011	0.00	0.00	
18	1.00	0.557	11.81	31.66	33.51	1.100	4.576	12.27	1	1.080	0.00	0.00	
19	1.00	0.597	12.66	32.17	31.76	1.100	4.576	11.63	1	1.100	0.00	0.00	
20	1.00	0.643	13.63	32.73	30.01	1.100	4.576	10.99	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #10	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #13	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



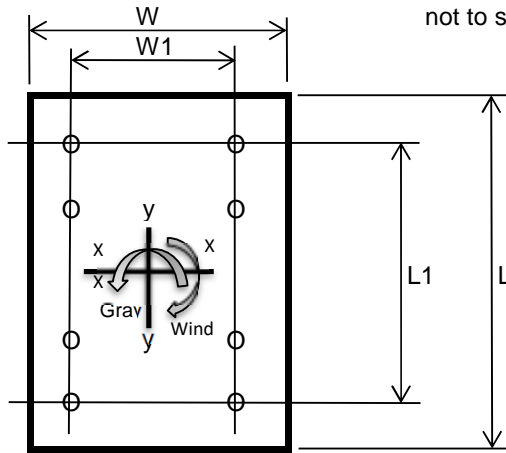
Flange Analysis - Arm #1

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	2748	4188	-	lbs
Shear (Wind)	3869	2515	-	lbs
Torsion (Arm Rise)	14192	9224	-	ft-lbs
Moment (Gravity)	85096	136462	-	ft-lbs
Moment (Wind)	137190	86259	-	ft-lbs
Nat. Wind Moment	-	-	32774	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	17.50	in
Tube Wall Thick.	0.25	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	19.42	24.59	ksi
Bolt Shear Stress - fv	1.79	1.34	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.45	0.56	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	3.1	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.45	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	13.77	22.08	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	22.58	14.20	ksi
Combined applied stress for interaction (SRSS)	26.45	26.25	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70'/60' Arms w/24' Lum.

Arm #2 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	3.00	0.00	15.580	15.160	121.2	1.4932	1.49	3.843	3.843	37.63
2	I	3.00	3.00	15.160	14.740	117.9	1.4930	4.49	3.738	3.738	36.64
3	I	3.00	6.00	14.740	14.320	114.5	1.4928	7.49	3.633	3.633	35.65
4	I	3.00	9.00	14.320	13.900	111.1	1.4926	10.49	3.528	3.528	34.66
5	I	3.00	12.00	13.900	13.480	107.8	1.4923	13.49	3.423	3.423	33.67
6	I	3.00	15.00	13.480	13.060	104.4	1.4921	16.49	3.318	3.318	32.68
7	I	3.00	18.00	13.060	12.640	101.0	1.4918	19.49	3.213	3.213	31.69
8	J	2.69	21.00	13.000	12.623	152.9	1.3384	22.34	2.872	2.872	28.33
9	O	3.03	23.69	12.623	12.200	70.9	1.5043	25.19	3.130	3.130	30.92
10	O	3.03	26.72	12.200	11.776	68.5	1.5040	28.22	3.023	3.023	29.91
11	O	3.03	29.74	11.776	11.353	66.0	1.5037	31.25	2.916	2.916	28.91
12	O	3.03	32.77	11.353	10.929	63.6	1.5033	34.27	2.809	2.809	27.90
13	O	3.03	35.79	10.929	10.505	61.1	1.5029	37.30	2.702	2.702	26.89
14	O	3.03	38.82	10.505	10.082	58.7	1.5025	40.32	2.596	2.596	25.89
15	O	3.03	41.85	10.082	9.658	56.2	1.5021	43.35	2.489	2.489	24.88
16	O	3.03	44.87	9.658	9.234	53.7	1.5016	46.37	2.382	2.382	23.87
17	O	3.03	47.90	9.234	8.811	51.3	1.5011	49.40	2.275	2.275	22.87
18	O	3.03	50.92	8.811	8.387	48.8	1.5005	52.42	2.168	2.168	21.86
19	O	3.03	53.95	8.387	7.964	46.4	1.4999	55.45	2.061	2.061	20.85
20	O	3.03	56.97	7.964	7.540	43.9	1.4991	58.47	1.955	1.955	19.85
		<u>60.00</u>				<u>1620</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	12.50	37.500	1.000	112.50
Fix. #3	105	26.00	13.750	2.000	126.00
Fix. #4	22.5	34.00	7.500	1.000	22.50
Fix. #5	65	37.00	8.700	1.000	78.00
Fix. #6	22	46.00	1.000	1.000	9.00
Fix. #7	22.5	45.00	7.500	1.000	22.50
Fix. #8	65	48.00	8.700	1.000	78.00
Fix. #9	22	57.00	1.000	1.000	9.00
Fix. #10	26.7	56.00	10.500	1.000	31.50
Fix. #11	80	59.00	11.000	1.000	102.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#2 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	46.120	23.135
Cross-Section Area (in^2)	12.034	7.218
Width-Thickness Ratio	62.32	72.50
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	36.300	35.489
Allow. Shear Stress (ksi)	18.150	18.150



16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70'/60' Arms w/24' Lum.

Arm #2 Analysis Continued

Sec. Num.	Kz	Truck Induced Gust											Gallop Loads (lbs)
		Group 2			Group 3	Natural Wind Gust			Hght Corr. Factor = 1.00				
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	36.66	48.03	1.100	4.576	17.58	0	0.562	0.00	0.00	
2	1.00	0.450	9.54	35.66	46.72	1.100	4.576	17.10	0	0.582	0.00	0.00	
3	1.00	0.450	9.54	34.65	45.41	1.100	4.576	16.62	0	0.604	0.00	0.00	
4	1.00	0.450	9.54	33.65	44.09	1.100	4.576	16.14	0	0.628	0.00	0.00	
5	1.00	0.450	9.54	32.65	42.78	1.100	4.576	15.66	0	0.653	0.00	0.00	
6	1.00	0.450	9.54	31.65	41.47	1.100	4.576	15.18	0	0.680	0.00	0.00	
7	1.00	0.450	9.54	30.65	40.16	1.100	4.576	14.70	0	0.709	0.00	0.00	
8	1.00	0.450	9.54	27.40	35.90	1.100	4.576	13.14	0	0.711	0.00	0.00	
9	1.00	0.450	9.54	29.86	39.12	1.100	4.576	14.32	0	0.741	0.00	0.00	
10	1.00	0.450	9.54	28.84	37.79	1.100	4.576	13.83	0	0.776	0.00	0.00	
11	1.00	0.450	9.54	27.82	36.45	1.100	4.576	13.34	0	0.813	0.00	0.00	
12	1.00	0.450	9.54	26.80	35.11	1.100	4.576	12.85	0	0.853	0.00	0.00	
13	1.00	0.463	9.81	26.51	33.78	1.100	4.576	12.37	0	0.897	0.00	0.00	
14	1.00	0.488	10.34	26.84	32.44	1.100	4.576	11.88	0	0.946	0.00	0.00	
15	1.00	0.515	10.92	27.18	31.11	1.100	4.576	11.39	0	0.999	0.00	0.00	
16	1.00	0.545	11.56	27.53	29.77	1.100	4.576	10.90	1	1.057	0.00	0.00	
17	1.00	0.579	12.27	27.92	28.44	1.100	4.576	10.41	1	1.100	0.00	0.00	
18	1.00	0.616	13.06	28.32	27.10	1.100	4.576	9.92	1	1.100	0.00	0.00	
19	1.00	0.658	13.95	28.76	25.77	1.100	4.576	9.43	1	1.100	0.00	0.00	
20	1.00	0.705	14.95	29.22	24.43	1.100	4.576	8.94	1	1.100	0.00	0.00	
Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00





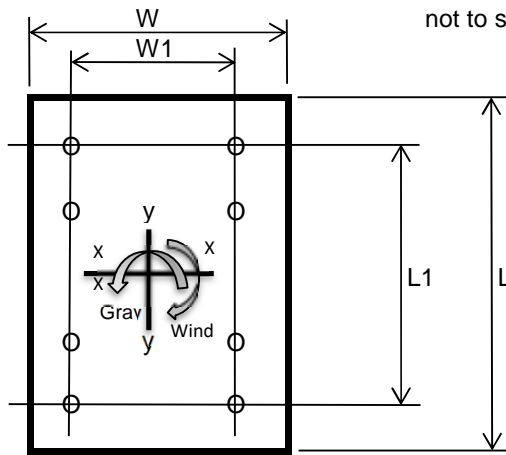
Flange Analysis - Arm #2

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	2161	3337	-	lbs
Shear (Wind)	3319	2098	-	lbs
Torsion (Arm Rise)	10435	6598	-	ft-lbs
Moment (Gravity)	58769	96007	-	ft-lbs
Moment (Wind)	104534	63624	-	ft-lbs
Nat. Wind Moment	-	-	24233	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	15.58	in
Tube Wall Thick.	0.25	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	14.05	17.39	ksi
Bolt Shear Stress - fv	1.36	1	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.33	0.40	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	2.29	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.33	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	9.97	16.28	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	18.03	10.98	ksi
Combined applied stress for interaction (SRSS)	20.60	19.64	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	





16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70'/60' Arms w/24' Lum.

Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.00	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.368421	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.75	
Kf - Fatigue stress concentration factor for finite life	2.41	
Ki - Fatigue stress concentration factor for infinite life	5.32	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.25	in
Dt - Arm base diameter	17.50	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	1.82	
Dop - Baseplate center hole diameter	6.00	in
Cop - Center hole to arm diameter ratio	0.342857	
Kf - Fatigue stress concentration factor for finite life	1.76	
Ki - Fatigue stress concentration factor for infinite life	3.33	
Fatigue Allowable	7	ksi

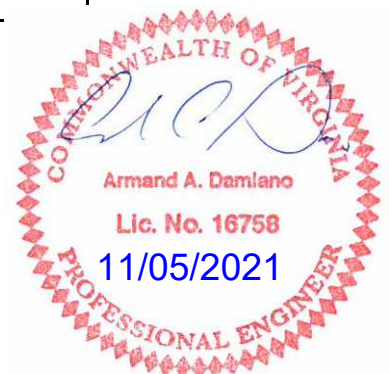
Note: Maximum diagonal distance between bolts used as bolt circle

**ARM 2 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.25	in
Dt - Arm base diameter	15.58	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	2.042349	
Dop - Baseplate center hole diameter	6	in
Cop - Center hole to arm diameter ratio	0.385109	
Kf - Fatigue stress concentration factor for finite life	1.83	
Ki - Fatigue stress concentration factor for infinite life	3.50	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle



16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70/60' Arms w/24' Lum.

## Lower Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	18.57	in
Shaft Thickness	0.313	in
Total Area	23.0768	in <sup>2</sup>
Ix	848	in <sup>4</sup>
Iy	944	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	29338	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	15.16	ksi
CSR	0.95	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	4.31	ksi
CSR	0.62	
Therefore	<b>OK</b>	



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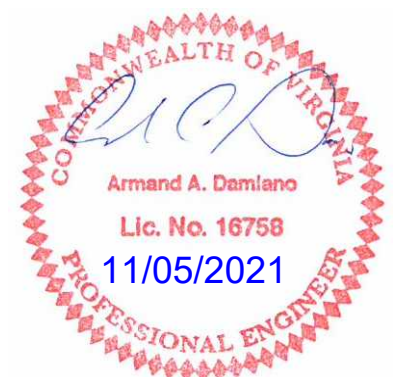
## Upper Hand Hole Stresses

**INPUTS**

Handhole Width	3.00	in
Handhole Height	5.00	in
Distance From Base Plate To Hand Hole Center Line	216	in
Radial Orientation	0	Degrees
Rim Thickness	0.50	in
Rim Depth	3.50	in
Rim Projection	0.31	in
Shaft Diameter (At hand hole location)	16.48	in
Shaft Thickness	0.313	in
Total Area	18.1555	in <sup>2</sup>
Ix	533	in <sup>4</sup>
Iy	589	in <sup>4</sup>
Controlling Moment - Galloping	4435	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	3.23	ksi
CSR	0.20	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	0.84	ksi
CSR	0.12	
Therefore	<b>OK</b>	



16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70'/60' Arms w/24' Lum.

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					
<b>Arm#1 Base</b>											
Gp I	2748		2748	85096		85097		406	17487		0.49
Gp II	2748	3869	4746	85096	137190	161439	14192	701	33175	1459	0.71
Gp III	4188	2515	4886	136462	86259	161439	9224	722	33175	948	0.70
Gp IV Natural		956	956		32774	32774	3507	142	6735	361	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-
<b>Arm#1 Joint</b>											
Gp I	1710		1710	36287		36287		397	13839		0.41
Gp II	1710	2605	3116	36287	65080	74513	9554	723	28416	1822	0.64
Gp III	2742	1656	3204	60410	39979	72441	6073	744	27626	1158	0.62
Gp IV Natural		628	628		15186	15186	2305	146	5792	440	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-
<b>Arm#2 Base</b>											
Gp I	2161		2161	58769		58770		360	15292		0.43
Gp II	2161	3319	3961	58769	104534	119922	10435	659	31203	1358	0.66
Gp III	3337	2098	3942	96007	63624	115176	6598	656	29968	859	0.63
Gp IV Natural		799	799		24233	24233	2514	133	6306	328	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-
<b>Arm#2 Joint</b>											
Gp I	1273		1273	22969		22969		353	11914		0.34
Gp II	1273	2099	2455	22969	45981	51399	6599	681	26661	1712	0.58
Gp III	2084	1298	2456	39262	27203	47766	4080	681	24776	1059	0.54
Gp IV Natural		493	493		10356	10356	1552	137	5372	403	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



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**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

**Shaft Base**

Gp I	6873		85096	58769	103418		375		14486		0.42
Gp II	6873	4923	112657	160044	195718	173590	375	537	27415	12158	0.86
Gp III	10096	3355	132467	183806	226566	107761	551	366	31736	7547	0.79
Gp IV Natural			23979	16904	29338				4110		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9947										

**Shaft At Arm**

Gp I	5660		85096	58769	103418		357		19354		0.55
Gp II	5660	4258	68628	98511	120059	173590	357	537	22468	16243	0.96
Gp III	8371	2787	102415	144503	177116	107761	528	352	33146	10083	0.89
Gp IV Natural			3654	2513	4435				830		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9947										



16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70'/60' Arms w/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	4923 lbs
Bending Moment	226566 ft-lbs
Torsion Moment	173590 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.00 in

**ANALYSIS - ANCHOR BOLTS**

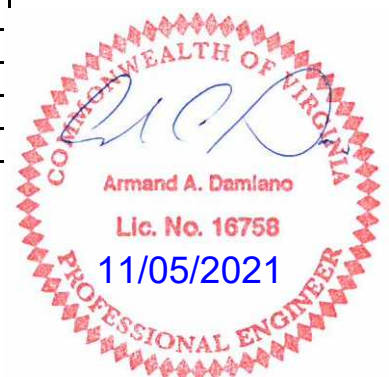
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	20.865 ksi
Bolt Direct Shear Stress	0.268 ksi
Bolt Torsion Shear Stress	8.709 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	20.865 ksi
$f_v =$	8.977 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.71 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.5 in
Design Moment	183 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	27.65 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.938 in
Design Moment	102 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	16.17 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-8 - VA - 70 MPH - MP-3 Std. Loads - Type F - 70/60' Arms w/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	29338 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	2.71 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.39
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

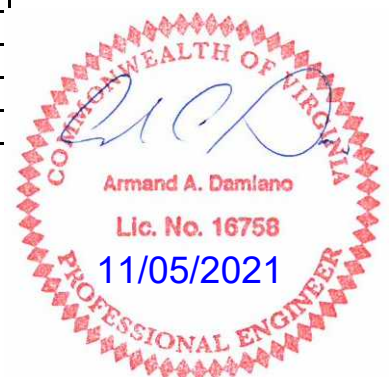
Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	52163 lbs
Computed Factor-of Safety	1.19 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	52163 lbs
Total Tensile Load	417304 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	1.13 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	52163 lbs
Total Tensile Load	417304 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	<b>9</b> Qty.





**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-9 - VA - 70 MPH - MP-3 Std. Loads - Type A - 30' Arm

11/04/21

**General**

Wind Vel. - mph	70	No	Roadway - mph	55	<b>Fatigue Importance Factors</b>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.00
Fatigue Cat.	0		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.00
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.00
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	0		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.2500	0.14	15.00	19.50	-	-	-	0	55	29000	-
Traffic Arm #1	0.1793	0.14	12.00	30.00	18.00	-	1.57	0	55	29000	180
Traffic Arm #2					-	-		0	55	29000	90
Lum Arm #1					-	-		0	36	29000	180
Lum Arm #2					-	-		0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	6	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00 in	Double Top Nuts	Yes	
A.B. Bolt Circle	24.00 in	Foundation Diameter	48	in
Baseplate Dia.	30.00 in	Concrete Cover	4	in
Baseplate Thk.	2.00 in	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	10.50 in	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.	Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50 in	in
Flange Plate Length (V)	24.00 in	in
Flange Plate Width (H)	24.00 in	in
Spac. Between Bolt (V)	19.50 in	in
Spac. Between Bolt (H)	19.50 in	in
Flange Plate Thk.	2.00 in	in
Flange Plate Yield (Fy)	50 ksi	ksi
Gusset Thk.	0.375 in	in
Plate Center Hole	6.00 in	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.12	0.17	0.25								4.14	0.00
GP II CSR	0.38	0.23	0.48									
GP III CSR	0.28	0.26	0.41								7.36	

Arm #1 Flange Bolt (Max.) CSR	0.13
Arm #1 Flange Bolt Fatigue CSR	0.00
Arm #1 Flange Plate (Max.) CSR	0.22
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.00
Handhole at Toe (Fatigue) CSR	0.00
Minimum Qty of Vertical Reinf. Bars	3

Fatigue Allowable - Shaft to Baseplate	
Fatigue Allowable - Arm#1 to Flange	
Fatigue Allowable - Arm#2 to Flange	
Anchor Bolt Max. CSR	0.24
Anchor Bolt Max. Fatigue Stress Ratio	0.00
Base Plate Max. CSR	0.31
Anchorage Capacity S.F.	3.45
Concrete Pull Out Capacity S.F.	3.95

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
2814	2861	55587	34395



16362-1-9 - VA - 70 MPH - MP-3 Std. Loads - Type A - 30' Arm

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.2
	#2	Ped Head	10.5	2.4	1			1	6	30	1.2
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.2
	#4										
Lum #1	#1										
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	12'x2.5' Sign	7			12	2.5	1	30	66	1.20
	#3	Camera	10	1	1			1	3	22	1.20
	#4	2.5'x3' Sign	15			2.5	3	1	7.5	22.5	1.13
	#5	5 Section Head w/BP	19	13.75	4			2	42	105	1.20
	#6	Camera	21	1	1			1	3	22	1.20
	#7	3'x3.5' Sign	26			3	3.5	1	10.5	26.7	1.13
	#8	4 Section Head w/BP	29	11	5			1	34	80	1.20
	#9										
	#10										
	#11										
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
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	#18										
	#19										
	#20										



16362-1-9 - VA - 70 MPH - MP-3 Std. Loads - Type A - 30' Arm

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	15.000	14.852	41.53	0.5285	0.53	1.317	12.91	0.80
2	I	1.06	1.06	14.852	14.704	41.11	0.5285	1.59	1.304	12.79	0.80
3	I	1.06	2.12	14.704	14.555	40.69	0.5285	2.65	1.291	12.66	0.80
4	I	1.06	3.18	14.555	14.407	40.27	0.5285	3.70	1.278	12.54	0.80
5	I	1.06	4.24	14.407	14.259	39.85	0.5285	4.76	1.265	12.42	0.80
6	I	1.06	5.29	14.259	14.111	39.43	0.5285	5.82	1.252	12.29	0.80
7	I	1.06	6.35	14.111	13.962	39.01	0.5285	6.88	1.239	12.17	0.80
8	I	1.06	7.41	13.962	13.814	38.59	0.5285	7.94	1.225	12.05	0.80
9	I	1.06	8.47	13.814	13.666	38.17	0.5285	9.00	1.212	11.92	0.80
10	I	1.06	9.53	13.666	13.518	37.75	0.5284	10.06	1.199	11.80	0.80
11	I	1.06	10.59	13.518	13.369	37.33	0.5284	11.12	1.186	11.68	0.80
12	I	1.06	11.65	13.369	13.221	36.91	0.5284	12.18	1.173	11.56	0.80
13	I	1.06	12.71	13.221	13.073	36.49	0.5284	13.23	1.160	11.43	1.00
14	I	1.06	13.76	13.073	12.925	36.08	0.5284	14.29	1.147	11.31	1.00
15	I	1.06	14.82	12.925	12.776	35.66	0.5284	15.35	1.134	11.19	1.00
16	I	1.06	15.88	12.776	12.628	35.24	0.5284	16.41	1.121	11.06	1.00
17	I	1.06	16.94	12.628	12.480	34.82	0.5284	17.47	1.108	10.94	1.00
18	J	0.50	18.00	12.480	12.410	16.30	0.2498	18.25	0.519	5.12	1.00
19	I	0.50	18.50	12.410	12.340	16.20	0.2498	18.75	0.516	5.10	1.00
20	I	0.50	19.00	12.340	12.270	16.11	0.2498	19.25	0.513	5.07	1.00
						698					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in <sup>4</sup> )	314.89	179.50	0.00	170.41
Section Modulus (in <sup>3</sup> )	42.70	29.35	0.00	
Cross-Section Area (in <sup>2</sup> )	11.58	9.60	0.00	
Width-Thickness Ratio	60.00	49.92	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	13.845	13.845	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

Shaft Deflection From Arm#1 GP I Load (in)	0.531
Shaft Deflection From Arm#2 GP I Load (in)	0.000



16362-1-9 - VA - 70 MPH - MP-3 Std. Loads - Type A - 30' Arm

## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	10.06	0.000	16.46	1.100	0.000	0.00
2	0.450	7.64	9.96	0.000	16.30	1.100	0.000	0.00
3	0.450	7.64	9.86	0.000	16.14	1.100	0.000	0.00
4	0.450	7.64	9.76	0.000	15.97	1.100	0.000	0.00
5	0.450	7.64	9.66	0.000	15.81	1.100	0.000	0.00
6	0.450	7.64	9.56	0.001	15.64	1.100	0.000	0.00
7	0.450	7.64	9.46	0.001	15.48	1.100	0.000	0.00
8	0.450	7.64	9.36	0.001	15.32	1.100	0.000	0.00
9	0.450	7.64	9.26	0.001	15.15	1.100	0.000	0.00
10	0.450	7.64	9.16	0.002	14.99	1.100	0.000	0.00
11	0.450	7.64	9.06	0.002	14.83	1.100	0.000	0.00
12	0.450	7.64	8.96	0.002	14.66	1.100	0.000	0.00
13	0.450	9.54	11.07	0.003	14.50	1.100	0.000	0.00
14	0.450	9.54	10.94	0.004	14.34	1.100	0.000	0.00
15	0.450	9.54	10.82	0.004	14.17	1.100	0.000	0.00
16	0.450	9.54	10.69	0.004	14.01	1.100	0.000	0.00
17	0.450	9.54	10.57	0.005	13.85	1.100	0.000	0.00
18	0.450	9.54	4.95	0.002	6.48	1.100	0.000	0.00
19	0.450	9.54	4.92	0.003	6.45	1.100	0.000	0.00
20	0.450	9.54	4.89	0.003	6.41	1.100	0.000	0.00
Fix. #1	1.200	20.36	48.86	0.009	30.00	1.200	0.000	0.00
Fix. #2	1.200	20.36	48.86	0.009	30.00	1.200	0.000	0.00
Fix. #3	1.200	25.44	349.80	0.123	174.90	1.200	0.000	0.00
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-9 - VA - 70 MPH - MP-3 Std. Loads - Type A - 30' Arm

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	1.50	0.00	12.000	11.790	33.7	0.7478	0.75	1.487	1.487	14.72
2	I	1.50	1.50	11.790	11.580	33.1	0.7478	2.25	1.461	1.461	14.47
3	I	1.50	3.00	11.580	11.370	32.5	0.7477	3.75	1.434	1.434	14.23
4	I	1.50	4.50	11.370	11.160	31.9	0.7477	5.25	1.408	1.408	13.98
5	I	1.50	6.00	11.160	10.950	31.3	0.7476	6.75	1.382	1.382	13.73
6	I	1.50	7.50	10.950	10.740	30.7	0.7476	8.25	1.356	1.356	13.48
7	I	1.50	9.00	10.740	10.530	30.1	0.7475	9.75	1.329	1.329	13.24
8	I	1.50	10.50	10.530	10.320	29.5	0.7475	11.25	1.303	1.303	12.99
9	I	1.50	12.00	10.320	10.110	28.9	0.7474	12.75	1.277	1.277	12.74
10	I	1.50	13.50	10.110	9.900	28.2	0.7474	14.25	1.251	1.251	12.49
11	I	1.50	15.00	9.900	9.690	27.6	0.7473	15.75	1.224	1.224	12.25
12	I	1.50	16.50	9.690	9.480	27.0	0.7473	17.25	1.198	1.198	12.00
13	I	1.50	18.00	9.480	9.270	26.4	0.7472	18.75	1.172	1.172	11.75
14	I	1.50	19.50	9.270	9.060	25.8	0.7471	20.25	1.146	1.146	11.50
15	I	1.50	21.00	9.060	8.850	25.2	0.7471	21.75	1.119	1.119	11.26
16	I	1.50	22.50	8.850	8.640	24.6	0.7470	23.25	1.093	1.093	11.01
17	I	1.50	24.00	8.640	8.430	24.0	0.7469	24.75	1.067	1.067	10.76
18	I	1.50	25.50	8.430	8.220	23.4	0.7468	26.25	1.041	1.041	10.51
19	I	1.50	27.00	8.220	8.010	22.8	0.7468	27.75	1.014	1.014	10.27
20	I	1.50	28.50	8.010	7.800	22.2	0.7467	29.25	0.988	0.988	10.02
		<u>30.00</u>				<u>559</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	66	7.00	30.000	1.000	90.00
Fix. #3	22	10.00	1.000	1.000	9.00
Fix. #4	22.5	15.00	7.500	1.000	22.50
Fix. #5	105	19.00	13.750	2.000	126.00
Fix. #6	22	21.00	1.000	1.000	9.00
Fix. #7	26.7	26.00	10.500	1.000	31.50
Fix. #8	80	29.00	11.000	1.000	102.00
Fix. #9	0	0.00	0.000	0.000	0.00
Fix. #10	0	0.00	0.000	0.000	0.00
Fix. #11	0	0.00	0.000	0.000	0.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	19.667	0.000
Cross-Section Area (in^2)	6.655	0.000
Width-Thickness Ratio	66.93	0.00
Compact Limit	68.55	0.00
Non-Compact Limit	137.09	0.00
Maximum Limit	237.27	0.00
Allow. Bending Stress (ksi)	36.300	0.000
Allow. Shear Stress (ksi)	18.150	0.000



16362-1-9 - VA - 70 MPH - MP-3 Std. Loads - Type A - 30' Arm

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	
1	1.00	0.450	9.54	14.18	18.59	1.100	0.000	0.00	0	0.784	0.00	0.00	
2	1.00	0.450	9.54	13.93	18.26	1.100	0.000	0.00	0	0.802	0.00	0.00	
3	1.00	0.450	9.54	13.68	17.93	1.100	0.000	0.00	0	0.821	0.00	0.00	
4	1.00	0.450	9.54	13.43	17.60	1.100	0.000	0.00	0	0.841	0.00	0.00	
5	1.00	0.450	9.54	13.18	17.27	1.100	0.000	0.00	0	0.862	0.00	0.00	
6	1.00	0.456	9.66	13.10	16.95	1.100	0.000	0.00	0	0.884	0.00	0.00	
7	1.00	0.467	9.91	13.17	16.62	1.100	0.000	0.00	0	0.906	0.00	0.00	
8	1.00	0.480	10.17	13.25	16.29	1.100	0.000	0.00	0	0.930	0.00	0.00	
9	1.00	0.492	10.44	13.33	15.96	1.100	0.000	0.00	0	0.955	0.00	0.00	
10	1.00	0.506	10.73	13.42	15.63	1.100	0.000	0.00	0	0.981	0.00	0.00	
11	1.00	0.520	11.03	13.50	15.30	1.100	0.000	0.00	1	1.009	0.00	0.00	
12	1.00	0.535	11.34	13.59	14.98	1.100	0.000	0.00	1	1.037	0.00	0.00	
13	1.00	0.550	11.67	13.68	14.65	1.100	0.000	0.00	1	1.068	0.00	0.00	
14	1.00	0.567	12.02	13.77	14.32	1.100	0.000	0.00	1	1.100	0.00	0.00	
15	1.00	0.584	12.39	13.87	13.99	1.100	0.000	0.00	1	1.100	0.00	0.00	
16	1.00	0.603	12.78	13.97	13.66	1.100	0.000	0.00	1	1.100	0.00	0.00	
17	1.00	0.622	13.19	14.07	13.34	1.100	0.000	0.00	1	1.100	0.00	0.00	
18	1.00	0.642	13.62	14.17	13.01	1.100	0.000	0.00	1	1.100	0.00	0.00	
19	1.00	0.664	14.08	14.28	12.68	1.100	0.000	0.00	1	1.100	0.00	0.00	
20	1.00	0.687	14.57	14.40	12.35	1.100	0.000	0.00	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.199	25.43	762.90	381.45	1.199	0.000	0.00	0	1.199	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	0.000	0.00	1	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	349.80	174.90	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.132	24.00	252.00	131.25	1.132	0.000	0.00	1	1.132	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	279.84	139.92	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #10	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #11	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



16362-1-9 - VA - 70 MPH - MP-3 Std. Loads - Type A - 30' Arm

Flange Analysis - Arm #1

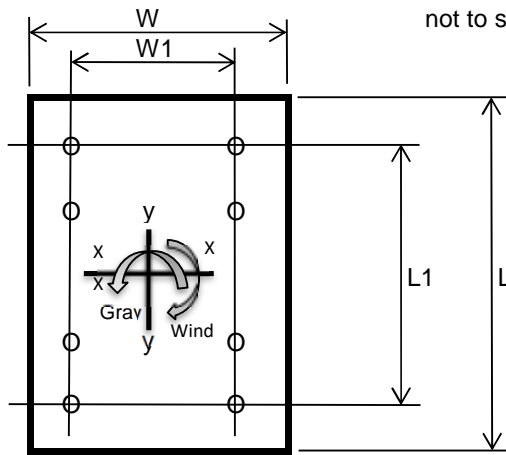
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Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	925	1572	-	lbs
Shear (Wind)	2175	1269	-	lbs
Torsion (Arm Rise)	3420	1995	-	ft-lbs
Moment (Gravity)	14359	25276	-	ft-lbs
Moment (Wind)	34395	19627	-	ft-lbs
Nat. Wind Moment	-	-	-	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	12.00	in
Tube Wall Thick.	0.1793	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.00
W	24
W1	19.50
L	24
L1	19.50
L2 - Dist. between bolts (Typ.)	6.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	596.99	596.99	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1073.57	1073.57	in <sup>4</sup>
Bolt Tensile Stress - ft	4.69	5.40	ksi
Bolt Shear Stress - fv	0.59	0.42	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.11	0.13	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	0	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	3.63	6.38	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	8.83	5.04	ksi
Combined applied stress for interaction (SRSS)	9.55	8.13	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	





16362-1-9 - VA - 70 MPH - MP-3 Std. Loads - Type A - 30' Arm

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear	Shear	Bending	Torsion	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

<b>Arm#1 Base</b>											
Gp I	925		925	14359		14360		278	8762		0.25
Gp II	925	2175	2364	14359	34395	37273	3420	711	22743	1044	0.48
Gp III	1572	1269	2020	25276	19627	32002	1995	608	19527	609	0.41
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Arm#1 Joint</b>											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Arm#2 Base</b>											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Arm#2 Joint</b>											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Lum#1 Base</b>											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Lum#2 Base</b>											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-9 - VA - 70 MPH - MP-3 Std. Loads - Type A - 30' Arm

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	1788		14359	0	14359		154		4036		0.12
Gp II	1788	2861	22874	50663	55587	34395	154	495	15623	4833	0.38
Gp III	2814	1816	24833	36107	43822	19627	243	314	12316	2758	0.28
Gp IV Natural			0	0	0				0		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9971										

<b>Shaft At Arm</b>											
Gp I	974		14359	0	14359		101		5870		0.17
Gp II	974	2190	3420	14370	14771	34395	101	457	6039	7031	0.23
Gp III	1620	1288	1995	25291	25370	19627	169	269	10371	4012	0.26
Gp IV Natural			0	0	0				0		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9971										



16362-1-9 - VA - 70 MPH - MP-3 Std. Loads - Type A - 30' Arm

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	2861 lbs
Bending Moment	55587 ft-lbs
Torsion Moment	34395 ft-lbs
Num. Anchor Bolts	6
Bolt Circle	24 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	30 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	15.00 in

**ANALYSIS - ANCHOR BOLTS**

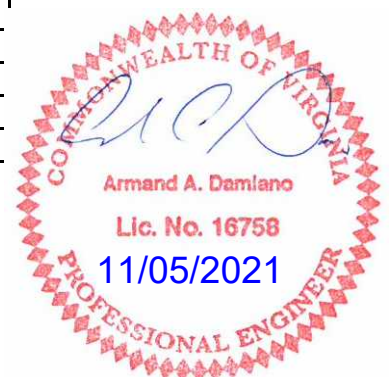
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1082.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	12.00 in
Bolt Tensile Stress	7.392 ksi
Bolt Direct Shear Stress	0.208 ksi
Bolt Torsion Shear Stress	2.493 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	7.392 ksi
$f_v =$	2.701 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.24 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	12.701 in
Dist. Shaft Face To Bolt Center	4.5 in
Design Moment	84 in-kip
Section Modulus of Failure Plane	8.46 in <sup>3</sup>
Applied Plate Stress	9.93 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	12.052 in
Dist From Shaft To Nut Face	2.938 in
Design Moment	55 in-kip
Section Modulus of Failure Plane	8.03 in <sup>3</sup>
Applied Plate Stress	6.85 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-9 - VA - 70 MPH - MP-3 Std. Loads - Type A - 30' Arm

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	0 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1082.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	12.00 in
Bolt Tensile Stress	0 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

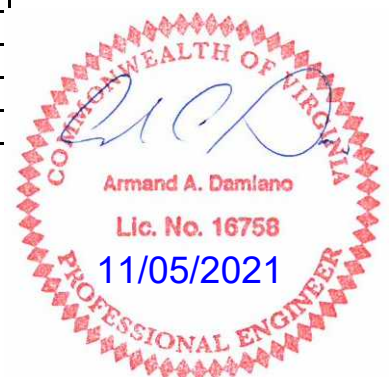
Anchor Bolt Length	60.0 in
Anchor Bolt Max. Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	127540 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	11 in
T Reduced For Group Action	63770 lbs
Maximum Applied Tensile Load	18480 lbs
Computed Factor-of Safety	3.45 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	18480 lbs
Total Tensile Load	110880 lbs
Concrete Failure Surface Area	4002.39 in <sup>2</sup>
Concrete Shear Strength	438440 psi
Computed Factor-of Safety	3.95 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	18480 lbs
Total Tensile Load	110880 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	45.36 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	3 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-10 - VA - 70 MPH - MP-3 Std. Loads - Type A - 40' Arm

11/04/21

**General**

Wind Vel. - mph	70	No	Roadway - mph	55	<i>Fatigue Importance Factors</i>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.00
Fatigue Cat.	0		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.00
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.00
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	0		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Member E (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.2500	0.14	15.00	19.50	-	-	-	0	55	29000	29000	-
Traffic Arm #1	0.1793	0.14	12.00	40.00	18.00	-	2.10	0	55	29000	29000	180
Traffic Arm #2					-	-		0	55	29000	29000	90
Lum Arm #1					-	-		0	36	29000	29000	180
Lum Arm #2					-	-		0	36	29000	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	6	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	in	Double Top Nuts	Yes
A.B. Bolt Circle	24.00	in	Foundation Diameter	48
Baseplate Dia.	30.00	in	Concrete Cover	4
Baseplate Thk.	2.00	in	f'c = 28 Day Concrete Comp. Strength	3000
B.P. Center Hole	10.50	in	Vertical Reinforcing Bar Size #	8
Weld Type	Full Pen.		Rebar Yield Strength fy	60
				ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50	in
Flange Plate Length (V)	24.00	in
Flange Plate Width (H)	24.00	in
Spac. Between Bolt (V)	19.50	in
Spac. Between Bolt (H)	19.50	in
Flange Plate Thk.	2.00	in
Flange Plate Yield (Fy)	50	ksi
Gusset Thk.	0.375	in
Plate Center Hole	6.00	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	<b>Shaft At</b>		<b>Arm#1</b>		<b>Arm#2</b>		<b>Lum#1</b>		<b>Lum#2</b>		<b>Tip Deflection (in)</b>	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.18	0.26	0.38								10.68	0.00
GP II CSR	0.50	0.41	0.73									
GP III CSR	0.39	0.41	0.63								18.90	

Arm #1 Flange Bolt (Max.) CSR	0.19
Arm #1 Flange Bolt Fatigue CSR	0.00
Arm #1 Flange Plate (Max.) CSR	0.33
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.00
Handhole at Toe (Fatigue) CSR	0.00
Minimum Qty of Vertical Reinf. Bars	3

Fatigue Allowable - Shaft to Baseplate	
Fatigue Allowable - Arm#1 to Flange	
Fatigue Allowable - Arm#2 to Flange	
Anchor Bolt Max. CSR	0.31
Anchor Bolt Max. Fatigue Stress Ratio	0.00
Base Plate Max. CSR	0.37
Anchorage Capacity S.F.	2.87
Concrete Pull Out Capacity S.F.	3.29

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
3150	3188	66648	51736



16362-1-10 - VA - 70 MPH - MP-3 Std. Loads - Type A - 40' Arm

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1										
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	12'x2.5' Sign	8			12	2.5	1	30	66	1.20
	#3	5 Section Head w/BP	17	13.75	4			2	42	105	1.20
	#4		Camera	20	1	1			1	3	22
	#5	2.5'x3' Sign	25			2.5	3	1	7.5	22.5	1.13
	#6	3 Section Head w/BP	28	8.7	4			1	26	65	1.20
	#7		Camera	30	1	1			1	3	22
	#8	4 Section Head w/BP	36			3	3.5	1	10.5	26.7	1.13
	#9			39	11	5			1	34	80
	#10										
	#11										
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
	#8										
	#9										
	#10										
	#11										
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										



16362-1-10 - VA - 70 MPH - MP-3 Std. Loads - Type A - 40' Arm

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	15.000	14.852	41.53	0.5285	0.53	1.317	12.91	0.80
2	I	1.06	1.06	14.852	14.704	41.11	0.5285	1.59	1.304	12.79	0.80
3	I	1.06	2.12	14.704	14.555	40.69	0.5285	2.65	1.291	12.66	0.80
4	I	1.06	3.18	14.555	14.407	40.27	0.5285	3.70	1.278	12.54	0.80
5	I	1.06	4.24	14.407	14.259	39.85	0.5285	4.76	1.265	12.42	0.80
6	I	1.06	5.29	14.259	14.111	39.43	0.5285	5.82	1.252	12.29	0.80
7	I	1.06	6.35	14.111	13.962	39.01	0.5285	6.88	1.239	12.17	0.80
8	I	1.06	7.41	13.962	13.814	38.59	0.5285	7.94	1.225	12.05	0.80
9	I	1.06	8.47	13.814	13.666	38.17	0.5285	9.00	1.212	11.92	0.80
10	I	1.06	9.53	13.666	13.518	37.75	0.5284	10.06	1.199	11.80	0.80
11	I	1.06	10.59	13.518	13.369	37.33	0.5284	11.12	1.186	11.68	0.80
12	I	1.06	11.65	13.369	13.221	36.91	0.5284	12.18	1.173	11.56	0.80
13	I	1.06	12.71	13.221	13.073	36.49	0.5284	13.23	1.160	11.43	1.00
14	I	1.06	13.76	13.073	12.925	36.08	0.5284	14.29	1.147	11.31	1.00
15	I	1.06	14.82	12.925	12.776	35.66	0.5284	15.35	1.134	11.19	1.00
16	I	1.06	15.88	12.776	12.628	35.24	0.5284	16.41	1.121	11.06	1.00
17	I	1.06	16.94	12.628	12.480	34.82	0.5284	17.47	1.108	10.94	1.00
18	J	0.50	18.00	12.480	12.410	16.30	0.2498	18.25	0.519	5.12	1.00
19	I	0.50	18.50	12.410	12.340	16.20	0.2498	18.75	0.516	5.10	1.00
20	I	0.50	19.00	12.340	12.270	16.11	0.2498	19.25	0.513	5.07	1.00
						698					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in <sup>4</sup> )	314.89	179.50	0.00	170.41
Section Modulus (in <sup>3</sup> )	42.70	29.35	0.00	
Cross-Section Area (in <sup>2</sup> )	11.58	9.60	0.00	
Width-Thickness Ratio	60.00	49.92	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	13.845	13.845	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

Shaft Deflection From Arm#1 GP I Load (in)	0.827
Shaft Deflection From Arm#2 GP I Load (in)	0.000

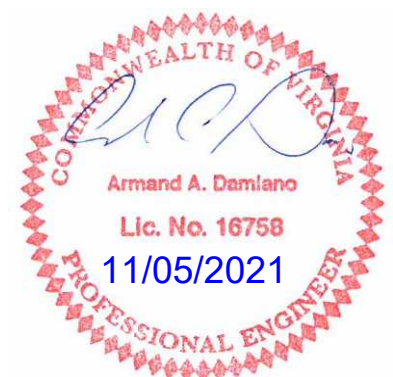




16362-1-10 - VA - 70 MPH - MP-3 Std. Loads - Type A - 40' Arm

## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	10.06	0.000	16.46	1.100	0.000	0.00
2	0.450	7.64	9.96	0.000	16.30	1.100	0.000	0.00
3	0.450	7.64	9.86	0.000	16.14	1.100	0.000	0.00
4	0.450	7.64	9.76	0.000	15.97	1.100	0.000	0.00
5	0.450	7.64	9.66	0.000	15.81	1.100	0.000	0.00
6	0.450	7.64	9.56	0.001	15.64	1.100	0.000	0.00
7	0.450	7.64	9.46	0.001	15.48	1.100	0.000	0.00
8	0.450	7.64	9.36	0.001	15.32	1.100	0.000	0.00
9	0.450	7.64	9.26	0.001	15.15	1.100	0.000	0.00
10	0.450	7.64	9.16	0.002	14.99	1.100	0.000	0.00
11	0.450	7.64	9.06	0.002	14.83	1.100	0.000	0.00
12	0.450	7.64	8.96	0.002	14.66	1.100	0.000	0.00
13	0.450	9.54	11.07	0.003	14.50	1.100	0.000	0.00
14	0.450	9.54	10.94	0.004	14.34	1.100	0.000	0.00
15	0.450	9.54	10.82	0.004	14.17	1.100	0.000	0.00
16	0.450	9.54	10.69	0.004	14.01	1.100	0.000	0.00
17	0.450	9.54	10.57	0.005	13.85	1.100	0.000	0.00
18	0.450	9.54	4.95	0.002	6.48	1.100	0.000	0.00
19	0.450	9.54	4.92	0.003	6.45	1.100	0.000	0.00
20	0.450	9.54	4.89	0.003	6.41	1.100	0.000	0.00
Fix. #1	1.200	20.36	48.86	0.009	30.00	1.200	0.000	0.00
Fix. #2	1.200	20.36	48.86	0.009	30.00	1.200	0.000	0.00
Fix. #3	1.200	25.44	349.80	0.123	174.90	1.200	0.000	0.00
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-10 - VA - 70 MPH - MP-3 Std. Loads - Type A - 40' Arm

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	2.00	0.00	12.000	11.720	44.8	0.9961	1.00	1.977	1.977	19.57
2	I	2.00	2.00	11.720	11.440	43.7	0.9960	3.00	1.930	1.930	19.13
3	I	2.00	4.00	11.440	11.160	42.6	0.9959	5.00	1.883	1.883	18.69
4	I	2.00	6.00	11.160	10.880	41.6	0.9958	7.00	1.837	1.837	18.25
5	I	2.00	8.00	10.880	10.600	40.5	0.9957	9.00	1.790	1.790	17.81
6	I	2.00	10.00	10.600	10.320	39.4	0.9955	11.00	1.743	1.743	17.37
7	I	2.00	12.00	10.320	10.040	38.3	0.9954	13.00	1.697	1.697	16.93
8	I	2.00	14.00	10.040	9.760	37.3	0.9953	15.00	1.650	1.650	16.49
9	I	2.00	16.00	9.760	9.480	36.2	0.9951	17.00	1.603	1.603	16.05
10	I	2.00	18.00	9.480	9.200	35.1	0.9950	19.00	1.557	1.557	15.61
11	I	2.00	20.00	9.200	8.920	34.0	0.9948	20.99	1.510	1.510	15.17
12	I	2.00	22.00	8.920	8.640	33.0	0.9947	22.99	1.463	1.463	14.73
13	I	2.00	24.00	8.640	8.360	31.9	0.9945	24.99	1.417	1.417	14.29
14	I	2.00	26.00	8.360	8.080	30.8	0.9943	26.99	1.370	1.370	13.85
15	I	2.00	28.00	8.080	7.800	29.8	0.9941	28.99	1.323	1.323	13.41
16	I	2.00	30.00	7.800	7.520	28.7	0.9939	30.99	1.277	1.277	12.97
17	I	2.00	32.00	7.520	7.240	27.6	0.9937	32.99	1.230	1.230	12.53
18	I	2.00	34.00	7.240	6.960	26.5	0.9934	34.99	1.183	1.183	12.10
19	I	2.00	36.00	6.960	6.680	25.5	0.9932	36.99	1.137	1.137	11.66
20	I	2.00	38.00	6.680	6.400	24.4	0.9929	38.99	1.090	1.090	11.22
		<u>40.00</u>				<u>692</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	66	8.00	30.000	1.000	90.00
Fix. #3	105	17.00	13.750	2.000	126.00
Fix. #4	22	20.00	1.000	1.000	9.00
Fix. #5	22.5	25.00	7.500	1.000	22.50
Fix. #6	65	28.00	8.700	1.000	78.00
Fix. #7	22	30.00	1.000	1.000	9.00
Fix. #8	26.7	36.00	10.500	1.000	31.50
Fix. #9	80	39.00	11.000	1.000	102.00
Fix. #10	0	0.00	0.000	0.000	0.00
Fix. #11	0	0.00	0.000	0.000	0.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	19.667	0.000
Cross-Section Area (in^2)	6.655	0.000
Width-Thickness Ratio	66.93	0.00
Compact Limit	68.55	0.00
Non-Compact Limit	137.09	0.00
Maximum Limit	237.27	0.00
Allow. Bending Stress (ksi)	36.300	0.000
Allow. Shear Stress (ksi)	18.150	0.000



16362-1-10 - VA - 70 MPH - MP-3 Std. Loads - Type A - 40' Arm

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000 Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	18.86	24.71	1.100	0.000	0.00	0	0.787	0.00	0.00	
2	1.00	0.450	9.54	18.41	24.13	1.100	0.000	0.00	0	0.811	0.00	0.00	
3	1.00	0.450	9.54	17.97	23.54	1.100	0.000	0.00	0	0.838	0.00	0.00	
4	1.00	0.450	9.54	17.52	22.96	1.100	0.000	0.00	0	0.865	0.00	0.00	
5	1.00	0.461	9.78	17.51	22.38	1.100	0.000	0.00	0	0.895	0.00	0.00	
6	1.00	0.477	10.13	17.66	21.79	1.100	0.000	0.00	0	0.926	0.00	0.00	
7	1.00	0.495	10.49	17.80	21.21	1.100	0.000	0.00	0	0.959	0.00	0.00	
8	1.00	0.513	10.88	17.95	20.63	1.100	0.000	0.00	0	0.995	0.00	0.00	
9	1.00	0.532	11.29	18.10	20.04	1.100	0.000	0.00	0	1.033	0.00	0.00	
10	1.00	0.553	11.73	18.26	19.46	1.100	0.000	0.00	0	1.073	0.00	0.00	
11	1.00	0.575	12.21	18.44	18.88	1.100	0.000	0.00	0	1.100	0.00	0.00	
12	1.00	0.599	12.71	18.60	18.29	1.100	0.000	0.00	0	1.100	0.00	0.00	
13	1.00	0.625	13.26	18.79	17.71	1.100	0.000	0.00	1	1.100	0.00	0.00	
14	1.00	0.653	13.85	18.97	17.13	1.100	0.000	0.00	1	1.100	0.00	0.00	
15	1.00	0.683	14.49	19.18	16.54	1.100	0.000	0.00	1	1.100	0.00	0.00	
16	1.00	0.716	15.18	19.38	15.96	1.100	0.000	0.00	1	1.100	0.00	0.00	
17	1.00	0.751	15.93	19.59	15.38	1.100	0.000	0.00	1	1.100	0.00	0.00	
18	1.00	0.790	16.75	19.82	14.79	1.100	0.000	0.00	1	1.100	0.00	0.00	
19	1.00	0.833	17.65	20.06	14.21	1.100	0.000	0.00	1	1.100	0.00	0.00	
20	1.00	0.879	18.64	20.32	13.63	1.100	0.000	0.00	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.199	25.43	762.90	381.45	1.199	0.000	0.00	0	1.199	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #5	1.00	1.134	24.05	180.38	93.75	1.134	0.000	0.00	1	1.134	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	221.33	110.66	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #8	1.00	1.132	24.00	252.00	131.25	1.132	0.000	0.00	1	1.132	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	279.84	139.92	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #11	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



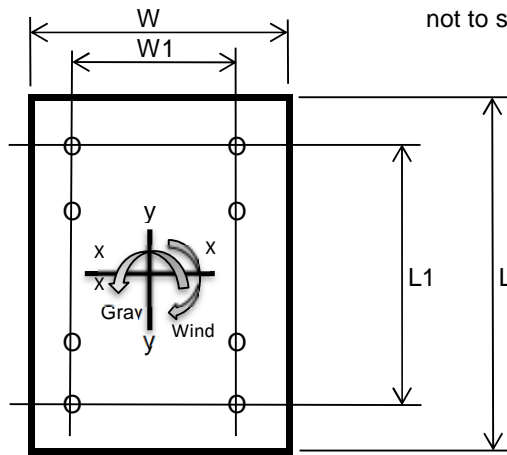
Flange Analysis - Arm #1

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	1123	1908	-	lbs
Shear (Wind)	2496	1453	-	lbs
Torsion (Arm Rise)	5232	3047	-	ft-lbs
Moment (Gravity)	22366	39143	-	ft-lbs
Moment (Wind)	51736	29225	-	ft-lbs
Nat. Wind Moment	-	-	-	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	12.00	in
Tube Wall Thick.	0.1793	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.00
W	24
W1	19.50
L	24
L1	19.50
L2 - Dist. between bolts (Typ.)	6.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	596.99	596.99	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1073.57	1073.57	in <sup>4</sup>
Bolt Tensile Stress - ft	7.15	8.31	ksi
Bolt Shear Stress - fv	0.83	0.57	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.17	0.19	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	0	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	5.65	9.88	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	13.28	7.51	ksi
Combined applied stress for interaction (SRSS)	14.43	12.41	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



16362-1-10 - VA - 70 MPH - MP-3 Std. Loads - Type A - 40' Arm

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

<b>Arm#1 Base</b>											
Gp I	1123		1123	22366		22366		338	13647		0.38
Gp II	1123	2496	2737	22366	51736	56364	5232	823	34392	1597	0.73
Gp III	1908	1453	2399	39143	29225	48850	3047	721	29807	930	0.63
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Arm#1 Joint</b>											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Arm#2 Base</b>											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Arm#2 Joint</b>											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Lum#1 Base</b>											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

<b>Lum#2 Base</b>											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-10 - VA - 70 MPH - MP-3 Std. Loads - Type A - 40' Arm

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	1985		22366	0	22366		171		6286		0.18
Gp II	1985	3188	32397	58244	66648	51736	171	551	18732	7270	0.50
Gp III	3150	2004	29209	50849	58641	29225	272	347	16481	4107	0.39
Gp IV Natural			0	0	0				0		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9966										

<b>Shaft At Arm</b>											
Gp I	1171		22366	0	22366		122		9143		0.26
Gp II	1171	2511	5232	22377	22981	51736	122	523	9395	10575	0.41
Gp III	1956	1473	3047	39158	39276	29225	204	307	16056	5974	0.41
Gp IV Natural			0	0	0				0		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9966										



16362-1-10 - VA - 70 MPH - MP-3 Std. Loads - Type A - 40' Arm

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	3188 lbs
Bending Moment	66648 ft-lbs
Torsion Moment	51736 ft-lbs
Num. Anchor Bolts	6
Bolt Circle	24 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	30 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	15.00 in

**ANALYSIS - ANCHOR BOLTS**

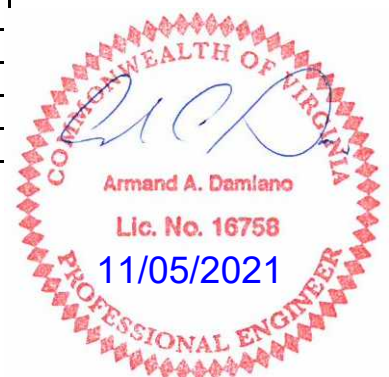
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1082.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	12.00 in
Bolt Tensile Stress	8.862 ksi
Bolt Direct Shear Stress	0.232 ksi
Bolt Torsion Shear Stress	3.75 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	8.862 ksi
$f_v =$	3.982 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.31 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	12.701 in
Dist. Shaft Face To Bolt Center	4.5 in
Design Moment	100 in-kip
Section Modulus of Failure Plane	8.46 in <sup>3</sup>
Applied Plate Stress	11.83 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	12.052 in
Dist From Shaft To Nut Face	2.938 in
Design Moment	66 in-kip
Section Modulus of Failure Plane	8.03 in <sup>3</sup>
Applied Plate Stress	8.22 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>





16362-1-10 - VA - 70 MPH - MP-3 Std. Loads - Type A - 40' Arm

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	0 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1082.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	12.00 in
Bolt Tensile Stress	0 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	127540 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	11 in
T Reduced For Group Action	63770 lbs
Maximum Applied Tensile Load	22155 lbs
Computed Factor-of Safety	2.87 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	22155 lbs
Total Tensile Load	132930 lbs
Concrete Failure Surface Area	4002.39 in <sup>2</sup>
Concrete Shear Strength	438440 psi
Computed Factor-of Safety	3.29 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	22155 lbs
Total Tensile Load	132930 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	45.36 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	3 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-11 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 60' Arm

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<b>Fatigue Importance Factors</b>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	0		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.50	19.50	-	-	-	0	55	29000	-
Traffic Arm #1	0.2500	0.14	15.58	23.69	18.00	-	3.14	0	55	29000	180
	0.1793	0.14	13.00	39.00	-	2.69		0	55	29000	
Traffic Arm #2								0	55	29000	90
								0	55	29000	
Lum Arm #1								0	36	29000	180
Lum Arm #2								0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8		Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	in	Double Top Nuts	Yes	
A.B. Bolt Circle	26.00	in	Foundation Diameter	48	in
Baseplate Dia.	32.00	in	Concrete Cover	4	in
Baseplate Thk.	2.00	in	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	14.25	in	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.		Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1		Arm #2	
Flange Bolt Qty.	8		NA	
Bolt Diameter	1.50	in		in
Flange Plate Length (V)	27.00	in		in
Flange Plate Width (H)	27.00	in		in
Spac. Between Bolt (V)	22.50	in		in
Spac. Between Bolt (H)	22.50	in		in
Flange Plate Thk.	2.25	in		in
Flange Plate Yield (Fy)	50	ksi		ksi
Gusset Thk.	0.500	in		in
Plate Center Hole	6.00	in		in
Weld Type	Full Pen.			

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.23	0.29	0.43	0.34							19.71	0.00
GP II CSR	0.40	0.38	0.66	0.58								
GP III CSR	0.38	0.42	0.63	0.54							33.00	
Nat.Wind (psi)	2587	444	6306	5372								

Arm #1 Flange Bolt (Max.) CSR	0.40
Arm #1 Flange Bolt Fatigue CSR	0.33
Arm #1 Flange Plate (Max.) CSR	0.47
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.60
Handhole at Toe (Fatigue) CSR	0.39
Minimum Qty of Vertical Reinf. Bars	5

Fatigue Allowable - Shaft to Baseplate	4.5 ksi
Fatigue Allowable - Arm#1 to Flange	7 ksi
Fatigue Allowable - Arm#2 to Flange	-
Anchor Bolt Max. CSR	0.40
Anchor Bolt Max. Fatigue Stress Ratio	0.26
Base Plate Max. CSR	0.43
Anchorage Capacity S.F.	2.24
Concrete Pull Out Capacity S.F.	2.13

**Ground Line Reactions**

	Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
	5112	4089	120130	104534



16362-1-11 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 60' Arm

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd	
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20	
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20	
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20	
	#4											
Lum #1	#1											
Lum #2	#1											
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20	
	#2	15'x2.5' Sign	12.5			15	2.5	1	37.5	88.5	1.21	
	#3	5 Section Head w/BP	26	13.75	4			2	42	105	1.20	
	#4		2.5'x3' Sign	34			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	37	8.7	4			1	26	65	1.20	
	#6		Camera	46	1	1			1	3	22	1.20
	#7	2.5'x3' Sign	45			2.5	3	1	7.5	22.5	1.13	
	#8	3 Section Head w/BP	48	8.7	4			1	26	65	1.20	
	#9		Camera	57	1	1			1	3	22	1.20
	#10	3'x3.5' Sign	56			3	3.5	1	10.5	26.7	1.13	
	#11	4 Section Head w/BP	59	11	5			1	34	80	1.20	
	#12											
	#13											
	#14											
	#15											
	#16											
	#17											
	#18											
	#19											
	#20											
For Arm #2	#1											
	#2											
	#3											
	#4											
	#5											
	#6											
	#7											
	#8											
	#9											
	#10											
	#11											
	#12											
	#13											
	#14											
	#15											
	#16											
	#17											
	#18											
	#19											
	#20											



16362-1-11 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 60' Arm

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.500	19.352	67.61	0.5287	0.53	1.714	16.65	0.80
2	I	1.06	1.06	19.352	19.204	67.08	0.5287	1.59	1.701	16.53	0.80
3	I	1.06	2.12	19.204	19.055	66.56	0.5287	2.65	1.688	16.41	0.80
4	I	1.06	3.18	19.055	18.907	66.03	0.5287	3.71	1.675	16.28	0.80
5	I	1.06	4.24	18.907	18.759	65.51	0.5287	4.76	1.662	16.16	0.80
6	I	1.06	5.29	18.759	18.611	64.99	0.5287	5.82	1.649	16.04	0.80
7	I	1.06	6.35	18.611	18.462	64.46	0.5287	6.88	1.636	15.91	0.80
8	I	1.06	7.41	18.462	18.314	63.94	0.5287	7.94	1.622	15.79	0.80
9	I	1.06	8.47	18.314	18.166	63.41	0.5287	9.00	1.609	15.67	0.80
10	I	1.06	9.53	18.166	18.018	62.89	0.5287	10.06	1.596	15.54	0.80
11	I	1.06	10.59	18.018	17.869	62.36	0.5287	11.12	1.583	15.42	0.80
12	I	1.06	11.65	17.869	17.721	61.84	0.5287	12.18	1.570	15.30	0.80
13	I	1.06	12.71	17.721	17.573	61.31	0.5287	13.23	1.557	15.17	1.00
14	I	1.06	13.76	17.573	17.425	60.79	0.5287	14.29	1.544	15.05	1.00
15	I	1.06	14.82	17.425	17.276	60.27	0.5287	15.35	1.531	14.93	1.00
16	I	1.06	15.88	17.276	17.128	59.74	0.5287	16.41	1.518	14.80	1.00
17	I	1.06	16.94	17.128	16.980	59.22	0.5286	17.47	1.505	14.68	1.00
18	J	0.50	18.00	16.980	16.910	27.78	0.2498	18.25	0.706	6.89	1.00
19	I	0.50	18.50	16.910	16.840	27.66	0.2498	18.75	0.703	6.86	1.00
20	I	0.50	19.00	16.840	16.770	27.55	0.2498	19.25	0.700	6.83	1.00
						1161					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in^4)	866.45	567.94	0.00	546.74
Section Modulus (in^3)	90.31	68.15	0.00	
Cross-Section Area (in^2)	18.83	16.35	0.00	
Width-Thickness Ratio	62.40	54.34	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	20.514	20.514	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

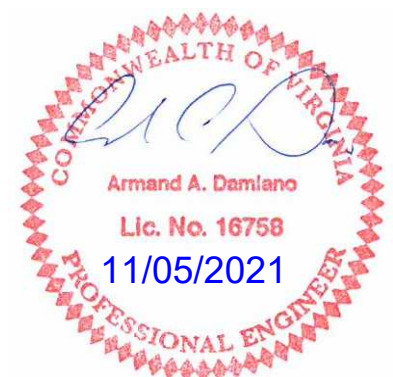
Shaft Deflection From Arm#1 GP I Load (in)	0.754
Shaft Deflection From Arm#2 GP I Load (in)	0.000



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## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	13.10	0.000	21.43	1.100	4.576	7.84
2	0.450	7.64	13.00	0.000	21.26	1.100	4.576	7.78
3	0.450	7.64	12.90	0.000	21.10	1.100	4.576	7.72
4	0.450	7.64	12.80	0.000	20.94	1.100	4.576	7.66
5	0.450	7.64	12.70	0.000	20.77	1.100	4.576	7.60
6	0.450	7.64	12.60	0.000	20.61	1.100	4.576	7.54
7	0.450	7.64	12.50	0.000	20.44	1.100	4.576	7.48
8	0.450	7.64	12.40	0.000	20.28	1.100	4.576	7.42
9	0.450	7.64	12.30	0.001	20.12	1.100	4.576	7.36
10	0.450	7.64	12.20	0.001	19.95	1.100	4.576	7.30
11	0.450	7.64	12.10	0.001	19.79	1.100	4.576	7.24
12	0.450	7.64	12.00	0.001	19.63	1.100	4.576	7.19
13	0.450	9.54	14.85	0.001	19.46	1.100	4.576	7.13
14	0.450	9.54	14.73	0.002	19.30	1.100	4.576	7.07
15	0.450	9.54	14.61	0.002	19.14	1.100	4.576	7.01
16	0.450	9.54	14.48	0.002	18.97	1.100	4.576	6.95
17	0.450	9.54	14.36	0.002	18.81	1.100	4.576	6.89
18	0.450	9.54	6.74	0.001	8.83	1.100	4.576	3.23
19	0.450	9.54	6.71	0.001	8.79	1.100	4.576	3.22
20	0.450	9.54	6.68	0.001	8.75	1.100	4.576	3.20
Fix. #1	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.043	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-11 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 60' Arm

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	3.00	0.00	15.580	15.160	121.2	1.4932	1.49	3.843	3.843	37.63
2	I	3.00	3.00	15.160	14.740	117.9	1.4930	4.49	3.738	3.738	36.64
3	I	3.00	6.00	14.740	14.320	114.5	1.4928	7.49	3.633	3.633	35.65
4	I	3.00	9.00	14.320	13.900	111.1	1.4926	10.49	3.528	3.528	34.66
5	I	3.00	12.00	13.900	13.480	107.8	1.4923	13.49	3.423	3.423	33.67
6	I	3.00	15.00	13.480	13.060	104.4	1.4921	16.49	3.318	3.318	32.68
7	I	3.00	18.00	13.060	12.640	101.0	1.4918	19.49	3.213	3.213	31.69
8	J	2.69	21.00	13.000	12.623	152.9	1.3384	22.34	2.872	2.872	28.33
9	O	3.03	23.69	12.623	12.200	70.9	1.5043	25.19	3.130	3.130	30.92
10	O	3.03	26.72	12.200	11.776	68.5	1.5040	28.22	3.023	3.023	29.91
11	O	3.03	29.74	11.776	11.353	66.0	1.5037	31.25	2.916	2.916	28.91
12	O	3.03	32.77	11.353	10.929	63.6	1.5033	34.27	2.809	2.809	27.90
13	O	3.03	35.79	10.929	10.505	61.1	1.5029	37.30	2.702	2.702	26.89
14	O	3.03	38.82	10.505	10.082	58.7	1.5025	40.32	2.596	2.596	25.89
15	O	3.03	41.85	10.082	9.658	56.2	1.5021	43.35	2.489	2.489	24.88
16	O	3.03	44.87	9.658	9.234	53.7	1.5016	46.37	2.382	2.382	23.87
17	O	3.03	47.90	9.234	8.811	51.3	1.5011	49.40	2.275	2.275	22.87
18	O	3.03	50.92	8.811	8.387	48.8	1.5005	52.42	2.168	2.168	21.86
19	O	3.03	53.95	8.387	7.964	46.4	1.4999	55.45	2.061	2.061	20.85
20	O	3.03	56.97	7.964	7.540	43.9	1.4991	58.47	1.955	1.955	19.85
		<u>60.00</u>				<u>1620</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	12.50	37.500	1.000	112.50
Fix. #3	105	26.00	13.750	2.000	126.00
Fix. #4	22.5	34.00	7.500	1.000	22.50
Fix. #5	65	37.00	8.700	1.000	78.00
Fix. #6	22	46.00	1.000	1.000	9.00
Fix. #7	22.5	45.00	7.500	1.000	22.50
Fix. #8	65	48.00	8.700	1.000	78.00
Fix. #9	22	57.00	1.000	1.000	9.00
Fix. #10	26.7	56.00	10.500	1.000	31.50
Fix. #11	80	59.00	11.000	1.000	102.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	46.120	23.135
Cross-Section Area (in^2)	12.034	7.218
Width-Thickness Ratio	62.32	72.50
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	36.300	35.489
Allow. Shear Stress (ksi)	18.150	18.150





16362-1-11 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 60' Arm

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000 Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	36.66	48.03	1.100	4.576	17.58	0	0.562	0.00	0.00	
2	1.00	0.450	9.54	35.66	46.72	1.100	4.576	17.10	0	0.582	0.00	0.00	
3	1.00	0.450	9.54	34.65	45.41	1.100	4.576	16.62	0	0.604	0.00	0.00	
4	1.00	0.450	9.54	33.65	44.09	1.100	4.576	16.14	0	0.628	0.00	0.00	
5	1.00	0.450	9.54	32.65	42.78	1.100	4.576	15.66	0	0.653	0.00	0.00	
6	1.00	0.450	9.54	31.65	41.47	1.100	4.576	15.18	0	0.680	0.00	0.00	
7	1.00	0.450	9.54	30.65	40.16	1.100	4.576	14.70	0	0.709	0.00	0.00	
8	1.00	0.450	9.54	27.40	35.90	1.100	4.576	13.14	0	0.711	0.00	0.00	
9	1.00	0.450	9.54	29.86	39.12	1.100	4.576	14.32	0	0.741	0.00	0.00	
10	1.00	0.450	9.54	28.84	37.79	1.100	4.576	13.83	0	0.776	0.00	0.00	
11	1.00	0.450	9.54	27.82	36.45	1.100	4.576	13.34	0	0.813	0.00	0.00	
12	1.00	0.450	9.54	26.80	35.11	1.100	4.576	12.85	0	0.853	0.00	0.00	
13	1.00	0.463	9.81	26.51	33.78	1.100	4.576	12.37	0	0.897	0.00	0.00	
14	1.00	0.488	10.34	26.84	32.44	1.100	4.576	11.88	0	0.946	0.00	0.00	
15	1.00	0.515	10.92	27.18	31.11	1.100	4.576	11.39	0	0.999	0.00	0.00	
16	1.00	0.545	11.56	27.53	29.77	1.100	4.576	10.90	1	1.057	0.00	0.00	
17	1.00	0.579	12.27	27.92	28.44	1.100	4.576	10.41	1	1.100	0.00	0.00	
18	1.00	0.616	13.06	28.32	27.10	1.100	4.576	9.92	1	1.100	0.00	0.00	
19	1.00	0.658	13.95	28.76	25.77	1.100	4.576	9.43	1	1.100	0.00	0.00	
20	1.00	0.705	14.95	29.22	24.43	1.100	4.576	8.94	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00





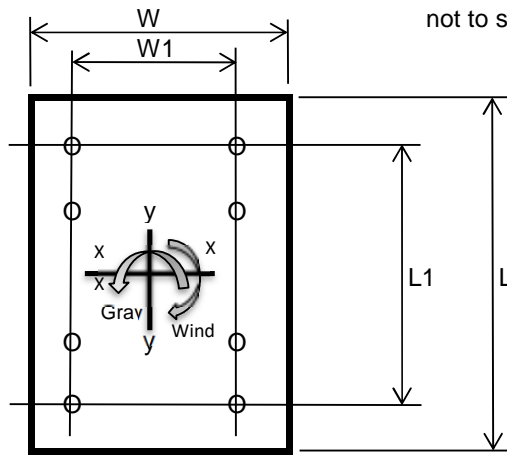
Flange Analysis - Arm #1

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	2161	3337	-	lbs
Shear (Wind)	3319	2098	-	lbs
Torsion (Arm Rise)	10435	6598	-	ft-lbs
Moment (Gravity)	58769	96007	-	ft-lbs
Moment (Wind)	104534	63624	-	ft-lbs
Nat. Wind Moment	-	-	24233	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	15.58	in
Tube Wall Thick.	0.25	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	14.05	17.39	ksi
Bolt Shear Stress - fv	1.36	1	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Fv =	44.22	44.22	ksi
Allowable Shear Stress = Ft =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.33	0.40	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	2.29	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.33	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	9.97	16.28	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	18.03	10.98	ksi
Combined applied stress for interaction (SRSS)	20.60	19.64	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



16362-1-11 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 60' Arm

Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.50	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.333333	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.730769	
Kf - Fatigue stress concentration factor for finite life	2.31	
Ki - Fatigue stress concentration factor for infinite life	5.05	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.25	in
Dt - Arm base diameter	15.58	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	2.04	
Dop - Baseplate center hole diameter	6	in
Cop - Center hole to arm diameter ratio	0.385109	
Kf - Fatigue stress concentration factor for finite life	1.83	
Ki - Fatigue stress concentration factor for infinite life	3.50	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle



## 16362-1-11 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 60' Arm

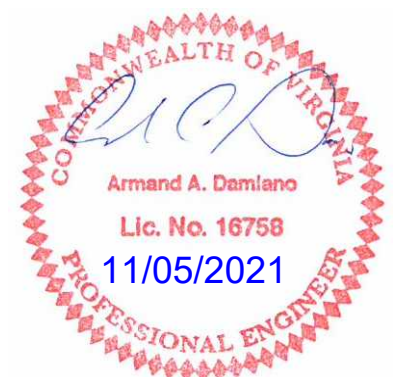
## Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	19.07	in
Shaft Thickness	0.313	in
Total Area	23.571	in <sup>2</sup>
Ix	911	in <sup>4</sup>
Iy	1023	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	19467	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	9.62	ksi
CSR	0.60	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	2.71	ksi
CSR	0.39	
Therefore	<b>OK</b>	



16362-1-11 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 60' Arm

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	2161		2161	58769		58770		360	15292		0.43
Gp II	2161	3319	3961	58769	104534	119922	10435	659	31203	1358	0.66
Gp III	3337	2098	3942	96007	63624	115176	6598	656	29968	859	0.63
Gp IV Natural		799	799		24233	24233	2514	133	6306	328	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

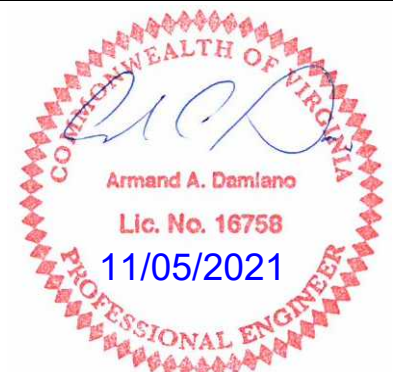
Arm#1 Joint											
Gp I	1273		1273	22969		22969		353	11914		0.34
Gp II	1273	2099	2455	22969	45981	51399	6599	681	26661	1712	0.58
Gp III	2084	1298	2456	39262	27203	47766	4080	681	24776	1059	0.54
Gp IV Natural		493	493		10356	10356	1552	137	5372	403	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Lum#1 Base											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Lum#2 Base											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-11 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 60' Arm

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	3487		58769	0	58769		185		7809		0.23
Gp II	3487	4089	70173	81515	107559	104534	185	435	14291	6945	0.40
Gp III	5112	2755	44369	111636	120130	63624	271	293	15962	4227	0.38
Gp IV Natural			19467	0	19467				2587		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9978										

<b>Shaft At Arm</b>											
Gp I	2244		58769	0	58769		137		10348		0.29
Gp II	2244	3339	10435	58785	59704	104534	137	409	10513	9203	0.38
Gp III	3420	2125	6598	96027	96253	63624	209	260	16949	5602	0.42
Gp IV Natural			2521	0	2521				444		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9978										



16362-1-11 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 60' Arm

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	4089 lbs
Bending Moment	120130 ft-lbs
Torsion Moment	104534 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.50 in

**ANALYSIS - ANCHOR BOLTS**

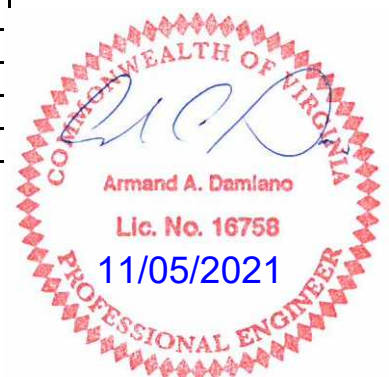
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	11.063 ksi
Bolt Direct Shear Stress	0.223 ksi
Bolt Torsion Shear Stress	5.245 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	11.063 ksi
$f_v =$	5.468 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.4 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.25 in
Design Moment	90 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	13.6 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.688 in
Design Moment	47 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	7.45 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-11 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 60' Arm

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	19467 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	1.8 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.26
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

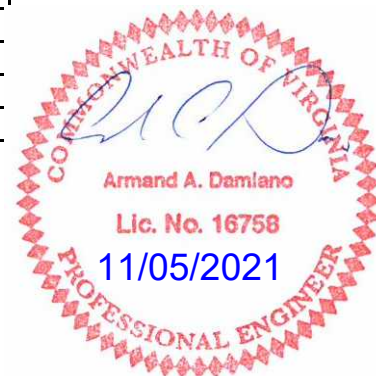
Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	27658 lbs
Computed Factor-of Safety	2.24 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	27658 lbs
Total Tensile Load	221264 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	2.13 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	27658 lbs
Total Tensile Load	221264 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	5 Qty.





**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-12 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 65' Arm

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<i>Fatigue Importance Factors</i>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	0		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.50	19.50	-	-	-	0	55	29000	-
Traffic Arm #1	0.2500	0.14	16.28	28.69	18.00	-	3.41	0	55	29000	180
	0.1793	0.14	13.00	39.00	-	2.69		0	55	29000	
Traffic Arm #2								0	55	29000	90
								0	55	29000	
Lum Arm #1								0	36	29000	180
Lum Arm #2								0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8		Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	in	Double Top Nuts	Yes	
A.B. Bolt Circle	26.00	in	Foundation Diameter	48	in
Baseplate Dia.	32.00	in	Concrete Cover	4	in
Baseplate Thk.	2.00	in	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	14.25	in	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.		Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50 in	in
Flange Plate Length (V)	27.00 in	in
Flange Plate Width (H)	27.00 in	in
Spac. Between Bolt (V)	22.50 in	in
Spac. Between Bolt (H)	22.50 in	in
Flange Plate Thk.	2.25 in	in
Flange Plate Yield (Fy)	50.00 ksi	ksi
Gusset Thk.	0.500 in	in
Plate Center Hole	6.00 in	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.27	0.35	0.47	0.33							24.24	0.00
GP II CSR	0.48	0.48	0.70	0.56								
GP III CSR	0.45	0.51	0.68	0.52							40.33	
Nat.Wind (psi)	2925	546	6690	5252								

Arm #1 Flange Bolt (Max.) CSR	0.47
Arm #1 Flange Bolt Fatigue CSR	0.38
Arm #1 Flange Plate (Max.) CSR	0.54
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.68
Handhole at Toe (Fatigue) CSR	0.44
Minimum Qty of Vertical Reinf. Bars	6

Fatigue Allowable - Shaft to Baseplate	4.5 ksi
Fatigue Allowable - Arm#1 to Flange	7 ksi
Fatigue Allowable - Arm#2 to Flange	-
Anchor Bolt Max. CSR	0.46
Anchor Bolt Max. Fatigue Stress Ratio	0.29
Base Plate Max. CSR	0.51
Anchorage Capacity S.F.	1.92
Concrete Pull Out Capacity S.F.	1.82

**Ground Line Reactions**

	Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
	5574	4564	140509	120288



16362-1-12 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 65' Arm

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1										
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	15'x2.5' Sign	9.5			15	2.5	1	37.5	88.5	1.21
	#3	5 Section Head w/BP	20	13.75	4			2	42	105	1.20
	#4		2.5'x3' Sign	24			2.5	3	1	7.5	22.5
	#5	3 Section Head w/BP	31	8.7	4			1	26	65	1.20
	#6	Camera	35	1	1			1	3	22	1.20
	#7	2.5'x3' Sign	39			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	42	8.7	4			1	26	65	1.20
	#9	2.5'x3' Sign	50			2.5	3	1	7.5	22.5	1.13
	#10	3 Section Head w/BP	53	8.7	4			1	26	65	1.20
	#11	Camera	57	1	1			1	3	22	1.20
	#12	3'x3.5' Sign	61			3	3.5	1	10.5	26.7	1.13
	#13	4 Section Head w/BP	64	11	5			1	34	80	1.20
#14											
#15											
#16											
#17											
#18											
#19											
#20											
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
	#8										
	#9										
	#10										
	#11										
	#12										
	#13										
#14											
#15											
#16											
#17											
#18											
#19											
#20											



16362-1-12 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 65' Arm

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.500	19.352	67.61	0.5287	0.53	1.714	16.65	0.80
2	I	1.06	1.06	19.352	19.204	67.08	0.5287	1.59	1.701	16.53	0.80
3	I	1.06	2.12	19.204	19.055	66.56	0.5287	2.65	1.688	16.41	0.80
4	I	1.06	3.18	19.055	18.907	66.03	0.5287	3.71	1.675	16.28	0.80
5	I	1.06	4.24	18.907	18.759	65.51	0.5287	4.76	1.662	16.16	0.80
6	I	1.06	5.29	18.759	18.611	64.99	0.5287	5.82	1.649	16.04	0.80
7	I	1.06	6.35	18.611	18.462	64.46	0.5287	6.88	1.636	15.91	0.80
8	I	1.06	7.41	18.462	18.314	63.94	0.5287	7.94	1.622	15.79	0.80
9	I	1.06	8.47	18.314	18.166	63.41	0.5287	9.00	1.609	15.67	0.80
10	I	1.06	9.53	18.166	18.018	62.89	0.5287	10.06	1.596	15.54	0.80
11	I	1.06	10.59	18.018	17.869	62.36	0.5287	11.12	1.583	15.42	0.80
12	I	1.06	11.65	17.869	17.721	61.84	0.5287	12.18	1.570	15.30	0.80
13	I	1.06	12.71	17.721	17.573	61.31	0.5287	13.23	1.557	15.17	1.00
14	I	1.06	13.76	17.573	17.425	60.79	0.5287	14.29	1.544	15.05	1.00
15	I	1.06	14.82	17.425	17.276	60.27	0.5287	15.35	1.531	14.93	1.00
16	I	1.06	15.88	17.276	17.128	59.74	0.5287	16.41	1.518	14.80	1.00
17	I	1.06	16.94	17.128	16.980	59.22	0.5286	17.47	1.505	14.68	1.00
18	J	0.50	18.00	16.980	16.910	27.78	0.2498	18.25	0.706	6.89	1.00
19	I	0.50	18.50	16.910	16.840	27.66	0.2498	18.75	0.703	6.86	1.00
20	I	0.50	19.00	16.840	16.770	27.55	0.2498	19.25	0.700	6.83	1.00
						1161					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in^4)	866.45	567.94	0.00	546.74
Section Modulus (in^3)	90.31	68.15	0.00	
Cross-Section Area (in^2)	18.83	16.35	0.00	
Width-Thickness Ratio	62.40	54.34	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	20.514	20.514	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

Shaft Deflection From Arm#1 GP I Load (in)	0.901
Shaft Deflection From Arm#2 GP I Load (in)	0.000



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## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	13.10	0.000	21.43	1.100	4.576	7.84
2	0.450	7.64	13.00	0.000	21.26	1.100	4.576	7.78
3	0.450	7.64	12.90	0.000	21.10	1.100	4.576	7.72
4	0.450	7.64	12.80	0.000	20.94	1.100	4.576	7.66
5	0.450	7.64	12.70	0.000	20.77	1.100	4.576	7.60
6	0.450	7.64	12.60	0.000	20.61	1.100	4.576	7.54
7	0.450	7.64	12.50	0.000	20.44	1.100	4.576	7.48
8	0.450	7.64	12.40	0.000	20.28	1.100	4.576	7.42
9	0.450	7.64	12.30	0.001	20.12	1.100	4.576	7.36
10	0.450	7.64	12.20	0.001	19.95	1.100	4.576	7.30
11	0.450	7.64	12.10	0.001	19.79	1.100	4.576	7.24
12	0.450	7.64	12.00	0.001	19.63	1.100	4.576	7.19
13	0.450	9.54	14.85	0.001	19.46	1.100	4.576	7.13
14	0.450	9.54	14.73	0.002	19.30	1.100	4.576	7.07
15	0.450	9.54	14.61	0.002	19.14	1.100	4.576	7.01
16	0.450	9.54	14.48	0.002	18.97	1.100	4.576	6.95
17	0.450	9.54	14.36	0.002	18.81	1.100	4.576	6.89
18	0.450	9.54	6.74	0.001	8.83	1.100	4.576	3.23
19	0.450	9.54	6.71	0.001	8.79	1.100	4.576	3.22
20	0.450	9.54	6.68	0.001	8.75	1.100	4.576	3.20
Fix. #1	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.043	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-12 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 65' Arm

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	3.25	0.00	16.280	15.825	137.3	1.6173	1.62	4.348	4.348	42.51
2	I	3.25	3.25	15.825	15.370	133.3	1.6171	4.87	4.224	4.224	41.34
3	I	3.25	6.50	15.370	14.915	129.4	1.6169	8.12	4.101	4.101	40.18
4	I	3.25	9.75	14.915	14.460	125.4	1.6166	11.37	3.978	3.978	39.02
5	I	3.25	13.00	14.460	14.005	121.4	1.6163	14.62	3.855	3.855	37.86
6	I	3.25	16.25	14.005	13.550	117.5	1.6161	17.87	3.731	3.731	36.70
7	I	3.25	19.50	13.550	13.095	113.5	1.6158	21.12	3.608	3.608	35.54
8	I	3.25	22.75	13.095	12.640	109.6	1.6154	24.37	3.485	3.485	34.38
9	J	2.69	26.00	13.000	12.623	152.9	1.3384	27.34	2.872	2.872	28.33
10	O	3.30	28.69	12.623	12.161	77.3	1.6402	30.33	3.409	3.409	33.68
11	O	3.30	31.99	12.161	11.699	74.3	1.6398	33.63	3.282	3.282	32.48
12	O	3.30	35.29	11.699	11.237	71.4	1.6394	36.93	3.155	3.155	31.29
13	O	3.30	38.59	11.237	10.775	68.5	1.6389	40.23	3.027	3.027	30.09
14	O	3.30	41.89	10.775	10.313	65.6	1.6384	43.53	2.900	2.900	28.89
15	O	3.30	45.19	10.313	9.851	62.7	1.6378	46.83	2.773	2.773	27.69
16	O	3.30	48.50	9.851	9.389	59.7	1.6372	50.13	2.646	2.646	26.49
17	O	3.30	51.80	9.389	8.926	56.8	1.6366	53.43	2.519	2.519	25.30
18	O	3.30	55.10	8.926	8.464	53.9	1.6358	56.73	2.392	2.392	24.10
19	O	3.30	58.40	8.464	8.002	51.0	1.6350	60.03	2.265	2.265	22.90
20	O	3.30	61.70	8.002	7.540	48.0	1.6341	63.33	2.138	2.138	21.70
		<u>65.00</u>				<u>1829</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	9.50	37.500	1.000	112.50
Fix. #3	105	20.00	13.750	2.000	126.00
Fix. #4	22.5	24.00	7.500	1.000	22.50
Fix. #5	65	31.00	8.700	1.000	78.00
Fix. #6	22	35.00	1.000	1.000	9.00
Fix. #7	22.5	39.00	7.500	1.000	22.50
Fix. #8	65	42.00	8.700	1.000	78.00
Fix. #9	22.5	50.00	7.500	1.000	22.50
Fix. #10	65	53.00	8.700	1.000	78.00
Fix. #11	22	57.00	1.000	1.000	9.00
Fix. #12	26.7	61.00	10.500	1.000	31.50
Fix. #13	80	64.00	11.000	1.000	102.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	50.429	23.135
Cross-Section Area (in^2)	12.584	7.218
Width-Thickness Ratio	65.12	72.50
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	36.300	35.489
Allow. Shear Stress (ksi)	18.150	18.150



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Arm #1 Analysis Continued

Sec. Num.	Kz	Truck Induced Gust											
		Group 2			Group 3	Natural Wind Gust			Hght Corr. Factor = 1.000				Gallop
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	Loads (lbs)
1	1.00	0.450	9.54	41.48	54.34	1.100	4.576	19.89	0	0.531	0.00	0.00	
2	1.00	0.450	9.54	40.30	52.80	1.100	4.576	19.33	0	0.551	0.00	0.00	
3	1.00	0.450	9.54	39.12	51.26	1.100	4.576	18.77	0	0.572	0.00	0.00	
4	1.00	0.450	9.54	37.95	49.72	1.100	4.576	18.20	0	0.596	0.00	0.00	
5	1.00	0.450	9.54	36.77	48.18	1.100	4.576	17.64	0	0.621	0.00	0.00	
6	1.00	0.450	9.54	35.60	46.64	1.100	4.576	17.07	0	0.647	0.00	0.00	
7	1.00	0.450	9.54	34.42	45.10	1.100	4.576	16.51	0	0.676	0.00	0.00	
8	1.00	0.450	9.54	33.25	43.56	1.100	4.576	15.95	0	0.707	0.00	0.00	
9	1.00	0.450	9.54	27.40	35.90	1.100	4.576	13.14	0	0.711	0.00	0.00	
10	1.00	0.450	9.54	32.52	42.61	1.100	4.576	15.60	0	0.743	0.00	0.00	
11	1.00	0.450	9.54	31.31	41.02	1.100	4.576	15.02	0	0.781	0.00	0.00	
12	1.00	0.450	9.54	30.09	39.43	1.100	4.576	14.44	0	0.822	0.00	0.00	
13	1.00	0.450	9.54	28.88	37.84	1.100	4.576	13.85	0	0.867	0.00	0.00	
14	1.00	0.473	10.02	29.06	36.25	1.100	4.576	13.27	0	0.916	0.00	0.00	
15	1.00	0.501	10.62	29.45	34.67	1.100	4.576	12.69	0	0.971	0.00	0.00	
16	1.00	0.532	11.29	29.87	33.08	1.100	4.576	12.11	0	1.033	0.00	0.00	
17	1.00	0.568	12.04	30.33	31.49	1.100	4.576	11.53	1	1.101	0.00	0.00	
18	1.00	0.607	12.87	30.78	29.90	1.100	4.576	10.95	1	1.100	0.00	0.00	
19	1.00	0.652	13.82	31.30	28.31	1.100	4.576	10.36	1	1.100	0.00	0.00	
20	1.00	0.703	14.9	31.85	26.72	1.100	4.576	9.78	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #10	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #13	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00





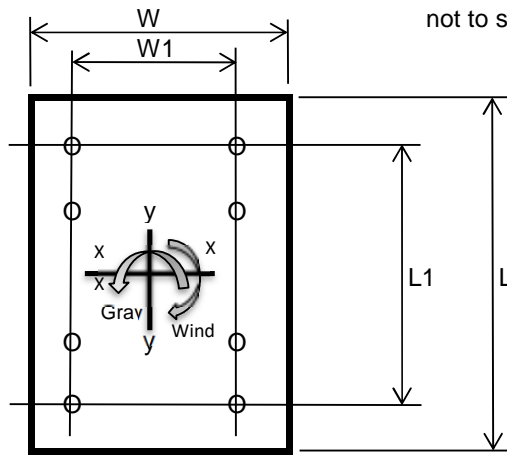
Flange Analysis - Arm #1

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	2458	3799	-	lbs
Shear (Wind)	3784	2386	-	lbs
Torsion (Arm Rise)	12888	8126	-	ft-lbs
Moment (Gravity)	70215	113930	-	ft-lbs
Moment (Wind)	120288	73912	-	ft-lbs
Nat. Wind Moment	-	-	28111	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	16.28	in
Tube Wall Thick.	0.25	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	16.48	20.59	ksi
Bolt Shear Stress - fv	1.65	1.2	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.39	0.47	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	2.66	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.38	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	11.71	19.00	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	20.40	12.54	ksi
Combined applied stress for interaction (SRSS)	23.52	22.77	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	





16362-1-12 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 65' Arm

Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

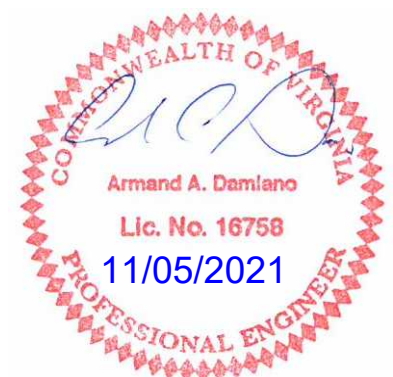
Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.50	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.333333	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.730769	
Kf - Fatigue stress concentration factor for finite life	2.31	
Ki - Fatigue stress concentration factor for infinite life	5.05	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.25	in
Dt - Arm base diameter	16.28	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	1.95	
Dop - Baseplate center hole diameter	6.00	in
Cop - Center hole to arm diameter ratio	0.36855	
Kf - Fatigue stress concentration factor for finite life	1.80	
Ki - Fatigue stress concentration factor for infinite life	3.44	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle



## 16362-1-12 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 65' Arm

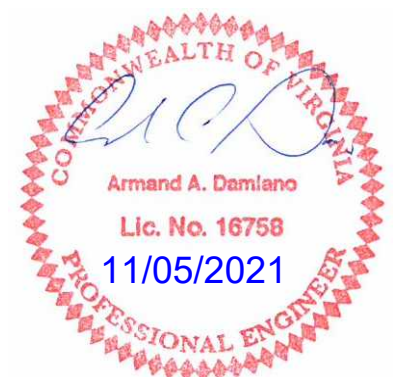
## Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	19.07	in
Shaft Thickness	0.313	in
Total Area	23.571	in <sup>2</sup>
Ix	911	in <sup>4</sup>
Iy	1023	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	22014	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	10.88	ksi
CSR	0.68	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	3.06	ksi
CSR	0.44	
Therefore	<b>OK</b>	



16362-1-12 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 65' Arm

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	2458		2458	70215		70215		391	16709		0.47
Gp II	2458	3784	4513	70215	120288	139282	12888	718	33144	1534	0.70
Gp III	3799	2386	4487	113930	73912	135806	8126	714	32317	967	0.68
Gp IV Natural		909	909		28111	28111	3095	145	6690	369	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	1233		1233	22307		22307		342	11571		0.33
Gp II	1233	1970	2325	22307	44802	50049	6711	645	25960	1741	0.56
Gp III	1996	1233	2347	38171	26615	46534	4201	651	24137	1090	0.52
Gp IV Natural		468	468		10125	10125	1595	130	5252	414	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Lum#1 Base											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Lum#2 Base											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-12 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 65' Arm

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	3784		70215	0	70215		201		9329		0.27
Gp II	3784	4564	80994	95125	124935	120288	201	485	16600	7991	0.48
Gp III	5574	3048	51070	130899	140509	73912	296	324	18669	4910	0.45
Gp IV Natural			22014	0	22014				2925		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9975										

<b>Shaft At Arm</b>											
Gp I	2541		70215	0	70215		155		12364		0.35
Gp II	2541	3804	12888	70230	71403	120288	155	466	12573	10590	0.48
Gp III	3882	2412	8126	113950	114239	73912	237	295	20116	6507	0.51
Gp IV Natural			3102	0	3102				546		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9975										



16362-1-12 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 65' Arm

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	4564 lbs
Bending Moment	140509 ft-lbs
Torsion Moment	120288 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.50 in

**ANALYSIS - ANCHOR BOLTS**

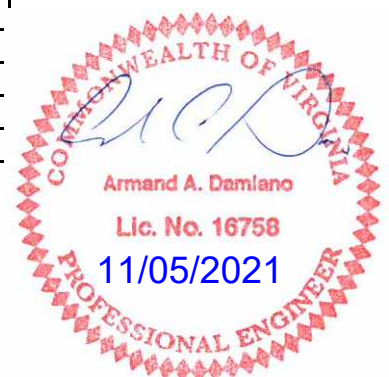
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	12.94 ksi
Bolt Direct Shear Stress	0.249 ksi
Bolt Torsion Shear Stress	6.035 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	12.94 ksi
$f_v =$	6.284 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.46 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.25 in
Design Moment	106 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	16.02 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.688 in
Design Moment	55 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	8.72 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-12 - VA - 70 MPH - MP-3 Std. Loads - Type B1 - 65' Arm

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	22014 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	2.03 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.29
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	32350 lbs
Computed Factor-of Safety	1.92 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	32350 lbs
Total Tensile Load	258800 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	1.82 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	32350 lbs
Total Tensile Load	258800 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	6 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-13 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 30' Arm W/24' Lum.

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<i>Fatigue Importance Factors</i>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.00
Fatigue Cat.	0		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.00
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.00
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	1		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.2500	0.14	15.00	25.00	-	-	-	0	55	29000	-
Traffic Arm #1	0.1793	0.14	12.00	30.00	18.00	-	1.57	0	55	29000	180
Traffic Arm #2						-		0	55	29000	90
Lum Arm #1	0.2760		2.88	24.00	24.00	-	5	0	36	29000	180
Lum Arm #2						-		0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	6	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	Double Top Nuts	Yes	
A.B. Bolt Circle	24.00	Foundation Diameter	48	in
Baseplate Dia.	30.00	Concrete Cover	4	in
Baseplate Thk.	2.00	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	10.50	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.	Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50	in
Flange Plate Length (V)	24.00	in
Flange Plate Width (H)	24.00	in
Spac. Between Bolt (V)	19.50	in
Spac. Between Bolt (H)	19.50	in
Flange Plate Thk.	2.00	in
Flange Plate Yield (Fy)	50	ksi
Gusset Thk.	0.375	in
Plate Center Hole	6.00	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.12	0.17	0.25								4.14	0.00
GP II CSR	0.45	0.29	0.48				0.78					
GP III CSR	0.32	0.29	0.41				0.63				7.36	

Arm #1 Flange Bolt (Max.) CSR	0.13
Arm #1 Flange Bolt Fatigue CSR	0.00
Arm #1 Flange Plate (Max.) CSR	0.22
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.00
Handhole at Toe (Fatigue) CSR	0.00
Minimum Qty of Vertical Reinf. Bars	3

Fatigue Allowable - Shaft to Baseplate	
Fatigue Allowable - Arm#1 to Flange	
Fatigue Allowable - Arm#2 to Flange	
Anchor Bolt Max. CSR	0.28
Anchor Bolt Max. Fatigue Stress Ratio	0.00
Base Plate Max. CSR	0.38
Anchorage Capacity S.F.	2.86
Concrete Pull Out Capacity S.F.	3.28

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
3518	3221	66858	35521





16362-1-13 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 30' Arm W/24' Lum.

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.2
	#2	Ped Head	10.5	2.4	1			1	6	30	1.2
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.2
	#4										
Lum #1	#1	Cobra Head w/Camera	24	2	1			4.54	9	57	1
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	12'x2.5' Sign	7			12	2.5	1	30	66	1.20
	#3	Camera	10	1	1			1	3	22	1.20
	#4	2.5'x3' Sign	15			2.5	3	1	7.5	22.5	1.13
	#5	5 Section Head w/BP	19	13.75	4			2	42	105	1.20
	#6	Camera	21	1	1			1	3	22	1.20
	#7	3'x3.5' Sign	26			3	3.5	1	10.5	26.7	1.13
	#8	4 Section Head w/BP	29	11	5			1	34	80	1.20
	#9										
	#10										
	#11										
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
	#8										
	#9										
	#10										
	#11										
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										



16362-1-13 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 30' Arm W/24' Lum.

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	15.000	14.852	41.53	0.5285	0.53	1.317	12.91	0.80
2	I	1.06	1.06	14.852	14.704	41.11	0.5285	1.59	1.304	12.79	0.80
3	I	1.06	2.12	14.704	14.555	40.69	0.5285	2.65	1.291	12.66	0.80
4	I	1.06	3.18	14.555	14.407	40.27	0.5285	3.70	1.278	12.54	0.80
5	I	1.06	4.24	14.407	14.259	39.85	0.5285	4.76	1.265	12.42	0.80
6	I	1.06	5.29	14.259	14.111	39.43	0.5285	5.82	1.252	12.29	0.80
7	I	1.06	6.35	14.111	13.962	39.01	0.5285	6.88	1.239	12.17	0.80
8	I	1.06	7.41	13.962	13.814	38.59	0.5285	7.94	1.225	12.05	0.80
9	I	1.06	8.47	13.814	13.666	38.17	0.5285	9.00	1.212	11.92	0.80
10	I	1.06	9.53	13.666	13.518	37.75	0.5284	10.06	1.199	11.80	0.80
11	I	1.06	10.59	13.518	13.369	37.33	0.5284	11.12	1.186	11.68	0.80
12	I	1.06	11.65	13.369	13.221	36.91	0.5284	12.18	1.173	11.56	0.80
13	I	1.06	12.71	13.221	13.073	36.49	0.5284	13.23	1.160	11.43	1.00
14	I	1.06	13.76	13.073	12.925	36.08	0.5284	14.29	1.147	11.31	1.00
15	I	1.06	14.82	12.925	12.776	35.66	0.5284	15.35	1.134	11.19	1.00
16	I	1.06	15.88	12.776	12.628	35.24	0.5284	16.41	1.121	11.06	1.00
17	I	1.06	16.94	12.628	12.480	34.82	0.5284	17.47	1.108	10.94	1.00
18	J	3.00	18.00	12.480	12.060	96.37	1.4914	19.49	3.068	30.32	1.00
19	I	3.00	21.00	12.060	11.640	93.00	1.4911	22.49	2.963	29.33	1.00
20	J	1.00	24.00	11.640	11.500	30.25	0.4990	24.50	0.964	9.56	1.00
						869					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in^4)	314.89	179.50	0.00	139.71
Section Modulus (in^3)	42.70	29.35	0.00	
Cross-Section Area (in^2)	11.58	9.60	0.00	
Width-Thickness Ratio	60.00	49.92	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	7.946	7.946	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

Shaft Deflection From Arm#1 GP I Load (in)	0.531
Shaft Deflection From Arm#2 GP I Load (in)	0.000



16362-1-13 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 30' Arm W/24' Lum.

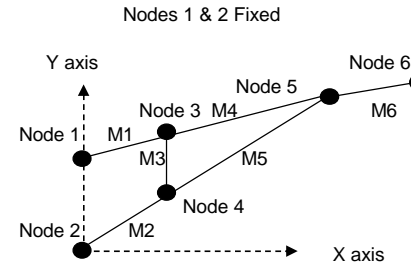
## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	10.06	0.000	16.46	1.100	0.000	0.00
2	0.450	7.64	9.96	0.000	16.30	1.100	0.000	0.00
3	0.450	7.64	9.86	0.000	16.14	1.100	0.000	0.00
4	0.450	7.64	9.76	0.000	15.97	1.100	0.000	0.00
5	0.450	7.64	9.66	0.001	15.81	1.100	0.000	0.00
6	0.450	7.64	9.56	0.001	15.64	1.100	0.000	0.00
7	0.450	7.64	9.46	0.001	15.48	1.100	0.000	0.00
8	0.450	7.64	9.36	0.001	15.32	1.100	0.000	0.00
9	0.450	7.64	9.26	0.002	15.15	1.100	0.000	0.00
10	0.450	7.64	9.16	0.002	14.99	1.100	0.000	0.00
11	0.450	7.64	9.06	0.003	14.83	1.100	0.000	0.00
12	0.450	7.64	8.96	0.003	14.66	1.100	0.000	0.00
13	0.450	9.54	11.07	0.004	14.50	1.100	0.000	0.00
14	0.450	9.54	10.94	0.005	14.34	1.100	0.000	0.00
15	0.450	9.54	10.82	0.006	14.17	1.100	0.000	0.00
16	0.450	9.54	10.69	0.006	14.01	1.100	0.000	0.00
17	0.450	9.54	10.57	0.007	13.85	1.100	0.000	0.00
18	0.450	9.54	29.26	0.023	38.34	1.100	0.000	0.00
19	0.450	9.54	28.26	0.029	37.03	1.100	0.000	0.00
20	0.450	9.54	9.20	0.011	12.05	1.100	0.000	0.00
Fix. #1	1.200	20.36	48.86	0.012	30.00	1.200	0.000	0.00
Fix. #2	1.200	20.36	48.86	0.012	30.00	1.200	0.000	0.00
Fix. #3	1.200	25.44	349.80	0.172	174.90	1.200	0.000	0.00
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-13 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 30' Arm W/24' Lum. - Luminaire Arm - Group II

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-33.67	-24.6	0	0	0
Node #2	0	0	0	0	-35.63	-26	0	0	0
Node #3	100	59.5	0	0	-66.63	-51.3	0	0	0
Node #4	100	48.8	0	0	-69.41	-53.4	0	0	0
Node #5	200	79	0	0	-94.35	-75.6	0	0	0
Node #6	288	87	0	0	-85.29	-69.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-67.33	1.1	1	-49.04	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-71.25	1.1	1	-51.90	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-0.68	1.1	1	-1.18	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-65.23	1.1	1.1	-52.27	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-66.89	1.1	1.1	-53.59	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-56.58	1.1	1.1	-45.33	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-57.00	1	1.1	-46.64					

AASHTO Gp	2
Mntg Hght =	29.00
Datum =	1

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2180.2	lbs
P1y	-694.6	lbs
P1z	178.8	lbs
M1x	6661.9	in-lbs
M1y	-25162.7	in-lbs
M1z	-898.1	in-lbs
P2x	2180.2	lbs
P2y	1079.6	lbs
P2z	121.5	lbs
M2x	6843.3	in-lbs
M2y	-20414.5	in-lbs
M2z	-928.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1018	138	19343	-491	0.55
#2	1071	87	15894	-954	0.78
#3	1489	431	8552	-392	0.35
#4	-1001	64	7424	-23	0.2
#5	1020	75	8261	-288	0.5
#6	4	98	7210	1	0.22

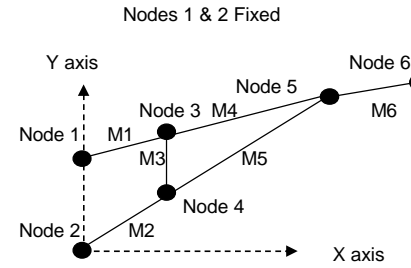
Arm Tip Displacement At Node 6	
X dir	0.103 (in)
Y dir	-0.898 (in)
Z dir	-10.462 (in)

V09.19.15



16362-1-13 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 30' Arm W/24' Lum. - Luminaire Arm - Group III

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-40.85	-13.2	0	0	0
Node #2	0	0	0	0	-43.23	-14	0	0	0
Node #3	100	59.5	0	0	-81.04	-26.6	0	0	0
Node #4	100	48.8	0	0	-84.42	-27.7	0	0	0
Node #5	200	79	0	0	-114.49	-37.8	0	0	0
Node #6	288	87	0	0	-115.33	-36.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-81.69	1.1	1	-26.29	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-86.45	1.1	1	-27.82	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-1.22	1.1	1	-0.63	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-79.16	1.1	1.1	-26.13	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-81.16	1.1	1.1	-26.80	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-68.65	1.1	1.1	-22.67	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-81.00	1	1.1	-25.00					

AASHTO Gp	3
Mntg Hght =	29.00
Datum =	1

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2797.7	lbs
P1y	-898.7	lbs
P1z	92.5	lbs
M1x	3425.6	in-lbs
M1y	-12957.4	in-lbs
M1z	-1426.8	in-lbs
P2x	2797.7	lbs
P2y	1378.1	lbs
P2z	63.2	lbs
M2x	3519.9	in-lbs
M2y	-10515.8	in-lbs
M2z	-1452.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1307	75	10010	-255	0.26
#2	1373	50	8249	-493	0.63
#3	1905	442	8972	-201	0.38
#4	-1287	45	3944	-13	0.08
#5	1311	48	4359	-150	0.46
#6	5	107	7919	1	0.24

Arm Tip Displacement At Node 6	
X dir	0.137 (in)
Y dir	-1.214 (in)
Z dir	-5.396 (in)

V09.19.15



16362-1-13 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 30' Arm W/24' Lum.

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	1.50	0.00	12.000	11.790	33.7	0.7478	0.75	1.487	1.487	14.72
2	I	1.50	1.50	11.790	11.580	33.1	0.7478	2.25	1.461	1.461	14.47
3	I	1.50	3.00	11.580	11.370	32.5	0.7477	3.75	1.434	1.434	14.23
4	I	1.50	4.50	11.370	11.160	31.9	0.7477	5.25	1.408	1.408	13.98
5	I	1.50	6.00	11.160	10.950	31.3	0.7476	6.75	1.382	1.382	13.73
6	I	1.50	7.50	10.950	10.740	30.7	0.7476	8.25	1.356	1.356	13.48
7	I	1.50	9.00	10.740	10.530	30.1	0.7475	9.75	1.329	1.329	13.24
8	I	1.50	10.50	10.530	10.320	29.5	0.7475	11.25	1.303	1.303	12.99
9	I	1.50	12.00	10.320	10.110	28.9	0.7474	12.75	1.277	1.277	12.74
10	I	1.50	13.50	10.110	9.900	28.2	0.7474	14.25	1.251	1.251	12.49
11	I	1.50	15.00	9.900	9.690	27.6	0.7473	15.75	1.224	1.224	12.25
12	I	1.50	16.50	9.690	9.480	27.0	0.7473	17.25	1.198	1.198	12.00
13	I	1.50	18.00	9.480	9.270	26.4	0.7472	18.75	1.172	1.172	11.75
14	I	1.50	19.50	9.270	9.060	25.8	0.7471	20.25	1.146	1.146	11.50
15	I	1.50	21.00	9.060	8.850	25.2	0.7471	21.75	1.119	1.119	11.26
16	I	1.50	22.50	8.850	8.640	24.6	0.7470	23.25	1.093	1.093	11.01
17	I	1.50	24.00	8.640	8.430	24.0	0.7469	24.75	1.067	1.067	10.76
18	I	1.50	25.50	8.430	8.220	23.4	0.7468	26.25	1.041	1.041	10.51
19	I	1.50	27.00	8.220	8.010	22.8	0.7468	27.75	1.014	1.014	10.27
20	I	1.50	28.50	8.010	7.800	22.2	0.7467	29.25	0.988	0.988	10.02
		<u>30.00</u>				<u>559</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	66	7.00	30.000	1.000	90.00
Fix. #3	22	10.00	1.000	1.000	9.00
Fix. #4	22.5	15.00	7.500	1.000	22.50
Fix. #5	105	19.00	13.750	2.000	126.00
Fix. #6	22	21.00	1.000	1.000	9.00
Fix. #7	26.7	26.00	10.500	1.000	31.50
Fix. #8	80	29.00	11.000	1.000	102.00
Fix. #9	0	0.00	0.000	0.000	0.00
Fix. #10	0	0.00	0.000	0.000	0.00
Fix. #11	0	0.00	0.000	0.000	0.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	19.667	0.000
Cross-Section Area (in^2)	6.655	0.000
Width-Thickness Ratio	66.93	0.00
Compact Limit	68.55	0.00
Non-Compact Limit	137.09	0.00
Maximum Limit	237.27	0.00
Allow. Bending Stress (ksi)	36.300	0.000
Allow. Shear Stress (ksi)	18.150	0.000



16362-1-13 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 30' Arm W/24' Lum.

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000 Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	14.18	18.59	1.100	0.000	0.00	0	0.784	0.00	0.00	
2	1.00	0.450	9.54	13.93	18.26	1.100	0.000	0.00	0	0.802	0.00	0.00	
3	1.00	0.450	9.54	13.68	17.93	1.100	0.000	0.00	0	0.821	0.00	0.00	
4	1.00	0.450	9.54	13.43	17.60	1.100	0.000	0.00	0	0.841	0.00	0.00	
5	1.00	0.450	9.54	13.18	17.27	1.100	0.000	0.00	0	0.862	0.00	0.00	
6	1.00	0.456	9.66	13.10	16.95	1.100	0.000	0.00	0	0.884	0.00	0.00	
7	1.00	0.467	9.91	13.17	16.62	1.100	0.000	0.00	0	0.906	0.00	0.00	
8	1.00	0.480	10.17	13.25	16.29	1.100	0.000	0.00	0	0.930	0.00	0.00	
9	1.00	0.492	10.44	13.33	15.96	1.100	0.000	0.00	0	0.955	0.00	0.00	
10	1.00	0.506	10.73	13.42	15.63	1.100	0.000	0.00	0	0.981	0.00	0.00	
11	1.00	0.520	11.03	13.50	15.30	1.100	0.000	0.00	1	1.009	0.00	0.00	
12	1.00	0.535	11.34	13.59	14.98	1.100	0.000	0.00	1	1.037	0.00	0.00	
13	1.00	0.550	11.67	13.68	14.65	1.100	0.000	0.00	1	1.068	0.00	0.00	
14	1.00	0.567	12.02	13.77	14.32	1.100	0.000	0.00	1	1.100	0.00	0.00	
15	1.00	0.584	12.39	13.87	13.99	1.100	0.000	0.00	1	1.100	0.00	0.00	
16	1.00	0.603	12.78	13.97	13.66	1.100	0.000	0.00	1	1.100	0.00	0.00	
17	1.00	0.622	13.19	14.07	13.34	1.100	0.000	0.00	1	1.100	0.00	0.00	
18	1.00	0.642	13.62	14.17	13.01	1.100	0.000	0.00	1	1.100	0.00	0.00	
19	1.00	0.664	14.08	14.28	12.68	1.100	0.000	0.00	1	1.100	0.00	0.00	
20	1.00	0.687	14.57	14.40	12.35	1.100	0.000	0.00	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.199	25.43	762.90	381.45	1.199	0.000	0.00	0	1.199	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	0.000	0.00	1	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	349.80	174.90	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.132	24.00	252.00	131.25	1.132	0.000	0.00	1	1.132	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	279.84	139.92	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #10	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #11	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00





16362-1-13 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 30' Arm W/24' Lum.

Flange Analysis - Arm #1

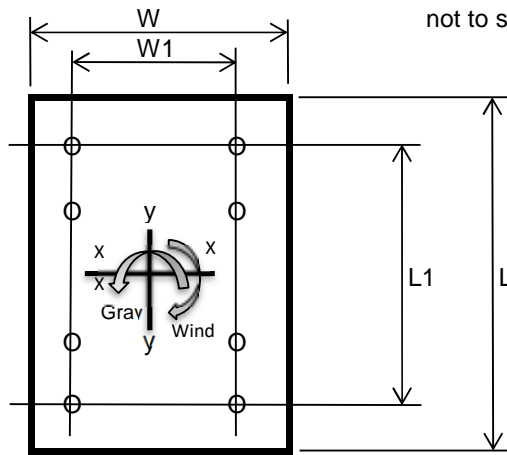
V06-21-16

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	925	1572	-	lbs
Shear (Wind)	2175	1269	-	lbs
Torsion (Arm Rise)	3420	1995	-	ft-lbs
Moment (Gravity)	14359	25276	-	ft-lbs
Moment (Wind)	34395	19627	-	ft-lbs
Nat. Wind Moment	-	-	-	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	12.00	in
Tube Wall Thick.	0.1793	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.00
W	24
W1	19.50
L	24
L1	19.50
L2 - Dist. between bolts (Typ.)	6.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	596.99	596.99	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1073.57	1073.57	in <sup>4</sup>
Bolt Tensile Stress - ft	4.69	5.40	ksi
Bolt Shear Stress - fv	0.59	0.42	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.11	0.13	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	0	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	3.63	6.38	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	8.83	5.04	ksi
Combined applied stress for interaction (SRSS)	9.55	8.13	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



16362-1-13 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 30' Arm W/24' Lum.

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	925		925	14359		14360		278	8762		0.25
Gp II	925	2175	2364	14359	34395	37273	3420	711	22743	1044	0.48
Gp III	1572	1269	2020	25276	19627	32002	1995	608	19527	609	0.41
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-13 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 30' Arm W/24' Lum.

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	2344		14359	0	14359		202		4036		0.12
Gp II	2344	3221	22874	62823	66858	35521	202	557	18791	4992	0.45
Gp III	3518	2044	24833	43313	49927	20206	304	354	14032	2839	0.32
Gp IV Natural			0	0	0				0		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9964										

<b>Shaft At Arm</b>											
Gp I	1530		14359	0	14359		159		5870		0.17
Gp II	1530	2542	3420	20190	20478	35521	159	530	8371	7261	0.29
Gp III	2271	1512	1995	28468	28538	20206	237	315	11666	4130	0.29
Gp IV Natural			0	0	0				0		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9964										



16362-1-13 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 30' Arm W/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	3221 lbs
Bending Moment	66858 ft-lbs
Torsion Moment	35521 ft-lbs
Num. Anchor Bolts	6
Bolt Circle	24 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	30 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	15.00 in

**ANALYSIS - ANCHOR BOLTS**

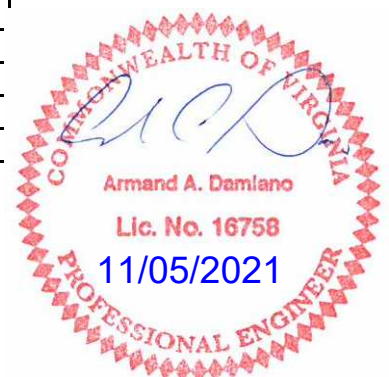
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1082.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	12.00 in
Bolt Tensile Stress	8.89 ksi
Bolt Direct Shear Stress	0.234 ksi
Bolt Torsion Shear Stress	2.574 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	8.89 ksi
$f_v =$	2.808 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.28 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	12.701 in
Dist. Shaft Face To Bolt Center	4.5 in
Design Moment	101 in-kip
Section Modulus of Failure Plane	8.46 in <sup>3</sup>
Applied Plate Stress	11.94 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	12.052 in
Dist From Shaft To Nut Face	2.938 in
Design Moment	66 in-kip
Section Modulus of Failure Plane	8.03 in <sup>3</sup>
Applied Plate Stress	8.22 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-13 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 30' Arm W/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	0 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1082.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	12.00 in
Bolt Tensile Stress	0 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

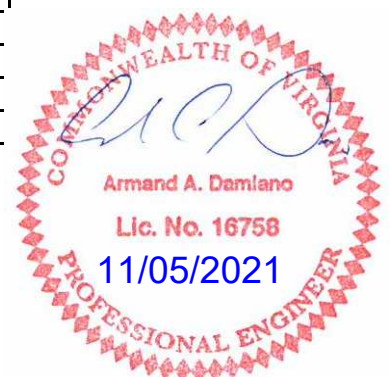
Anchor Bolt Length	60.0 in
Anchor Bolt Max. Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	127540 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	11 in
T Reduced For Group Action	63770 lbs
Maximum Applied Tensile Load	22225 lbs
Computed Factor-of Safety	2.86 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	22225 lbs
Total Tensile Load	133350 lbs
Concrete Failure Surface Area	4002.39 in <sup>2</sup>
Concrete Shear Strength	438440 psi
Computed Factor-of Safety	3.28 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	22225 lbs
Total Tensile Load	133350 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	45.36 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	3 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-14 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 40' Arm W/24' Lum.

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<i>Fatigue Importance Factors</i>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.00
Fatigue Cat.	0		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.00
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.00
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	1		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.2500	0.14	15.00	25.00	-	-	-	0	55	29000	-
Traffic Arm #1	0.1793	0.14	12.00	40.00	18.00	-	2.10	0	55	29000	180
Traffic Arm #2						-		0	55	29000	90
Lum Arm #1	0.2760		2.88	24.00	24.00	-	5	0	36	29000	180
Lum Arm #2						-		0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	6	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	Double Top Nuts	Yes	
A.B. Bolt Circle	24.00	Foundation Diameter	48	in
Baseplate Dia.	30.00	Concrete Cover	4	in
Baseplate Thk.	2.00	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	10.50	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.	Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50	in
Flange Plate Length (V)	24.00	in
Flange Plate Width (H)	24.00	in
Spac. Between Bolt (V)	19.50	in
Spac. Between Bolt (H)	19.50	in
Flange Plate Thk.	2.00	in
Flange Plate Yield (Fy)	50	ksi
Gusset Thk.	0.375	in
Plate Center Hole	6.00	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.19	0.26	0.38								10.68	0.00
GP II CSR	0.57	0.48	0.73				0.78					
GP III CSR	0.43	0.44	0.63				0.63				18.90	

Arm #1 Flange Bolt (Max.) CSR	0.19
Arm #1 Flange Bolt Fatigue CSR	0.00
Arm #1 Flange Plate (Max.) CSR	0.33
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.00
Handhole at Toe (Fatigue) CSR	0.00
Minimum Qty of Vertical Reinf. Bars	4

Fatigue Allowable - Shaft to Baseplate	
Fatigue Allowable - Arm#1 to Flange	
Fatigue Allowable - Arm#2 to Flange	
Anchor Bolt Max. CSR	0.34
Anchor Bolt Max. Fatigue Stress Ratio	0.00
Base Plate Max. CSR	0.43
Anchorage Capacity S.F.	2.47
Concrete Pull Out Capacity S.F.	2.83

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
3855	3547	77500	52862



16362-1-14 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 40' Arm W/24' Lum.

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1	Cobra Head w/Camera	24	2	1			4.54	9	57	1.00
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	12'x2.5' Sign	8			12	2.5	1	30	66	1.20
	#3	5 Section Head w/BP	17	13.75	4			2	42	105	1.20
	#4		Camera	20	1	1			1	3	22
	#5	2.5'x3' Sign	25			2.5	3	1	7.5	22.5	1.13
	#6	3 Section Head w/BP	28	8.7	4			1	26	65	1.20
	#7		Camera	30	1	1			1	3	22
	#8	4 Section Head w/BP	36			3	3.5	1	10.5	26.7	1.13
	#9			39	11	5			1	34	80
	#10										
	#11										
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
	#8										
	#9										
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	#18										
	#19										
	#20										





16362-1-14 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 40' Arm W/24' Lum.

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	15.000	14.852	41.53	0.5285	0.53	1.317	12.91	0.80
2	I	1.06	1.06	14.852	14.704	41.11	0.5285	1.59	1.304	12.79	0.80
3	I	1.06	2.12	14.704	14.555	40.69	0.5285	2.65	1.291	12.66	0.80
4	I	1.06	3.18	14.555	14.407	40.27	0.5285	3.70	1.278	12.54	0.80
5	I	1.06	4.24	14.407	14.259	39.85	0.5285	4.76	1.265	12.42	0.80
6	I	1.06	5.29	14.259	14.111	39.43	0.5285	5.82	1.252	12.29	0.80
7	I	1.06	6.35	14.111	13.962	39.01	0.5285	6.88	1.239	12.17	0.80
8	I	1.06	7.41	13.962	13.814	38.59	0.5285	7.94	1.225	12.05	0.80
9	I	1.06	8.47	13.814	13.666	38.17	0.5285	9.00	1.212	11.92	0.80
10	I	1.06	9.53	13.666	13.518	37.75	0.5284	10.06	1.199	11.80	0.80
11	I	1.06	10.59	13.518	13.369	37.33	0.5284	11.12	1.186	11.68	0.80
12	I	1.06	11.65	13.369	13.221	36.91	0.5284	12.18	1.173	11.56	0.80
13	I	1.06	12.71	13.221	13.073	36.49	0.5284	13.23	1.160	11.43	1.00
14	I	1.06	13.76	13.073	12.925	36.08	0.5284	14.29	1.147	11.31	1.00
15	I	1.06	14.82	12.925	12.776	35.66	0.5284	15.35	1.134	11.19	1.00
16	I	1.06	15.88	12.776	12.628	35.24	0.5284	16.41	1.121	11.06	1.00
17	I	1.06	16.94	12.628	12.480	34.82	0.5284	17.47	1.108	10.94	1.00
18	J	3.00	18.00	12.480	12.060	96.37	1.4914	19.49	3.068	30.32	1.00
19	I	3.00	21.00	12.060	11.640	93.00	1.4911	22.49	2.963	29.33	1.00
20	J	1.00	24.00	11.640	11.500	30.25	0.4990	24.50	0.964	9.56	1.00
						869					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in^4)	314.89	179.50	0.00	139.71
Section Modulus (in^3)	42.70	29.35	0.00	
Cross-Section Area (in^2)	11.58	9.60	0.00	
Width-Thickness Ratio	60.00	49.92	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	7.946	7.946	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

Shaft Deflection From Arm#1 GP I Load (in)	0.827
Shaft Deflection From Arm#2 GP I Load (in)	0.000



16362-1-14 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 40' Arm W/24' Lum.

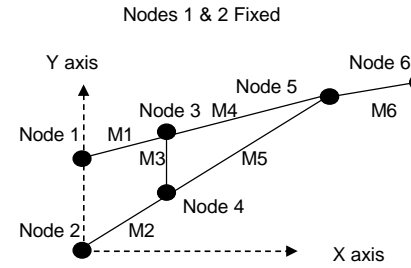
## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	10.06	0.000	16.46	1.100	0.000	0.00
2	0.450	7.64	9.96	0.000	16.30	1.100	0.000	0.00
3	0.450	7.64	9.86	0.000	16.14	1.100	0.000	0.00
4	0.450	7.64	9.76	0.000	15.97	1.100	0.000	0.00
5	0.450	7.64	9.66	0.001	15.81	1.100	0.000	0.00
6	0.450	7.64	9.56	0.001	15.64	1.100	0.000	0.00
7	0.450	7.64	9.46	0.001	15.48	1.100	0.000	0.00
8	0.450	7.64	9.36	0.001	15.32	1.100	0.000	0.00
9	0.450	7.64	9.26	0.002	15.15	1.100	0.000	0.00
10	0.450	7.64	9.16	0.002	14.99	1.100	0.000	0.00
11	0.450	7.64	9.06	0.003	14.83	1.100	0.000	0.00
12	0.450	7.64	8.96	0.003	14.66	1.100	0.000	0.00
13	0.450	9.54	11.07	0.004	14.50	1.100	0.000	0.00
14	0.450	9.54	10.94	0.005	14.34	1.100	0.000	0.00
15	0.450	9.54	10.82	0.006	14.17	1.100	0.000	0.00
16	0.450	9.54	10.69	0.006	14.01	1.100	0.000	0.00
17	0.450	9.54	10.57	0.007	13.85	1.100	0.000	0.00
18	0.450	9.54	29.26	0.023	38.34	1.100	0.000	0.00
19	0.450	9.54	28.26	0.029	37.03	1.100	0.000	0.00
20	0.450	9.54	9.20	0.011	12.05	1.100	0.000	0.00
Fix. #1	1.200	20.36	48.86	0.012	30.00	1.200	0.000	0.00
Fix. #2	1.200	20.36	48.86	0.012	30.00	1.200	0.000	0.00
Fix. #3	1.200	25.44	349.80	0.172	174.90	1.200	0.000	0.00
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-14 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 40' Arm W/24' Lum. - Luminaire Arm - Group II

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-33.67	-24.6	0	0	0
Node #2	0	0	0	0	-35.63	-26	0	0	0
Node #3	100	59.5	0	0	-66.63	-51.3	0	0	0
Node #4	100	48.8	0	0	-69.41	-53.4	0	0	0
Node #5	200	79	0	0	-94.35	-75.6	0	0	0
Node #6	288	87	0	0	-85.29	-69.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-67.33	1.1	1	-49.04	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-71.25	1.1	1	-51.90	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-0.68	1.1	1	-1.18	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-65.23	1.1	1.1	-52.27	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-66.89	1.1	1.1	-53.59	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-56.58	1.1	1.1	-45.33	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-57.00	1	1.1	-46.64					

AASHTO Gp	2
Mntg Hght =	29.00
Datum =	1

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2180.2	lbs
P1y	-694.6	lbs
P1z	178.8	lbs
M1x	6661.9	in-lbs
M1y	-25162.7	in-lbs
M1z	-898.1	in-lbs
P2x	2180.2	lbs
P2y	1079.6	lbs
P2z	121.5	lbs
M2x	6843.3	in-lbs
M2y	-20414.5	in-lbs
M2z	-928.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1018	138	19343	-491	0.55
#2	1071	87	15894	-954	0.78
#3	1489	431	8552	-392	0.35
#4	-1001	64	7424	-23	0.2
#5	1020	75	8261	-288	0.5
#6	4	98	7210	1	0.22

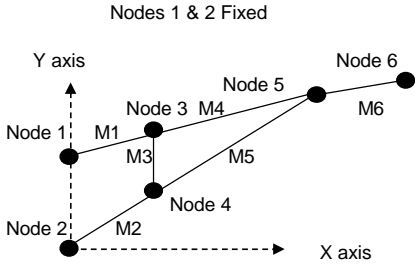
Arm Tip Displacement At Node 6	
X dir	0.103 (in)
Y dir	-0.898 (in)
Z dir	-10.462 (in)

V09.19.15



16362-1-14 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 40' Arm W/24' Lum. - Luminaire Arm - Group III

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-40.85	-13.2	0	0	0
Node #2	0	0	0	0	-43.23	-14	0	0	0
Node #3	100	59.5	0	0	-81.04	-26.6	0	0	0
Node #4	100	48.8	0	0	-84.42	-27.7	0	0	0
Node #5	200	79	0	0	-114.49	-37.8	0	0	0
Node #6	288	87	0	0	-115.33	-36.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



Member #3 is a bar computed as equivalent pipe section to the weak axis

	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-81.69	1.1	1	-26.29	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-86.45	1.1	1	-27.82	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-1.22	1.1	1	-0.63	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-79.16	1.1	1.1	-26.13	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-81.16	1.1	1.1	-26.80	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-68.65	1.1	1.1	-22.67	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-81.00	1	1.1	-25.00					

AASHTO Gp	3
Mntg Hght =	29.00
Datum =	1

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2797.7	lbs
P1y	-898.7	lbs
P1z	92.5	lbs
M1x	3425.6	in-lbs
M1y	-12957.4	in-lbs
M1z	-1426.8	in-lbs
P2x	2797.7	lbs
P2y	1378.1	lbs
P2z	63.2	lbs
M2x	3519.9	in-lbs
M2y	-10515.8	in-lbs
M2z	-1452.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1307	75	10010	-255	0.26
#2	1373	50	8249	-493	0.63
#3	1905	442	8972	-201	0.38
#4	-1287	45	3944	-13	0.08
#5	1311	48	4359	-150	0.46
#6	5	107	7919	1	0.24

Arm Tip Displacement At Node 6	
X dir	0.137 (in)
Y dir	-1.214 (in)
Z dir	-5.396 (in)

V09.19.15



16362-1-14 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 40' Arm W/24' Lum.

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	2.00	0.00	12.000	11.720	44.8	0.9961	1.00	1.977	1.977	19.57
2	I	2.00	2.00	11.720	11.440	43.7	0.9960	3.00	1.930	1.930	19.13
3	I	2.00	4.00	11.440	11.160	42.6	0.9959	5.00	1.883	1.883	18.69
4	I	2.00	6.00	11.160	10.880	41.6	0.9958	7.00	1.837	1.837	18.25
5	I	2.00	8.00	10.880	10.600	40.5	0.9957	9.00	1.790	1.790	17.81
6	I	2.00	10.00	10.600	10.320	39.4	0.9955	11.00	1.743	1.743	17.37
7	I	2.00	12.00	10.320	10.040	38.3	0.9954	13.00	1.697	1.697	16.93
8	I	2.00	14.00	10.040	9.760	37.3	0.9953	15.00	1.650	1.650	16.49
9	I	2.00	16.00	9.760	9.480	36.2	0.9951	17.00	1.603	1.603	16.05
10	I	2.00	18.00	9.480	9.200	35.1	0.9950	19.00	1.557	1.557	15.61
11	I	2.00	20.00	9.200	8.920	34.0	0.9948	20.99	1.510	1.510	15.17
12	I	2.00	22.00	8.920	8.640	33.0	0.9947	22.99	1.463	1.463	14.73
13	I	2.00	24.00	8.640	8.360	31.9	0.9945	24.99	1.417	1.417	14.29
14	I	2.00	26.00	8.360	8.080	30.8	0.9943	26.99	1.370	1.370	13.85
15	I	2.00	28.00	8.080	7.800	29.8	0.9941	28.99	1.323	1.323	13.41
16	I	2.00	30.00	7.800	7.520	28.7	0.9939	30.99	1.277	1.277	12.97
17	I	2.00	32.00	7.520	7.240	27.6	0.9937	32.99	1.230	1.230	12.53
18	I	2.00	34.00	7.240	6.960	26.5	0.9934	34.99	1.183	1.183	12.10
19	I	2.00	36.00	6.960	6.680	25.5	0.9932	36.99	1.137	1.137	11.66
20	I	2.00	38.00	6.680	6.400	24.4	0.9929	38.99	1.090	1.090	11.22
		<u>40.00</u>				<u>692</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	66	8.00	30.000	1.000	90.00
Fix. #3	105	17.00	13.750	2.000	126.00
Fix. #4	22	20.00	1.000	1.000	9.00
Fix. #5	22.5	25.00	7.500	1.000	22.50
Fix. #6	65	28.00	8.700	1.000	78.00
Fix. #7	22	30.00	1.000	1.000	9.00
Fix. #8	26.7	36.00	10.500	1.000	31.50
Fix. #9	80	39.00	11.000	1.000	102.00
Fix. #10	0	0.00	0.000	0.000	0.00
Fix. #11	0	0.00	0.000	0.000	0.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	19.667	0.000
Cross-Section Area (in^2)	6.655	0.000
Width-Thickness Ratio	66.93	0.00
Compact Limit	68.55	0.00
Non-Compact Limit	137.09	0.00
Maximum Limit	237.27	0.00
Allow. Bending Stress (ksi)	36.300	0.000
Allow. Shear Stress (ksi)	18.150	0.000



16362-1-14 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 40' Arm W/24' Lum.

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000 Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	18.86	24.71	1.100	0.000	0.00	0	0.787	0.00	0.00	
2	1.00	0.450	9.54	18.41	24.13	1.100	0.000	0.00	0	0.811	0.00	0.00	
3	1.00	0.450	9.54	17.97	23.54	1.100	0.000	0.00	0	0.838	0.00	0.00	
4	1.00	0.450	9.54	17.52	22.96	1.100	0.000	0.00	0	0.865	0.00	0.00	
5	1.00	0.461	9.78	17.51	22.38	1.100	0.000	0.00	0	0.895	0.00	0.00	
6	1.00	0.477	10.13	17.66	21.79	1.100	0.000	0.00	0	0.926	0.00	0.00	
7	1.00	0.495	10.49	17.80	21.21	1.100	0.000	0.00	0	0.959	0.00	0.00	
8	1.00	0.513	10.88	17.95	20.63	1.100	0.000	0.00	0	0.995	0.00	0.00	
9	1.00	0.532	11.29	18.10	20.04	1.100	0.000	0.00	0	1.033	0.00	0.00	
10	1.00	0.553	11.73	18.26	19.46	1.100	0.000	0.00	0	1.073	0.00	0.00	
11	1.00	0.575	12.21	18.44	18.88	1.100	0.000	0.00	0	1.100	0.00	0.00	
12	1.00	0.599	12.71	18.60	18.29	1.100	0.000	0.00	0	1.100	0.00	0.00	
13	1.00	0.625	13.26	18.79	17.71	1.100	0.000	0.00	1	1.100	0.00	0.00	
14	1.00	0.653	13.85	18.97	17.13	1.100	0.000	0.00	1	1.100	0.00	0.00	
15	1.00	0.683	14.49	19.18	16.54	1.100	0.000	0.00	1	1.100	0.00	0.00	
16	1.00	0.716	15.18	19.38	15.96	1.100	0.000	0.00	1	1.100	0.00	0.00	
17	1.00	0.751	15.93	19.59	15.38	1.100	0.000	0.00	1	1.100	0.00	0.00	
18	1.00	0.790	16.75	19.82	14.79	1.100	0.000	0.00	1	1.100	0.00	0.00	
19	1.00	0.833	17.65	20.06	14.21	1.100	0.000	0.00	1	1.100	0.00	0.00	
20	1.00	0.879	18.64	20.32	13.63	1.100	0.000	0.00	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.199	25.43	762.90	381.45	1.199	0.000	0.00	0	1.199	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	0	1.200	0.00	0.00	0.00
Fix. #5	1.00	1.134	24.05	180.38	93.75	1.134	0.000	0.00	1	1.134	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	221.33	110.66	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.200	25.44	25.44	12.72	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #8	1.00	1.132	24.00	252.00	131.25	1.132	0.000	0.00	1	1.132	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	279.84	139.92	1.200	0.000	0.00	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #11	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



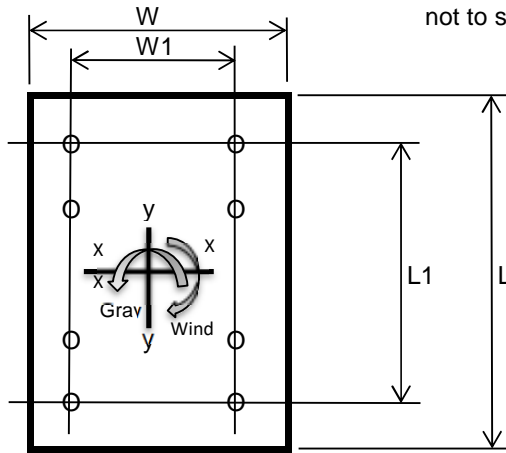
Flange Analysis - Arm #1

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	1123	1908	-	lbs
Shear (Wind)	2496	1453	-	lbs
Torsion (Arm Rise)	5232	3047	-	ft-lbs
Moment (Gravity)	22366	39143	-	ft-lbs
Moment (Wind)	51736	29225	-	ft-lbs
Nat. Wind Moment	-	-	-	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	12.00	in
Tube Wall Thick.	0.1793	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.00
W	24
W1	19.50
L	24
L1	19.50
L2 - Dist. between bolts (Typ.)	6.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	596.99	596.99	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1073.57	1073.57	in <sup>4</sup>
Bolt Tensile Stress - ft	7.15	8.31	ksi
Bolt Shear Stress - fv	0.83	0.57	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.17	0.19	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	0	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	5.65	9.88	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	13.28	7.51	ksi
Combined applied stress for interaction (SRSS)	14.43	12.41	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	





16362-1-14 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 40' Arm W/24' Lum.

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	1123		1123	22366		22366		338	13647		0.38
Gp II	1123	2496	2737	22366	51736	56364	5232	823	34392	1597	0.73
Gp III	1908	1453	2399	39143	29225	48850	3047	721	29807	930	0.63
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-14 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 40' Arm W/24' Lum.

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	2541		22366	0	22366		219		6286		0.19
Gp II	2541	3547	32397	70404	77500	52862	219	613	21782	7428	0.57
Gp III	3855	2232	29209	58055	64989	29804	333	386	18265	4188	0.43
Gp IV Natural			0	0	0				0		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9959										

<b>Shaft At Arm</b>											
Gp I	1727		22366	0	22366		180		9143		0.26
Gp II	1727	2863	5232	28196	28677	52862	180	597	11723	10805	0.48
Gp III	2607	1697	3047	42335	42445	29804	272	354	17352	6092	0.44
Gp IV Natural			0	0	0				0		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9959										



16362-1-14 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 40' Arm W/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	3547 lbs
Bending Moment	77500 ft-lbs
Torsion Moment	52862 ft-lbs
Num. Anchor Bolts	6
Bolt Circle	24 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	30 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	15.00 in

**ANALYSIS - ANCHOR BOLTS**

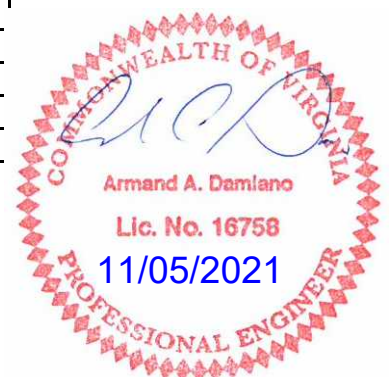
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1082.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	12.00 in
Bolt Tensile Stress	10.305 ksi
Bolt Direct Shear Stress	0.258 ksi
Bolt Torsion Shear Stress	3.831 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	10.305 ksi
$f_v =$	4.089 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.34 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	12.701 in
Dist. Shaft Face To Bolt Center	4.5 in
Design Moment	116 in-kip
Section Modulus of Failure Plane	8.46 in <sup>3</sup>
Applied Plate Stress	13.72 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	12.052 in
Dist From Shaft To Nut Face	2.938 in
Design Moment	76 in-kip
Section Modulus of Failure Plane	8.03 in <sup>3</sup>
Applied Plate Stress	9.47 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-14 - Virginia - 70 MPH - MP-3 Std. Loads - Type D - 40' Arm W/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	0 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1082.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	12.00 in
Bolt Tensile Stress	0 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

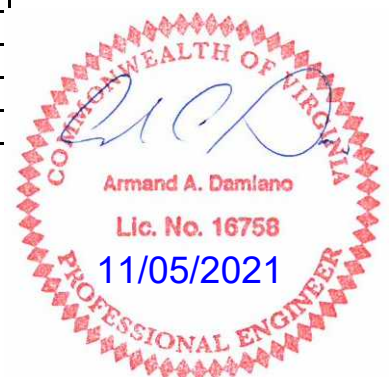
Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	127540 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	11 in
T Reduced For Group Action	63770 lbs
Maximum Applied Tensile Load	25763 lbs
Computed Factor-of Safety	2.47 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	25763 lbs
Total Tensile Load	154578 lbs
Concrete Failure Surface Area	4002.39 in <sup>2</sup>
Concrete Shear Strength	438440 psi
Computed Factor-of Safety	2.83 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	25763 lbs
Total Tensile Load	154578 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	45.36 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	4 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-15 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 60' Arm W/24' Lum.

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<b>Fatigue Importance Factors</b>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	1		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.50	25.00	-	-	-	0	55	29000	-
Traffic Arm #1	0.2500	0.14	15.58	23.69	18.00	-	3.14	0	55	29000	180
	0.1793	0.14	13.00	39.00	-	2.69		0	55	29000	
Traffic Arm #2								0	55	29000	90
								0	55	29000	
Lum Arm #1	0.2760		2.88	24.00	24.00	-	5	0	36	29000	180
Lum Arm #2						-		0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8		Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	in	Double Top Nuts	Yes	
A.B. Bolt Circle	26.00	in	Foundation Diameter	48	in
Baseplate Dia.	32.00	in	Concrete Cover	4	in
Baseplate Thk.	2.00	in	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	14.25	in	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.		Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50 in	in
Flange Plate Length (V)	27.00 in	in
Flange Plate Width (H)	27.00 in	in
Spac. Between Bolt (V)	22.50 in	in
Spac. Between Bolt (H)	22.50 in	in
Flange Plate Thk.	2.25 in	in
Flange Plate Yield (Fy)	50 ksi	ksi
Gusset Thk.	0.500 in	in
Plate Center Hole	6.00 in	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.23	0.30	0.43	0.34							19.71	0.00
GP II CSR	0.43	0.41	0.66	0.58			0.78					
GP III CSR	0.40	0.44	0.63	0.54			0.63				33.00	
Nat.Wind (psi)	2688	469	6306	5372								

Arm #1 Flange Bolt (Max.) CSR	0.40
Arm #1 Flange Bolt Fatigue CSR	0.33
Arm #1 Flange Plate (Max.) CSR	0.47
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.62
Handhole at Toe (Fatigue) CSR	0.40
Minimum Qty of Vertical Reinf. Bars	5

Fatigue Allowable - Shaft to Baseplate	4.5 ksi
Fatigue Allowable - Arm#1 to Flange	7 ksi
Fatigue Allowable - Arm#2 to Flange	-
Anchor Bolt Max. CSR	0.41
Anchor Bolt Max. Fatigue Stress Ratio	0.27
Base Plate Max. CSR	0.46
Anchorage Capacity S.F.	2.11
Concrete Pull Out Capacity S.F.	2.01

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
5960	4469	127392	105659



16362-1-15 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 60' Arm W/24' Lum.

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1	Cobra Head w/Camera	24	2	1			4.54	9	57	1.00
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	15'x2.5' Sign	12.5			15	2.5	1	37.5	88.5	1.21
	#3	5 Section Head w/BP	26	13.75	4			2	42	105	1.20
	#4	2.5'x3' Sign	34			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	37	8.7	4			1	26	65	1.20
	#6	Camera	46	1	1			1	3	22	1.20
	#7	2.5'x3' Sign	45			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	48	8.7	4			1	26	65	1.20
	#9	Camera	57	1	1			1	3	22	1.20
	#10	3'x3.5' Sign	56			3	3.5	1	10.5	26.7	1.13
	#11	4 Section Head w/BP	59	11	5			1	34	80	1.20
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
	#8										
	#9										
	#10										
	#11										
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										



16362-1-15 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 60' Arm W/24' Lum.

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.500	19.352	67.61	0.5287	0.53	1.714	16.65	0.80
2	I	1.06	1.06	19.352	19.204	67.08	0.5287	1.59	1.701	16.53	0.80
3	I	1.06	2.12	19.204	19.055	66.56	0.5287	2.65	1.688	16.41	0.80
4	I	1.06	3.18	19.055	18.907	66.03	0.5287	3.71	1.675	16.28	0.80
5	I	1.06	4.24	18.907	18.759	65.51	0.5287	4.76	1.662	16.16	0.80
6	I	1.06	5.29	18.759	18.611	64.99	0.5287	5.82	1.649	16.04	0.80
7	I	1.06	6.35	18.611	18.462	64.46	0.5287	6.88	1.636	15.91	0.80
8	I	1.06	7.41	18.462	18.314	63.94	0.5287	7.94	1.622	15.79	0.80
9	I	1.06	8.47	18.314	18.166	63.41	0.5287	9.00	1.609	15.67	0.80
10	I	1.06	9.53	18.166	18.018	62.89	0.5287	10.06	1.596	15.54	0.80
11	I	1.06	10.59	18.018	17.869	62.36	0.5287	11.12	1.583	15.42	0.80
12	I	1.06	11.65	17.869	17.721	61.84	0.5287	12.18	1.570	15.30	0.80
13	I	1.06	12.71	17.721	17.573	61.31	0.5287	13.23	1.557	15.17	1.00
14	I	1.06	13.76	17.573	17.425	60.79	0.5287	14.29	1.544	15.05	1.00
15	I	1.06	14.82	17.425	17.276	60.27	0.5287	15.35	1.531	14.93	1.00
16	I	1.06	15.88	17.276	17.128	59.74	0.5287	16.41	1.518	14.80	1.00
17	I	1.06	16.94	17.128	16.980	59.22	0.5286	17.47	1.505	14.68	1.00
18	J	3.00	18.00	16.980	16.560	164.94	1.4937	19.49	4.193	40.93	1.00
19	I	3.00	21.00	16.560	16.140	160.73	1.4936	22.49	4.088	39.94	1.00
20	J	1.00	24.00	16.140	16.000	52.64	0.4993	24.50	1.339	13.09	1.00
						<u>1457</u>					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in <sup>4</sup> )	866.45	567.94	0.00	473.53
Section Modulus (in <sup>3</sup> )	90.31	68.15	0.00	
Cross-Section Area (in <sup>2</sup> )	18.83	16.35	0.00	
Width-Thickness Ratio	62.40	54.34	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	14.296	14.296	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

Shaft Deflection From Arm#1 GP I Load (in)	0.754
Shaft Deflection From Arm#2 GP I Load (in)	0.000





16362-1-15 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 60' Arm W/24' Lum.

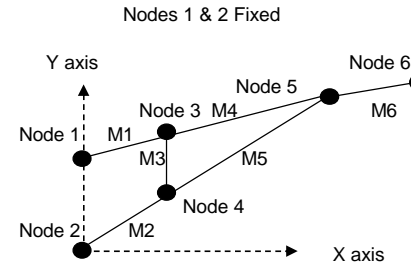
## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	13.10	0.000	21.43	1.100	4.576	7.84
2	0.450	7.64	13.00	0.000	21.26	1.100	4.576	7.78
3	0.450	7.64	12.90	0.000	21.10	1.100	4.576	7.72
4	0.450	7.64	12.80	0.000	20.94	1.100	4.576	7.66
5	0.450	7.64	12.70	0.000	20.77	1.100	4.576	7.60
6	0.450	7.64	12.60	0.000	20.61	1.100	4.576	7.54
7	0.450	7.64	12.50	0.000	20.44	1.100	4.576	7.48
8	0.450	7.64	12.40	0.001	20.28	1.100	4.576	7.42
9	0.450	7.64	12.30	0.001	20.12	1.100	4.576	7.36
10	0.450	7.64	12.20	0.001	19.95	1.100	4.576	7.30
11	0.450	7.64	12.10	0.001	19.79	1.100	4.576	7.24
12	0.450	7.64	12.00	0.001	19.63	1.100	4.576	7.19
13	0.450	9.54	14.85	0.002	19.46	1.100	4.576	7.13
14	0.450	9.54	14.73	0.002	19.30	1.100	4.576	7.07
15	0.450	9.54	14.61	0.003	19.14	1.100	4.576	7.01
16	0.450	9.54	14.48	0.003	18.97	1.100	4.576	6.95
17	0.450	9.54	14.36	0.003	18.81	1.100	4.576	6.89
18	0.450	9.54	40.00	0.011	52.41	1.100	4.576	19.18
19	0.450	9.54	38.99	0.014	51.09	1.100	4.576	18.70
20	0.450	9.54	12.78	0.005	16.74	1.100	4.576	6.13
Fix. #1	1.200	20.36	48.86	0.004	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.004	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.060	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-15 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 60' Arm W/24' Lum. - Luminaire Arm - Group II

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-33.67	-24.6	0	0	0
Node #2	0	0	0	0	-35.63	-26	0	0	0
Node #3	100	59.5	0	0	-66.63	-51.3	0	0	0
Node #4	100	48.8	0	0	-69.41	-53.4	0	0	0
Node #5	200	79	0	0	-94.35	-75.6	0	0	0
Node #6	288	87	0	0	-85.29	-69.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-67.33	1.1	1	-49.04	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-71.25	1.1	1	-51.90	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-0.68	1.1	1	-1.18	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-65.23	1.1	1.1	-52.27	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-66.89	1.1	1.1	-53.59	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-56.58	1.1	1.1	-45.33	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-57.00	1	1.1	-46.64					

AASHTO Gp	2
Mntg Hght =	29.00
Datum =	1

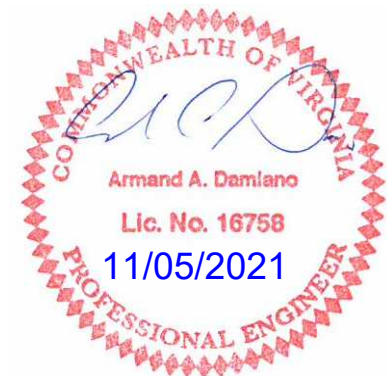
ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2180.2	lbs
P1y	-694.6	lbs
P1z	178.8	lbs
M1x	6661.9	in-lbs
M1y	-25162.7	in-lbs
M1z	-898.1	in-lbs
P2x	2180.2	lbs
P2y	1079.6	lbs
P2z	121.5	lbs
M2x	6843.3	in-lbs
M2y	-20414.5	in-lbs
M2z	-928.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1018	138	19343	-491	0.55
#2	1071	87	15894	-954	0.78
#3	1489	431	8552	-392	0.35
#4	-1001	64	7424	-23	0.2
#5	1020	75	8261	-288	0.5
#6	4	98	7210	1	0.22

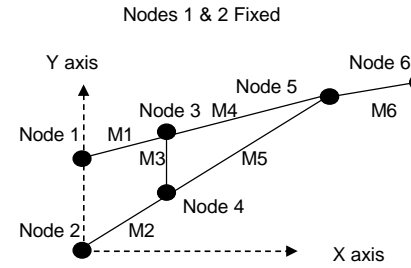
Arm Tip Displacement At Node 6	
X dir	0.103 (in)
Y dir	-0.898 (in)
Z dir	-10.462 (in)

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16362-1-15 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 60' Arm W/24' Lum. - Luminaire Arm - Group III

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-40.85	-13.2	0	0	0
Node #2	0	0	0	0	-43.23	-14	0	0	0
Node #3	100	59.5	0	0	-81.04	-26.6	0	0	0
Node #4	100	48.8	0	0	-84.42	-27.7	0	0	0
Node #5	200	79	0	0	-114.49	-37.8	0	0	0
Node #6	288	87	0	0	-115.33	-36.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



Member #3 is a bar computed as equivalent pipe section to the weak axis

	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-81.69	1.1	1	-26.29	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-86.45	1.1	1	-27.82	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-1.22	1.1	1	-0.63	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-79.16	1.1	1.1	-26.13	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-81.16	1.1	1.1	-26.80	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-68.65	1.1	1.1	-22.67	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-81.00	1	1.1	-25.00					

AASHTO Gp	3
Mntg Hght =	29.00
Datum =	1

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2797.7	lbs
P1y	-898.7	lbs
P1z	92.5	lbs
M1x	3425.6	in-lbs
M1y	-12957.4	in-lbs
M1z	-1426.8	in-lbs
P2x	2797.7	lbs
P2y	1378.1	lbs
P2z	63.2	lbs
M2x	3519.9	in-lbs
M2y	-10515.8	in-lbs
M2z	-1452.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1307	75	10010	-255	0.26
#2	1373	50	8249	-493	0.63
#3	1905	442	8972	-201	0.38
#4	-1287	45	3944	-13	0.08
#5	1311	48	4359	-150	0.46
#6	5	107	7919	1	0.24

Arm Tip Displacement At Node 6	
X dir	0.137 (in)
Y dir	-1.214 (in)
Z dir	-5.396 (in)

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16362-1-15 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 60' Arm W/24' Lum.

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	3.00	0.00	15.580	15.160	121.2	1.4932	1.49	3.843	3.843	37.63
2	I	3.00	3.00	15.160	14.740	117.9	1.4930	4.49	3.738	3.738	36.64
3	I	3.00	6.00	14.740	14.320	114.5	1.4928	7.49	3.633	3.633	35.65
4	I	3.00	9.00	14.320	13.900	111.1	1.4926	10.49	3.528	3.528	34.66
5	I	3.00	12.00	13.900	13.480	107.8	1.4923	13.49	3.423	3.423	33.67
6	I	3.00	15.00	13.480	13.060	104.4	1.4921	16.49	3.318	3.318	32.68
7	I	3.00	18.00	13.060	12.640	101.0	1.4918	19.49	3.213	3.213	31.69
8	J	2.69	21.00	13.000	12.623	152.9	1.3384	22.34	2.872	2.872	28.33
9	O	3.03	23.69	12.623	12.200	70.9	1.5043	25.19	3.130	3.130	30.92
10	O	3.03	26.72	12.200	11.776	68.5	1.5040	28.22	3.023	3.023	29.91
11	O	3.03	29.74	11.776	11.353	66.0	1.5037	31.25	2.916	2.916	28.91
12	O	3.03	32.77	11.353	10.929	63.6	1.5033	34.27	2.809	2.809	27.90
13	O	3.03	35.79	10.929	10.505	61.1	1.5029	37.30	2.702	2.702	26.89
14	O	3.03	38.82	10.505	10.082	58.7	1.5025	40.32	2.596	2.596	25.89
15	O	3.03	41.85	10.082	9.658	56.2	1.5021	43.35	2.489	2.489	24.88
16	O	3.03	44.87	9.658	9.234	53.7	1.5016	46.37	2.382	2.382	23.87
17	O	3.03	47.90	9.234	8.811	51.3	1.5011	49.40	2.275	2.275	22.87
18	O	3.03	50.92	8.811	8.387	48.8	1.5005	52.42	2.168	2.168	21.86
19	O	3.03	53.95	8.387	7.964	46.4	1.4999	55.45	2.061	2.061	20.85
20	O	3.03	56.97	7.964	7.540	43.9	1.4991	58.47	1.955	1.955	19.85
		<u>60.00</u>				<u>1620</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	12.50	37.500	1.000	112.50
Fix. #3	105	26.00	13.750	2.000	126.00
Fix. #4	22.5	34.00	7.500	1.000	22.50
Fix. #5	65	37.00	8.700	1.000	78.00
Fix. #6	22	46.00	1.000	1.000	9.00
Fix. #7	22.5	45.00	7.500	1.000	22.50
Fix. #8	65	48.00	8.700	1.000	78.00
Fix. #9	22	57.00	1.000	1.000	9.00
Fix. #10	26.7	56.00	10.500	1.000	31.50
Fix. #11	80	59.00	11.000	1.000	102.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	46.120	23.135
Cross-Section Area (in^2)	12.034	7.218
Width-Thickness Ratio	62.32	72.50
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	36.300	35.489
Allow. Shear Stress (ksi)	18.150	18.150



16362-1-15 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 60' Arm W/24' Lum.

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000 Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	36.66	48.03	1.100	4.576	17.58	0	0.562	0.00	0.00	
2	1.00	0.450	9.54	35.66	46.72	1.100	4.576	17.10	0	0.582	0.00	0.00	
3	1.00	0.450	9.54	34.65	45.41	1.100	4.576	16.62	0	0.604	0.00	0.00	
4	1.00	0.450	9.54	33.65	44.09	1.100	4.576	16.14	0	0.628	0.00	0.00	
5	1.00	0.450	9.54	32.65	42.78	1.100	4.576	15.66	0	0.653	0.00	0.00	
6	1.00	0.450	9.54	31.65	41.47	1.100	4.576	15.18	0	0.680	0.00	0.00	
7	1.00	0.450	9.54	30.65	40.16	1.100	4.576	14.70	0	0.709	0.00	0.00	
8	1.00	0.450	9.54	27.40	35.90	1.100	4.576	13.14	0	0.711	0.00	0.00	
9	1.00	0.450	9.54	29.86	39.12	1.100	4.576	14.32	0	0.741	0.00	0.00	
10	1.00	0.450	9.54	28.84	37.79	1.100	4.576	13.83	0	0.776	0.00	0.00	
11	1.00	0.450	9.54	27.82	36.45	1.100	4.576	13.34	0	0.813	0.00	0.00	
12	1.00	0.450	9.54	26.80	35.11	1.100	4.576	12.85	0	0.853	0.00	0.00	
13	1.00	0.463	9.81	26.51	33.78	1.100	4.576	12.37	0	0.897	0.00	0.00	
14	1.00	0.488	10.34	26.84	32.44	1.100	4.576	11.88	0	0.946	0.00	0.00	
15	1.00	0.515	10.92	27.18	31.11	1.100	4.576	11.39	0	0.999	0.00	0.00	
16	1.00	0.545	11.56	27.53	29.77	1.100	4.576	10.90	1	1.057	0.00	0.00	
17	1.00	0.579	12.27	27.92	28.44	1.100	4.576	10.41	1	1.100	0.00	0.00	
18	1.00	0.616	13.06	28.32	27.10	1.100	4.576	9.92	1	1.100	0.00	0.00	
19	1.00	0.658	13.95	28.76	25.77	1.100	4.576	9.43	1	1.100	0.00	0.00	
20	1.00	0.705	14.95	29.22	24.43	1.100	4.576	8.94	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00

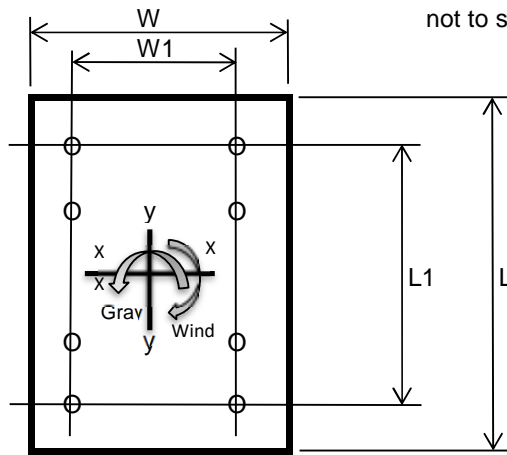


Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	2161	3337	-	lbs
Shear (Wind)	3319	2098	-	lbs
Torsion (Arm Rise)	10435	6598	-	ft-lbs
Moment (Gravity)	58769	96007	-	ft-lbs
Moment (Wind)	104534	63624	-	ft-lbs
Nat. Wind Moment	-	-	24233	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	15.58	in
Tube Wall Thick.	0.25	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	14.05	17.39	ksi
Bolt Shear Stress - fv	1.36	1	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Fv =	44.22	44.22	ksi
Allowable Shear Stress = Ft =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.33	0.40	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	2.29	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.33	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	9.97	16.28	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	18.03	10.98	ksi
Combined applied stress for interaction (SRSS)	20.60	19.64	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



16362-1-15 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 60' Arm W/24' Lum.

Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

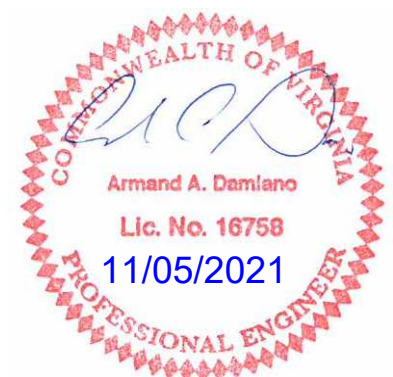
Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.50	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.333333	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.730769	
Kf - Fatigue stress concentration factor for finite life	2.31	
Ki - Fatigue stress concentration factor for infinite life	5.05	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.25	in
Dt - Arm base diameter	15.58	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	2.04	
Dop - Baseplate center hole diameter	6	in
Cop - Center hole to arm diameter ratio	0.385109	
Kf - Fatigue stress concentration factor for finite life	1.83	
Ki - Fatigue stress concentration factor for infinite life	3.50	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle





16362-1-15 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 60' Arm W/24' Lum.

## Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	19.07	in
Shaft Thickness	0.313	in
Total Area	23.571	in <sup>2</sup>
Ix	911	in <sup>4</sup>
Iy	1023	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	20231	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	10.00	ksi
CSR	0.62	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	2.81	ksi
CSR	0.40	
Therefore	<b>OK</b>	



16362-1-15 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 60' Arm W/24' Lum.

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	2161		2161	58769		58770		360	15292		0.43
Gp II	2161	3319	3961	58769	104534	119922	10435	659	31203	1358	0.66
Gp III	3337	2098	3942	96007	63624	115176	6598	656	29968	859	0.63
Gp IV Natural		799	799		24233	24233	2514	133	6306	328	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	1273		1273	22969		22969		353	11914		0.34
Gp II	1273	2099	2455	22969	45981	51399	6599	681	26661	1712	0.58
Gp III	2084	1298	2456	39262	27203	47766	4080	681	24776	1059	0.54
Gp IV Natural		493	493		10356	10356	1552	137	5372	403	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-15 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 60' Arm W/24' Lum.

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	4167		58769	0	58769		221		7809		0.23
Gp II	4167	4469	70173	94113	117395	105659	221	475	15598	7019	0.43
Gp III	5960	3010	44369	119416	127392	64203	317	320	16926	4265	0.40
Gp IV Natural			20231	0	20231				2688		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9975										

<b>Shaft At Arm</b>											
Gp I	2924		58769	0	58769		179		10348		0.30
Gp II	2924	3711	10435	64687	65523	105659	179	454	11538	9302	0.41
Gp III	4194	2374	6598	99314	99533	64203	256	291	17526	5653	0.44
Gp IV Natural			2666	0	2666				469		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9975										



16362-1-15 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 60' Arm W/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	4469 lbs
Bending Moment	127392 ft-lbs
Torsion Moment	105659 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.50 in

**ANALYSIS - ANCHOR BOLTS**

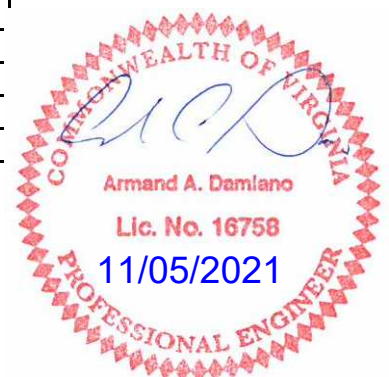
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	11.732 ksi
Bolt Direct Shear Stress	0.243 ksi
Bolt Torsion Shear Stress	5.301 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	11.732 ksi
$f_v =$	5.544 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.41 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.25 in
Design Moment	96 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	14.51 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.688 in
Design Moment	50 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	7.93 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-15 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 60' Arm W/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	20231 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	1.87 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.27
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

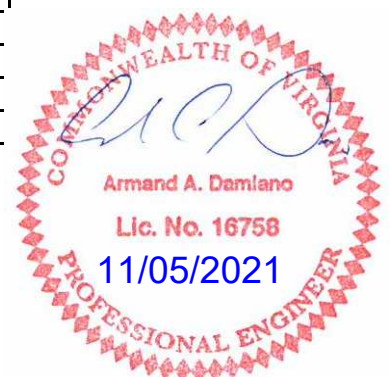
Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	29330 lbs
Computed Factor-of Safety	2.11 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	29330 lbs
Total Tensile Load	234640 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	2.01 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	29330 lbs
Total Tensile Load	234640 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	5 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-16 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 65' Arm W/24' Lum.

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<i>Fatigue Importance Factors</i>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	1		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.50	25.00	-	-	-	0	55	29000	-
Traffic Arm #1	0.2500	0.14	16.28	28.69	18.00	-	3.41	0	55	29000	180
	0.1793	0.14	13.00	39.00	-	2.69		0	55	29000	
Traffic Arm #2								0	55	29000	90
								0	55	29000	
Lum Arm #1	0.2760		2.88	24.00	24.00	-	5	0	36	29000	180
Lum Arm #2						-		0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8		Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	in	Double Top Nuts	Yes	
A.B. Bolt Circle	26.00	in	Foundation Diameter	48	in
Baseplate Dia.	32.00	in	Concrete Cover	4	in
Baseplate Thk.	2.00	in	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	14.25	in	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.		Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50 in	in
Flange Plate Length (V)	27.00 in	in
Flange Plate Width (H)	27.00 in	in
Spac. Between Bolt (V)	22.50 in	in
Spac. Between Bolt (H)	22.50 in	in
Flange Plate Thk.	2.25 in	in
Flange Plate Yield (Fy)	50.00 ksi	ksi
Gusset Thk.	0.500 in	in
Plate Center Hole	6.00 in	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.27	0.35	0.47	0.33							24.24	0.00
GP II CSR	0.51	0.51	0.70	0.56			0.78					
GP III CSR	0.47	0.52	0.68	0.52			0.63				40.33	
Nat.Wind (psi)	3026	572	6690	5252								

Arm #1 Flange Bolt (Max.) CSR	0.47
Arm #1 Flange Bolt Fatigue CSR	0.38
Arm #1 Flange Plate (Max.) CSR	0.54
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.70
Handhole at Toe (Fatigue) CSR	0.45
Minimum Qty of Vertical Reinf. Bars	6

Fatigue Allowable - Shaft to Baseplate	4.5 ksi
Fatigue Allowable - Arm#1 to Flange	7 ksi
Fatigue Allowable - Arm#2 to Flange	-
Anchor Bolt Max. CSR	0.48
Anchor Bolt Max. Fatigue Stress Ratio	0.30
Base Plate Max. CSR	0.53
Anchorage Capacity S.F.	1.82
Concrete Pull Out Capacity S.F.	1.73

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
6422	4943	147783	121414



16362-1-16 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 65' Arm W/24' Lum.

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1	Cobra Head w/Camera	24	2	1			4.54	9	57	1.00
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	15'x2.5' Sign	9.5			15	2.5	1	37.5	88.5	1.21
	#3	5 Section Head w/BP	20	13.75	4			2	42	105	1.20
	#4	2.5'x3' Sign	24			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	31	8.7	4			1	26	65	1.20
	#6	Camera	35	1	1			1	3	22	1.20
	#7	2.5'x3' Sign	39			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	42	8.7	4			1	26	65	1.20
	#9	2.5'x3' Sign	50			2.5	3	1	7.5	22.5	1.13
	#10	3 Section Head w/BP	53	8.7	4			1	26	65	1.20
	#11	Camera	57	1	1			1	3	22	1.20
	#12	3'x3.5' Sign	61			3	3.5	1	10.5	26.7	1.13
	#13	4 Section Head w/BP	64	11	5			1	34	80	1.20
	#14										
#15											
#16											
#17											
#18											
#19											
#20											
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
	#8										
	#9										
	#10										
	#11										
	#12										
	#13										
	#14										
#15											
#16											
#17											
#18											
#19											
#20											





16362-1-16 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 65' Arm W/24' Lum.

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.500	19.352	67.61	0.5287	0.53	1.714	16.65	0.80
2	I	1.06	1.06	19.352	19.204	67.08	0.5287	1.59	1.701	16.53	0.80
3	I	1.06	2.12	19.204	19.055	66.56	0.5287	2.65	1.688	16.41	0.80
4	I	1.06	3.18	19.055	18.907	66.03	0.5287	3.71	1.675	16.28	0.80
5	I	1.06	4.24	18.907	18.759	65.51	0.5287	4.76	1.662	16.16	0.80
6	I	1.06	5.29	18.759	18.611	64.99	0.5287	5.82	1.649	16.04	0.80
7	I	1.06	6.35	18.611	18.462	64.46	0.5287	6.88	1.636	15.91	0.80
8	I	1.06	7.41	18.462	18.314	63.94	0.5287	7.94	1.622	15.79	0.80
9	I	1.06	8.47	18.314	18.166	63.41	0.5287	9.00	1.609	15.67	0.80
10	I	1.06	9.53	18.166	18.018	62.89	0.5287	10.06	1.596	15.54	0.80
11	I	1.06	10.59	18.018	17.869	62.36	0.5287	11.12	1.583	15.42	0.80
12	I	1.06	11.65	17.869	17.721	61.84	0.5287	12.18	1.570	15.30	0.80
13	I	1.06	12.71	17.721	17.573	61.31	0.5287	13.23	1.557	15.17	1.00
14	I	1.06	13.76	17.573	17.425	60.79	0.5287	14.29	1.544	15.05	1.00
15	I	1.06	14.82	17.425	17.276	60.27	0.5287	15.35	1.531	14.93	1.00
16	I	1.06	15.88	17.276	17.128	59.74	0.5287	16.41	1.518	14.80	1.00
17	I	1.06	16.94	17.128	16.980	59.22	0.5286	17.47	1.505	14.68	1.00
18	J	3.00	18.00	16.980	16.560	164.94	1.4937	19.49	4.193	40.93	1.00
19	I	3.00	21.00	16.560	16.140	160.73	1.4936	22.49	4.088	39.94	1.00
20	J	1.00	24.00	16.140	16.000	52.64	0.4993	24.50	1.339	13.09	1.00
						1457					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in <sup>4</sup> )	866.45	567.94	0.00	473.53
Section Modulus (in <sup>3</sup> )	90.31	68.15	0.00	
Cross-Section Area (in <sup>2</sup> )	18.83	16.35	0.00	
Width-Thickness Ratio	62.40	54.34	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	14.296	14.296	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

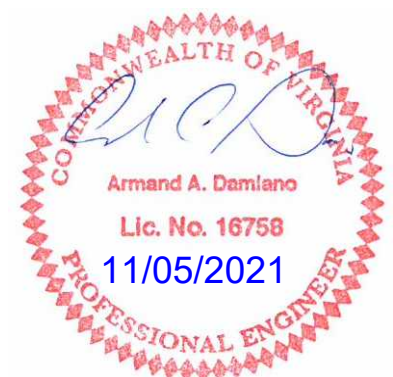
Shaft Deflection From Arm#1 GP I Load (in)	0.901
Shaft Deflection From Arm#2 GP I Load (in)	0.000



16362-1-16 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 65' Arm W/24' Lum.

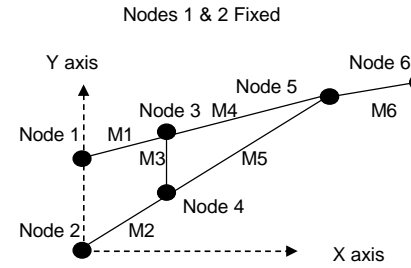
## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	13.10	0.000	21.43	1.100	4.576	7.84
2	0.450	7.64	13.00	0.000	21.26	1.100	4.576	7.78
3	0.450	7.64	12.90	0.000	21.10	1.100	4.576	7.72
4	0.450	7.64	12.80	0.000	20.94	1.100	4.576	7.66
5	0.450	7.64	12.70	0.000	20.77	1.100	4.576	7.60
6	0.450	7.64	12.60	0.000	20.61	1.100	4.576	7.54
7	0.450	7.64	12.50	0.000	20.44	1.100	4.576	7.48
8	0.450	7.64	12.40	0.001	20.28	1.100	4.576	7.42
9	0.450	7.64	12.30	0.001	20.12	1.100	4.576	7.36
10	0.450	7.64	12.20	0.001	19.95	1.100	4.576	7.30
11	0.450	7.64	12.10	0.001	19.79	1.100	4.576	7.24
12	0.450	7.64	12.00	0.001	19.63	1.100	4.576	7.19
13	0.450	9.54	14.85	0.002	19.46	1.100	4.576	7.13
14	0.450	9.54	14.73	0.002	19.30	1.100	4.576	7.07
15	0.450	9.54	14.61	0.003	19.14	1.100	4.576	7.01
16	0.450	9.54	14.48	0.003	18.97	1.100	4.576	6.95
17	0.450	9.54	14.36	0.003	18.81	1.100	4.576	6.89
18	0.450	9.54	40.00	0.011	52.41	1.100	4.576	19.18
19	0.450	9.54	38.99	0.014	51.09	1.100	4.576	18.70
20	0.450	9.54	12.78	0.005	16.74	1.100	4.576	6.13
Fix. #1	1.200	20.36	48.86	0.004	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.004	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.060	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-16 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 65' Arm W/24' Lum. - Luminaire Arm - Group II

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-33.67	-24.6	0	0	0
Node #2	0	0	0	0	-35.63	-26	0	0	0
Node #3	100	59.5	0	0	-66.63	-51.3	0	0	0
Node #4	100	48.8	0	0	-69.41	-53.4	0	0	0
Node #5	200	79	0	0	-94.35	-75.6	0	0	0
Node #6	288	87	0	0	-85.29	-69.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-67.33	1.1	1	-49.04	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-71.25	1.1	1	-51.90	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-0.68	1.1	1	-1.18	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-65.23	1.1	1.1	-52.27	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-66.89	1.1	1.1	-53.59	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-56.58	1.1	1.1	-45.33	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-57.00	1	1.1	-46.64					

AASHTO Gp	2
Mntg Hght =	29.00
Datum =	1

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2180.2	lbs
P1y	-694.6	lbs
P1z	178.8	lbs
M1x	6661.9	in-lbs
M1y	-25162.7	in-lbs
M1z	-898.1	in-lbs
P2x	2180.2	lbs
P2y	1079.6	lbs
P2z	121.5	lbs
M2x	6843.3	in-lbs
M2y	-20414.5	in-lbs
M2z	-928.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1018	138	19343	-491	0.55
#2	1071	87	15894	-954	0.78
#3	1489	431	8552	-392	0.35
#4	-1001	64	7424	-23	0.2
#5	1020	75	8261	-288	0.5
#6	4	98	7210	1	0.22

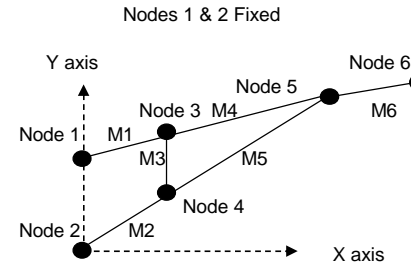
Arm Tip Displacement At Node 6	
X dir	0.103 (in)
Y dir	-0.898 (in)
Z dir	-10.462 (in)

V09.19.15



16362-1-16 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 65' Arm W/24' Lum. - Luminaire Arm - Group III

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-40.85	-13.2	0	0	0
Node #2	0	0	0	0	-43.23	-14	0	0	0
Node #3	100	59.5	0	0	-81.04	-26.6	0	0	0
Node #4	100	48.8	0	0	-84.42	-27.7	0	0	0
Node #5	200	79	0	0	-114.49	-37.8	0	0	0
Node #6	288	87	0	0	-115.33	-36.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-81.69	1.1	1	-26.29	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-86.45	1.1	1	-27.82	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-1.22	1.1	1	-0.63	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-79.16	1.1	1.1	-26.13	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-81.16	1.1	1.1	-26.80	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-68.65	1.1	1.1	-22.67	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-81.00	1	1.1	-25.00					

AASHTO Gp	3
Mntg Hght =	29.00
Datum =	1

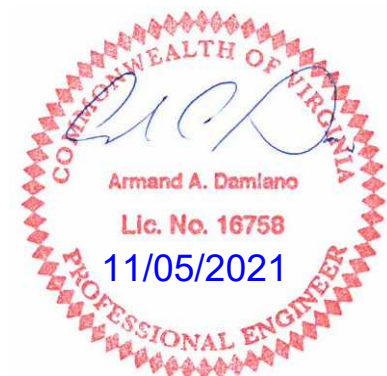
ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2797.7	lbs
P1y	-898.7	lbs
P1z	92.5	lbs
M1x	3425.6	in-lbs
M1y	-12957.4	in-lbs
M1z	-1426.8	in-lbs
P2x	2797.7	lbs
P2y	1378.1	lbs
P2z	63.2	lbs
M2x	3519.9	in-lbs
M2y	-10515.8	in-lbs
M2z	-1452.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1307	75	10010	-255	0.26
#2	1373	50	8249	-493	0.63
#3	1905	442	8972	-201	0.38
#4	-1287	45	3944	-13	0.08
#5	1311	48	4359	-150	0.46
#6	5	107	7919	1	0.24

Arm Tip Displacement At Node 6	
X dir	0.137 (in)
Y dir	-1.214 (in)
Z dir	-5.396 (in)

V09.19.15



16362-1-16 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 65' Arm W/24' Lum.

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	3.25	0.00	16.280	15.825	137.3	1.6173	1.62	4.348	4.348	42.51
2	I	3.25	3.25	15.825	15.370	133.3	1.6171	4.87	4.224	4.224	41.34
3	I	3.25	6.50	15.370	14.915	129.4	1.6169	8.12	4.101	4.101	40.18
4	I	3.25	9.75	14.915	14.460	125.4	1.6166	11.37	3.978	3.978	39.02
5	I	3.25	13.00	14.460	14.005	121.4	1.6163	14.62	3.855	3.855	37.86
6	I	3.25	16.25	14.005	13.550	117.5	1.6161	17.87	3.731	3.731	36.70
7	I	3.25	19.50	13.550	13.095	113.5	1.6158	21.12	3.608	3.608	35.54
8	I	3.25	22.75	13.095	12.640	109.6	1.6154	24.37	3.485	3.485	34.38
9	J	2.69	26.00	13.000	12.623	152.9	1.3384	27.34	2.872	2.872	28.33
10	O	3.30	28.69	12.623	12.161	77.3	1.6402	30.33	3.409	3.409	33.68
11	O	3.30	31.99	12.161	11.699	74.3	1.6398	33.63	3.282	3.282	32.48
12	O	3.30	35.29	11.699	11.237	71.4	1.6394	36.93	3.155	3.155	31.29
13	O	3.30	38.59	11.237	10.775	68.5	1.6389	40.23	3.027	3.027	30.09
14	O	3.30	41.89	10.775	10.313	65.6	1.6384	43.53	2.900	2.900	28.89
15	O	3.30	45.19	10.313	9.851	62.7	1.6378	46.83	2.773	2.773	27.69
16	O	3.30	48.50	9.851	9.389	59.7	1.6372	50.13	2.646	2.646	26.49
17	O	3.30	51.80	9.389	8.926	56.8	1.6366	53.43	2.519	2.519	25.30
18	O	3.30	55.10	8.926	8.464	53.9	1.6358	56.73	2.392	2.392	24.10
19	O	3.30	58.40	8.464	8.002	51.0	1.6350	60.03	2.265	2.265	22.90
20	O	3.30	61.70	8.002	7.540	48.0	1.6341	63.33	2.138	2.138	21.70
		<u>65.00</u>				<u>1829</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	9.50	37.500	1.000	112.50
Fix. #3	105	20.00	13.750	2.000	126.00
Fix. #4	22.5	24.00	7.500	1.000	22.50
Fix. #5	65	31.00	8.700	1.000	78.00
Fix. #6	22	35.00	1.000	1.000	9.00
Fix. #7	22.5	39.00	7.500	1.000	22.50
Fix. #8	65	42.00	8.700	1.000	78.00
Fix. #9	22.5	50.00	7.500	1.000	22.50
Fix. #10	65	53.00	8.700	1.000	78.00
Fix. #11	22	57.00	1.000	1.000	9.00
Fix. #12	26.7	61.00	10.500	1.000	31.50
Fix. #13	80	64.00	11.000	1.000	102.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	50.429	23.135
Cross-Section Area (in^2)	12.584	7.218
Width-Thickness Ratio	65.12	72.50
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	36.300	35.489
Allow. Shear Stress (ksi)	18.150	18.150



16362-1-16 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 65' Arm W/24' Lum.

Arm #1 Analysis Continued

Sec. Num.	Kz	Truck Induced Gust											
		Group 2			Group 3	Natural Wind Gust			Hght Corr. Factor = 1.000				Gallop
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	Loads (lbs)
1	1.00	0.450	9.54	41.48	54.34	1.100	4.576	19.89	0	0.531	0.00	0.00	
2	1.00	0.450	9.54	40.30	52.80	1.100	4.576	19.33	0	0.551	0.00	0.00	
3	1.00	0.450	9.54	39.12	51.26	1.100	4.576	18.77	0	0.572	0.00	0.00	
4	1.00	0.450	9.54	37.95	49.72	1.100	4.576	18.20	0	0.596	0.00	0.00	
5	1.00	0.450	9.54	36.77	48.18	1.100	4.576	17.64	0	0.621	0.00	0.00	
6	1.00	0.450	9.54	35.60	46.64	1.100	4.576	17.07	0	0.647	0.00	0.00	
7	1.00	0.450	9.54	34.42	45.10	1.100	4.576	16.51	0	0.676	0.00	0.00	
8	1.00	0.450	9.54	33.25	43.56	1.100	4.576	15.95	0	0.707	0.00	0.00	
9	1.00	0.450	9.54	27.40	35.90	1.100	4.576	13.14	0	0.711	0.00	0.00	
10	1.00	0.450	9.54	32.52	42.61	1.100	4.576	15.60	0	0.743	0.00	0.00	
11	1.00	0.450	9.54	31.31	41.02	1.100	4.576	15.02	0	0.781	0.00	0.00	
12	1.00	0.450	9.54	30.09	39.43	1.100	4.576	14.44	0	0.822	0.00	0.00	
13	1.00	0.450	9.54	28.88	37.84	1.100	4.576	13.85	0	0.867	0.00	0.00	
14	1.00	0.473	10.02	29.06	36.25	1.100	4.576	13.27	0	0.916	0.00	0.00	
15	1.00	0.501	10.62	29.45	34.67	1.100	4.576	12.69	0	0.971	0.00	0.00	
16	1.00	0.532	11.29	29.87	33.08	1.100	4.576	12.11	0	1.033	0.00	0.00	
17	1.00	0.568	12.04	30.33	31.49	1.100	4.576	11.53	1	1.101	0.00	0.00	
18	1.00	0.607	12.87	30.78	29.90	1.100	4.576	10.95	1	1.100	0.00	0.00	
19	1.00	0.652	13.82	31.30	28.31	1.100	4.576	10.36	1	1.100	0.00	0.00	
20	1.00	0.703	14.9	31.85	26.72	1.100	4.576	9.78	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #10	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #13	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00





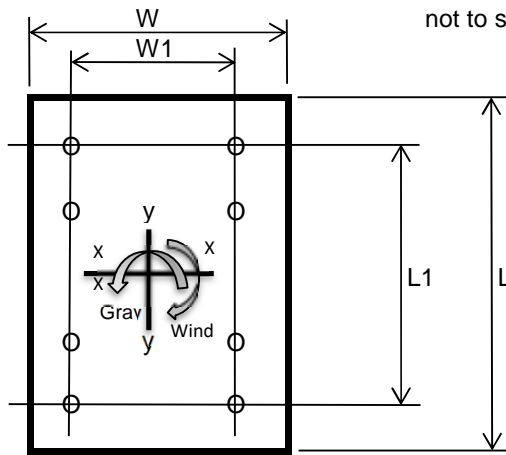
Flange Analysis - Arm #1

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	2458	3799	-	lbs
Shear (Wind)	3784	2386	-	lbs
Torsion (Arm Rise)	12888	8126	-	ft-lbs
Moment (Gravity)	70215	113930	-	ft-lbs
Moment (Wind)	120288	73912	-	ft-lbs
Nat. Wind Moment	-	-	28111	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	16.28	in
Tube Wall Thick.	0.25	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	16.48	20.59	ksi
Bolt Shear Stress - fv	1.65	1.2	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.39	0.47	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	2.66	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.38	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	11.71	19.00	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	20.40	12.54	ksi
Combined applied stress for interaction (SRSS)	23.52	22.77	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	





16362-1-16 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 65' Arm W/24' Lum.

Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.50	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.333333	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.730769	
Kf - Fatigue stress concentration factor for finite life	2.31	
Ki - Fatigue stress concentration factor for infinite life	5.05	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.25	in
Dt - Arm base diameter	16.28	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	1.95	
Dop - Baseplate center hole diameter	6.00	in
Cop - Center hole to arm diameter ratio	0.36855	
Kf - Fatigue stress concentration factor for finite life	1.80	
Ki - Fatigue stress concentration factor for infinite life	3.44	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle



16362-1-16 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 65' Arm W/24' Lum.

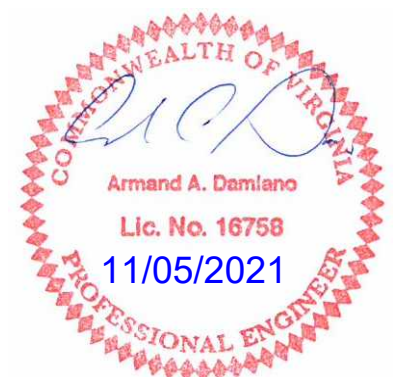
## Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	19.07	in
Shaft Thickness	0.313	in
Total Area	23.571	in <sup>2</sup>
Ix	911	in <sup>4</sup>
Iy	1023	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	22777	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	11.26	ksi
CSR	0.70	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	3.17	ksi
CSR	0.45	
Therefore	<b>OK</b>	



16362-1-16 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 65' Arm W/24' Lum.

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	2458		2458	70215		70215		391	16709		0.47
Gp II	2458	3784	4513	70215	120288	139282	12888	718	33144	1534	0.70
Gp III	3799	2386	4487	113930	73912	135806	8126	714	32317	967	0.68
Gp IV Natural		909	909		28111	28111	3095	145	6690	369	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	1233		1233	22307		22307		342	11571		0.33
Gp II	1233	1970	2325	22307	44802	50049	6711	645	25960	1741	0.56
Gp III	1996	1233	2347	38171	26615	46534	4201	651	24137	1090	0.52
Gp IV Natural		468	468		10125	10125	1595	130	5252	414	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-16 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 65' Arm W/24' Lum.

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	4464		70215	0	70215		237		9329		0.27
Gp II	4464	4943	80994	107723	134775	121414	237	526	17907	8066	0.51
Gp III	6422	3303	51070	138678	147783	74491	341	351	19636	4949	0.47
Gp IV Natural			22777	0	22777				3026		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9972										

<b>Shaft At Arm</b>											
Gp I	3221		70215	0	70215		197		12364		0.35
Gp II	3221	4176	12888	76133	77216	121414	197	511	13597	10690	0.51
Gp III	4657	2662	8126	117237	117518	74491	285	326	20693	6558	0.52
Gp IV Natural			3247	0	3247				572		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9972										



16362-1-16 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 65' Arm W/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	4943 lbs
Bending Moment	147783 ft-lbs
Torsion Moment	121414 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.50 in

**ANALYSIS - ANCHOR BOLTS**

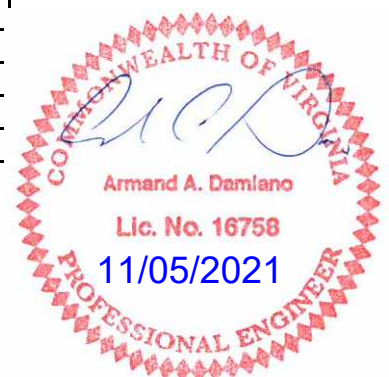
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	13.61 ksi
Bolt Direct Shear Stress	0.269 ksi
Bolt Torsion Shear Stress	6.091 ksi
Combined Bolt Stress	
$F_v = .3 F_y * \text{Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y * \text{Allowable Increase Factor}$	36.575 ksi
$f_t =$	13.61 ksi
$f_v =$	6.36 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.48 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.25 in
Design Moment	111 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	16.77 ksi
Allowable Plate Stress = $.66 F_y * \text{Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.688 in
Design Moment	58 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	9.2 ksi
Allowable Plate Stress = $.66 F_y * \text{Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-16 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 65' Arm W/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	22777 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	2.1 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.3
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

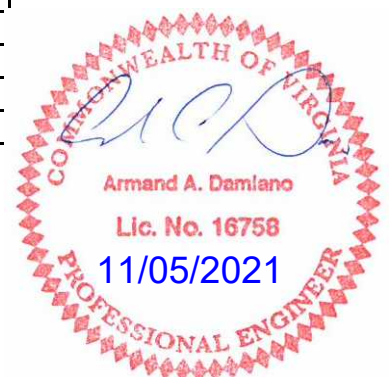
Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	34025 lbs
Computed Factor-of Safety	1.82 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	34025 lbs
Total Tensile Load	272200 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	1.73 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	34025 lbs
Total Tensile Load	272200 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	6 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-17 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 70' Arm

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<b>Fatigue Importance Factors</b>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	0		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.50	19.50	-	-	-	0	55	29000	-
Traffic Arm #1	0.2500	0.14	17.50	25.00	18.00	-	3.67	0	55	29000	180
	0.1880	0.14	14.79	47.92	-	2.92		0	55	29000	
Traffic Arm #2								0	55	29000	90
								0	55	29000	
Lum Arm #1								0	36	29000	180
Lum Arm #2								0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8		Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	in	Double Top Nuts	Yes	
A.B. Bolt Circle	26.00	in	Foundation Diameter	48	in
Baseplate Dia.	32.00	in	Concrete Cover	4	in
Baseplate Thk.	2.00	in	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	14.25	in	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.		Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1		Arm #2	
Flange Bolt Qty.	8		NA	
Bolt Diameter	1.50	in		in
Flange Plate Length (V)	27.00	in		in
Flange Plate Width (H)	27.00	in		in
Spac. Between Bolt (V)	22.50	in		in
Spac. Between Bolt (H)	22.50	in		in
Flange Plate Thk.	2.25	in		in
Flange Plate Yield (Fy)	50	ksi		ksi
Gusset Thk.	0.500	in		in
Plate Center Hole	6.00	in		in
Weld Type	Full Pen.			

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.32	0.42	0.49	0.41							28.94	0.00
GP II CSR	0.55	0.60	0.71	0.64								
GP III CSR	0.53	0.62	0.70	0.62							47.45	
Nat.Wind (psi)	3092	619	6735	5792								

Arm #1 Flange Bolt (Max.) CSR	0.56
Arm #1 Flange Bolt Fatigue CSR	0.45
Arm #1 Flange Plate (Max.) CSR	0.60
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.72
Handhole at Toe (Fatigue) CSR	0.46
Minimum Qty of Vertical Reinf. Bars	7

Fatigue Allowable - Shaft to Baseplate	4.5 ksi
Fatigue Allowable - Arm#1 to Flange	7 ksi
Fatigue Allowable - Arm#2 to Flange	-
Anchor Bolt Max. CSR	0.53
Anchor Bolt Max. Fatigue Stress Ratio	0.31
Base Plate Max. CSR	0.59
Anchorage Capacity S.F.	1.65
Concrete Pull Out Capacity S.F.	1.56

**Ground Line Reactions**

	Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
	5963	4651	163464	137190





16362-1-17 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 70' Arm

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.2
	#2	Ped Head	10.5	2.4	1			1	6	30	1.2
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.2
	#4										
Lum #1	#1										
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	15'x2.5' Sign	12			15	2.5	1	37.5	88.5	1.21
	#3	5 Section Head w/BP	25	13.75	4			2	42	105	1.20
	#4	2.5'x3' Sign	29			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	36	8.7	4			1	26	65	1.20
	#6	Camera	40	1	1			1	3	22	1.20
	#7	2.5'x3' Sign	44			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	47	8.7	4			1	26	65	1.20
	#9	2.5'x3' Sign	55			2.5	3	1	7.5	22.5	1.13
	#10	3 Section Head w/BP	58	8.7	4			1	26	65	1.20
	#11	Camera	62	1	1			1	3	22	1.20
	#12	3'x3.5' Sign	66			3	3.5	1	10.5	26.7	1.13
	#13	4 Section Head w/BP	69	11	5			1	34	80	1.20
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
	#8										
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	#18										
	#19										
	#20										



16362-1-17 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 70' Arm

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.500	19.352	67.61	0.5287	0.53	1.714	16.65	0.80
2	I	1.06	1.06	19.352	19.204	67.08	0.5287	1.59	1.701	16.53	0.80
3	I	1.06	2.12	19.204	19.055	66.56	0.5287	2.65	1.688	16.41	0.80
4	I	1.06	3.18	19.055	18.907	66.03	0.5287	3.71	1.675	16.28	0.80
5	I	1.06	4.24	18.907	18.759	65.51	0.5287	4.76	1.662	16.16	0.80
6	I	1.06	5.29	18.759	18.611	64.99	0.5287	5.82	1.649	16.04	0.80
7	I	1.06	6.35	18.611	18.462	64.46	0.5287	6.88	1.636	15.91	0.80
8	I	1.06	7.41	18.462	18.314	63.94	0.5287	7.94	1.622	15.79	0.80
9	I	1.06	8.47	18.314	18.166	63.41	0.5287	9.00	1.609	15.67	0.80
10	I	1.06	9.53	18.166	18.018	62.89	0.5287	10.06	1.596	15.54	0.80
11	I	1.06	10.59	18.018	17.869	62.36	0.5287	11.12	1.583	15.42	0.80
12	I	1.06	11.65	17.869	17.721	61.84	0.5287	12.18	1.570	15.30	0.80
13	I	1.06	12.71	17.721	17.573	61.31	0.5287	13.23	1.557	15.17	1.00
14	I	1.06	13.76	17.573	17.425	60.79	0.5287	14.29	1.544	15.05	1.00
15	I	1.06	14.82	17.425	17.276	60.27	0.5287	15.35	1.531	14.93	1.00
16	I	1.06	15.88	17.276	17.128	59.74	0.5287	16.41	1.518	14.80	1.00
17	I	1.06	16.94	17.128	16.980	59.22	0.5286	17.47	1.505	14.68	1.00
18	J	0.50	18.00	16.980	16.910	27.78	0.2498	18.25	0.706	6.89	1.00
19	I	0.50	18.50	16.910	16.840	27.66	0.2498	18.75	0.703	6.86	1.00
20	I	0.50	19.00	16.840	16.770	27.55	0.2498	19.25	0.700	6.83	1.00
						1161					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in <sup>4</sup> )	866.45	567.94	0.00	546.74
Section Modulus (in <sup>3</sup> )	90.31	68.15	0.00	
Cross-Section Area (in <sup>2</sup> )	18.83	16.35	0.00	
Width-Thickness Ratio	62.40	54.34	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	20.514	20.514	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

Shaft Deflection From Arm#1 GP I Load (in)	1.091
Shaft Deflection From Arm#2 GP I Load (in)	0.000



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## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	13.10	0.000	21.43	1.100	4.576	7.84
2	0.450	7.64	13.00	0.000	21.26	1.100	4.576	7.78
3	0.450	7.64	12.90	0.000	21.10	1.100	4.576	7.72
4	0.450	7.64	12.80	0.000	20.94	1.100	4.576	7.66
5	0.450	7.64	12.70	0.000	20.77	1.100	4.576	7.60
6	0.450	7.64	12.60	0.000	20.61	1.100	4.576	7.54
7	0.450	7.64	12.50	0.000	20.44	1.100	4.576	7.48
8	0.450	7.64	12.40	0.000	20.28	1.100	4.576	7.42
9	0.450	7.64	12.30	0.001	20.12	1.100	4.576	7.36
10	0.450	7.64	12.20	0.001	19.95	1.100	4.576	7.30
11	0.450	7.64	12.10	0.001	19.79	1.100	4.576	7.24
12	0.450	7.64	12.00	0.001	19.63	1.100	4.576	7.19
13	0.450	9.54	14.85	0.001	19.46	1.100	4.576	7.13
14	0.450	9.54	14.73	0.002	19.30	1.100	4.576	7.07
15	0.450	9.54	14.61	0.002	19.14	1.100	4.576	7.01
16	0.450	9.54	14.48	0.002	18.97	1.100	4.576	6.95
17	0.450	9.54	14.36	0.002	18.81	1.100	4.576	6.89
18	0.450	9.54	6.74	0.001	8.83	1.100	4.576	3.23
19	0.450	9.54	6.71	0.001	8.79	1.100	4.576	3.22
20	0.450	9.54	6.68	0.001	8.75	1.100	4.576	3.20
Fix. #1	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.043	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-17 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 70' Arm

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	3.68	0.00	17.500	16.985	167.1	1.8308	1.83	5.288	5.288	51.57
2	I	3.68	3.68	16.985	16.470	162.1	1.8306	5.51	5.130	5.130	50.08
3	I	3.68	7.36	16.470	15.954	157.0	1.8303	9.19	4.972	4.972	48.59
4	I	3.68	11.04	15.954	15.439	151.9	1.8299	12.87	4.814	4.814	47.10
5	I	3.68	14.72	15.439	14.924	146.8	1.8296	16.55	4.656	4.656	45.61
6	I	3.68	18.40	14.924	14.409	141.8	1.8292	20.23	4.498	4.498	44.12
7	J	2.92	22.08	14.790	14.381	193.4	1.4532	23.53	3.549	3.549	34.83
8	O	3.46	25.00	14.381	13.897	97.1	1.7209	26.72	4.079	4.079	40.07
9	O	3.46	28.46	13.897	13.412	93.7	1.7205	30.18	3.939	3.939	38.75
10	O	3.46	31.92	13.412	12.927	90.3	1.7202	33.64	3.799	3.799	37.43
11	O	3.46	35.38	12.927	12.443	86.9	1.7197	37.10	3.659	3.659	36.12
12	O	3.46	38.85	12.443	11.958	83.6	1.7193	40.57	3.519	3.519	34.80
13	O	3.46	42.31	11.958	11.474	80.2	1.7188	44.03	3.380	3.380	33.48
14	O	3.46	45.77	11.474	10.989	76.8	1.7183	47.49	3.240	3.240	32.16
15	O	3.46	49.23	10.989	10.504	73.5	1.7178	50.95	3.100	3.100	30.85
16	O	3.46	52.69	10.504	10.020	70.1	1.7171	54.41	2.960	2.960	29.53
17	O	3.46	56.15	10.020	9.535	66.7	1.7165	57.87	2.820	2.820	28.21
18	O	3.46	59.62	9.535	9.050	63.3	1.7157	61.33	2.681	2.681	26.89
19	O	3.46	63.08	9.050	8.566	60.0	1.7149	64.79	2.541	2.541	25.58
20	O	3.46	66.54	8.566	8.081	56.6	1.7140	68.25	2.401	2.401	24.26
		<u>70.00</u>				<u>2119</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	12.00	37.500	1.000	112.50
Fix. #3	105	25.00	13.750	2.000	126.00
Fix. #4	22.5	29.00	7.500	1.000	22.50
Fix. #5	65	36.00	8.700	1.000	78.00
Fix. #6	22	40.00	1.000	1.000	9.00
Fix. #7	22.5	44.00	7.500	1.000	22.50
Fix. #8	65	47.00	8.700	1.000	78.00
Fix. #9	22.5	55.00	7.500	1.000	22.50
Fix. #10	65	58.00	8.700	1.000	78.00
Fix. #11	22	62.00	1.000	1.000	9.00
Fix. #12	26.7	66.00	10.500	1.000	31.50
Fix. #13	80	69.00	11.000	1.000	102.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	58.397	31.467
Cross-Section Area (in^2)	13.541	8.620
Width-Thickness Ratio	70.00	78.67
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	35.991	34.389
Allow. Shear Stress (ksi)	18.150	17.040



16362-1-17 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 70' Arm

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000 Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	50.44	66.10	1.100	4.576	24.20	0	0.484	0.00	0.00	
2	1.00	0.450	9.54	48.94	64.12	1.100	4.576	23.47	0	0.503	0.00	0.00	
3	1.00	0.450	9.54	47.43	62.15	1.100	4.576	22.75	0	0.524	0.00	0.00	
4	1.00	0.450	9.54	45.92	60.17	1.100	4.576	22.03	0	0.546	0.00	0.00	
5	1.00	0.450	9.54	44.42	58.20	1.100	4.576	21.30	0	0.571	0.00	0.00	
6	1.00	0.450	9.54	42.91	56.22	1.100	4.576	20.58	0	0.597	0.00	0.00	
7	1.00	0.450	9.54	33.86	44.36	1.100	4.576	16.24	0	0.601	0.00	0.00	
8	1.00	0.450	9.54	38.91	50.98	1.100	4.576	18.66	0	0.626	0.00	0.00	
9	1.00	0.450	9.54	37.58	49.23	1.100	4.576	18.02	0	0.655	0.00	0.00	
10	1.00	0.450	9.54	36.24	47.49	1.100	4.576	17.38	0	0.686	0.00	0.00	
11	1.00	0.450	9.54	34.91	45.74	1.100	4.576	16.74	0	0.721	0.00	0.00	
12	1.00	0.450	9.54	33.57	43.99	1.100	4.576	16.10	0	0.758	0.00	0.00	
13	1.00	0.450	9.54	32.24	42.24	1.100	4.576	15.46	0	0.799	0.00	0.00	
14	1.00	0.450	9.54	30.91	40.50	1.100	4.576	14.83	0	0.844	0.00	0.00	
15	1.00	0.461	9.78	30.32	38.75	1.100	4.576	14.19	0	0.894	0.00	0.00	
16	1.00	0.489	10.38	30.73	37.00	1.100	4.576	13.55	0	0.949	0.00	0.00	
17	1.00	0.521	11.05	31.17	35.25	1.100	4.576	12.91	1	1.011	0.00	0.00	
18	1.00	0.557	11.81	31.66	33.51	1.100	4.576	12.27	1	1.080	0.00	0.00	
19	1.00	0.597	12.66	32.17	31.76	1.100	4.576	11.63	1	1.100	0.00	0.00	
20	1.00	0.643	13.63	32.73	30.01	1.100	4.576	10.99	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #10	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #13	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



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Flange Analysis - Arm #1

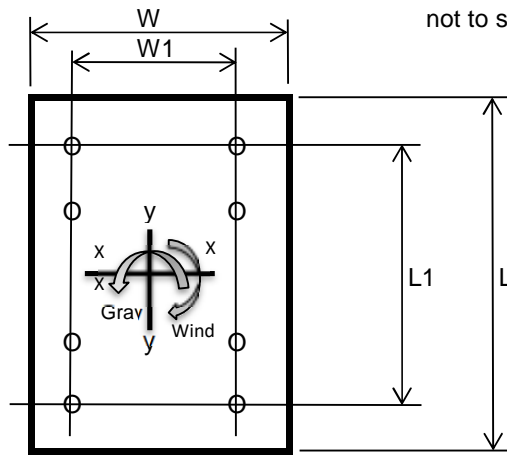
V06-21-16

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	2748	4188	-	lbs
Shear (Wind)	3869	2515	-	lbs
Torsion (Arm Rise)	14192	9224	-	ft-lbs
Moment (Gravity)	85096	136462	-	ft-lbs
Moment (Wind)	137190	86259	-	ft-lbs
Nat. Wind Moment	-	-	32774	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	17.50	in
Tube Wall Thick.	0.25	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	19.42	24.59	ksi
Bolt Shear Stress - fv	1.79	1.34	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.45	0.56	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	3.1	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.45	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W t^2 / 6)$	13.77	22.08	ksi
Stress from wind loads = $4P \cdot e / (L t^2 / 6)$	22.58	14.20	ksi
Combined applied stress for interaction (SRSS)	26.45	26.25	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



16362-1-17 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 70' Arm

Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

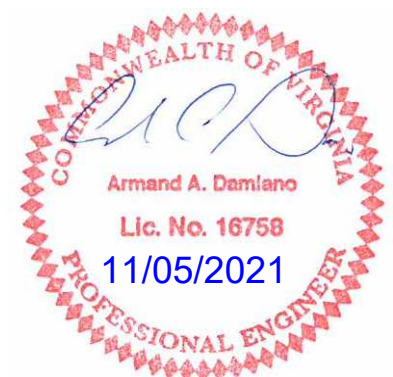
Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.50	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.333333	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.730769	
Kf - Fatigue stress concentration factor for finite life	2.31	
Ki - Fatigue stress concentration factor for infinite life	5.05	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.25	in
Dt - Arm base diameter	17.50	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	1.82	
Dop - Baseplate center hole diameter	6	in
Cop - Center hole to arm diameter ratio	0.342857	
Kf - Fatigue stress concentration factor for finite life	1.76	
Ki - Fatigue stress concentration factor for infinite life	3.33	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle





16362-1-17 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 70' Arm  
Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	19.07	in
Shaft Thickness	0.313	in
Total Area	23.571	in <sup>2</sup>
Ix	911	in <sup>4</sup>
Iy	1023	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	23274	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	11.50	ksi
CSR	0.72	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	3.24	ksi
CSR	0.46	
Therefore	<b>OK</b>	



16362-1-17 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 70' Arm

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	2748		2748	85096		85097		406	17487		0.49
Gp II	2748	3869	4746	85096	137190	161439	14192	701	33175	1459	0.71
Gp III	4188	2515	4886	136462	86259	161439	9224	722	33175	948	0.70
Gp IV Natural		956	956		32774	32774	3507	142	6735	361	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	1710		1710	36287		36287		397	13839		0.41
Gp II	1710	2605	3116	36287	65080	74513	9554	723	28416	1822	0.64
Gp III	2742	1656	3204	60410	39979	72441	6073	744	27626	1158	0.62
Gp IV Natural		628	628		15186	15186	2305	146	5792	440	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-17 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 70' Arm

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	4074		85096	0	85096		216		11307		0.32
Gp II	4074	4651	83834	110574	138761	137190	216	495	18437	9114	0.55
Gp III	5963	3180	54488	154115	163464	86259	317	338	21719	5731	0.53
Gp IV Natural			23274	0	23274				3092		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9973										

<b>Shaft At Arm</b>											
Gp I	2831		85096	0	85096		173		14984		0.42
Gp II	2831	3889	14192	85111	86286	137190	173	476	15194	12079	0.60
Gp III	4271	2541	9224	136482	136793	86259	261	311	24087	7594	0.62
Gp IV Natural			3513	0	3513				619		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9973										



16362-1-17 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 70' Arm

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	4651 lbs
Bending Moment	163464 ft-lbs
Torsion Moment	137190 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.50 in

**ANALYSIS - ANCHOR BOLTS**

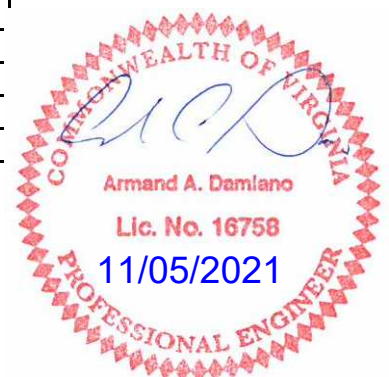
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	15.054 ksi
Bolt Direct Shear Stress	0.253 ksi
Bolt Torsion Shear Stress	6.883 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	15.054 ksi
$f_v =$	7.136 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.53 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.25 in
Design Moment	123 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	18.59 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.688 in
Design Moment	64 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	10.15 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-17 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 70' Arm

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	23274 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	2.15 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.31
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

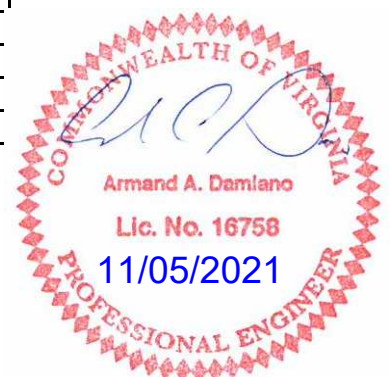
Anchor Bolt Length	60.0 in
Anchor Bolt Max. Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	37635 lbs
Computed Factor-of Safety	1.65 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	37635 lbs
Total Tensile Load	301080 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	1.56 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	37635 lbs
Total Tensile Load	301080 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	7 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-18 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 70' Arm w/24' Arm

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<i>Fatigue Importance Factors</i>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	1		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.50	25.00	-	-	-	0	55	29000	-
Traffic Arm #1	0.2500	0.14	17.50	25.00	18.00	-	3.67	0	55	29000	180
	0.1880	0.14	14.79	47.92	-	2.92		0	55	29000	
Traffic Arm #2								0	55	29000	90
								0	55	29000	
Lum Arm #1	0.2760		2.88	24.00	24.00	-	5	0	36	29000	180
Lum Arm #2						-		0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	in	Double Top Nuts	Yes
A.B. Bolt Circle	26.00	in	Foundation Diameter	48
Baseplate Dia.	32.00	in	Concrete Cover	4
Baseplate Thk.	2.00	in	f'c = 28 Day Concrete Comp. Strength	3000
B.P. Center Hole	14.25	in	Vertical Reinforcing Bar Size #	8
Weld Type	Full Pen.		Rebar Yield Strength fy	60
				ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50	in
Flange Plate Length (V)	27.00	in
Flange Plate Width (H)	27.00	in
Spac. Between Bolt (V)	22.50	in
Spac. Between Bolt (H)	22.50	in
Flange Plate Thk.	2.25	in
Flange Plate Yield (Fy)	50	ksi
Gusset Thk.	0.500	in
Plate Center Hole	6.00	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	<i>Shaft At</i>		<i>Arm#1</i>		<i>Arm#2</i>		<i>Lum#1</i>		<i>Lum#2</i>		<i>Tip Deflection (in)</i>	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.33	0.43	0.49	0.41							28.94	0.00
GP II CSR	0.58	0.62	0.71	0.64			0.78					
GP III CSR	0.55	0.63	0.70	0.62			0.63				47.45	
Nat.Wind (psi)	3194	644	6735	5792								

Arm #1 Flange Bolt (Max.) CSR	0.56
Arm #1 Flange Bolt Fatigue CSR	0.45
Arm #1 Flange Plate (Max.) CSR	0.60
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.74
Handhole at Toe (Fatigue) CSR	0.48
Minimum Qty of Vertical Reinf. Bars	7

Fatigue Allowable - Shaft to Baseplate	4.5	ksi
Fatigue Allowable - Arm#1 to Flange	7	ksi
Fatigue Allowable - Arm#2 to Flange	-	
Anchor Bolt Max. CSR	0.55	
Anchor Bolt Max. Fatigue Stress Ratio	0.32	
Base Plate Max. CSR	0.61	
Anchorage Capacity S.F.	1.57	
Concrete Pull Out Capacity S.F.	1.50	

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
6811	5030	170817	138315



16362-1-18 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 70' Arm w/24' Arm

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1	Cobra Head w/Camera	24	2	1			4.54	9	57	1.00
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	15'x2.5' Sign	12			15	2.5	1	37.5	88.5	1.21
	#3	5 Section Head w/BP	25	13.75	4			2	42	105	1.20
	#4	2.5'x3' Sign	29			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	36	8.7	4			1	26	65	1.20
	#6	Camera	40	1	1			1	3	22	1.20
	#7	2.5'x3' Sign	44			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	47	8.7	4			1	26	65	1.20
	#9	2.5'x3' Sign	55			2.5	3	1	7.5	22.5	1.13
	#10	3 Section Head w/BP	58	8.7	4			1	26	65	1.20
	#11	Camera	62	1	1			1	3	22	1.20
	#12	3'x3.5' Sign	66			3	3.5	1	10.5	26.7	1.13
	#13	4 Section Head w/BP	69	11	5			1	34	80	1.20
	#14										
#15											
#16											
#17											
#18											
#19											
#20											
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
	#8										
	#9										
	#10										
	#11										
	#12										
	#13										
	#14										
#15											
#16											
#17											
#18											
#19											
#20											





16362-1-18 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 70' Arm w/24' Arm

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.500	19.352	67.61	0.5287	0.53	1.714	16.65	0.80
2	I	1.06	1.06	19.352	19.204	67.08	0.5287	1.59	1.701	16.53	0.80
3	I	1.06	2.12	19.204	19.055	66.56	0.5287	2.65	1.688	16.41	0.80
4	I	1.06	3.18	19.055	18.907	66.03	0.5287	3.71	1.675	16.28	0.80
5	I	1.06	4.24	18.907	18.759	65.51	0.5287	4.76	1.662	16.16	0.80
6	I	1.06	5.29	18.759	18.611	64.99	0.5287	5.82	1.649	16.04	0.80
7	I	1.06	6.35	18.611	18.462	64.46	0.5287	6.88	1.636	15.91	0.80
8	I	1.06	7.41	18.462	18.314	63.94	0.5287	7.94	1.622	15.79	0.80
9	I	1.06	8.47	18.314	18.166	63.41	0.5287	9.00	1.609	15.67	0.80
10	I	1.06	9.53	18.166	18.018	62.89	0.5287	10.06	1.596	15.54	0.80
11	I	1.06	10.59	18.018	17.869	62.36	0.5287	11.12	1.583	15.42	0.80
12	I	1.06	11.65	17.869	17.721	61.84	0.5287	12.18	1.570	15.30	0.80
13	I	1.06	12.71	17.721	17.573	61.31	0.5287	13.23	1.557	15.17	1.00
14	I	1.06	13.76	17.573	17.425	60.79	0.5287	14.29	1.544	15.05	1.00
15	I	1.06	14.82	17.425	17.276	60.27	0.5287	15.35	1.531	14.93	1.00
16	I	1.06	15.88	17.276	17.128	59.74	0.5287	16.41	1.518	14.80	1.00
17	I	1.06	16.94	17.128	16.980	59.22	0.5286	17.47	1.505	14.68	1.00
18	J	3.00	18.00	16.980	16.560	164.94	1.4937	19.49	4.193	40.93	1.00
19	I	3.00	21.00	16.560	16.140	160.73	1.4936	22.49	4.088	39.94	1.00
20	J	1.00	24.00	16.140	16.000	52.64	0.4993	24.50	1.339	13.09	1.00
						1457					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in <sup>4</sup> )	866.45	567.94	0.00	473.53
Section Modulus (in <sup>3</sup> )	90.31	68.15	0.00	
Cross-Section Area (in <sup>2</sup> )	18.83	16.35	0.00	
Width-Thickness Ratio	62.40	54.34	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	14.296	14.296	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

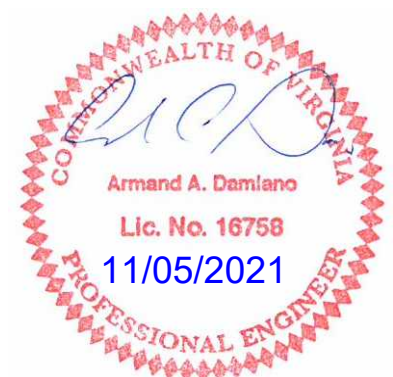
Shaft Deflection From Arm#1 GP I Load (in)	1.091
Shaft Deflection From Arm#2 GP I Load (in)	0.000



16362-1-18 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 70' Arm w/24' Arm

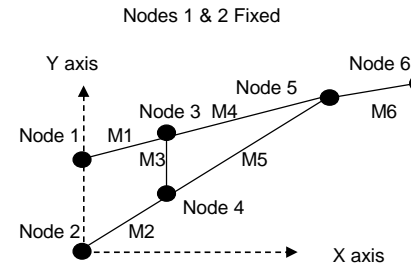
## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	13.10	0.000	21.43	1.100	4.576	7.84
2	0.450	7.64	13.00	0.000	21.26	1.100	4.576	7.78
3	0.450	7.64	12.90	0.000	21.10	1.100	4.576	7.72
4	0.450	7.64	12.80	0.000	20.94	1.100	4.576	7.66
5	0.450	7.64	12.70	0.000	20.77	1.100	4.576	7.60
6	0.450	7.64	12.60	0.000	20.61	1.100	4.576	7.54
7	0.450	7.64	12.50	0.000	20.44	1.100	4.576	7.48
8	0.450	7.64	12.40	0.001	20.28	1.100	4.576	7.42
9	0.450	7.64	12.30	0.001	20.12	1.100	4.576	7.36
10	0.450	7.64	12.20	0.001	19.95	1.100	4.576	7.30
11	0.450	7.64	12.10	0.001	19.79	1.100	4.576	7.24
12	0.450	7.64	12.00	0.001	19.63	1.100	4.576	7.19
13	0.450	9.54	14.85	0.002	19.46	1.100	4.576	7.13
14	0.450	9.54	14.73	0.002	19.30	1.100	4.576	7.07
15	0.450	9.54	14.61	0.003	19.14	1.100	4.576	7.01
16	0.450	9.54	14.48	0.003	18.97	1.100	4.576	6.95
17	0.450	9.54	14.36	0.003	18.81	1.100	4.576	6.89
18	0.450	9.54	40.00	0.011	52.41	1.100	4.576	19.18
19	0.450	9.54	38.99	0.014	51.09	1.100	4.576	18.70
20	0.450	9.54	12.78	0.005	16.74	1.100	4.576	6.13
Fix. #1	1.200	20.36	48.86	0.004	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.004	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.060	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-18 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 70' Arm w/24' Arm - Luminaire Arm - Group II

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-33.67	-24.6	0	0	0
Node #2	0	0	0	0	-35.63	-26	0	0	0
Node #3	100	59.5	0	0	-66.63	-51.3	0	0	0
Node #4	100	48.8	0	0	-69.41	-53.4	0	0	0
Node #5	200	79	0	0	-94.35	-75.6	0	0	0
Node #6	288	87	0	0	-85.29	-69.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-67.33	1.1	1	-49.04	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-71.25	1.1	1	-51.90	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-0.68	1.1	1	-1.18	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-65.23	1.1	1.1	-52.27	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-66.89	1.1	1.1	-53.59	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-56.58	1.1	1.1	-45.33	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-57.00	1	1.1	-46.64					

AASHTO Gp	2
Mntg Hght =	29.00
Datum =	1

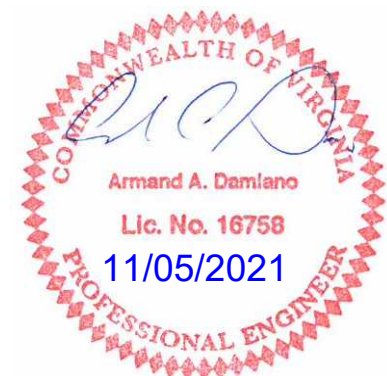
ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2180.2	lbs
P1y	-694.6	lbs
P1z	178.8	lbs
M1x	6661.9	in-lbs
M1y	-25162.7	in-lbs
M1z	-898.1	in-lbs
P2x	2180.2	lbs
P2y	1079.6	lbs
P2z	121.5	lbs
M2x	6843.3	in-lbs
M2y	-20414.5	in-lbs
M2z	-928.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1018	138	19343	-491	0.55
#2	1071	87	15894	-954	0.78
#3	1489	431	8552	-392	0.35
#4	-1001	64	7424	-23	0.2
#5	1020	75	8261	-288	0.5
#6	4	98	7210	1	0.22

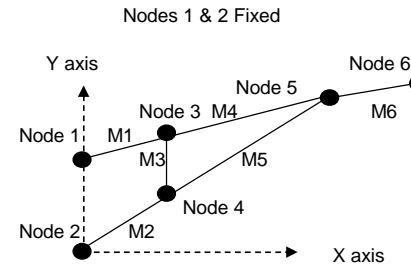
Arm Tip Displacement At Node 6	
X dir	0.103 (in)
Y dir	-0.898 (in)
Z dir	-10.462 (in)

V09.19.15



16362-1-18 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 70' Arm w/24' Arm - Luminaire Arm - Group III

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-40.85	-13.2	0	0	0
Node #2	0	0	0	0	-43.23	-14	0	0	0
Node #3	100	59.5	0	0	-81.04	-26.6	0	0	0
Node #4	100	48.8	0	0	-84.42	-27.7	0	0	0
Node #5	200	79	0	0	-114.49	-37.8	0	0	0
Node #6	288	87	0	0	-115.33	-36.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-81.69	1.1	1	-26.29	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-86.45	1.1	1	-27.82	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-1.22	1.1	1	-0.63	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-79.16	1.1	1.1	-26.13	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-81.16	1.1	1.1	-26.80	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-68.65	1.1	1.1	-22.67	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-81.00	1	1.1	-25.00					

AASHTO Gp	3
Mntg Hght =	29.00
Datum =	1

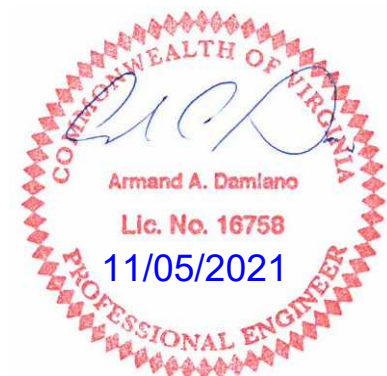
ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2797.7	lbs
P1y	-898.7	lbs
P1z	92.5	lbs
M1x	3425.6	in-lbs
M1y	-12957.4	in-lbs
M1z	-1426.8	in-lbs
P2x	2797.7	lbs
P2y	1378.1	lbs
P2z	63.2	lbs
M2x	3519.9	in-lbs
M2y	-10515.8	in-lbs
M2z	-1452.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1307	75	10010	-255	0.26
#2	1373	50	8249	-493	0.63
#3	1905	442	8972	-201	0.38
#4	-1287	45	3944	-13	0.08
#5	1311	48	4359	-150	0.46
#6	5	107	7919	1	0.24

Arm Tip Displacement At Node 6	
X dir	0.137 (in)
Y dir	-1.214 (in)
Z dir	-5.396 (in)

V09.19.15



16362-1-18 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 70' Arm w/24' Arm

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	3.68	0.00	17.500	16.985	167.1	1.8308	1.83	5.288	5.288	51.57
2	I	3.68	3.68	16.985	16.470	162.1	1.8306	5.51	5.130	5.130	50.08
3	I	3.68	7.36	16.470	15.954	157.0	1.8303	9.19	4.972	4.972	48.59
4	I	3.68	11.04	15.954	15.439	151.9	1.8299	12.87	4.814	4.814	47.10
5	I	3.68	14.72	15.439	14.924	146.8	1.8296	16.55	4.656	4.656	45.61
6	I	3.68	18.40	14.924	14.409	141.8	1.8292	20.23	4.498	4.498	44.12
7	J	2.92	22.08	14.790	14.381	193.4	1.4532	23.53	3.549	3.549	34.83
8	O	3.46	25.00	14.381	13.897	97.1	1.7209	26.72	4.079	4.079	40.07
9	O	3.46	28.46	13.897	13.412	93.7	1.7205	30.18	3.939	3.939	38.75
10	O	3.46	31.92	13.412	12.927	90.3	1.7202	33.64	3.799	3.799	37.43
11	O	3.46	35.38	12.927	12.443	86.9	1.7197	37.10	3.659	3.659	36.12
12	O	3.46	38.85	12.443	11.958	83.6	1.7193	40.57	3.519	3.519	34.80
13	O	3.46	42.31	11.958	11.474	80.2	1.7188	44.03	3.380	3.380	33.48
14	O	3.46	45.77	11.474	10.989	76.8	1.7183	47.49	3.240	3.240	32.16
15	O	3.46	49.23	10.989	10.504	73.5	1.7178	50.95	3.100	3.100	30.85
16	O	3.46	52.69	10.504	10.020	70.1	1.7171	54.41	2.960	2.960	29.53
17	O	3.46	56.15	10.020	9.535	66.7	1.7165	57.87	2.820	2.820	28.21
18	O	3.46	59.62	9.535	9.050	63.3	1.7157	61.33	2.681	2.681	26.89
19	O	3.46	63.08	9.050	8.566	60.0	1.7149	64.79	2.541	2.541	25.58
20	O	3.46	66.54	8.566	8.081	56.6	1.7140	68.25	2.401	2.401	24.26
		<u>70.00</u>				<u>2119</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	12.00	37.500	1.000	112.50
Fix. #3	105	25.00	13.750	2.000	126.00
Fix. #4	22.5	29.00	7.500	1.000	22.50
Fix. #5	65	36.00	8.700	1.000	78.00
Fix. #6	22	40.00	1.000	1.000	9.00
Fix. #7	22.5	44.00	7.500	1.000	22.50
Fix. #8	65	47.00	8.700	1.000	78.00
Fix. #9	22.5	55.00	7.500	1.000	22.50
Fix. #10	65	58.00	8.700	1.000	78.00
Fix. #11	22	62.00	1.000	1.000	9.00
Fix. #12	26.7	66.00	10.500	1.000	31.50
Fix. #13	80	69.00	11.000	1.000	102.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	58.397	31.467
Cross-Section Area (in^2)	13.541	8.620
Width-Thickness Ratio	70.00	78.67
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	35.991	34.389
Allow. Shear Stress (ksi)	18.150	17.040



16362-1-18 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 70' Arm w/24' Arm

Arm #1 Analysis Continued

Sec. Num.	Kz	Truck Induced Gust											
		Group 2			Group 3	Natural Wind Gust			Hght Corr. Factor = 1.000				Gallop
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	Loads (lbs)
1	1.00	0.450	9.54	50.44	66.10	1.100	4.576	24.20	0	0.484	0.00	0.00	
2	1.00	0.450	9.54	48.94	64.12	1.100	4.576	23.47	0	0.503	0.00	0.00	
3	1.00	0.450	9.54	47.43	62.15	1.100	4.576	22.75	0	0.524	0.00	0.00	
4	1.00	0.450	9.54	45.92	60.17	1.100	4.576	22.03	0	0.546	0.00	0.00	
5	1.00	0.450	9.54	44.42	58.20	1.100	4.576	21.30	0	0.571	0.00	0.00	
6	1.00	0.450	9.54	42.91	56.22	1.100	4.576	20.58	0	0.597	0.00	0.00	
7	1.00	0.450	9.54	33.86	44.36	1.100	4.576	16.24	0	0.601	0.00	0.00	
8	1.00	0.450	9.54	38.91	50.98	1.100	4.576	18.66	0	0.626	0.00	0.00	
9	1.00	0.450	9.54	37.58	49.23	1.100	4.576	18.02	0	0.655	0.00	0.00	
10	1.00	0.450	9.54	36.24	47.49	1.100	4.576	17.38	0	0.686	0.00	0.00	
11	1.00	0.450	9.54	34.91	45.74	1.100	4.576	16.74	0	0.721	0.00	0.00	
12	1.00	0.450	9.54	33.57	43.99	1.100	4.576	16.10	0	0.758	0.00	0.00	
13	1.00	0.450	9.54	32.24	42.24	1.100	4.576	15.46	0	0.799	0.00	0.00	
14	1.00	0.450	9.54	30.91	40.50	1.100	4.576	14.83	0	0.844	0.00	0.00	
15	1.00	0.461	9.78	30.32	38.75	1.100	4.576	14.19	0	0.894	0.00	0.00	
16	1.00	0.489	10.38	30.73	37.00	1.100	4.576	13.55	0	0.949	0.00	0.00	
17	1.00	0.521	11.05	31.17	35.25	1.100	4.576	12.91	1	1.011	0.00	0.00	
18	1.00	0.557	11.81	31.66	33.51	1.100	4.576	12.27	1	1.080	0.00	0.00	
19	1.00	0.597	12.66	32.17	31.76	1.100	4.576	11.63	1	1.100	0.00	0.00	
20	1.00	0.643	13.63	32.73	30.01	1.100	4.576	10.99	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #10	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #13	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00





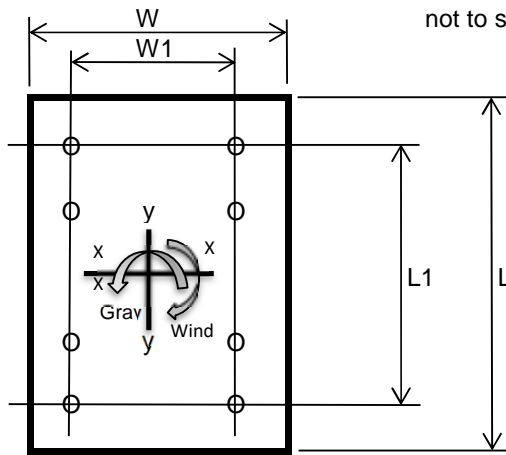
Flange Analysis - Arm #1

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	2748	4188	-	lbs
Shear (Wind)	3869	2515	-	lbs
Torsion (Arm Rise)	14192	9224	-	ft-lbs
Moment (Gravity)	85096	136462	-	ft-lbs
Moment (Wind)	137190	86259	-	ft-lbs
Nat. Wind Moment	-	-	32774	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	17.50	in
Tube Wall Thick.	0.25	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	19.42	24.59	ksi
Bolt Shear Stress - fv	1.79	1.34	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
[(fv/Fv) ^2 + (ft/Ft) ^2] ^0.5 <= 1	0.45	0.56	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	3.1	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.45	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	13.77	22.08	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	22.58	14.20	ksi
Combined applied stress for interaction (SRSS)	26.45	26.25	ksi
Allow. Plate Stress = $0.66 \cdot F_y \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	





16362-1-18 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 70' Arm w/24' Arm

Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

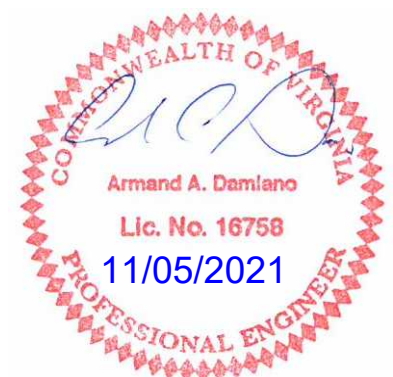
Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.50	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.333333	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.730769	
Kf - Fatigue stress concentration factor for finite life	2.31	
Ki - Fatigue stress concentration factor for infinite life	5.05	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.25	in
Dt - Arm base diameter	17.50	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	1.82	
Dop - Baseplate center hole diameter	6	in
Cop - Center hole to arm diameter ratio	0.342857	
Kf - Fatigue stress concentration factor for finite life	1.76	
Ki - Fatigue stress concentration factor for infinite life	3.33	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle



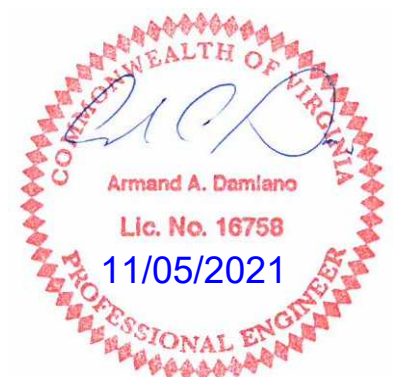
16362-1-18 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 70' Arm w/24' Arm  
Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	19.07	in
Shaft Thickness	0.313	in
Total Area	23.571	in <sup>2</sup>
Ix	911	in <sup>4</sup>
Iy	1023	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	24038	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	11.88	ksi
CSR	0.74	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	3.34	ksi
CSR	0.48	
Therefore	<b>OK</b>	



16362-1-18 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 70' Arm w/24' Arm

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	2748		2748	85096		85097		406	17487		0.49
Gp II	2748	3869	4746	85096	137190	161439	14192	701	33175	1459	0.71
Gp III	4188	2515	4886	136462	86259	161439	9224	722	33175	948	0.70
Gp IV Natural		956	956		32774	32774	3507	142	6735	361	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	1710		1710	36287		36287		397	13839		0.41
Gp II	1710	2605	3116	36287	65080	74513	9554	723	28416	1822	0.64
Gp III	2742	1656	3204	60410	39979	72441	6073	744	27626	1158	0.62
Gp IV Natural		628	628		15186	15186	2305	146	5792	440	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-18 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 70' Arm w/24' Arm

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	4754		85096	0	85096		252		11307		0.33
Gp II	4754	5030	83834	123172	148995	138315	252	535	19797	9189	0.58
Gp III	6811	3434	54488	161894	170817	86837	362	365	22696	5769	0.55
Gp IV Natural			24038	0	24038				3194		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9970										

<b>Shaft At Arm</b>											
Gp I	3511		85096	0	85096		215		14984		0.43
Gp II	3511	4261	14192	91014	92114	138315	215	522	16220	12178	0.62
Gp III	5046	2791	9224	139769	140073	86837	309	342	24665	7645	0.63
Gp IV Natural			3659	0	3659				644		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9970										



16362-1-18 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 70' Arm w/24' Arm

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	5030 lbs
Bending Moment	170817 ft-lbs
Torsion Moment	138315 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.50 in

**ANALYSIS - ANCHOR BOLTS**

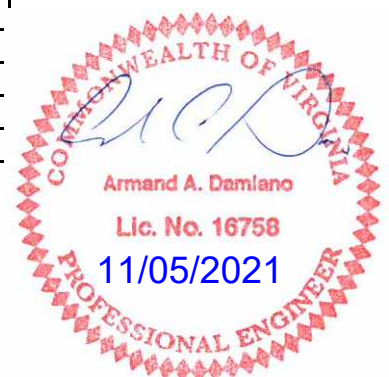
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	15.731 ksi
Bolt Direct Shear Stress	0.274 ksi
Bolt Torsion Shear Stress	6.939 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	15.731 ksi
$f_v =$	7.213 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.55 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.25 in
Design Moment	128 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	19.34 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.688 in
Design Moment	67 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	10.62 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-18 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 70' Arm w/24' Arm

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	24038 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	2.22 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.32
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

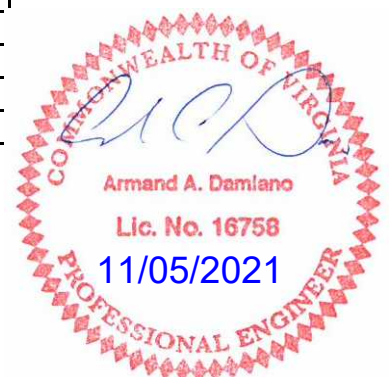
Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	39328 lbs
Computed Factor-of Safety	1.57 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	39328 lbs
Total Tensile Load	314624 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	1.5 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	39328 lbs
Total Tensile Load	314624 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	7 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-19 - Virginia - 70 MPH - MP-3 Std. Loads - Type C - 49'/49' Arms

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<i>Fatigue Importance Factors</i>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	2		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	0		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

**Pole Variables**

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.00	19.50	-	-	-	0	55	29000	-
Traffic Arm #1	0.1793	0.14	13.00	49.00	18.00	-	2.57	0	55	29000	180
Traffic Arm #2	0.1793	0.14	13.00	49.00	18.00	-	2.57	0	55	29000	270
Lum Arm #1						-		0	36	29000	180
Lum Arm #2						-		0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	Double Top Nuts	Yes	
A.B. Bolt Circle	26.00	Foundation Diameter	48	in
Baseplate Dia.	32.00	Concrete Cover	4	in
Baseplate Thk.	2.00	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	14.25	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.	Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1	Arm #2
--	--------	--------

**Hand Hole**

Flange Bolt Qty.	8	Handhole Width	6.00	in
Bolt Diameter	1.50	Handhole Height	24.50	in
Flange Plate Length (V)	27.00	Height To C.L.	37	in
Flange Plate Width (H)	27.00	Radial Orientation	0	Deg.
Spac. Between Bolt (V)	22.50	Rim Thickness	0.75	in
Spac. Between Bolt (H)	22.50	Rim Depth	5.00	in
Flange Plate Thk.	2.25	Rim Projection	1.00	in
Flange Plate Yield (Fy)	50			
Gusset Thk.	0.500			
Plate Center Hole	5.00			
Weld Type	Full Pen.			

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.19	0.25	0.49		0.49						14.80	14.80
GP II CSR	0.44	0.40	0.90		0.90							
GP III CSR	0.40	0.40	0.79		0.79						26.05	26.05
Nat.Wind (psi)	3007	459	8313		8313							

Arm #1 Flange Bolt (Max.) CSR	0.25
Arm #1 Flange Bolt Fatigue CSR	0.22
Arm #1 Flange Plate (Max.) CSR	0.34
Arm #2 Flange Bolt (Max.) CSR	0.25
Arm #2 Flange Bolt Fatigue CSR	0.22
Arm #2 Flange Plate (Max.) CSR	0.34
Handhole at Root (Fatigue) CSR	0.69
Handhole at Toe (Fatigue) CSR	0.45
Minimum Qty of Vertical Reinf. Bars	5

Fatigue Allowable - Shaft to Baseplate	4.5	ksi
Fatigue Allowable - Arm#1 to Flange	10	ksi
Fatigue Allowable - Arm#2 to Flange	10	ksi
Anchor Bolt Max. CSR	0.40	
Anchor Bolt Max. Fatigue Stress Ratio	0.29	
Base Plate Max. CSR	0.47	
Anchorage Capacity S.F.	2.2	
Concrete Pull Out Capacity S.F.	2.09	

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
6474	3672	122215	103893





16362-1-19 - Virginia - 70 MPH - MP-3 Std. Loads - Type C - 49/49' Arms

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft.)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1										
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	12'x2.5' Sign	7.5			12	2.5	1	30	66	1.20
	#3	5 Section Head w/BP	16	13.75	4			2	42	105	1.20
	#4		2.5'x3' Sign	23			2.5	3	1	7.5	22.5
	#5	Camera	24	1	1			1	3	22	1.20
	#6	3 Section Head w/BP	26	8.7	4			1	26	65	1.20
	#7	2.5'x3' Sign	34			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	37	8.7	4			1	26	65	1.20
	#9	Camera	39	1	1			1	3	22	1.20
	#10	3'x3.5' Sign	45			3	3.5	1	10.5	26.7	1.13
	#11	4 Section Head w/BP	48	11	5			1	34	80	1.20
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1	Camera	4	1	1			1	3	22	1.20
	#2	12'x2.5' Sign	7.5			12	2.5	1	30	66	1.20
	#3	5 Section Head w/BP	16	13.75	4			2	42	105	1.20
	#4		2.5'x3' Sign	23			2.5	3	1	7.5	22.5
	#5	Camera	24	1	1			1	3	22	1.20
	#6	3 Section Head w/BP	26	8.7	4			1	26	65	1.20
	#7	2.5'x3' Sign	34			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	37	8.7	4			1	26	65	1.20
	#9	Camera	39	1	1			1	3	22	1.20
	#10	3'x3.5' Sign	45			3	3.5	1	10.5	26.7	1.13
	#11	4 Section Head w/BP	48	11	5			1	34	80	1.20
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										



16362-1-19 - Virginia - 70 MPH - MP-3 Std. Loads - Type C - 49'/49' Arms

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.000	18.852	65.84	0.5287	0.53	1.670	16.24	0.80
2	I	1.06	1.06	18.852	18.704	65.31	0.5287	1.59	1.657	16.11	0.80
3	I	1.06	2.12	18.704	18.555	64.79	0.5287	2.65	1.644	15.99	0.80
4	I	1.06	3.18	18.555	18.407	64.27	0.5287	3.71	1.631	15.87	0.80
5	I	1.06	4.24	18.407	18.259	63.74	0.5287	4.76	1.618	15.74	0.80
6	I	1.06	5.29	18.259	18.111	63.22	0.5287	5.82	1.605	15.62	0.80
7	I	1.06	6.35	18.111	17.962	62.69	0.5287	6.88	1.591	15.50	0.80
8	I	1.06	7.41	17.962	17.814	62.17	0.5287	7.94	1.578	15.37	0.80
9	I	1.06	8.47	17.814	17.666	61.64	0.5287	9.00	1.565	15.25	0.80
10	I	1.06	9.53	17.666	17.518	61.12	0.5287	10.06	1.552	15.13	0.80
11	I	1.06	10.59	17.518	17.369	60.59	0.5287	11.12	1.539	15.00	0.80
12	I	1.06	11.65	17.369	17.221	60.07	0.5287	12.18	1.526	14.88	0.80
13	I	1.06	12.71	17.221	17.073	59.55	0.5286	13.23	1.513	14.76	1.00
14	I	1.06	13.76	17.073	16.925	59.02	0.5286	14.29	1.500	14.63	1.00
15	I	1.06	14.82	16.925	16.776	58.50	0.5286	15.35	1.487	14.51	1.00
16	I	1.06	15.88	16.776	16.628	57.97	0.5286	16.41	1.474	14.39	1.00
17	I	1.06	16.94	16.628	16.480	57.45	0.5286	17.47	1.461	14.27	1.00
18	J	0.50	18.00	16.480	16.410	26.95	0.2498	18.25	0.685	6.69	1.00
19	I	0.50	18.50	16.410	16.340	26.83	0.2498	18.75	0.682	6.67	1.00
20	I	0.50	19.00	16.340	16.270	26.71	0.2498	19.25	0.679	6.64	1.00
						1129					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in^4)	800.47	518.34	518.34	498.41
Section Modulus (in^3)	85.67	64.12	64.12	
Cross-Section Area (in^2)	18.34	15.86	15.86	
Width-Thickness Ratio	60.80	52.74	52.74	
Compact Limit	68.55	68.55	68.55	
Non-Compact Limit	137.09	137.09	137.09	
Maximum Limit	237.27	237.27	237.27	
Allow. Bending Stress (ksi)	36.300	36.300	36.300	
Allow. Compressive Str (ksi)	19.983	19.983	19.983	
Allow. Shear Stress (ksi)	18.150	18.150	18.150	

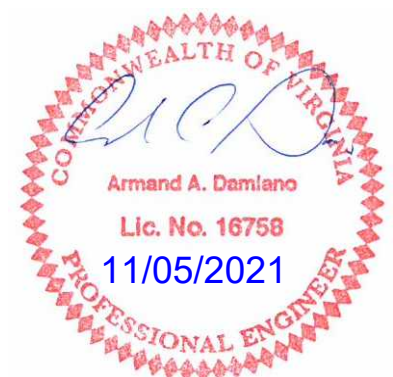
Shaft Deflection From Arm#1 GP I Load (in)	0.461
Shaft Deflection From Arm#2 GP I Load (in)	0.461



16362-1-19 - Virginia - 70 MPH - MP-3 Std. Loads - Type C - 49'/49' Arms

## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	12.76	0.000	20.87	1.100	4.576	7.64
2	0.450	7.64	12.66	0.000	20.71	1.100	4.576	7.58
3	0.450	7.64	12.56	0.000	20.55	1.100	4.576	7.52
4	0.450	7.64	12.46	0.000	20.38	1.100	4.576	7.46
5	0.450	7.64	12.36	0.000	20.22	1.100	4.576	7.40
6	0.450	7.64	12.26	0.000	20.06	1.100	4.576	7.34
7	0.450	7.64	12.16	0.000	19.89	1.100	4.576	7.28
8	0.450	7.64	12.06	0.001	19.73	1.100	4.576	7.22
9	0.450	7.64	11.96	0.001	19.57	1.100	4.576	7.16
10	0.450	7.64	11.86	0.001	19.40	1.100	4.576	7.10
11	0.450	7.64	11.76	0.001	19.24	1.100	4.576	7.04
12	0.450	7.64	11.66	0.001	19.08	1.100	4.576	6.98
13	0.450	9.54	14.43	0.002	18.91	1.100	4.576	6.92
14	0.450	9.54	14.31	0.002	18.75	1.100	4.576	6.86
15	0.450	9.54	14.18	0.002	18.59	1.100	4.576	6.80
16	0.450	9.54	14.06	0.002	18.42	1.100	4.576	6.74
17	0.450	9.54	13.93	0.002	18.26	1.100	4.576	6.68
18	0.450	9.54	6.54	0.001	8.57	1.100	4.576	3.14
19	0.450	9.54	6.51	0.001	8.53	1.100	4.576	3.12
20	0.450	9.54	6.48	0.001	8.49	1.100	4.576	3.11
Fix. #1	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.047	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-19 - Virginia - 70 MPH - MP-3 Std. Loads - Type C - 49/49' Arms

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	2.45	0.00	13.000	12.657	59.4	1.2195	1.22	2.619	2.619	25.84
2	I	2.45	2.45	12.657	12.314	57.8	1.2194	3.67	2.549	2.549	25.18
3	I	2.45	4.90	12.314	11.971	56.2	1.2192	6.12	2.479	2.479	24.52
4	I	2.45	7.35	11.971	11.628	54.6	1.2191	8.57	2.409	2.409	23.86
5	I	2.45	9.80	11.628	11.285	53.0	1.2189	11.02	2.339	2.339	23.20
6	I	2.45	12.25	11.285	10.942	51.3	1.2187	13.47	2.269	2.269	22.54
7	I	2.45	14.70	10.942	10.599	49.7	1.2185	15.92	2.199	2.199	21.88
8	I	2.45	17.15	10.599	10.256	48.1	1.2183	18.37	2.129	2.129	21.22
9	I	2.45	19.60	10.256	9.913	46.5	1.2181	20.82	2.059	2.059	20.56
10	I	2.45	22.05	9.913	9.570	44.9	1.2178	23.27	1.989	1.989	19.90
11	I	2.45	24.50	9.570	9.227	43.3	1.2175	25.72	1.919	1.919	19.24
12	I	2.45	26.95	9.227	8.884	41.7	1.2173	28.17	1.849	1.849	18.58
13	I	2.45	29.40	8.884	8.541	40.1	1.2170	30.62	1.779	1.779	17.92
14	I	2.45	31.85	8.541	8.198	38.5	1.2166	33.07	1.709	1.709	17.26
15	I	2.45	34.30	8.198	7.855	36.9	1.2163	35.52	1.639	1.639	16.60
16	I	2.45	36.75	7.855	7.512	35.2	1.2159	37.97	1.569	1.569	15.94
17	I	2.45	39.20	7.512	7.169	33.6	1.2155	40.42	1.499	1.499	15.28
18	I	2.45	41.65	7.169	6.826	32.0	1.2150	42.86	1.429	1.429	14.62
19	I	2.45	44.10	6.826	6.483	30.4	1.2145	45.31	1.359	1.359	13.96
20	I	2.45	46.55	6.483	6.140	28.8	1.2139	47.76	1.289	1.289	13.30
		<u>49.00</u>				<u>882</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	66	7.50	30.000	1.000	90.00
Fix. #3	105	16.00	13.750	2.000	126.00
Fix. #4	22.5	23.00	7.500	1.000	22.50
Fix. #5	22	24.00	1.000	1.000	9.00
Fix. #6	65	26.00	8.700	1.000	78.00
Fix. #7	22.5	34.00	7.500	1.000	22.50
Fix. #8	65	37.00	8.700	1.000	78.00
Fix. #9	22	39.00	1.000	1.000	9.00
Fix. #10	26.7	45.00	10.500	1.000	31.50
Fix. #11	80	48.00	11.000	1.000	102.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	23.135	0.000
Cross-Section Area (in^2)	7.218	0.000
Width-Thickness Ratio	72.50	0.00
Compact Limit	68.55	0.00
Non-Compact Limit	137.09	0.00
Maximum Limit	237.27	0.00
Allow. Bending Stress (ksi)	35.489	0.000
Allow. Shear Stress (ksi)	18.150	0.000



16362-1-19 - Virginia - 70 MPH - MP-3 Std. Loads - Type C - 49'/49' Arms

Arm #1 Analysis Continued

Sec. Num.	Kz	Truck Induced Gust											
		Group 2			Group 3	Natural Wind Gust			Hght Corr. Factor = 1.000				Gallop
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	Loads (lbs)
1	1.00	0.450	9.54	24.99	32.74	1.100	4.576	11.99	0	0.710	0.00	0.00	
2	1.00	0.450	9.54	24.32	31.86	1.100	4.576	11.66	0	0.736	0.00	0.00	
3	1.00	0.450	9.54	23.65	30.99	1.100	4.576	11.34	0	0.763	0.00	0.00	
4	1.00	0.450	9.54	22.98	30.11	1.100	4.576	11.02	0	0.792	0.00	0.00	
5	1.00	0.450	9.54	22.31	29.24	1.100	4.576	10.70	0	0.823	0.00	0.00	
6	1.00	0.450	9.54	21.65	28.36	1.100	4.576	10.38	0	0.856	0.00	0.00	
7	1.00	0.460	9.75	21.44	27.49	1.100	4.576	10.06	0	0.891	0.00	0.00	
8	1.00	0.479	10.17	21.65	26.61	1.100	4.576	9.74	0	0.930	0.00	0.00	
9	1.00	0.501	10.62	21.87	25.74	1.100	4.576	9.42	0	0.971	0.00	0.00	
10	1.00	0.524	11.11	22.10	24.86	1.100	4.576	9.10	0	1.016	0.00	0.00	
11	1.00	0.549	11.64	22.34	23.99	1.100	4.576	8.78	0	1.064	0.00	0.00	
12	1.00	0.576	12.21	22.57	23.11	1.100	4.576	8.46	0	1.100	0.00	0.00	
13	1.00	0.606	12.84	22.84	22.24	1.100	4.576	8.14	0	1.100	0.00	0.00	
14	1.00	0.638	13.53	23.12	21.36	1.100	4.576	7.82	0	1.100	0.00	0.00	
15	1.00	0.674	14.29	23.42	20.48	1.100	4.576	7.50	1	1.100	0.00	0.00	
16	1.00	0.713	15.12	23.72	19.61	1.100	4.576	7.18	1	1.100	0.00	0.00	
17	1.00	0.757	16.04	24.04	18.73	1.100	4.576	6.86	1	1.100	0.00	0.00	
18	1.00	0.805	17.07	24.39	17.86	1.100	4.576	6.54	1	1.100	0.00	0.00	
19	1.00	0.860	18.23	24.77	16.98	1.100	4.576	6.22	1	1.100	0.00	0.00	
20	1.00	0.921	19.52	25.15	16.11	1.100	4.576	5.90	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.199	25.43	762.90	381.45	1.199	4.990	149.70	0	1.199	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



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Flange Analysis - Arm #1

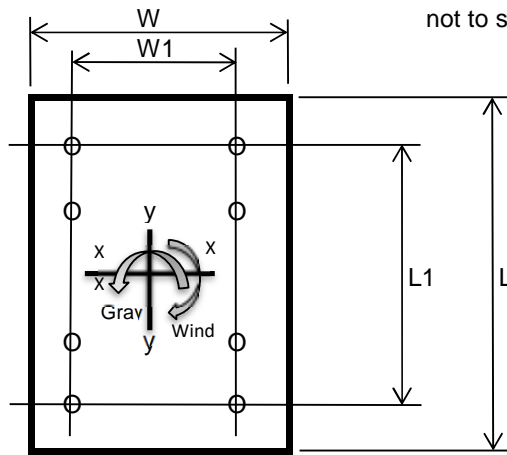
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Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	1401	2370	-	lbs
Shear (Wind)	2988	1763	-	lbs
Torsion (Arm Rise)	7671	4527	-	ft-lbs
Moment (Gravity)	33046	57360	-	ft-lbs
Moment (Wind)	73474	41987	-	ft-lbs
Nat. Wind Moment	-	-	16026	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	13.00	in
Tube Wall Thick.	0.1793	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	8.93	10.53	ksi
Bolt Shear Stress - fv	1.03	0.71	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Fv =	44.22	44.22	ksi
Allowable Shear Stress = Ft =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.21	0.25	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	1.52	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.22	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	5.99	10.39	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	13.54	7.74	ksi
Combined applied stress for interaction (SRSS)	14.81	12.96	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



16362-1-19 - Virginia - 70 MPH - MP-3 Std. Loads - Type C - 49/49' Arms

Arm #2 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	2.45	0.00	13.000	12.657	59.4	1.2195	1.22	2.619	2.619	25.84
2	I	2.45	2.45	12.657	12.314	57.8	1.2194	3.67	2.549	2.549	25.18
3	I	2.45	4.90	12.314	11.971	56.2	1.2192	6.12	2.479	2.479	24.52
4	I	2.45	7.35	11.971	11.628	54.6	1.2191	8.57	2.409	2.409	23.86
5	I	2.45	9.80	11.628	11.285	53.0	1.2189	11.02	2.339	2.339	23.20
6	I	2.45	12.25	11.285	10.942	51.3	1.2187	13.47	2.269	2.269	22.54
7	I	2.45	14.70	10.942	10.599	49.7	1.2185	15.92	2.199	2.199	21.88
8	I	2.45	17.15	10.599	10.256	48.1	1.2183	18.37	2.129	2.129	21.22
9	I	2.45	19.60	10.256	9.913	46.5	1.2181	20.82	2.059	2.059	20.56
10	I	2.45	22.05	9.913	9.570	44.9	1.2178	23.27	1.989	1.989	19.90
11	I	2.45	24.50	9.570	9.227	43.3	1.2175	25.72	1.919	1.919	19.24
12	I	2.45	26.95	9.227	8.884	41.7	1.2173	28.17	1.849	1.849	18.58
13	I	2.45	29.40	8.884	8.541	40.1	1.2170	30.62	1.779	1.779	17.92
14	I	2.45	31.85	8.541	8.198	38.5	1.2166	33.07	1.709	1.709	17.26
15	I	2.45	34.30	8.198	7.855	36.9	1.2163	35.52	1.639	1.639	16.60
16	I	2.45	36.75	7.855	7.512	35.2	1.2159	37.97	1.569	1.569	15.94
17	I	2.45	39.20	7.512	7.169	33.6	1.2155	40.42	1.499	1.499	15.28
18	I	2.45	41.65	7.169	6.826	32.0	1.2150	42.86	1.429	1.429	14.62
19	I	2.45	44.10	6.826	6.483	30.4	1.2145	45.31	1.359	1.359	13.96
20	I	2.45	46.55	6.483	6.140	28.8	1.2139	47.76	1.289	1.289	13.30
		49.00				882					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	66	7.50	30.000	1.000	90.00
Fix. #3	105	16.00	13.750	2.000	126.00
Fix. #4	22.5	23.00	7.500	1.000	22.50
Fix. #5	22	24.00	1.000	1.000	9.00
Fix. #6	65	26.00	8.700	1.000	78.00
Fix. #7	22.5	34.00	7.500	1.000	22.50
Fix. #8	65	37.00	8.700	1.000	78.00
Fix. #9	22	39.00	1.000	1.000	9.00
Fix. #10	26.7	45.00	10.500	1.000	31.50
Fix. #11	80	48.00	11.000	1.000	102.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#2 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	23.135	0.000
Cross-Section Area (in^2)	7.218	0.000
Width-Thickness Ratio	72.50	0.00
Compact Limit	68.55	0.00
Non-Compact Limit	137.09	0.00
Maximum Limit	237.27	0.00
Allow. Bending Stress (ksi)	35.489	0.000
Allow. Shear Stress (ksi)	18.150	0.000





16362-1-19 - Virginia - 70 MPH - MP-3 Std. Loads - Type C - 49'/49' Arms

Arm #2 Analysis Continued

Sec. Num.	Kz	Truck Induced Gust											Gallop Loads (lbs)
		Group 2			Group 3	Natural Wind Gust			Hght Corr. Factor = 1.00				
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	24.99	32.74	1.100	4.576	11.99	0	0.710	0.00	0.00	
2	1.00	0.450	9.54	24.32	31.86	1.100	4.576	11.66	0	0.736	0.00	0.00	
3	1.00	0.450	9.54	23.65	30.99	1.100	4.576	11.34	0	0.763	0.00	0.00	
4	1.00	0.450	9.54	22.98	30.11	1.100	4.576	11.02	0	0.792	0.00	0.00	
5	1.00	0.450	9.54	22.31	29.24	1.100	4.576	10.70	0	0.823	0.00	0.00	
6	1.00	0.450	9.54	21.65	28.36	1.100	4.576	10.38	0	0.856	0.00	0.00	
7	1.00	0.460	9.75	21.44	27.49	1.100	4.576	10.06	0	0.891	0.00	0.00	
8	1.00	0.479	10.17	21.65	26.61	1.100	4.576	9.74	0	0.930	0.00	0.00	
9	1.00	0.501	10.62	21.87	25.74	1.100	4.576	9.42	0	0.971	0.00	0.00	
10	1.00	0.524	11.11	22.10	24.86	1.100	4.576	9.10	0	1.016	0.00	0.00	
11	1.00	0.549	11.64	22.34	23.99	1.100	4.576	8.78	0	1.064	0.00	0.00	
12	1.00	0.576	12.21	22.57	23.11	1.100	4.576	8.46	0	1.100	0.00	0.00	
13	1.00	0.606	12.84	22.84	22.24	1.100	4.576	8.14	0	1.100	0.00	0.00	
14	1.00	0.638	13.53	23.12	21.36	1.100	4.576	7.82	0	1.100	0.00	0.00	
15	1.00	0.674	14.29	23.42	20.48	1.100	4.576	7.50	1	1.100	0.00	0.00	
16	1.00	0.713	15.12	23.72	19.61	1.100	4.576	7.18	1	1.100	0.00	0.00	
17	1.00	0.757	16.04	24.04	18.73	1.100	4.576	6.86	1	1.100	0.00	0.00	
18	1.00	0.805	17.07	24.39	17.86	1.100	4.576	6.54	1	1.100	0.00	0.00	
19	1.00	0.860	18.23	24.77	16.98	1.100	4.576	6.22	1	1.100	0.00	0.00	
20	1.00	0.921	19.52	25.15	16.11	1.100	4.576	5.90	1	1.100	0.00	0.00	
Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.199	25.43	762.90	381.45	1.199	4.990	149.70	0	1.199	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



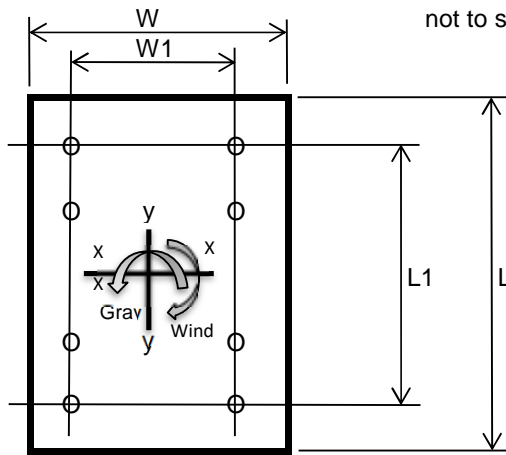
Flange Analysis - Arm #2

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	1401	2370	-	lbs
Shear (Wind)	2988	1763	-	lbs
Torsion (Arm Rise)	7671	4527	-	ft-lbs
Moment (Gravity)	33046	57360	-	ft-lbs
Moment (Wind)	73474	41987	-	ft-lbs
Nat. Wind Moment	-	-	16026	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	13.00	in
Tube Wall Thick.	0.1793	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	8.93	10.53	ksi
Bolt Shear Stress - fv	1.03	0.71	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.21	0.25	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	1.52	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.22	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	5.99	10.39	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	13.54	7.74	ksi
Combined applied stress for interaction (SRSS)	14.81	12.96	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



## 16362-1-19 - Virginia - 70 MPH - MP-3 Std. Loads - Type C - 49/49' Arms

## Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.00	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.368421	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.75	
Kf - Fatigue stress concentration factor for finite life	2.41	
Ki - Fatigue stress concentration factor for infinite life	5.32	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.1793	in
Dt - Arm base diameter	13.00	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	2.45	
Dop - Baseplate center hole diameter	5	in
Cop - Center hole to arm diameter ratio	0.384615	
Kf - Fatigue stress concentration factor for finite life	1.70	
Ki - Fatigue stress concentration factor for infinite life	2.93	
Fatigue Allowable	10	ksi

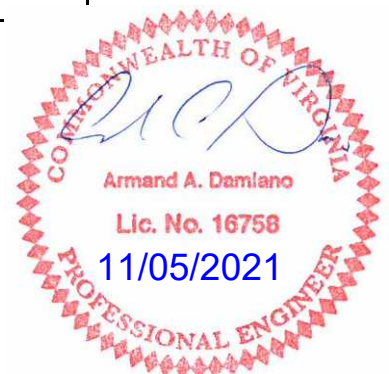
Note: Maximum diagonal distance between bolts used as bolt circle

**ARM 2 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.1793	in
Dt - Arm base diameter	13.00	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	2.447677	
Dop - Baseplate center hole diameter	5	in
Cop - Center hole to arm diameter ratio	0.384615	
Kf - Fatigue stress concentration factor for finite life	1.70	
Ki - Fatigue stress concentration factor for infinite life	2.93	
Fatigue Allowable	10	ksi

Note: Maximum diagonal distance between bolts used as bolt circle



## 16362-1-19 - Virginia - 70 MPH - MP-3 Std. Loads - Type C - 49'/49' Arms

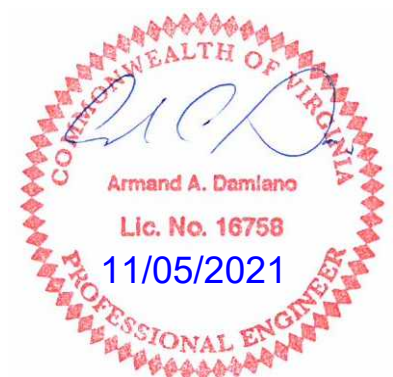
## Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	18.57	in
Shaft Thickness	0.313	in
Total Area	23.0768	in <sup>2</sup>
Ix	848	in <sup>4</sup>
Iy	944	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	21469	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	11.09	ksi
CSR	0.69	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	3.15	ksi
CSR	0.45	
Therefore	<b>OK</b>	



16362-1-19 - Virginia - 70 MPH - MP-3 Std. Loads - Type C - 49'/49' Arms

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear	Shear	Bending	Torsion	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	1401		1401	33046		33046		389	17141		0.49
Gp II	1401	2988	3300	33046	73474	80564	7671	915	41788	1990	0.90
Gp III	2370	1763	2954	57360	41987	71086	4527	819	36872	1175	0.79
Gp IV Natural		674	674		16026	16026	1731	187	8313	449	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	1401		1401	33046		33046		389	17141		0.49
Gp II	1401	2988	3300	33046	73474	80564	7671	915	41788	1990	0.90
Gp III	2370	1763	2954	57360	41987	71086	4527	819	36872	1175	0.79
Gp IV Natural		674	674		16026	16026	1731	187	8313	449	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-19 - Virginia - 70 MPH - MP-3 Std. Loads - Type C - 49/49' Arms

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	4095		33046	33046	46733		223		6546		0.19
Gp II	4095	3672	70876	90109	114643	103893	223	401	16059	7276	0.44
Gp III	6474	2356	81623	90963	122215	59370	353	257	17119	4158	0.40
Gp IV Natural			16392	13865	21469				3007		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9970										

<b>Shaft At Arm</b>											
Gp I	2882		33046	33046	46733		182		8746		0.25
Gp II	2882	3007	38374	38578	54413	103893	182	380	10183	9721	0.40
Gp III	4820	1789	60505	60636	85660	59370	304	226	16031	5555	0.40
Gp IV Natural			1738	1731	2453				459		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9970										



16362-1-19 - Virginia - 70 MPH - MP-3 Std. Loads - Type C - 49/49' Arms

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	3672 lbs
Bending Moment	122215 ft-lbs
Torsion Moment	103893 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.00 in

**ANALYSIS - ANCHOR BOLTS**

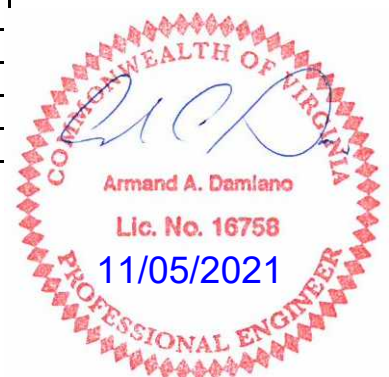
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	11.255 ksi
Bolt Direct Shear Stress	0.2 ksi
Bolt Torsion Shear Stress	5.213 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	11.255 ksi
$f_v =$	5.413 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.4 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.5 in
Design Moment	99 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	14.96 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.938 in
Design Moment	55 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	8.72 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>





16362-1-19 - Virginia - 70 MPH - MP-3 Std. Loads - Type C - 49/49' Arms

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	21469 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	1.98 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.29
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	28138 lbs
Computed Factor-of Safety	2.2 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	28138 lbs
Total Tensile Load	225104 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	2.09 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	28138 lbs
Total Tensile Load	225104 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	5 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49'/49' Arms w/24' Lum.

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<i>Fatigue Importance Factors</i>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	2		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	1		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.00	25.00	-	-	-	0	55	29000	-
Traffic Arm #1	0.1793	0.14	13.00	49.00	18.00	-	2.57	0	55	29000	180
Traffic Arm #2	0.1793	0.14	13.00	49.00	18.00	-	2.57	0	55	29000	90
Lum Arm #1	0.2760		2.88	24.00	24.00	-	5	0	36	29000	180
Lum Arm #2						-		0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	Double Top Nuts	Yes	
A.B. Bolt Circle	26.00	Foundation Diameter	48	in
Baseplate Dia.	32.00	Concrete Cover	4	in
Baseplate Thk.	2.00	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	14.25	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.	Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	8
Bolt Diameter	1.50	1.50
Flange Plate Length (V)	27.00	27.00
Flange Plate Width (H)	27.00	27.00
Spac. Between Bolt (V)	22.50	22.50
Spac. Between Bolt (H)	22.50	22.50
Flange Plate Thk.	2.25	2.25
Flange Plate Yield (Fy)	50.00	50.00
Gusset Thk.	0.500	0.500
Plate Center Hole	5.00	5.00
Weld Type	Full Pen.	Full Pen.

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	<i>Shaft At</i>		<i>Arm#1</i>		<i>Arm#2</i>		<i>Lum#1</i>		<i>Lum#2</i>		<i>Tip Deflection (in)</i>	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.19	0.25	0.49		0.49						14.80	14.80
GP II CSR	0.48	0.42	0.90		0.90		0.78					
GP III CSR	0.42	0.41	0.79		0.79		0.63				26.05	26.05
Nat.Wind (psi)	3087	478	8313		8313							

Arm #1 Flange Bolt (Max.) CSR	0.25
Arm #1 Flange Bolt Fatigue CSR	0.22
Arm #1 Flange Plate (Max.) CSR	0.34
Arm #2 Flange Bolt (Max.) CSR	0.25
Arm #2 Flange Bolt Fatigue CSR	0.22
Arm #2 Flange Plate (Max.) CSR	0.34
Handhole at Root (Fatigue) CSR	0.71
Handhole at Toe (Fatigue) CSR	0.46
Minimum Qty of Vertical Reinf. Bars	6

Fatigue Allowable - Shaft to Baseplate	4.5	ksi
Fatigue Allowable - Arm#1 to Flange	10	ksi
Fatigue Allowable - Arm#2 to Flange	10	ksi
Anchor Bolt Max. CSR	0.41	
Anchor Bolt Max. Fatigue Stress Ratio	0.29	
Base Plate Max. CSR	0.50	
Anchorage Capacity S.F.	2.1	
Concrete Pull Out Capacity S.F.	2.00	

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
7310	4042	128105	105018



16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49/49' Arms w/24' Lum.

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft.)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1	Cobra Head w/Camera	24	2	1			4.54	9	57	1.00
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	12'x2.5' Sign	7.5			12	2.5	1	30	66	1.20
	#3	5 Section Head w/BP	16	13.75	4			2	42	105	1.20
	#4		2.5'x3' Sign	23			2.5	3	1	7.5	22.5
	#5	Camera	24	1	1			1	3	22	1.20
	#6	3 Section Head w/BP	26	8.7	4			1	26	65	1.20
	#7	2.5'x3' Sign	34			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	37	8.7	4			1	26	65	1.20
	#9	Camera	39	1	1			1	3	22	1.20
	#10	3'x3.5' Sign	45			3	3.5	1	10.5	26.7	1.13
	#11	4 Section Head w/BP	48	11	5			1	34	80	1.20
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1	Camera	4	1	1			1	3	22	1.20
	#2	12'x2.5' Sign	7.5			12	2.5	1	30	66	1.20
	#3	5 Section Head w/BP	16	13.75	4			2	42	105	1.20
	#4		2.5'x3' Sign	23			2.5	3	1	7.5	22.5
	#5	Camera	24	1	1			1	3	22	1.20
	#6	3 Section Head w/BP	26	8.7	4			1	26	65	1.20
	#7	2.5'x3' Sign	34			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	37	8.7	4			1	26	65	1.20
	#9	Camera	39	1	1			1	3	22	1.20
	#10	3'x3.5' Sign	45			3	3.5	1	10.5	26.7	1.13
	#11	4 Section Head w/BP	48	11	5			1	34	80	1.20
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										



16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49'/49' Arms w/24' Lum.

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.000	18.852	65.84	0.5287	0.53	1.670	16.24	0.80
2	I	1.06	1.06	18.852	18.704	65.31	0.5287	1.59	1.657	16.11	0.80
3	I	1.06	2.12	18.704	18.555	64.79	0.5287	2.65	1.644	15.99	0.80
4	I	1.06	3.18	18.555	18.407	64.27	0.5287	3.71	1.631	15.87	0.80
5	I	1.06	4.24	18.407	18.259	63.74	0.5287	4.76	1.618	15.74	0.80
6	I	1.06	5.29	18.259	18.111	63.22	0.5287	5.82	1.605	15.62	0.80
7	I	1.06	6.35	18.111	17.962	62.69	0.5287	6.88	1.591	15.50	0.80
8	I	1.06	7.41	17.962	17.814	62.17	0.5287	7.94	1.578	15.37	0.80
9	I	1.06	8.47	17.814	17.666	61.64	0.5287	9.00	1.565	15.25	0.80
10	I	1.06	9.53	17.666	17.518	61.12	0.5287	10.06	1.552	15.13	0.80
11	I	1.06	10.59	17.518	17.369	60.59	0.5287	11.12	1.539	15.00	0.80
12	I	1.06	11.65	17.369	17.221	60.07	0.5287	12.18	1.526	14.88	0.80
13	I	1.06	12.71	17.221	17.073	59.55	0.5286	13.23	1.513	14.76	1.00
14	I	1.06	13.76	17.073	16.925	59.02	0.5286	14.29	1.500	14.63	1.00
15	I	1.06	14.82	16.925	16.776	58.50	0.5286	15.35	1.487	14.51	1.00
16	I	1.06	15.88	16.776	16.628	57.97	0.5286	16.41	1.474	14.39	1.00
17	I	1.06	16.94	16.628	16.480	57.45	0.5286	17.47	1.461	14.27	1.00
18	J	3.00	18.00	16.480	16.060	159.92	1.4935	19.49	4.068	39.75	1.00
19	I	3.00	21.00	16.060	15.640	155.72	1.4934	22.49	3.963	38.76	1.00
20	J	1.00	24.00	15.640	15.500	50.97	0.4993	24.50	1.298	12.70	1.00
						1415					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in <sup>4</sup> )	800.47	518.34	518.34	429.68
Section Modulus (in <sup>3</sup> )	85.67	64.12	64.12	
Cross-Section Area (in <sup>2</sup> )	18.34	15.86	15.86	
Width-Thickness Ratio	60.80	52.74	52.74	
Compact Limit	68.55	68.55	68.55	
Non-Compact Limit	137.09	137.09	137.09	
Maximum Limit	237.27	237.27	237.27	
Allow. Bending Stress (ksi)	36.300	36.300	36.300	
Allow. Compressive Str (ksi)	13.488	13.488	13.488	
Allow. Shear Stress (ksi)	18.150	18.150	18.150	

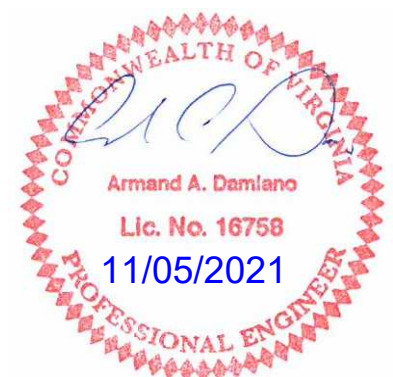
Shaft Deflection From Arm#1 GP I Load (in)	0.461
Shaft Deflection From Arm#2 GP I Load (in)	0.461



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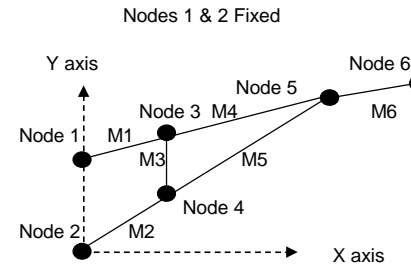
## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	12.76	0.000	20.87	1.100	4.576	7.64
2	0.450	7.64	12.66	0.000	20.71	1.100	4.576	7.58
3	0.450	7.64	12.56	0.000	20.55	1.100	4.576	7.52
4	0.450	7.64	12.46	0.000	20.38	1.100	4.576	7.46
5	0.450	7.64	12.36	0.000	20.22	1.100	4.576	7.40
6	0.450	7.64	12.26	0.000	20.06	1.100	4.576	7.34
7	0.450	7.64	12.16	0.001	19.89	1.100	4.576	7.28
8	0.450	7.64	12.06	0.001	19.73	1.100	4.576	7.22
9	0.450	7.64	11.96	0.001	19.57	1.100	4.576	7.16
10	0.450	7.64	11.86	0.001	19.40	1.100	4.576	7.10
11	0.450	7.64	11.76	0.001	19.24	1.100	4.576	7.04
12	0.450	7.64	11.66	0.001	19.08	1.100	4.576	6.98
13	0.450	9.54	14.43	0.002	18.91	1.100	4.576	6.92
14	0.450	9.54	14.31	0.002	18.75	1.100	4.576	6.86
15	0.450	9.54	14.18	0.003	18.59	1.100	4.576	6.80
16	0.450	9.54	14.06	0.003	18.42	1.100	4.576	6.74
17	0.450	9.54	13.93	0.003	18.26	1.100	4.576	6.68
18	0.450	9.54	38.80	0.012	50.84	1.100	4.576	18.61
19	0.450	9.54	37.80	0.014	49.53	1.100	4.576	18.13
20	0.450	9.54	12.38	0.005	16.22	1.100	4.576	5.94
Fix. #1	1.200	20.36	48.86	0.005	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.005	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.065	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49'/49' Arms w/24' Lum. - Luminaire Arm - Group II

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-33.67	-24.6	0	0	0
Node #2	0	0	0	0	-35.63	-26	0	0	0
Node #3	100	59.5	0	0	-66.63	-51.3	0	0	0
Node #4	100	48.8	0	0	-69.41	-53.4	0	0	0
Node #5	200	79	0	0	-94.35	-75.6	0	0	0
Node #6	288	87	0	0	-85.29	-69.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



Member #3 is a bar computed as equivalent pipe section to the weak axis

	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-67.33	1.1	1	-49.04	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-71.25	1.1	1	-51.90	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-0.68	1.1	1	-1.18	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-65.23	1.1	1.1	-52.27	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-66.89	1.1	1.1	-53.59	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-56.58	1.1	1.1	-45.33	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-57.00	1	1.1	-46.64					

AASHTO Gp	2
Mntg Hght =	29.00
Datum =	1

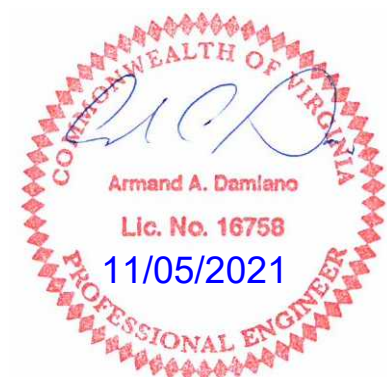
ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2180.2	lbs
P1y	-694.6	lbs
P1z	178.8	lbs
M1x	6661.9	in-lbs
M1y	-25162.7	in-lbs
M1z	-898.1	in-lbs
P2x	2180.2	lbs
P2y	1079.6	lbs
P2z	121.5	lbs
M2x	6843.3	in-lbs
M2y	-20414.5	in-lbs
M2z	-928.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1018	138	19343	-491	0.55
#2	1071	87	15894	-954	0.78
#3	1489	431	8552	-392	0.35
#4	-1001	64	7424	-23	0.2
#5	1020	75	8261	-288	0.5
#6	4	98	7210	1	0.22

Arm Tip Displacement At Node 6	
X dir	0.103 (in)
Y dir	-0.898 (in)
Z dir	-10.462 (in)

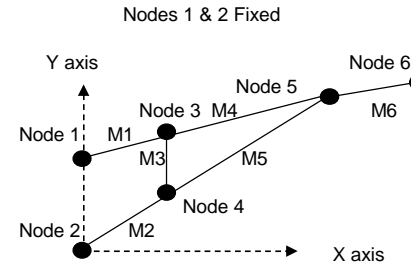
V09.19.15





16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49/49' Arms w/24' Lum. - Luminaire Arm - Group III

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-40.85	-13.2	0	0	0
Node #2	0	0	0	0	-43.23	-14	0	0	0
Node #3	100	59.5	0	0	-81.04	-26.6	0	0	0
Node #4	100	48.8	0	0	-84.42	-27.7	0	0	0
Node #5	200	79	0	0	-114.49	-37.8	0	0	0
Node #6	288	87	0	0	-115.33	-36.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



Member #3 is a bar computed as equivalent pipe section to the weak axis

	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-81.69	1.1	1	-26.29	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-86.45	1.1	1	-27.82	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-1.22	1.1	1	-0.63	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-79.16	1.1	1.1	-26.13	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-81.16	1.1	1.1	-26.80	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-68.65	1.1	1.1	-22.67	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-81.00	1	1.1	-25.00					

AASHTO Gp	3
Mntg Hght =	29.00
Datum =	1

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2797.7	lbs
P1y	-898.7	lbs
P1z	92.5	lbs
M1x	3425.6	in-lbs
M1y	-12957.4	in-lbs
M1z	-1426.8	in-lbs
P2x	2797.7	lbs
P2y	1378.1	lbs
P2z	63.2	lbs
M2x	3519.9	in-lbs
M2y	-10515.8	in-lbs
M2z	-1452.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1307	75	10010	-255	0.26
#2	1373	50	8249	-493	0.63
#3	1905	442	8972	-201	0.38
#4	-1287	45	3944	-13	0.08
#5	1311	48	4359	-150	0.46
#6	5	107	7919	1	0.24

Arm Tip Displacement At Node 6	
X dir	0.137 (in)
Y dir	-1.214 (in)
Z dir	-5.396 (in)

V09.19.15





16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49'/49' Arms w/24' Lum.

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	2.45	0.00	13.000	12.657	59.4	1.2195	1.22	2.619	2.619	25.84
2	I	2.45	2.45	12.657	12.314	57.8	1.2194	3.67	2.549	2.549	25.18
3	I	2.45	4.90	12.314	11.971	56.2	1.2192	6.12	2.479	2.479	24.52
4	I	2.45	7.35	11.971	11.628	54.6	1.2191	8.57	2.409	2.409	23.86
5	I	2.45	9.80	11.628	11.285	53.0	1.2189	11.02	2.339	2.339	23.20
6	I	2.45	12.25	11.285	10.942	51.3	1.2187	13.47	2.269	2.269	22.54
7	I	2.45	14.70	10.942	10.599	49.7	1.2185	15.92	2.199	2.199	21.88
8	I	2.45	17.15	10.599	10.256	48.1	1.2183	18.37	2.129	2.129	21.22
9	I	2.45	19.60	10.256	9.913	46.5	1.2181	20.82	2.059	2.059	20.56
10	I	2.45	22.05	9.913	9.570	44.9	1.2178	23.27	1.989	1.989	19.90
11	I	2.45	24.50	9.570	9.227	43.3	1.2175	25.72	1.919	1.919	19.24
12	I	2.45	26.95	9.227	8.884	41.7	1.2173	28.17	1.849	1.849	18.58
13	I	2.45	29.40	8.884	8.541	40.1	1.2170	30.62	1.779	1.779	17.92
14	I	2.45	31.85	8.541	8.198	38.5	1.2166	33.07	1.709	1.709	17.26
15	I	2.45	34.30	8.198	7.855	36.9	1.2163	35.52	1.639	1.639	16.60
16	I	2.45	36.75	7.855	7.512	35.2	1.2159	37.97	1.569	1.569	15.94
17	I	2.45	39.20	7.512	7.169	33.6	1.2155	40.42	1.499	1.499	15.28
18	I	2.45	41.65	7.169	6.826	32.0	1.2150	42.86	1.429	1.429	14.62
19	I	2.45	44.10	6.826	6.483	30.4	1.2145	45.31	1.359	1.359	13.96
20	I	2.45	46.55	6.483	6.140	28.8	1.2139	47.76	1.289	1.289	13.30
		<u>49.00</u>				<u>882</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	66	7.50	30.000	1.000	90.00
Fix. #3	105	16.00	13.750	2.000	126.00
Fix. #4	22.5	23.00	7.500	1.000	22.50
Fix. #5	22	24.00	1.000	1.000	9.00
Fix. #6	65	26.00	8.700	1.000	78.00
Fix. #7	22.5	34.00	7.500	1.000	22.50
Fix. #8	65	37.00	8.700	1.000	78.00
Fix. #9	22	39.00	1.000	1.000	9.00
Fix. #10	26.7	45.00	10.500	1.000	31.50
Fix. #11	80	48.00	11.000	1.000	102.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	23.135	0.000
Cross-Section Area (in^2)	7.218	0.000
Width-Thickness Ratio	72.50	0.00
Compact Limit	68.55	0.00
Non-Compact Limit	137.09	0.00
Maximum Limit	237.27	0.00
Allow. Bending Stress (ksi)	35.489	0.000
Allow. Shear Stress (ksi)	18.150	0.000



16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49'/49' Arms w/24' Lum.

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000 Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	24.99	32.74	1.100	4.576	11.99	0	0.710	0.00	0.00	
2	1.00	0.450	9.54	24.32	31.86	1.100	4.576	11.66	0	0.736	0.00	0.00	
3	1.00	0.450	9.54	23.65	30.99	1.100	4.576	11.34	0	0.763	0.00	0.00	
4	1.00	0.450	9.54	22.98	30.11	1.100	4.576	11.02	0	0.792	0.00	0.00	
5	1.00	0.450	9.54	22.31	29.24	1.100	4.576	10.70	0	0.823	0.00	0.00	
6	1.00	0.450	9.54	21.65	28.36	1.100	4.576	10.38	0	0.856	0.00	0.00	
7	1.00	0.460	9.75	21.44	27.49	1.100	4.576	10.06	0	0.891	0.00	0.00	
8	1.00	0.479	10.17	21.65	26.61	1.100	4.576	9.74	0	0.930	0.00	0.00	
9	1.00	0.501	10.62	21.87	25.74	1.100	4.576	9.42	0	0.971	0.00	0.00	
10	1.00	0.524	11.11	22.10	24.86	1.100	4.576	9.10	0	1.016	0.00	0.00	
11	1.00	0.549	11.64	22.34	23.99	1.100	4.576	8.78	0	1.064	0.00	0.00	
12	1.00	0.576	12.21	22.57	23.11	1.100	4.576	8.46	0	1.100	0.00	0.00	
13	1.00	0.606	12.84	22.84	22.24	1.100	4.576	8.14	0	1.100	0.00	0.00	
14	1.00	0.638	13.53	23.12	21.36	1.100	4.576	7.82	0	1.100	0.00	0.00	
15	1.00	0.674	14.29	23.42	20.48	1.100	4.576	7.50	1	1.100	0.00	0.00	
16	1.00	0.713	15.12	23.72	19.61	1.100	4.576	7.18	1	1.100	0.00	0.00	
17	1.00	0.757	16.04	24.04	18.73	1.100	4.576	6.86	1	1.100	0.00	0.00	
18	1.00	0.805	17.07	24.39	17.86	1.100	4.576	6.54	1	1.100	0.00	0.00	
19	1.00	0.860	18.23	24.77	16.98	1.100	4.576	6.22	1	1.100	0.00	0.00	
20	1.00	0.921	19.52	25.15	16.11	1.100	4.576	5.90	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.199	25.43	762.90	381.45	1.199	4.990	149.70	0	1.199	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



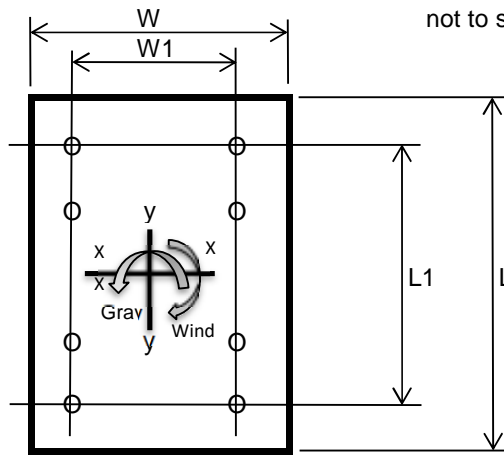
Flange Analysis - Arm #1

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	1401	2370	-	lbs
Shear (Wind)	2988	1763	-	lbs
Torsion (Arm Rise)	7671	4527	-	ft-lbs
Moment (Gravity)	33046	57360	-	ft-lbs
Moment (Wind)	73474	41987	-	ft-lbs
Nat. Wind Moment	-	-	16026	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	13.00	in
Tube Wall Thick.	0.1793	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	8.93	10.53	ksi
Bolt Shear Stress - fv	1.03	0.71	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.21	0.25	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	1.52	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.22	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	5.99	10.39	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	13.54	7.74	ksi
Combined applied stress for interaction (SRSS)	14.81	12.96	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49'/49' Arms w/24' Lum.

Arm #2 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	2.45	0.00	13.000	12.657	59.4	1.2195	1.22	2.619	2.619	25.84
2	I	2.45	2.45	12.657	12.314	57.8	1.2194	3.67	2.549	2.549	25.18
3	I	2.45	4.90	12.314	11.971	56.2	1.2192	6.12	2.479	2.479	24.52
4	I	2.45	7.35	11.971	11.628	54.6	1.2191	8.57	2.409	2.409	23.86
5	I	2.45	9.80	11.628	11.285	53.0	1.2189	11.02	2.339	2.339	23.20
6	I	2.45	12.25	11.285	10.942	51.3	1.2187	13.47	2.269	2.269	22.54
7	I	2.45	14.70	10.942	10.599	49.7	1.2185	15.92	2.199	2.199	21.88
8	I	2.45	17.15	10.599	10.256	48.1	1.2183	18.37	2.129	2.129	21.22
9	I	2.45	19.60	10.256	9.913	46.5	1.2181	20.82	2.059	2.059	20.56
10	I	2.45	22.05	9.913	9.570	44.9	1.2178	23.27	1.989	1.989	19.90
11	I	2.45	24.50	9.570	9.227	43.3	1.2175	25.72	1.919	1.919	19.24
12	I	2.45	26.95	9.227	8.884	41.7	1.2173	28.17	1.849	1.849	18.58
13	I	2.45	29.40	8.884	8.541	40.1	1.2170	30.62	1.779	1.779	17.92
14	I	2.45	31.85	8.541	8.198	38.5	1.2166	33.07	1.709	1.709	17.26
15	I	2.45	34.30	8.198	7.855	36.9	1.2163	35.52	1.639	1.639	16.60
16	I	2.45	36.75	7.855	7.512	35.2	1.2159	37.97	1.569	1.569	15.94
17	I	2.45	39.20	7.512	7.169	33.6	1.2155	40.42	1.499	1.499	15.28
18	I	2.45	41.65	7.169	6.826	32.0	1.2150	42.86	1.429	1.429	14.62
19	I	2.45	44.10	6.826	6.483	30.4	1.2145	45.31	1.359	1.359	13.96
20	I	2.45	46.55	6.483	6.140	28.8	1.2139	47.76	1.289	1.289	13.30
		49.00				882					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	66	7.50	30.000	1.000	90.00
Fix. #3	105	16.00	13.750	2.000	126.00
Fix. #4	22.5	23.00	7.500	1.000	22.50
Fix. #5	22	24.00	1.000	1.000	9.00
Fix. #6	65	26.00	8.700	1.000	78.00
Fix. #7	22.5	34.00	7.500	1.000	22.50
Fix. #8	65	37.00	8.700	1.000	78.00
Fix. #9	22	39.00	1.000	1.000	9.00
Fix. #10	26.7	45.00	10.500	1.000	31.50
Fix. #11	80	48.00	11.000	1.000	102.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#2 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	23.135	0.000
Cross-Section Area (in^2)	7.218	0.000
Width-Thickness Ratio	72.50	0.00
Compact Limit	68.55	0.00
Non-Compact Limit	137.09	0.00
Maximum Limit	237.27	0.00
Allow. Bending Stress (ksi)	35.489	0.000
Allow. Shear Stress (ksi)	18.150	0.000



16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49'/49' Arms w/24' Lum.

Arm #2 Analysis Continued

Sec. Num.	Kz	Truck Induced Gust											Gallop Loads (lbs)
		Group 2			Group 3	Natural Wind Gust			Hght Corr. Factor = 1.00				
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	24.99	32.74	1.100	4.576	11.99	0	0.710	0.00	0.00	
2	1.00	0.450	9.54	24.32	31.86	1.100	4.576	11.66	0	0.736	0.00	0.00	
3	1.00	0.450	9.54	23.65	30.99	1.100	4.576	11.34	0	0.763	0.00	0.00	
4	1.00	0.450	9.54	22.98	30.11	1.100	4.576	11.02	0	0.792	0.00	0.00	
5	1.00	0.450	9.54	22.31	29.24	1.100	4.576	10.70	0	0.823	0.00	0.00	
6	1.00	0.450	9.54	21.65	28.36	1.100	4.576	10.38	0	0.856	0.00	0.00	
7	1.00	0.460	9.75	21.44	27.49	1.100	4.576	10.06	0	0.891	0.00	0.00	
8	1.00	0.479	10.17	21.65	26.61	1.100	4.576	9.74	0	0.930	0.00	0.00	
9	1.00	0.501	10.62	21.87	25.74	1.100	4.576	9.42	0	0.971	0.00	0.00	
10	1.00	0.524	11.11	22.10	24.86	1.100	4.576	9.10	0	1.016	0.00	0.00	
11	1.00	0.549	11.64	22.34	23.99	1.100	4.576	8.78	0	1.064	0.00	0.00	
12	1.00	0.576	12.21	22.57	23.11	1.100	4.576	8.46	0	1.100	0.00	0.00	
13	1.00	0.606	12.84	22.84	22.24	1.100	4.576	8.14	0	1.100	0.00	0.00	
14	1.00	0.638	13.53	23.12	21.36	1.100	4.576	7.82	0	1.100	0.00	0.00	
15	1.00	0.674	14.29	23.42	20.48	1.100	4.576	7.50	1	1.100	0.00	0.00	
16	1.00	0.713	15.12	23.72	19.61	1.100	4.576	7.18	1	1.100	0.00	0.00	
17	1.00	0.757	16.04	24.04	18.73	1.100	4.576	6.86	1	1.100	0.00	0.00	
18	1.00	0.805	17.07	24.39	17.86	1.100	4.576	6.54	1	1.100	0.00	0.00	
19	1.00	0.860	18.23	24.77	16.98	1.100	4.576	6.22	1	1.100	0.00	0.00	
20	1.00	0.921	19.52	25.15	16.11	1.100	4.576	5.90	1	1.100	0.00	0.00	
Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.199	25.43	762.90	381.45	1.199	4.990	149.70	0	1.199	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



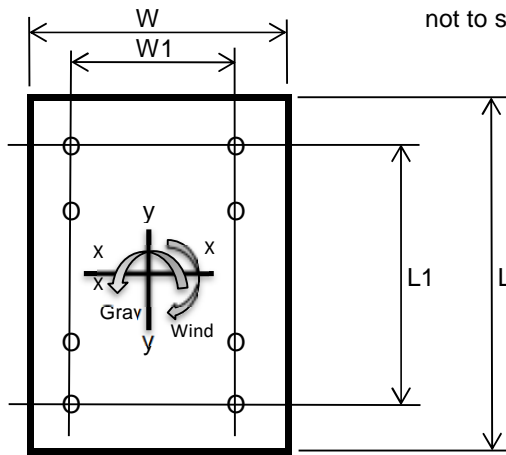
Flange Analysis - Arm #2

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	1401	2370	-	lbs
Shear (Wind)	2988	1763	-	lbs
Torsion (Arm Rise)	7671	4527	-	ft-lbs
Moment (Gravity)	33046	57360	-	ft-lbs
Moment (Wind)	73474	41987	-	ft-lbs
Nat. Wind Moment	-	-	16026	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	13.00	in
Tube Wall Thick.	0.1793	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	8.93	10.53	ksi
Bolt Shear Stress - fv	1.03	0.71	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.21	0.25	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	1.52	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.22	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	5.99	10.39	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	13.54	7.74	ksi
Combined applied stress for interaction (SRSS)	14.81	12.96	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	





16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49'/49' Arms w/24' Lum.

Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.00	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.368421	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.75	
Kf - Fatigue stress concentration factor for finite life	2.41	
Ki - Fatigue stress concentration factor for infinite life	5.32	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.1793	in
Dt - Arm base diameter	13.00	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	2.45	
Dop - Baseplate center hole diameter	5.00	in
Cop - Center hole to arm diameter ratio	0.384615	
Kf - Fatigue stress concentration factor for finite life	1.70	
Ki - Fatigue stress concentration factor for infinite life	2.93	
Fatigue Allowable	10	ksi

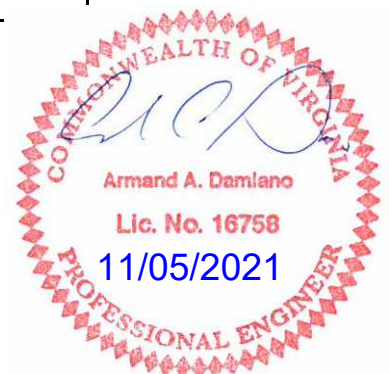
Note: Maximum diagonal distance between bolts used as bolt circle

**ARM 2 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.1793	in
Dt - Arm base diameter	13.00	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	2.447677	
Dop - Baseplate center hole diameter	5	in
Cop - Center hole to arm diameter ratio	0.384615	
Kf - Fatigue stress concentration factor for finite life	1.70	
Ki - Fatigue stress concentration factor for infinite life	2.93	
Fatigue Allowable	10	ksi

Note: Maximum diagonal distance between bolts used as bolt circle





16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49'/49' Arms w/24' Lum.

## Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	18.57	in
Shaft Thickness	0.313	in
Total Area	23.0768	in <sup>2</sup>
Ix	848	in <sup>4</sup>
Iy	944	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	22040	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	11.39	ksi
CSR	0.71	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	3.24	ksi
CSR	0.46	
Therefore	<b>OK</b>	



16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49'/49' Arms w/24' Lum.

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear	Shear	Bending	Torsion	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	1401		1401	33046		33046		389	17141		0.49
Gp II	1401	2988	3300	33046	73474	80564	7671	915	41788	1990	0.90
Gp III	2370	1763	2954	57360	41987	71086	4527	819	36872	1175	0.79
Gp IV Natural		674	674		16026	16026	1731	187	8313	449	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	1401		1401	33046		33046		389	17141		0.49
Gp II	1401	2988	3300	33046	73474	80564	7671	915	41788	1990	0.90
Gp III	2370	1763	2954	57360	41987	71086	4527	819	36872	1175	0.79
Gp IV Natural		674	674		16026	16026	1731	187	8313	449	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49'/49' Arms w/24' Lum.

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	4766		33046	33046	46733		260		6546		0.19
Gp II	4766	4042	65608	106347	124956	105018	260	441	17503	7355	0.48
Gp III	7310	2603	79684	100306	128105	59949	399	284	17944	4199	0.42
Gp IV Natural			17132	13865	22040				3087		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9967										

<b>Shaft At Arm</b>											
Gp I	3553		33046	33046	46733		224		8746		0.25
Gp II	3553	3377	37976	44830	58753	105018	224	426	10995	9827	0.42
Gp III	5585	2035	60505	63911	88008	59949	352	257	16470	5610	0.41
Gp IV Natural			1879	1731	2555				478		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9967										



16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49'/49' Arms w/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	4042 lbs
Bending Moment	128105 ft-lbs
Torsion Moment	105018 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.00 in

**ANALYSIS - ANCHOR BOLTS**

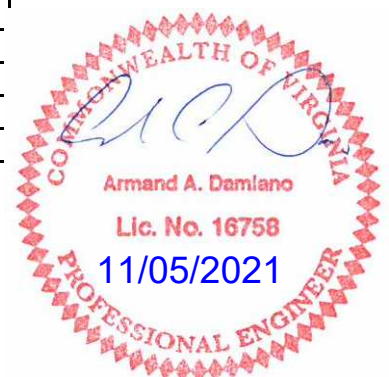
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	11.798 ksi
Bolt Direct Shear Stress	0.22 ksi
Bolt Torsion Shear Stress	5.269 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	11.798 ksi
$f_v =$	5.489 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.41 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.5 in
Design Moment	104 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	15.71 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.938 in
Design Moment	58 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	9.2 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-20 - Virginia - 70 MPH - MP-3 Std. Loads - Type F - 49'/49' Arms w/24' Lum.

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	22040 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	2.03 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.29
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

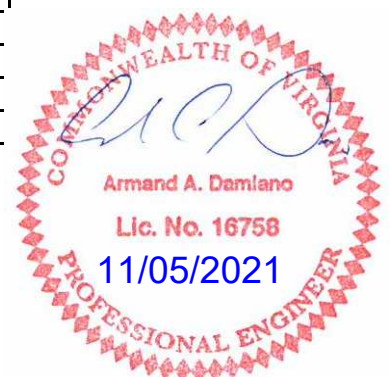
Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	29495 lbs
Computed Factor-of Safety	2.1 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	29495 lbs
Total Tensile Load	235960 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	2 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	29495 lbs
Total Tensile Load	235960 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	6 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-21 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 50' Arm

11/04/21

**General**

Wind Vel. - mph	70	No	Roadway - mph	55	<i>Fatigue Importance Factors</i>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	0		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Member E (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.50	19.50	-	-	-	0	55	29000	29000	-
Traffic Arm #1	0.1793	0.14	13.00	50.00	18.00	-	2.62	0	55	29000	29000	180
Traffic Arm #2					-	-		0	55	29000	29000	90
Lum Arm #1					-	-		0	36	29000	29000	180
Lum Arm #2					-	-		0	36	29000	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	Double Top Nuts	Yes	
A.B. Bolt Circle	26.00	Foundation Diameter	48	in
Baseplate Dia.	32.00	Concrete Cover	4	in
Baseplate Thk.	2.00	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	14.25	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.	Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50	in
Flange Plate Length (V)	27.00	in
Flange Plate Width (H)	27.00	in
Spac. Between Bolt (V)	22.50	in
Spac. Between Bolt (H)	22.50	in
Flange Plate Thk.	2.25	in
Flange Plate Yield (Fy)	50	ksi
Gusset Thk.	0.500	in
Plate Center Hole	5.00	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.14	0.18	0.52								16.23	0.00
GP II CSR	0.31	0.24	1.00									
GP III CSR	0.26	0.26	0.85								28.51	
Nat.Wind (psi)	2299	331	9198									

Arm #1 Flange Bolt (Max.) CSR	0.26
Arm #1 Flange Bolt Fatigue CSR	0.24
Arm #1 Flange Plate (Max.) CSR	0.37
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.53
Handhole at Toe (Fatigue) CSR	0.34
Minimum Qty of Vertical Reinf. Bars	4

Fatigue Allowable - Shaft to Baseplate	4.5	ksi
Fatigue Allowable - Arm#1 to Flange	10	ksi
Fatigue Allowable - Arm#2 to Flange	-	
Anchor Bolt Max. CSR	0.30	
Anchor Bolt Max. Fatigue Stress Ratio	0.23	
Base Plate Max. CSR	0.32	
Anchorage Capacity S.F.	3.03	
Concrete Pull Out Capacity S.F.	2.88	

**Ground Line Reactions**

	Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
	4206	3962	88743	82097



16362-1-21 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 50' Arm

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.2
	#2	Ped Head	10.5	2.4	1			1	6	30	1.2
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.2
	#4										
Lum #1	#1										
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	15'x2.5' Sign	12.5			15	2.5	1	37.5	88.5	1.21
	#3	5 Section Head w/BP	16	13.75	4			2	42	105	1.20
	#4		2.5'x3' Sign			24		2.5	3	1	7.5
	#5	3 Section Head w/BP	27	8.7	4			1	26	65	1.20
	#6	Camera	36	1	1			1	3	22	1.20
	#7	2.5'x3' Sign	35			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	38	8.7	4			1	26	65	1.20
	#9		Camera			47	1	1	1	3	22
	#10	3'x3.5' Sign	46			3	3.5	1	10.5	26.7	1.13
	#11	4 Section Head w/BP	49	11	5			1	34	80	1.20
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
	#8										
	#9										
	#10										
	#11										
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										





16362-1-21 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 50' Arm

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.500	19.352	67.61	0.5287	0.53	1.714	16.65	0.80
2	I	1.06	1.06	19.352	19.204	67.08	0.5287	1.59	1.701	16.53	0.80
3	I	1.06	2.12	19.204	19.055	66.56	0.5287	2.65	1.688	16.41	0.80
4	I	1.06	3.18	19.055	18.907	66.03	0.5287	3.71	1.675	16.28	0.80
5	I	1.06	4.24	18.907	18.759	65.51	0.5287	4.76	1.662	16.16	0.80
6	I	1.06	5.29	18.759	18.611	64.99	0.5287	5.82	1.649	16.04	0.80
7	I	1.06	6.35	18.611	18.462	64.46	0.5287	6.88	1.636	15.91	0.80
8	I	1.06	7.41	18.462	18.314	63.94	0.5287	7.94	1.622	15.79	0.80
9	I	1.06	8.47	18.314	18.166	63.41	0.5287	9.00	1.609	15.67	0.80
10	I	1.06	9.53	18.166	18.018	62.89	0.5287	10.06	1.596	15.54	0.80
11	I	1.06	10.59	18.018	17.869	62.36	0.5287	11.12	1.583	15.42	0.80
12	I	1.06	11.65	17.869	17.721	61.84	0.5287	12.18	1.570	15.30	0.80
13	I	1.06	12.71	17.721	17.573	61.31	0.5287	13.23	1.557	15.17	1.00
14	I	1.06	13.76	17.573	17.425	60.79	0.5287	14.29	1.544	15.05	1.00
15	I	1.06	14.82	17.425	17.276	60.27	0.5287	15.35	1.531	14.93	1.00
16	I	1.06	15.88	17.276	17.128	59.74	0.5287	16.41	1.518	14.80	1.00
17	I	1.06	16.94	17.128	16.980	59.22	0.5286	17.47	1.505	14.68	1.00
18	J	0.50	18.00	16.980	16.910	27.78	0.2498	18.25	0.706	6.89	1.00
19	I	0.50	18.50	16.910	16.840	27.66	0.2498	18.75	0.703	6.86	1.00
20	I	0.50	19.00	16.840	16.770	27.55	0.2498	19.25	0.700	6.83	1.00
						1161					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in^4)	866.45	567.94	0.00	546.74
Section Modulus (in^3)	90.31	68.15	0.00	
Cross-Section Area (in^2)	18.83	16.35	0.00	
Width-Thickness Ratio	62.40	54.34	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	20.514	20.514	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

Shaft Deflection From Arm#1 GP I Load (in)	0.448
Shaft Deflection From Arm#2 GP I Load (in)	0.000



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## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	13.10	0.000	21.43	1.100	4.576	7.84
2	0.450	7.64	13.00	0.000	21.26	1.100	4.576	7.78
3	0.450	7.64	12.90	0.000	21.10	1.100	4.576	7.72
4	0.450	7.64	12.80	0.000	20.94	1.100	4.576	7.66
5	0.450	7.64	12.70	0.000	20.77	1.100	4.576	7.60
6	0.450	7.64	12.60	0.000	20.61	1.100	4.576	7.54
7	0.450	7.64	12.50	0.000	20.44	1.100	4.576	7.48
8	0.450	7.64	12.40	0.000	20.28	1.100	4.576	7.42
9	0.450	7.64	12.30	0.001	20.12	1.100	4.576	7.36
10	0.450	7.64	12.20	0.001	19.95	1.100	4.576	7.30
11	0.450	7.64	12.10	0.001	19.79	1.100	4.576	7.24
12	0.450	7.64	12.00	0.001	19.63	1.100	4.576	7.19
13	0.450	9.54	14.85	0.001	19.46	1.100	4.576	7.13
14	0.450	9.54	14.73	0.002	19.30	1.100	4.576	7.07
15	0.450	9.54	14.61	0.002	19.14	1.100	4.576	7.01
16	0.450	9.54	14.48	0.002	18.97	1.100	4.576	6.95
17	0.450	9.54	14.36	0.002	18.81	1.100	4.576	6.89
18	0.450	9.54	6.74	0.001	8.83	1.100	4.576	3.23
19	0.450	9.54	6.71	0.001	8.79	1.100	4.576	3.22
20	0.450	9.54	6.68	0.001	8.75	1.100	4.576	3.20
Fix. #1	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.043	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



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Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	2.50	0.00	13.000	12.650	60.6	1.2443	1.24	2.672	2.672	26.36
2	I	2.50	2.50	12.650	12.300	58.9	1.2442	3.74	2.599	2.599	25.67
3	I	2.50	5.00	12.300	11.950	57.2	1.2440	6.24	2.526	2.526	24.99
4	I	2.50	7.50	11.950	11.600	55.6	1.2438	8.74	2.453	2.453	24.30
5	I	2.50	10.00	11.600	11.250	53.9	1.2436	11.24	2.380	2.380	23.61
6	I	2.50	12.50	11.250	10.900	52.2	1.2434	13.74	2.307	2.307	22.92
7	I	2.50	15.00	10.900	10.550	50.5	1.2432	16.24	2.234	2.234	22.24
8	I	2.50	17.50	10.550	10.200	48.9	1.2430	18.74	2.161	2.161	21.55
9	I	2.50	20.00	10.200	9.850	47.2	1.2427	21.24	2.089	2.089	20.86
10	I	2.50	22.50	9.850	9.500	45.5	1.2425	23.74	2.016	2.016	20.17
11	I	2.50	25.00	9.500	9.150	43.8	1.2422	26.24	1.943	1.943	19.49
12	I	2.50	27.50	9.150	8.800	42.1	1.2419	28.74	1.870	1.870	18.80
13	I	2.50	30.00	8.800	8.450	40.5	1.2415	31.24	1.797	1.797	18.11
14	I	2.50	32.50	8.450	8.100	38.8	1.2412	33.74	1.724	1.724	17.43
15	I	2.50	35.00	8.100	7.750	37.1	1.2408	36.24	1.651	1.651	16.74
16	I	2.50	37.50	7.750	7.400	35.4	1.2404	38.74	1.578	1.578	16.05
17	I	2.50	40.00	7.400	7.050	33.8	1.2399	41.24	1.505	1.505	15.36
18	I	2.50	42.50	7.050	6.700	32.1	1.2394	43.74	1.432	1.432	14.68
19	I	2.50	45.00	6.700	6.350	30.4	1.2388	46.24	1.359	1.359	13.99
20	I	2.50	47.50	6.350	6.000	28.7	1.2382	48.74	1.286	1.286	13.30
		<u>50.00</u>				<u>893</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	12.50	37.500	1.000	112.50
Fix. #3	105	16.00	13.750	2.000	126.00
Fix. #4	22.5	24.00	7.500	1.000	22.50
Fix. #5	65	27.00	8.700	1.000	78.00
Fix. #6	22	36.00	1.000	1.000	9.00
Fix. #7	22.5	35.00	7.500	1.000	22.50
Fix. #8	65	38.00	8.700	1.000	78.00
Fix. #9	22	47.00	1.000	1.000	9.00
Fix. #10	26.7	46.00	10.500	1.000	31.50
Fix. #11	80	49.00	11.000	1.000	102.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	23.135	0.000
Cross-Section Area (in^2)	7.218	0.000
Width-Thickness Ratio	72.50	0.00
Compact Limit	68.55	0.00
Non-Compact Limit	137.09	0.00
Maximum Limit	237.27	0.00
Allow. Bending Stress (ksi)	35.489	0.000
Allow. Shear Stress (ksi)	18.150	0.000



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Arm #1 Analysis Continued

Sec. Num.	Kz	Truck Induced Gust											
		Group 2			Group 3	Natural Wind Gust			Hght Corr. Factor = 1.000				Gallop
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	Loads (lbs)
1	1.00	0.450	9.54	25.49	33.40	1.100	4.576	12.23	0	0.710	0.00	0.00	
2	1.00	0.450	9.54	24.79	32.49	1.100	4.576	11.89	0	0.737	0.00	0.00	
3	1.00	0.450	9.54	24.10	31.58	1.100	4.576	11.56	0	0.764	0.00	0.00	
4	1.00	0.450	9.54	23.40	30.66	1.100	4.576	11.23	0	0.794	0.00	0.00	
5	1.00	0.450	9.54	22.71	29.75	1.100	4.576	10.89	0	0.826	0.00	0.00	
6	1.00	0.450	9.54	22.01	28.84	1.100	4.576	10.56	0	0.860	0.00	0.00	
7	1.00	0.462	9.8	21.90	27.93	1.100	4.576	10.22	0	0.896	0.00	0.00	
8	1.00	0.483	10.23	22.11	27.02	1.100	4.576	9.89	0	0.936	0.00	0.00	
9	1.00	0.505	10.7	22.35	26.11	1.100	4.576	9.56	0	0.979	0.00	0.00	
10	1.00	0.528	11.21	22.60	25.20	1.100	4.576	9.22	0	1.025	0.00	0.00	
11	1.00	0.554	11.76	22.85	24.28	1.100	4.576	8.89	0	1.075	0.00	0.00	
12	1.00	0.583	12.36	23.11	23.37	1.100	4.576	8.56	0	1.100	0.00	0.00	
13	1.00	0.614	13.01	23.38	22.46	1.100	4.576	8.22	0	1.100	0.00	0.00	
14	1.00	0.647	13.73	23.67	21.55	1.100	4.576	7.89	0	1.100	0.00	0.00	
15	1.00	0.685	14.52	23.97	20.64	1.100	4.576	7.56	1	1.100	0.00	0.00	
16	1.00	0.726	15.4	24.30	19.73	1.100	4.576	7.22	1	1.100	0.00	0.00	
17	1.00	0.772	16.38	24.66	18.82	1.100	4.576	6.89	1	1.100	0.00	0.00	
18	1.00	0.824	17.47	25.02	17.90	1.100	4.576	6.55	1	1.100	0.00	0.00	
19	1.00	0.882	18.7	25.42	16.99	1.100	4.576	6.22	1	1.100	0.00	0.00	
20	1.00	0.947	20.09	25.84	16.08	1.100	4.576	5.89	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



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Flange Analysis - Arm #1

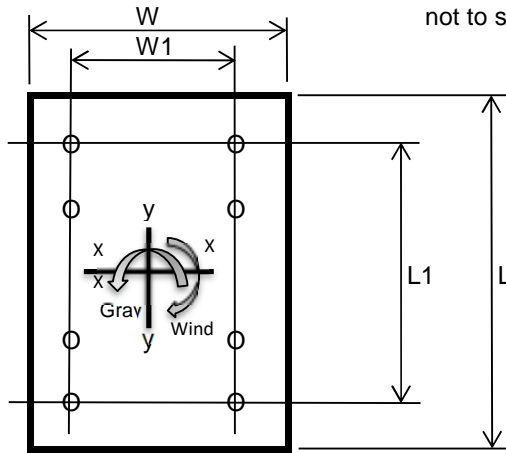
V06-21-16

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	1434	2431	-	lbs
Shear (Wind)	3194	1867	-	lbs
Torsion (Arm Rise)	8369	4893	-	ft-lbs
Moment (Gravity)	34937	60757	-	ft-lbs
Moment (Wind)	82097	46367	-	ft-lbs
Nat. Wind Moment	-	-	17732	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	13.00	in
Tube Wall Thick.	0.1793	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	9.77	11.22	ksi
Bolt Shear Stress - fv	1.12	0.76	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.23	0.26	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	1.68	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.24	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	6.33	11.01	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	15.13	8.55	ksi
Combined applied stress for interaction (SRSS)	16.40	13.94	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



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Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.50	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.333333	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.730769	
Kf - Fatigue stress concentration factor for finite life	2.31	
Ki - Fatigue stress concentration factor for infinite life	5.05	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.1793	in
Dt - Arm base diameter	13.00	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	2.45	
Dop - Baseplate center hole diameter	5	in
Cop - Center hole to arm diameter ratio	0.384615	
Kf - Fatigue stress concentration factor for finite life	1.70	
Ki - Fatigue stress concentration factor for infinite life	2.93	
Fatigue Allowable	10	ksi

Note: Maximum diagonal distance between bolts used as bolt circle



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Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	19.07	in
Shaft Thickness	0.313	in
Total Area	23.571	in <sup>2</sup>
Ix	911	in <sup>4</sup>
Iy	1023	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	17304	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	8.55	ksi
CSR	0.53	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	2.41	ksi
CSR	0.34	
Therefore	<b>OK</b>	





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Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear	Shear	Bending	Torsion	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	1434		1434	34937		34938		398	18122		0.52
Gp II	1434	3194	3502	34937	82097	89222	8369	971	46279	2171	1.00
Gp III	2431	1867	3066	60757	46367	76429	4893	850	39643	1269	0.85
Gp IV Natural		715	715		17732	17732	1873	199	9198	486	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-21 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 50' Arm

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	2760		34937	0	34937		147		4642		0.14
Gp II	2760	3962	48109	74571	88743	82097	147	421	11791	5454	0.31
Gp III	4206	2519	38504	75213	84496	46367	223	268	11227	3080	0.26
Gp IV Natural			17304	0	17304				2299		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9984										

<b>Shaft At Arm</b>											
Gp I	1517		34937	0	34937		93		6152		0.18
Gp II	1517	3214	8369	34952	35940	82097	93	394	6328	7228	0.24
Gp III	2514	1894	4893	60777	60974	46367	154	232	10737	4082	0.26
Gp IV Natural			1880	0	1880				331		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9984										



16362-1-2 - VA - 70 MPH -MP-3 Std. Loads-Type B1 w/50' Arm  
Weld Analysis

Page S4

**INPUTS**

	<b>Gp II</b>	<b>GpIII</b>			
<b>Applied Loads To Flange Connection</b>			<b>Arm Dimensions</b>		
Vert. Shr	1434	2431	lbs	Diameter (d)	13.0 in
Horz. Shr	3194	1867	lbs	Tube Wall Thk	0.1793 in
Torsion Moment	8369	4893	ft-lbs	Plate Thk (D)	2.25 in
Gravity Moment	34937	60757	ft-lbs	Plate Yield (Fy)	50 ksi
Wind Moment	82097	46367	ft-lbs		
<b>Applied Loads To Base Plate Connection</b>			<b>Shaft Dimensions</b>		
Axial	0	0	lbs	Diameter (d)	19.0 in
Shear	0	0	lbs	Tube Wall Thk	<b>0.3125</b> in
Shear	0	0	lbs	Plate Thk (D)	2 in
Bending Moment	0	0	ft-lbs	Plate Yield (Fy)	36 ksi
Bending Moment	0	0	ft-lbs	Arm Attach. Elev.	<b>18.0</b> ft
Torsion Moment	0	0	ft-lbs		

Additional Load Factor To Apply As Per Signal Plans & Specifications = 1.00

**Electrodes**

**AASHTO Gp II & III Factor** = 1.33

**E70 Electrodes (Used with plates having Fy = 36 ksi)**

$F_v = 0.27 F_u$  (AASHTO Bridge Spec 10.32.2)

$F_v = 0.27 \times 58000 = 15660$  psi

Allowable =  $F_v \times \text{Gp Factor} = 20828$  psi

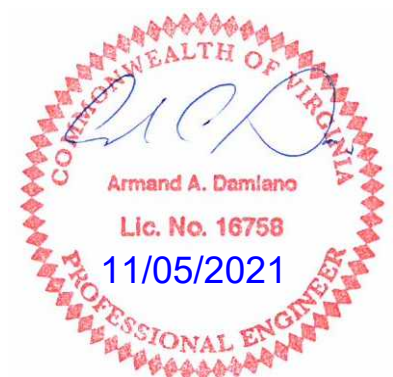
**E70 Electrodes (Used with plates having Fy = 50 ksi)**

$F_v = 0.27 \times 65000 = 17550$  psi

Allowable =  $F_v \times \text{Gp Factor} = 23342$  psi

Reference: *Design of Welded Structures*, Omer W. Blodgett

Method: Weld As A Line

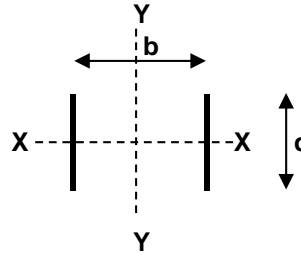


16362-1-2 - VA - 70 MPH -MP-3 Std. Loads-Type B1 w/50' Arm  
Weld Analysis - Continued

**ARM CONNECTING PLATES**

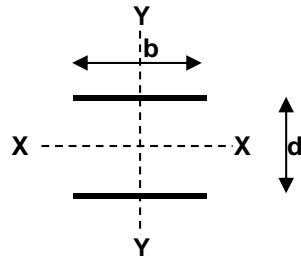
**Side Plates**

Vertical Length (d)	26.50	in
Horz. Dist Between Plates (b)	16.48	in
Thickness	<b>0.5</b>	in
Weld Size	<b>0.3125</b>	in
Weld Throat (t <sub>1</sub> )	0.221	in
A <sub>1</sub> = A <sub>w1</sub> * t <sub>1</sub> = 2 * d * t <sub>1</sub>	=	11.71 in <sup>2</sup>
S <sub>x1</sub> = S <sub>wx1</sub> * t <sub>1</sub> = (d <sup>2</sup> / 3) * t <sub>1</sub>	=	51.72 in <sup>3</sup>
S <sub>y1</sub> = S <sub>wy1</sub> * t <sub>1</sub> = b * d * t <sub>1</sub>	=	96.49 in <sup>3</sup>
J <sub>1</sub> = J <sub>w1</sub> * t <sub>1</sub> = t <sub>1</sub> * d(3b <sup>2</sup> + d <sup>2</sup> ) / 6	=	1480.30 in <sup>4</sup>



**Top & Bottom Plates**

Vert. Dist Between Plates (d)	26.50	in
Horz. Length (b)	25.89	in
Thickness	<b>0.5</b>	in
Weld Size	<b>0.3125</b>	in
Weld Throat (t <sub>2</sub> )	0.221	in
A <sub>2</sub> = A <sub>w2</sub> * t <sub>2</sub> = t <sub>2</sub> * 2 * b	=	11.4 in <sup>2</sup>
S <sub>x2</sub> = S <sub>wx2</sub> * t <sub>2</sub> = t <sub>2</sub> * b * d	=	151.6 in <sup>3</sup>
S <sub>y2</sub> = S <sub>wy2</sub> * t <sub>2</sub> = t <sub>2</sub> * (b <sup>2</sup> / 3)	=	49.4 in <sup>3</sup>
J <sub>2</sub> = J <sub>w2</sub> * t <sub>2</sub> = t <sub>2</sub> * (b <sup>3</sup> + 3bd <sup>2</sup> ) / 6	=	2647.0 in <sup>4</sup>



**Combined Analysis**

σ <sub>1</sub> = Gravity Mom / (S <sub>x1</sub> + S <sub>x2</sub> )	=	2063.0	Gp II	3587.0	psi
σ <sub>2</sub> = Wind Mom / (S <sub>y1</sub> + S <sub>y2</sub> )	=	6756.0	Gp III	3816.0	psi
σ <sub>2</sub> = [Tor. Mom * C / (J <sub>1</sub> + J <sub>2</sub> )] + [Res. Shr / (A <sub>1</sub> + A <sub>2</sub> )]	=	531.0		355.0	psi
Res. Weld Stress = σ <sub>r</sub> = Sqrt[ (σ <sub>1</sub> + σ <sub>2</sub> ) <sup>2</sup> + σ <sub>3</sub> <sup>2</sup> ]	=	8835		7412	psi
Allowable: E70 Electrodes * AASHTO Gp Factor	=	23341.5		23341.5	psi
<b>Actual Weld Stress vs. Allowable</b>		<b>Passes</b>		<b>Passes</b>	



16362-1-21 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 50' Arm

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	3962 lbs
Bending Moment	88743 ft-lbs
Torsion Moment	82097 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.50 in

**ANALYSIS - ANCHOR BOLTS**

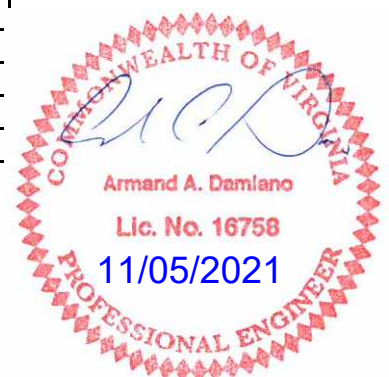
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	8.173 ksi
Bolt Direct Shear Stress	0.216 ksi
Bolt Torsion Shear Stress	4.119 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	8.173 ksi
$f_v =$	4.335 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.3 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.25 in
Design Moment	67 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	10.13 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.688 in
Design Moment	35 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	5.55 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-21 - Virginia - 70 MPH - MP-3 Std. Loads - Type B 1 - 50' Arm

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	17304 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	1.6 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.23
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

Anchor Bolt Length	60.0 in
Anchor Bolt Max. Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	20433 lbs
Computed Factor-of Safety	3.03 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	20433 lbs
Total Tensile Load	163464 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	2.88 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	20433 lbs
Total Tensile Load	163464 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	4 Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-22 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 50' Arm w/24' Arm

11/04/21

**General**

Wind Vel.- mph	70	No	Roadway - mph	55	<b>Fatigue Importance Factors</b>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	1		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	1		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.50	25.00	-	-	-	0	55	29000	-
Traffic Arm #1	0.1793	0.14	13.00	50.00	18.00	-	2.62	0	55	29000	180
Traffic Arm #2						-		0	55	29000	90
Lum Arm #1	0.2760		2.88	24.00	24.00	-	5	0	36	29000	180
Lum Arm #2						-		0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	in	Double Top Nuts	Yes
A.B. Bolt Circle	26.00	in	Foundation Diameter	48
Baseplate Dia.	32.00	in	Concrete Cover	4
Baseplate Thk.	2.00	in	f'c = 28 Day Concrete Comp. Strength	3000
B.P. Center Hole	14.25	in	Vertical Reinforcing Bar Size #	8
Weld Type	Full Pen.		Rebar Yield Strength fy	60
				ksi

**Flange Simplex**

	Arm #1	Arm #2
Flange Bolt Qty.	8	NA
Bolt Diameter	1.50	in
Flange Plate Length (V)	27.00	in
Flange Plate Width (H)	27.00	in
Spac. Between Bolt (V)	22.50	in
Spac. Between Bolt (H)	22.50	in
Flange Plate Thk.	2.25	in
Flange Plate Yield (Fy)	50	ksi
Gusset Thk.	0.500	in
Plate Center Hole	5.00	in
Weld Type	Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1		Lum#2		Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Root	Root	Arm #1	Arm #2
GP I CSR	0.14	0.18	0.52								16.23	0.00
GP II CSR	0.35	0.26	1.00				0.78					
GP III CSR	0.28	0.28	0.85				0.63				28.51	
Nat.Wind (psi)	2401	357	9198									

Arm #1 Flange Bolt (Max.) CSR	0.26
Arm #1 Flange Bolt Fatigue CSR	0.24
Arm #1 Flange Plate (Max.) CSR	0.37
Arm #2 Flange Bolt (Max.) CSR	-
Arm #2 Flange Bolt Fatigue CSR	-
Arm #2 Flange Plate (Max.) CSR	-
Handhole at Root (Fatigue) CSR	0.56
Handhole at Toe (Fatigue) CSR	0.36
Minimum Qty of Vertical Reinf. Bars	4

Fatigue Allowable - Shaft to Baseplate	4.5	ksi
Fatigue Allowable - Arm#1 to Flange	10	ksi
Fatigue Allowable - Arm#2 to Flange	-	
Anchor Bolt Max. CSR	0.33	
Anchor Bolt Max. Fatigue Stress Ratio	0.24	
Base Plate Max. CSR	0.36	
Anchorage Capacity S.F.	2.7	
Concrete Pull Out Capacity S.F.	2.57	

**Ground Line Reactions**

Axial (lbs)	5054	Shear (lbs)	4341	Bending (ft-lbs)	99564	Torsion (ft-lbs)	83222
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16362-1-22 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 50' Arm w/24' Arm

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1	Cobra Head w/Camera	24	2	1			4.54	9	57	1.00
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	15'x2.5' Sign	12.5			15	2.5	1	37.5	88.5	1.21
	#3	5 Section Head w/BP	16	13.75	4			2	42	105	1.20
	#4	2.5'x3' Sign	24			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	27	8.7	4			1	26	65	1.20
	#6	Camera	36	1	1			1	3	22	1.20
	#7	2.5'x3' Sign	35			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	38	8.7	4			1	26	65	1.20
	#9	Camera	47	1	1			1	3	22	1.20
	#10	3'x3.5' Sign	46			3	3.5	1	10.5	26.7	1.13
	#11	4 Section Head w/BP	49	11	5			1	34	80	1.20
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1										
	#2										
	#3										
	#4										
	#5										
	#6										
	#7										
	#8										
	#9										
	#10										
	#11										
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										



16362-1-22 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 50' Arm w/24' Arm

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.500	19.352	67.61	0.5287	0.53	1.714	16.65	0.80
2	I	1.06	1.06	19.352	19.204	67.08	0.5287	1.59	1.701	16.53	0.80
3	I	1.06	2.12	19.204	19.055	66.56	0.5287	2.65	1.688	16.41	0.80
4	I	1.06	3.18	19.055	18.907	66.03	0.5287	3.71	1.675	16.28	0.80
5	I	1.06	4.24	18.907	18.759	65.51	0.5287	4.76	1.662	16.16	0.80
6	I	1.06	5.29	18.759	18.611	64.99	0.5287	5.82	1.649	16.04	0.80
7	I	1.06	6.35	18.611	18.462	64.46	0.5287	6.88	1.636	15.91	0.80
8	I	1.06	7.41	18.462	18.314	63.94	0.5287	7.94	1.622	15.79	0.80
9	I	1.06	8.47	18.314	18.166	63.41	0.5287	9.00	1.609	15.67	0.80
10	I	1.06	9.53	18.166	18.018	62.89	0.5287	10.06	1.596	15.54	0.80
11	I	1.06	10.59	18.018	17.869	62.36	0.5287	11.12	1.583	15.42	0.80
12	I	1.06	11.65	17.869	17.721	61.84	0.5287	12.18	1.570	15.30	0.80
13	I	1.06	12.71	17.721	17.573	61.31	0.5287	13.23	1.557	15.17	1.00
14	I	1.06	13.76	17.573	17.425	60.79	0.5287	14.29	1.544	15.05	1.00
15	I	1.06	14.82	17.425	17.276	60.27	0.5287	15.35	1.531	14.93	1.00
16	I	1.06	15.88	17.276	17.128	59.74	0.5287	16.41	1.518	14.80	1.00
17	I	1.06	16.94	17.128	16.980	59.22	0.5286	17.47	1.505	14.68	1.00
18	J	3.00	18.00	16.980	16.560	164.94	1.4937	19.49	4.193	40.93	1.00
19	I	3.00	21.00	16.560	16.140	160.73	1.4936	22.49	4.088	39.94	1.00
20	J	1.00	24.00	16.140	16.000	52.64	0.4993	24.50	1.339	13.09	1.00
						1457					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in <sup>4</sup> )	866.45	567.94	0.00	473.53
Section Modulus (in <sup>3</sup> )	90.31	68.15	0.00	
Cross-Section Area (in <sup>2</sup> )	18.83	16.35	0.00	
Width-Thickness Ratio	62.40	54.34	0.00	
Compact Limit	68.55	68.55	0.00	
Non-Compact Limit	137.09	137.09	0.00	
Maximum Limit	237.27	237.27	0.00	
Allow. Bending Stress (ksi)	36.300	36.300	0.000	
Allow. Compressive Str (ksi)	14.296	14.296	0.000	
Allow. Shear Stress (ksi)	18.150	18.150	0.000	

Shaft Deflection From Arm#1 GP I Load (in)	0.448
Shaft Deflection From Arm#2 GP I Load (in)	0.000



16362-1-22 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 50' Arm w/24' Arm

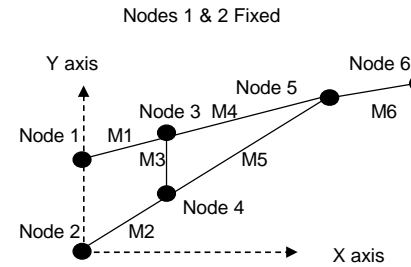
## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	13.10	0.000	21.43	1.100	4.576	7.84
2	0.450	7.64	13.00	0.000	21.26	1.100	4.576	7.78
3	0.450	7.64	12.90	0.000	21.10	1.100	4.576	7.72
4	0.450	7.64	12.80	0.000	20.94	1.100	4.576	7.66
5	0.450	7.64	12.70	0.000	20.77	1.100	4.576	7.60
6	0.450	7.64	12.60	0.000	20.61	1.100	4.576	7.54
7	0.450	7.64	12.50	0.000	20.44	1.100	4.576	7.48
8	0.450	7.64	12.40	0.001	20.28	1.100	4.576	7.42
9	0.450	7.64	12.30	0.001	20.12	1.100	4.576	7.36
10	0.450	7.64	12.20	0.001	19.95	1.100	4.576	7.30
11	0.450	7.64	12.10	0.001	19.79	1.100	4.576	7.24
12	0.450	7.64	12.00	0.001	19.63	1.100	4.576	7.19
13	0.450	9.54	14.85	0.002	19.46	1.100	4.576	7.13
14	0.450	9.54	14.73	0.002	19.30	1.100	4.576	7.07
15	0.450	9.54	14.61	0.003	19.14	1.100	4.576	7.01
16	0.450	9.54	14.48	0.003	18.97	1.100	4.576	6.95
17	0.450	9.54	14.36	0.003	18.81	1.100	4.576	6.89
18	0.450	9.54	40.00	0.011	52.41	1.100	4.576	19.18
19	0.450	9.54	38.99	0.014	51.09	1.100	4.576	18.70
20	0.450	9.54	12.78	0.005	16.74	1.100	4.576	6.13
Fix. #1	1.200	20.36	48.86	0.004	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.004	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.060	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-22 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 50' Arm w/24' Arm - Luminaire Arm - Group II

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-33.67	-24.6	0	0	0
Node #2	0	0	0	0	-35.63	-26	0	0	0
Node #3	100	59.5	0	0	-66.63	-51.3	0	0	0
Node #4	100	48.8	0	0	-69.41	-53.4	0	0	0
Node #5	200	79	0	0	-94.35	-75.6	0	0	0
Node #6	288	87	0	0	-85.29	-69.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



Member #3 is a bar computed as equivalent pipe section to the weak axis

	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-67.33	1.1	1	-49.04	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-71.25	1.1	1	-51.90	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-0.68	1.1	1	-1.18	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-65.23	1.1	1.1	-52.27	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-66.89	1.1	1.1	-53.59	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-56.58	1.1	1.1	-45.33	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-57.00	1	1.1	-46.64					

AASHTO Gp	2
Mntg Hght =	29.00
Datum =	1

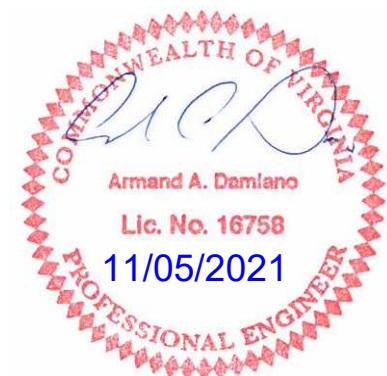
ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2180.2	lbs
P1y	-694.6	lbs
P1z	178.8	lbs
M1x	6661.9	in-lbs
M1y	-25162.7	in-lbs
M1z	-898.1	in-lbs
P2x	2180.2	lbs
P2y	1079.6	lbs
P2z	121.5	lbs
M2x	6843.3	in-lbs
M2y	-20414.5	in-lbs
M2z	-928.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1018	138	19343	-491	0.55
#2	1071	87	15894	-954	0.78
#3	1489	431	8552	-392	0.35
#4	-1001	64	7424	-23	0.2
#5	1020	75	8261	-288	0.5
#6	4	98	7210	1	0.22

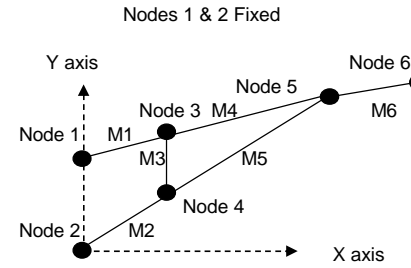
Arm Tip Displacement At Node 6	
X dir	0.103 (in)
Y dir	-0.898 (in)
Z dir	-10.462 (in)

V09.19.15



16362-1-22 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 50' Arm w/24' Arm - Luminaire Arm - Group III

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-40.85	-13.2	0	0	0
Node #2	0	0	0	0	-43.23	-14	0	0	0
Node #3	100	59.5	0	0	-81.04	-26.6	0	0	0
Node #4	100	48.8	0	0	-84.42	-27.7	0	0	0
Node #5	200	79	0	0	-114.49	-37.8	0	0	0
Node #6	288	87	0	0	-115.33	-36.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.276	105.15	2.10	2.258	-81.69	1.1	1	-26.29	1.936	1.936	3.872	11000000	29000000
Member #2	2.88	0.276	111.27	2.23	2.258	-86.45	1.1	1	-27.82	1.936	1.936	3.872	11000000	29000000
Member #3	0.68	0.1296	10.70	0.05	0.225	-1.22	1.1	1	-0.63	0.01	0.01	0.02	11000000	29000000
Member #4	2.88	0.276	101.88	2.04	2.258	-79.16	1.1	1.1	-26.13	1.936	1.936	3.872	11000000	29000000
Member #5	2.88	0.276	104.46	2.09	2.258	-81.16	1.1	1.1	-26.80	1.936	1.936	3.872	11000000	29000000
Member #6	2.88	0.276	88.36	1.77	2.258	-68.65	1.1	1.1	-22.67	1.936	1.936	3.872	11000000	29000000
Fixture Node 6				2		-81.00	1	1.1	-25.00					

AASHTO Gp	3
Mntg Hght =	29.00
Datum =	1

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	2576 psi
Fa Member 3	12654 psi
Fa Member 4	21600 psi
Fa Member 5	2923 psi
Fa Member 6	4086 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-2797.7	lbs
P1y	-898.7	lbs
P1z	92.5	lbs
M1x	3425.6	in-lbs
M1y	-12957.4	in-lbs
M1z	-1426.8	in-lbs
P2x	2797.7	lbs
P2y	1378.1	lbs
P2z	63.2	lbs
M2x	3519.9	in-lbs
M2y	-10515.8	in-lbs
M2z	-1452.7	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1307	75	10010	-255	0.26
#2	1373	50	8249	-493	0.63
#3	1905	442	8972	-201	0.38
#4	-1287	45	3944	-13	0.08
#5	1311	48	4359	-150	0.46
#6	5	107	7919	1	0.24

Arm Tip Displacement At Node 6	
X dir	0.137 (in)
Y dir	-1.214 (in)
Z dir	-5.396 (in)

V09.19.15



16362-1-22 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 50' Arm w/24' Arm

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	2.50	0.00	13.000	12.650	60.6	1.2443	1.24	2.672	2.672	26.36
2	I	2.50	2.50	12.650	12.300	58.9	1.2442	3.74	2.599	2.599	25.67
3	I	2.50	5.00	12.300	11.950	57.2	1.2440	6.24	2.526	2.526	24.99
4	I	2.50	7.50	11.950	11.600	55.6	1.2438	8.74	2.453	2.453	24.30
5	I	2.50	10.00	11.600	11.250	53.9	1.2436	11.24	2.380	2.380	23.61
6	I	2.50	12.50	11.250	10.900	52.2	1.2434	13.74	2.307	2.307	22.92
7	I	2.50	15.00	10.900	10.550	50.5	1.2432	16.24	2.234	2.234	22.24
8	I	2.50	17.50	10.550	10.200	48.9	1.2430	18.74	2.161	2.161	21.55
9	I	2.50	20.00	10.200	9.850	47.2	1.2427	21.24	2.089	2.089	20.86
10	I	2.50	22.50	9.850	9.500	45.5	1.2425	23.74	2.016	2.016	20.17
11	I	2.50	25.00	9.500	9.150	43.8	1.2422	26.24	1.943	1.943	19.49
12	I	2.50	27.50	9.150	8.800	42.1	1.2419	28.74	1.870	1.870	18.80
13	I	2.50	30.00	8.800	8.450	40.5	1.2415	31.24	1.797	1.797	18.11
14	I	2.50	32.50	8.450	8.100	38.8	1.2412	33.74	1.724	1.724	17.43
15	I	2.50	35.00	8.100	7.750	37.1	1.2408	36.24	1.651	1.651	16.74
16	I	2.50	37.50	7.750	7.400	35.4	1.2404	38.74	1.578	1.578	16.05
17	I	2.50	40.00	7.400	7.050	33.8	1.2399	41.24	1.505	1.505	15.36
18	I	2.50	42.50	7.050	6.700	32.1	1.2394	43.74	1.432	1.432	14.68
19	I	2.50	45.00	6.700	6.350	30.4	1.2388	46.24	1.359	1.359	13.99
20	I	2.50	47.50	6.350	6.000	28.7	1.2382	48.74	1.286	1.286	13.30
		<u>50.00</u>				<u>893</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	12.50	37.500	1.000	112.50
Fix. #3	105	16.00	13.750	2.000	126.00
Fix. #4	22.5	24.00	7.500	1.000	22.50
Fix. #5	65	27.00	8.700	1.000	78.00
Fix. #6	22	36.00	1.000	1.000	9.00
Fix. #7	22.5	35.00	7.500	1.000	22.50
Fix. #8	65	38.00	8.700	1.000	78.00
Fix. #9	22	47.00	1.000	1.000	9.00
Fix. #10	26.7	46.00	10.500	1.000	31.50
Fix. #11	80	49.00	11.000	1.000	102.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	23.135	0.000
Cross-Section Area (in^2)	7.218	0.000
Width-Thickness Ratio	72.50	0.00
Compact Limit	68.55	0.00
Non-Compact Limit	137.09	0.00
Maximum Limit	237.27	0.00
Allow. Bending Stress (ksi)	35.489	0.000
Allow. Shear Stress (ksi)	18.150	0.000



16362-1-22 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 50' Arm w/24' Arm

Arm #1 Analysis Continued

Sec. Num.	Kz	Truck Induced Gust											
		Group 2			Group 3	Natural Wind Gust			Hght Corr. Factor = 1.000				Gallop
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	Loads (lbs)
1	1.00	0.450	9.54	25.49	33.40	1.100	4.576	12.23	0	0.710	0.00	0.00	
2	1.00	0.450	9.54	24.79	32.49	1.100	4.576	11.89	0	0.737	0.00	0.00	
3	1.00	0.450	9.54	24.10	31.58	1.100	4.576	11.56	0	0.764	0.00	0.00	
4	1.00	0.450	9.54	23.40	30.66	1.100	4.576	11.23	0	0.794	0.00	0.00	
5	1.00	0.450	9.54	22.71	29.75	1.100	4.576	10.89	0	0.826	0.00	0.00	
6	1.00	0.450	9.54	22.01	28.84	1.100	4.576	10.56	0	0.860	0.00	0.00	
7	1.00	0.462	9.8	21.90	27.93	1.100	4.576	10.22	0	0.896	0.00	0.00	
8	1.00	0.483	10.23	22.11	27.02	1.100	4.576	9.89	0	0.936	0.00	0.00	
9	1.00	0.505	10.7	22.35	26.11	1.100	4.576	9.56	0	0.979	0.00	0.00	
10	1.00	0.528	11.21	22.60	25.20	1.100	4.576	9.22	0	1.025	0.00	0.00	
11	1.00	0.554	11.76	22.85	24.28	1.100	4.576	8.89	0	1.075	0.00	0.00	
12	1.00	0.583	12.36	23.11	23.37	1.100	4.576	8.56	0	1.100	0.00	0.00	
13	1.00	0.614	13.01	23.38	22.46	1.100	4.576	8.22	0	1.100	0.00	0.00	
14	1.00	0.647	13.73	23.67	21.55	1.100	4.576	7.89	0	1.100	0.00	0.00	
15	1.00	0.685	14.52	23.97	20.64	1.100	4.576	7.56	1	1.100	0.00	0.00	
16	1.00	0.726	15.4	24.30	19.73	1.100	4.576	7.22	1	1.100	0.00	0.00	
17	1.00	0.772	16.38	24.66	18.82	1.100	4.576	6.89	1	1.100	0.00	0.00	
18	1.00	0.824	17.47	25.02	17.90	1.100	4.576	6.55	1	1.100	0.00	0.00	
19	1.00	0.882	18.7	25.42	16.99	1.100	4.576	6.22	1	1.100	0.00	0.00	
20	1.00	0.947	20.09	25.84	16.08	1.100	4.576	5.89	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00





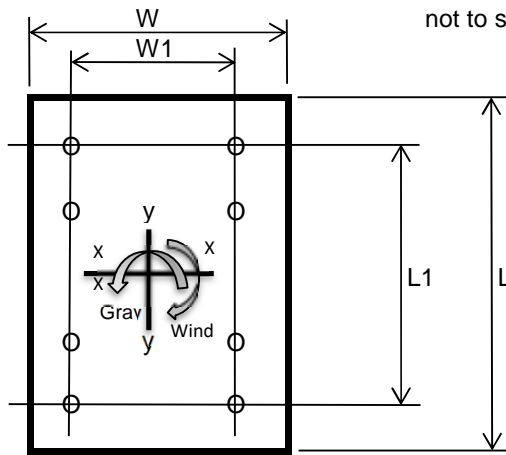
Flange Analysis - Arm #1

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	1434	2431	-	lbs
Shear (Wind)	3194	1867	-	lbs
Torsion (Arm Rise)	8369	4893	-	ft-lbs
Moment (Gravity)	34937	60757	-	ft-lbs
Moment (Wind)	82097	46367	-	ft-lbs
Nat. Wind Moment	-	-	17732	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	13.00	in
Tube Wall Thick.	0.1793	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	9.77	11.22	ksi
Bolt Shear Stress - fv	1.12	0.76	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.23	0.26	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	1.68	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.24	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	6.33	11.01	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	15.13	8.55	ksi
Combined applied stress for interaction (SRSS)	16.40	13.94	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



16362-1-22 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 50' Arm w/24' Arm

Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

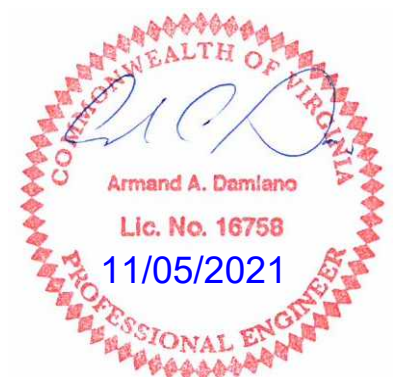
Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.50	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.333333	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.730769	
Kf - Fatigue stress concentration factor for finite life	2.31	
Ki - Fatigue stress concentration factor for infinite life	5.05	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.1793	in
Dt - Arm base diameter	13.00	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	2.45	
Dop - Baseplate center hole diameter	5	in
Cop - Center hole to arm diameter ratio	0.384615	
Kf - Fatigue stress concentration factor for finite life	1.70	
Ki - Fatigue stress concentration factor for infinite life	2.93	
Fatigue Allowable	10	ksi

Note: Maximum diagonal distance between bolts used as bolt circle



## 16362-1-22 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 50' Arm w/24' Arm

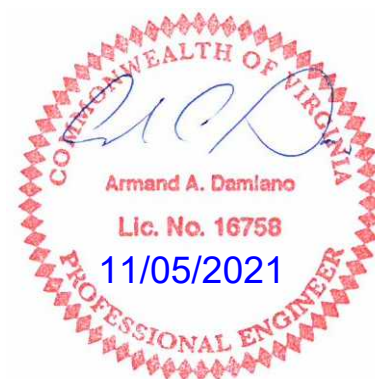
## Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	19.07	in
Shaft Thickness	0.313	in
Total Area	23.571	in <sup>2</sup>
Ix	911	in <sup>4</sup>
Iy	1023	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	18067	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	8.93	ksi
CSR	0.56	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	2.51	ksi
CSR	0.36	
Therefore	<b>OK</b>	



16362-1-22 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 50' Arm w/24' Arm

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	1434		1434	34937		34938		398	18122		0.52
Gp II	1434	3194	3502	34937	82097	89222	8369	971	46279	2171	1.00
Gp III	2431	1867	3066	60757	46367	76429	4893	850	39643	1269	0.85
Gp IV Natural		715	715		17732	17732	1873	199	9198	486	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-22 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 50' Arm w/24' Arm

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

<b>Shaft Base</b>											
Gp I	3441		34937	0	34937		183		4642		0.14
Gp II	3441	4341	48109	87169	99564	83222	183	462	13229	5529	0.35
Gp III	5054	2774	38504	82992	91489	46945	268	295	12156	3119	0.28
Gp IV Natural			18067	0	18067				2401		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9981										

<b>Shaft At Arm</b>											
Gp I	2198		34937	0	34937		134		6152		0.18
Gp II	2198	3586	8369	40855	41703	83222	134	439	7343	7327	0.26
Gp III	3289	2143	4893	64064	64251	46945	201	263	11314	4133	0.28
Gp IV Natural			2025	0	2025				357		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9981										



16362-1-22 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 50' Arm w/24' Arm

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	4341 lbs
Bending Moment	99564 ft-lbs
Torsion Moment	83222 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.50 in

**ANALYSIS - ANCHOR BOLTS**

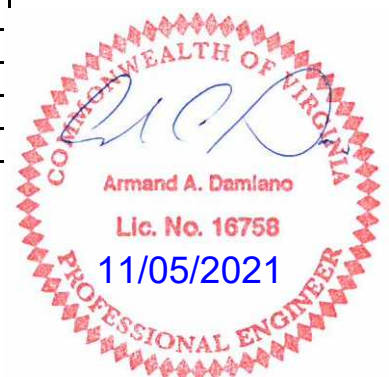
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	9.169 ksi
Bolt Direct Shear Stress	0.236 ksi
Bolt Torsion Shear Stress	4.176 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	9.169 ksi
$f_v =$	4.412 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.33 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.25 in
Design Moment	75 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	11.33 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.688 in
Design Moment	39 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	6.19 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-22 - Virginia - 70 MPH - MP-3 Std. Loads - Type E1 - 50' Arm w/24' Arm

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	18067 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	1.67 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.24
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

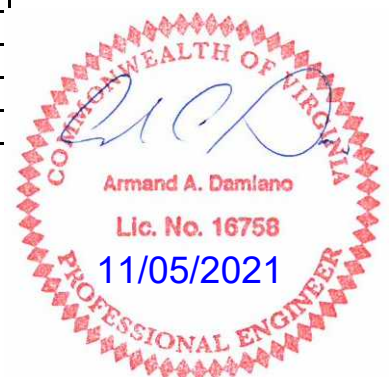
Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	22923 lbs
Computed Factor-of Safety	2.7 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	22923 lbs
Total Tensile Load	183384 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	2.57 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	22923 lbs
Total Tensile Load	183384 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	4 Qty.





**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-23 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/40' Arms

11/04/21

**General**

Wind Vel. - mph	70	No	Roadway - mph	55	<b>Fatigue Importance Factors</b>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	2		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	0		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.00	19.50	-	-	-	0	55	29000	-
Traffic Arm #1	0.2500	0.14	17.50	25.00	18.00	-	3.67	0	55	29000	180
	0.1880	0.14	14.79	47.92	-	2.92		0	55	29000	
Traffic Arm #2	0.1793	0.14	13.00	40.00	18.00	-	2.10	0	55	29000	270
					-			0	55	29000	
Lum Arm #1								0	36	29000	180
Lum Arm #2								0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	Double Top Nuts	Yes	
A.B. Bolt Circle	26.00	Foundation Diameter	48	in
Baseplate Dia.	32.00	Concrete Cover	4	in
Baseplate Thk.	2.00	f'c = 28 Day Concrete Comp. Strength	3000	psi
B.P. Center Hole	14.25	Vertical Reinforcing Bar Size #	8	
Weld Type	Full Pen.	Rebar Yield Strength fy	60	ksi

**Flange Simplex**

	Arm #1		Arm #2	
Flange Bolt Qty.	8		8	
Bolt Diameter	1.50	in	1.50	in
Flange Plate Length (V)	27.00	in	27.00	in
Flange Plate Width (H)	27.00	in	27.00	in
Spac. Between Bolt (V)	22.50	in	22.50	in
Spac. Between Bolt (H)	22.50	in	22.50	in
Flange Plate Thk.	2.25	in	2.25	in
Flange Plate Yield (Fy)	50	ksi	50	ksi
Gusset Thk.	0.500	in	0.500	in
Plate Center Hole	6.00	in	6.00	in
Weld Type	Full Pen.		Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1	Lum#2	Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Arm #1	Arm #2
GP I CSR	0.36	0.47	0.49	0.41	0.35				29.76	6.95
GP II CSR	0.66	0.73	0.71	0.64	0.64					
GP III CSR	0.63	0.72	0.70	0.62	0.57				48.75	12.16
Nat.Wind (psi)	3632	695	6735	5792	5957					

Arm #1 Flange Bolt (Max.) CSR	0.56
Arm #1 Flange Bolt Fatigue CSR	0.45
Arm #1 Flange Plate (Max.) CSR	0.60
Arm #2 Flange Bolt (Max.) CSR	0.18
Arm #2 Flange Bolt Fatigue CSR	0.16
Arm #2 Flange Plate (Max.) CSR	0.24
Handhole at Root (Fatigue) CSR	0.84
Handhole at Toe (Fatigue) CSR	0.54
Minimum Qty of Vertical Reinf. Bars	8

Fatigue Allowable - Shaft to Baseplate	4.5 ksi
Fatigue Allowable - Arm#1 to Flange	7 ksi
Fatigue Allowable - Arm#2 to Flange	7 ksi
Anchor Bolt Max. CSR	0.58
Anchor Bolt Max. Fatigue Stress Ratio	0.35
Base Plate Max. CSR	0.71
Anchorage Capacity S.F.	1.47
Concrete Pull Out Capacity S.F.	1.40

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
7939	4553	182829	146548



16362-1-23 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/40' Arms

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft.)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.2
	#2	Ped Head	10.5	2.4	1			1	6	30	1.2
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.2
	#4										
Lum #1	#1										
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	15'x2.5' Sign	12			15	2.5	1	37.5	88.5	1.21
	#3	5 Section Head w/BP	25	13.75	4			2	42	105	1.20
	#4	2.5'x3' Sign	29			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	36	8.7	4			1	26	65	1.20
	#6	Camera	40	1	1			1	3	22	1.20
	#7	2.5'x3' Sign	44			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	47	8.7	4			1	26	65	1.20
	#9	2.5'x3' Sign	55			2.5	3	1	7.5	22.5	1.13
	#10	3 Section Head w/BP	58	8.7	4			1	26	65	1.20
	#11	Camera	62	1	1			1	3	22	1.20
	#12	3'x3.5' Sign	66			3	3.5	1	10.5	26.7	1.13
	#13	4 Section Head w/BP	69	11	5			1	34	80	1.20
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1	Camera	4	1	1			1	3	22	1.20
	#2	12'x2.5' Sign	8			12	2.5	1	30	66	1.20
	#3	5 Section Head w/BP	17	13.75	4			2	42	105	1.20
	#4	Camera	20	1	1			1	3	22	1.20
	#5	2.5'x3' Sign	25			2.5	3	1	7.5	22.5	1.13
	#6	3 Section Head w/BP	28	8.7	4			1	26	65	1.20
	#7	Camera	30	1	1			1	3	22	1.20
	#8	3'x3.5' Sign	36			3	3.5	1	10.5	26.7	1.13
	#9	4 Section Head w/BP	39	11	5			1	34	80	1.20
	#10										
	#11										
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										



16362-1-23 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/40' Arms

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.000	18.852	65.84	0.5287	0.53	1.670	16.24	0.80
2	I	1.06	1.06	18.852	18.704	65.31	0.5287	1.59	1.657	16.11	0.80
3	I	1.06	2.12	18.704	18.555	64.79	0.5287	2.65	1.644	15.99	0.80
4	I	1.06	3.18	18.555	18.407	64.27	0.5287	3.71	1.631	15.87	0.80
5	I	1.06	4.24	18.407	18.259	63.74	0.5287	4.76	1.618	15.74	0.80
6	I	1.06	5.29	18.259	18.111	63.22	0.5287	5.82	1.605	15.62	0.80
7	I	1.06	6.35	18.111	17.962	62.69	0.5287	6.88	1.591	15.50	0.80
8	I	1.06	7.41	17.962	17.814	62.17	0.5287	7.94	1.578	15.37	0.80
9	I	1.06	8.47	17.814	17.666	61.64	0.5287	9.00	1.565	15.25	0.80
10	I	1.06	9.53	17.666	17.518	61.12	0.5287	10.06	1.552	15.13	0.80
11	I	1.06	10.59	17.518	17.369	60.59	0.5287	11.12	1.539	15.00	0.80
12	I	1.06	11.65	17.369	17.221	60.07	0.5287	12.18	1.526	14.88	0.80
13	I	1.06	12.71	17.221	17.073	59.55	0.5286	13.23	1.513	14.76	1.00
14	I	1.06	13.76	17.073	16.925	59.02	0.5286	14.29	1.500	14.63	1.00
15	I	1.06	14.82	16.925	16.776	58.50	0.5286	15.35	1.487	14.51	1.00
16	I	1.06	15.88	16.776	16.628	57.97	0.5286	16.41	1.474	14.39	1.00
17	I	1.06	16.94	16.628	16.480	57.45	0.5286	17.47	1.461	14.27	1.00
18	J	0.50	18.00	16.480	16.410	26.95	0.2498	18.25	0.685	6.69	1.00
19	I	0.50	18.50	16.410	16.340	26.83	0.2498	18.75	0.682	6.67	1.00
20	I	0.50	19.00	16.340	16.270	26.71	0.2498	19.25	0.679	6.64	1.00
						1129					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in <sup>4</sup> )	800.47	518.34	518.34	498.41
Section Modulus (in <sup>3</sup> )	85.67	64.12	64.12	
Cross-Section Area (in <sup>2</sup> )	18.34	15.86	15.86	
Width-Thickness Ratio	60.80	52.74	52.74	
Compact Limit	68.55	68.55	68.55	
Non-Compact Limit	137.09	137.09	137.09	
Maximum Limit	237.27	237.27	237.27	
Allow. Bending Stress (ksi)	36.300	36.300	36.300	
Allow. Compressive Str (ksi)	19.983	19.983	19.983	
Allow. Shear Stress (ksi)	18.150	18.150	18.150	

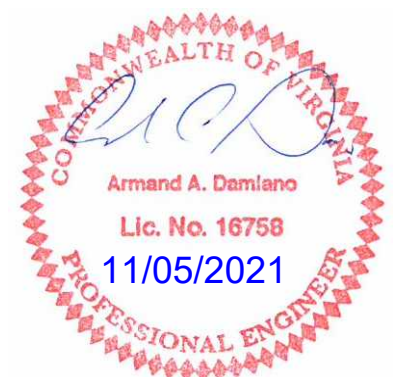
Shaft Deflection From Arm#1 GP I Load (in)	1.186
Shaft Deflection From Arm#2 GP I Load (in)	0.333



16362-1-23 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/40' Arms

## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	12.76	0.000	20.87	1.100	4.576	7.64
2	0.450	7.64	12.66	0.000	20.71	1.100	4.576	7.58
3	0.450	7.64	12.56	0.000	20.55	1.100	4.576	7.52
4	0.450	7.64	12.46	0.000	20.38	1.100	4.576	7.46
5	0.450	7.64	12.36	0.000	20.22	1.100	4.576	7.40
6	0.450	7.64	12.26	0.000	20.06	1.100	4.576	7.34
7	0.450	7.64	12.16	0.000	19.89	1.100	4.576	7.28
8	0.450	7.64	12.06	0.001	19.73	1.100	4.576	7.22
9	0.450	7.64	11.96	0.001	19.57	1.100	4.576	7.16
10	0.450	7.64	11.86	0.001	19.40	1.100	4.576	7.10
11	0.450	7.64	11.76	0.001	19.24	1.100	4.576	7.04
12	0.450	7.64	11.66	0.001	19.08	1.100	4.576	6.98
13	0.450	9.54	14.43	0.002	18.91	1.100	4.576	6.92
14	0.450	9.54	14.31	0.002	18.75	1.100	4.576	6.86
15	0.450	9.54	14.18	0.002	18.59	1.100	4.576	6.80
16	0.450	9.54	14.06	0.002	18.42	1.100	4.576	6.74
17	0.450	9.54	13.93	0.002	18.26	1.100	4.576	6.68
18	0.450	9.54	6.54	0.001	8.57	1.100	4.576	3.14
19	0.450	9.54	6.51	0.001	8.53	1.100	4.576	3.12
20	0.450	9.54	6.48	0.001	8.49	1.100	4.576	3.11
Fix. #1	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.047	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00



16362-1-23 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/40' Arms

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	3.68	0.00	17.500	16.985	167.1	1.8308	1.83	5.288	5.288	51.57
2	I	3.68	3.68	16.985	16.470	162.1	1.8306	5.51	5.130	5.130	50.08
3	I	3.68	7.36	16.470	15.954	157.0	1.8303	9.19	4.972	4.972	48.59
4	I	3.68	11.04	15.954	15.439	151.9	1.8299	12.87	4.814	4.814	47.10
5	I	3.68	14.72	15.439	14.924	146.8	1.8296	16.55	4.656	4.656	45.61
6	I	3.68	18.40	14.924	14.409	141.8	1.8292	20.23	4.498	4.498	44.12
7	J	2.92	22.08	14.790	14.381	193.4	1.4532	23.53	3.549	3.549	34.83
8	O	3.46	25.00	14.381	13.897	97.1	1.7209	26.72	4.079	4.079	40.07
9	O	3.46	28.46	13.897	13.412	93.7	1.7205	30.18	3.939	3.939	38.75
10	O	3.46	31.92	13.412	12.927	90.3	1.7202	33.64	3.799	3.799	37.43
11	O	3.46	35.38	12.927	12.443	86.9	1.7197	37.10	3.659	3.659	36.12
12	O	3.46	38.85	12.443	11.958	83.6	1.7193	40.57	3.519	3.519	34.80
13	O	3.46	42.31	11.958	11.474	80.2	1.7188	44.03	3.380	3.380	33.48
14	O	3.46	45.77	11.474	10.989	76.8	1.7183	47.49	3.240	3.240	32.16
15	O	3.46	49.23	10.989	10.504	73.5	1.7178	50.95	3.100	3.100	30.85
16	O	3.46	52.69	10.504	10.020	70.1	1.7171	54.41	2.960	2.960	29.53
17	O	3.46	56.15	10.020	9.535	66.7	1.7165	57.87	2.820	2.820	28.21
18	O	3.46	59.62	9.535	9.050	63.3	1.7157	61.33	2.681	2.681	26.89
19	O	3.46	63.08	9.050	8.566	60.0	1.7149	64.79	2.541	2.541	25.58
20	O	3.46	66.54	8.566	8.081	56.6	1.7140	68.25	2.401	2.401	24.26
		<u>70.00</u>				<u>2119</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	12.00	37.500	1.000	112.50
Fix. #3	105	25.00	13.750	2.000	126.00
Fix. #4	22.5	29.00	7.500	1.000	22.50
Fix. #5	65	36.00	8.700	1.000	78.00
Fix. #6	22	40.00	1.000	1.000	9.00
Fix. #7	22.5	44.00	7.500	1.000	22.50
Fix. #8	65	47.00	8.700	1.000	78.00
Fix. #9	22.5	55.00	7.500	1.000	22.50
Fix. #10	65	58.00	8.700	1.000	78.00
Fix. #11	22	62.00	1.000	1.000	9.00
Fix. #12	26.7	66.00	10.500	1.000	31.50
Fix. #13	80	69.00	11.000	1.000	102.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	58.397	31.467
Cross-Section Area (in^2)	13.541	8.620
Width-Thickness Ratio	70.00	78.67
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	35.991	34.389
Allow. Shear Stress (ksi)	18.150	17.040



16362-1-23 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/40' Arms

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000 Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	50.44	66.10	1.100	4.576	24.20	0	0.484	0.00	0.00	
2	1.00	0.450	9.54	48.94	64.12	1.100	4.576	23.47	0	0.503	0.00	0.00	
3	1.00	0.450	9.54	47.43	62.15	1.100	4.576	22.75	0	0.524	0.00	0.00	
4	1.00	0.450	9.54	45.92	60.17	1.100	4.576	22.03	0	0.546	0.00	0.00	
5	1.00	0.450	9.54	44.42	58.20	1.100	4.576	21.30	0	0.571	0.00	0.00	
6	1.00	0.450	9.54	42.91	56.22	1.100	4.576	20.58	0	0.597	0.00	0.00	
7	1.00	0.450	9.54	33.86	44.36	1.100	4.576	16.24	0	0.601	0.00	0.00	
8	1.00	0.450	9.54	38.91	50.98	1.100	4.576	18.66	0	0.626	0.00	0.00	
9	1.00	0.450	9.54	37.58	49.23	1.100	4.576	18.02	0	0.655	0.00	0.00	
10	1.00	0.450	9.54	36.24	47.49	1.100	4.576	17.38	0	0.686	0.00	0.00	
11	1.00	0.450	9.54	34.91	45.74	1.100	4.576	16.74	0	0.721	0.00	0.00	
12	1.00	0.450	9.54	33.57	43.99	1.100	4.576	16.10	0	0.758	0.00	0.00	
13	1.00	0.450	9.54	32.24	42.24	1.100	4.576	15.46	0	0.799	0.00	0.00	
14	1.00	0.450	9.54	30.91	40.50	1.100	4.576	14.83	0	0.844	0.00	0.00	
15	1.00	0.461	9.78	30.32	38.75	1.100	4.576	14.19	0	0.894	0.00	0.00	
16	1.00	0.489	10.38	30.73	37.00	1.100	4.576	13.55	0	0.949	0.00	0.00	
17	1.00	0.521	11.05	31.17	35.25	1.100	4.576	12.91	1	1.011	0.00	0.00	
18	1.00	0.557	11.81	31.66	33.51	1.100	4.576	12.27	1	1.080	0.00	0.00	
19	1.00	0.597	12.66	32.17	31.76	1.100	4.576	11.63	1	1.100	0.00	0.00	
20	1.00	0.643	13.63	32.73	30.01	1.100	4.576	10.99	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #10	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #13	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00





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Flange Analysis - Arm #1

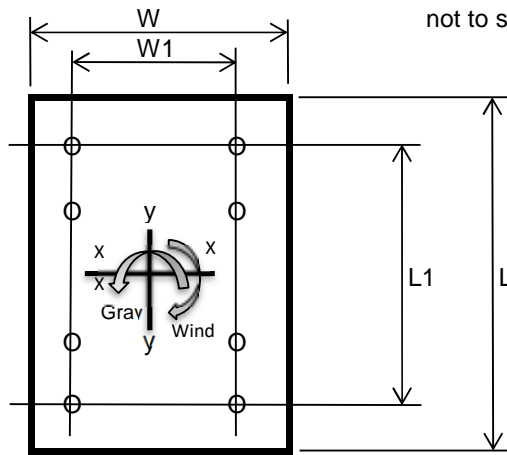
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Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	2748	4188	-	lbs
Shear (Wind)	3869	2515	-	lbs
Torsion (Arm Rise)	14192	9224	-	ft-lbs
Moment (Gravity)	85096	136462	-	ft-lbs
Moment (Wind)	137190	86259	-	ft-lbs
Nat. Wind Moment	-	-	32774	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	17.50	in
Tube Wall Thick.	0.25	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	19.42	24.59	ksi
Bolt Shear Stress - fv	1.79	1.34	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.45	0.56	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	3.1	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.45	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	13.77	22.08	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	22.58	14.20	ksi
Combined applied stress for interaction (SRSS)	26.45	26.25	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	





16362-1-23 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/40' Arms

Arm #2 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	2.00	0.00	13.000	12.720	48.6	0.9964	1.00	2.143	2.143	21.14
2	I	2.00	2.00	12.720	12.440	47.5	0.9963	3.00	2.097	2.097	20.70
3	I	2.00	4.00	12.440	12.160	46.5	0.9962	5.00	2.050	2.050	20.26
4	I	2.00	6.00	12.160	11.880	45.4	0.9961	7.00	2.003	2.003	19.82
5	I	2.00	8.00	11.880	11.600	44.3	0.9960	9.00	1.957	1.957	19.38
6	I	2.00	10.00	11.600	11.320	43.2	0.9959	11.00	1.910	1.910	18.94
7	I	2.00	12.00	11.320	11.040	42.2	0.9958	13.00	1.863	1.863	18.50
8	I	2.00	14.00	11.040	10.760	41.1	0.9957	15.00	1.817	1.817	18.06
9	I	2.00	16.00	10.760	10.480	40.0	0.9956	17.00	1.770	1.770	17.62
10	I	2.00	18.00	10.480	10.200	39.0	0.9955	19.00	1.723	1.723	17.18
11	I	2.00	20.00	10.200	9.920	37.9	0.9954	21.00	1.677	1.677	16.74
12	I	2.00	22.00	9.920	9.640	36.8	0.9952	23.00	1.630	1.630	16.30
13	I	2.00	24.00	9.640	9.360	35.7	0.9951	25.00	1.583	1.583	15.86
14	I	2.00	26.00	9.360	9.080	34.7	0.9949	26.99	1.537	1.537	15.43
15	I	2.00	28.00	9.080	8.800	33.6	0.9948	28.99	1.490	1.490	14.99
16	I	2.00	30.00	8.800	8.520	32.5	0.9946	30.99	1.443	1.443	14.55
17	I	2.00	32.00	8.520	8.240	31.4	0.9944	32.99	1.397	1.397	14.11
18	I	2.00	34.00	8.240	7.960	30.4	0.9942	34.99	1.350	1.350	13.67
19	I	2.00	36.00	7.960	7.680	29.3	0.9940	36.99	1.303	1.303	13.23
20	I	2.00	38.00	7.680	7.400	28.2	0.9938	38.99	1.257	1.257	12.79
		40.00				768					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	66	8.00	30.000	1.000	90.00
Fix. #3	105	17.00	13.750	2.000	126.00
Fix. #4	22	20.00	1.000	1.000	9.00
Fix. #5	22.5	25.00	7.500	1.000	22.50
Fix. #6	65	28.00	8.700	1.000	78.00
Fix. #7	22	30.00	1.000	1.000	9.00
Fix. #8	26.7	36.00	10.500	1.000	31.50
Fix. #9	80	39.00	11.000	1.000	102.00
Fix. #10	0	0.00	0.000	0.000	0.00
Fix. #11	0	0.00	0.000	0.000	0.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#2 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	23.135	0.000
Cross-Section Area (in^2)	7.218	0.000
Width-Thickness Ratio	72.50	0.00
Compact Limit	68.55	0.00
Non-Compact Limit	137.09	0.00
Maximum Limit	237.27	0.00
Allow. Bending Stress (ksi)	35.489	0.000
Allow. Shear Stress (ksi)	18.150	0.000



16362-1-23 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/40' Arms

Arm #2 Analysis Continued

Sec. Num.	Kz	Truck Induced Gust											Gallop Loads (lbs)
		Group 2			Group 3	Natural Wind Gust			Hght Corr. Factor = 1.00				
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	20.45	26.79	1.100	4.576	9.81	0	0.708	0.00	0.00	
2	1.00	0.450	9.54	20.00	26.21	1.100	4.576	9.59	0	0.729	0.00	0.00	
3	1.00	0.450	9.54	19.56	25.63	1.100	4.576	9.38	0	0.750	0.00	0.00	
4	1.00	0.450	9.54	19.11	25.04	1.100	4.576	9.17	0	0.773	0.00	0.00	
5	1.00	0.450	9.54	18.67	24.46	1.100	4.576	8.95	0	0.797	0.00	0.00	
6	1.00	0.450	9.54	18.22	23.88	1.100	4.576	8.74	0	0.822	0.00	0.00	
7	1.00	0.450	9.54	17.78	23.29	1.100	4.576	8.53	0	0.849	0.00	0.00	
8	1.00	0.453	9.60	17.44	22.71	1.100	4.576	8.31	0	0.878	0.00	0.00	
9	1.00	0.468	9.93	17.58	22.13	1.100	4.576	8.10	0	0.908	0.00	0.00	
10	1.00	0.485	10.28	17.72	21.54	1.100	4.576	7.89	0	0.940	0.00	0.00	
11	1.00	0.502	10.65	17.86	20.96	1.100	4.576	7.67	0	0.974	0.00	0.00	
12	1.00	0.521	11.05	18.01	20.38	1.100	4.576	7.46	0	1.011	0.00	0.00	
13	1.00	0.541	11.48	18.18	19.79	1.100	4.576	7.25	1	1.050	0.00	0.00	
14	1.00	0.563	11.93	18.33	19.21	1.100	4.576	7.03	1	1.091	0.00	0.00	
15	1.00	0.586	12.42	18.51	18.63	1.100	4.576	6.82	1	1.100	0.00	0.00	
16	1.00	0.610	12.94	18.68	18.04	1.100	4.576	6.60	1	1.100	0.00	0.00	
17	1.00	0.637	13.51	18.87	17.46	1.100	4.576	6.39	1	1.100	0.00	0.00	
18	1.00	0.666	14.12	19.06	16.88	1.100	4.576	6.18	1	1.100	0.00	0.00	
19	1.00	0.697	14.78	19.26	16.29	1.100	4.576	5.96	1	1.100	0.00	0.00	
20	1.00	0.731	15.49	19.47	15.71	1.100	4.576	5.75	1	1.100	0.00	0.00	
Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.199	25.43	762.90	381.45	1.199	4.990	149.70	0	1.199	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #5	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #8	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #9	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #10	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #11	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



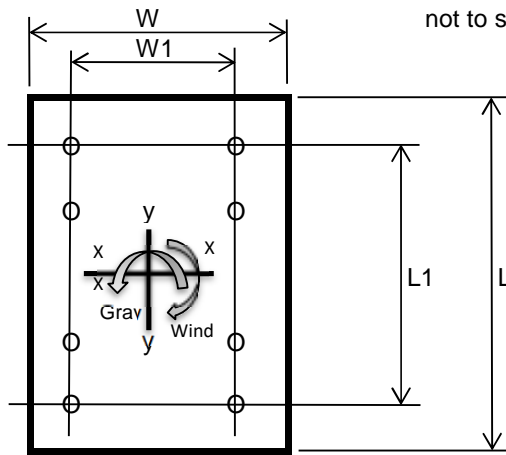
Flange Analysis - Arm #2

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	1199	2016	-	lbs
Shear (Wind)	2495	1495	-	lbs
Torsion (Arm Rise)	5231	3134	-	ft-lbs
Moment (Gravity)	23899	41305	-	ft-lbs
Moment (Wind)	51539	30058	-	ft-lbs
Nat. Wind Moment	-	-	11483	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	13.00	in
Tube Wall Thick.	0.1793	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	6.35	7.58	ksi
Bolt Shear Stress - fv	0.75	0.54	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.15	0.18	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	1.09	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.16	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	4.33	7.49	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	9.50	5.54	ksi
Combined applied stress for interaction (SRSS)	10.44	9.32	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



## 16362-1-23 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/40' Arms

## Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.00	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.368421	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.75	
Kf - Fatigue stress concentration factor for finite life	2.41	
Ki - Fatigue stress concentration factor for infinite life	5.32	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.25	in
Dt - Arm base diameter	17.50	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	1.82	
Dop - Baseplate center hole diameter	6	in
Cop - Center hole to arm diameter ratio	0.342857	
Kf - Fatigue stress concentration factor for finite life	1.76	
Ki - Fatigue stress concentration factor for infinite life	3.33	
Fatigue Allowable	7	ksi

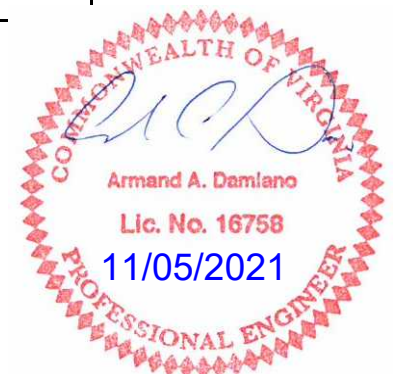
Note: Maximum diagonal distance between bolts used as bolt circle

**ARM 2 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.1793	in
Dt - Arm base diameter	13.00	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	2.447677	
Dop - Baseplate center hole diameter	6	in
Cop - Center hole to arm diameter ratio	0.461538	
Kf - Fatigue stress concentration factor for finite life	1.79	
Ki - Fatigue stress concentration factor for infinite life	3.16	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle



## 16362-1-23 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/40' Arms

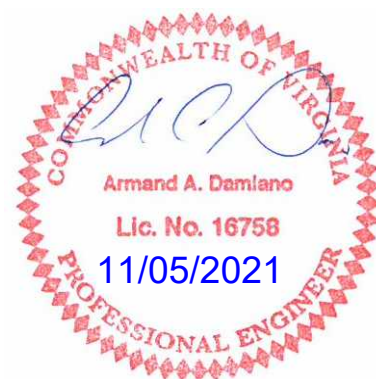
## Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	18.57	in
Shaft Thickness	0.313	in
Total Area	23.0768	in <sup>2</sup>
Ix	848	in <sup>4</sup>
Iy	944	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	25926	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	13.40	ksi
CSR	0.84	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	3.81	ksi
CSR	0.54	
Therefore	<b>OK</b>	



16362-1-23 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/40' Arms

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear	Shear	Bending	Torsion	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	2748		2748	85096		85097		406	17487		0.49
Gp II	2748	3869	4746	85096	137190	161439	14192	701	33175	1459	0.71
Gp III	4188	2515	4886	136462	86259	161439	9224	722	33175	948	0.70
Gp IV Natural		956	956		32774	32774	3507	142	6735	361	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	1710		1710	36287		36287		397	13839		0.41
Gp II	1710	2605	3116	36287	65080	74513	9554	723	28416	1822	0.64
Gp III	2742	1656	3204	60410	39979	72441	6073	744	27626	1158	0.62
Gp IV Natural		628	628		15186	15186	2305	146	5792	440	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	1199		1199	23899		23900		333	12397		0.35
Gp II	1199	2495	2769	23899	51539	56811	5231	768	29467	1357	0.64
Gp III	2016	1495	2510	41305	30058	51085	3134	696	26497	813	0.57
Gp IV Natural		572	572		11483	11483	1200	159	5957	312	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Lum#1 Base											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Lum#2 Base											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-23 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/40' Arms

**Summary - Continued**

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

**Shaft Base**

Gp I	5240		85096	23899	88389		286		12381		0.36
Gp II	5240	4553	86200	127293	153733	146548	286	497	21534	10264	0.66
Gp III	7939	3108	76329	166134	182829	91325	433	339	25610	6396	0.63
Gp IV Natural			23238	11496	25926				3632		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9959										

**Shaft At Arm**

Gp I	4028		85096	23899	88389		254		16541		0.47
Gp II	4028	3889	34108	88745	95074	146548	254	491	17792	13713	0.73
Gp III	6284	2540	47940	138658	146712	91325	396	321	27456	8545	0.72
Gp IV Natural			3513	1199	3712				695		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9959										





16362-1-23 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/40' Arms

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	4553 lbs
Bending Moment	182829 ft-lbs
Torsion Moment	146548 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.00 in

**ANALYSIS - ANCHOR BOLTS**

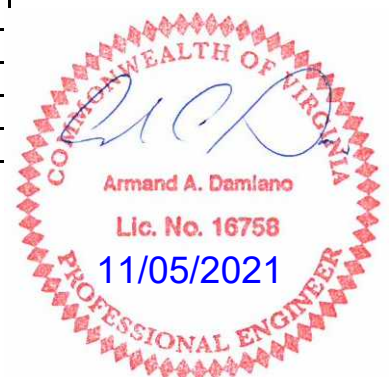
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	16.837 ksi
Bolt Direct Shear Stress	0.248 ksi
Bolt Torsion Shear Stress	7.352 ksi
Combined Bolt Stress	
$F_v = .3 F_y$ * Allowable Increase Factor	21.945 ksi
$F_t = .5 F_y$ * Allowable Increase Factor	36.575 ksi
$f_t =$	16.837 ksi
$f_v =$	7.6 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.58 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.5 in
Design Moment	148 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	22.36 ksi
Allowable Plate Stress = $.66 F_y$ * Allow. Incr.	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.938 in
Design Moment	82 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	13 ksi
Allowable Plate Stress = $.66 F_y$ * Allow. Incr.	31.6 ksi
Therefore	<b>OK</b>



16362-1-23 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/40' Arms

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	25926 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	2.39 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.35
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

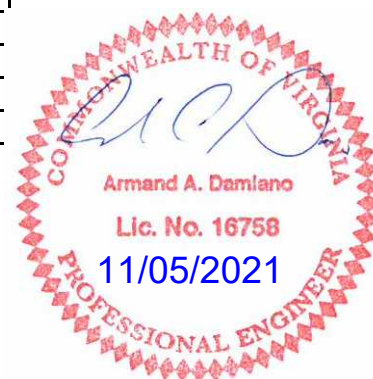
Anchor Bolt Length	60.0 in
Anchor Bolt Max. Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	42093 lbs
Computed Factor-of Safety	1.47 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	42093 lbs
Total Tensile Load	336744 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	1.4 <b>OK</b>

**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	42093 lbs
Total Tensile Load	336744 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	<b>8</b> Qty.



**MAST ARM POLE ANALYSIS TO AASHTO**

16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/30' Arms

11/04/21

**General**

Wind Vel. - mph	70	No	Roadway - mph	55	<b>Fatigue Importance Factors</b>	
Natural Wind	11.2		Plate Yield (ksi)	36	Cantilevered	Traffic
Truck Gust	65		Wind Import. Ir	0.870	Galloping	0.65
Fatigue Cat.	2		Vel. Conver. Cv	0.930	Vortex Shedding	0.00
Recurrence (yr)	25		Gust Effect G	1.300	Natural Wind Gust	0.80
Hurricane Region	0		Elev. Pole Bot.(ft)	1	Truck Gust	0.85
# Traffic Arms	2		<b>AASHTO Editon</b>	<b>6TH</b>	Wind Pressure - Appendix C	
# Lum. Arms	0		State	VA		

[Basic Shapes: 0=Round, 8=8 Sided, 12=12 Sided, 16=16 Sided]

[Fluted Shapes: 16F=16 Flat, 16S=16 Sharp, 8F=8 Flat, 8S=8 Sharp]

**Pole Variables**

	Wall (in)	Taper (in/ft)	Dia. (in)	Length (ft)	Attach. (ft)	Overlap (ft)	Arm Rise (ft)	Member Shape	Member Fy (ksi)	Young's E (ksi)	Orientation (deg)
Shaft	0.3125	0.14	19.00	19.50	-	-	-	0	55	29000	-
Traffic Arm #1	0.2500	0.14	17.50	25.00	18.00	-	3.67	0	55	29000	180
	0.1880	0.14	14.79	47.92	-	2.93		0	55	29000	
Traffic Arm #2	0.1793	0.14	13.00	30.00	18.00	-	1.57	0	55	29000	270
					-			0	55	29000	
Lum Arm #1								0	36	29000	180
Lum Arm #2								0	36	29000	90

**Anchor Bolt, Baseplate & Foundation**

Anchor Bolt Qty.	8	Anchor Bolt Length	60	in
Anchor Bolt Dia.	2.00	in	Double Top Nuts	Yes
A.B. Bolt Circle	26.00	in	Foundation Diameter	48
Baseplate Dia.	32.00	in	Concrete Cover	4
Baseplate Thk.	2.00	in	f'c = 28 Day Concrete Comp. Strength	3000
B.P. Center Hole	14.25	in	Vertical Reinforcing Bar Size #	8
Weld Type	Full Pen.		Rebar Yield Strength fy	60
				ksi

**Flange Simplex**

	Arm #1		Arm #2	
Flange Bolt Qty.	8		8	
Bolt Diameter	1.50	in	1.50	in
Flange Plate Length (V)	27.00	in	27.00	in
Flange Plate Width (H)	27.00	in	27.00	in
Spac. Between Bolt (V)	22.50	in	22.50	in
Spac. Between Bolt (H)	22.50	in	22.50	in
Flange Plate Thk.	2.25	in	2.25	in
Flange Plate Yield (Fy)	50	ksi	50	ksi
Gusset Thk.	0.500	in	0.500	in
Plate Center Hole	6.00	in	6.00	in
Weld Type	Full Pen.		Full Pen.	

**Hand Hole**

Handhole Width	6.00	in
Handhole Height	24.50	in
Height To C.L.	37	in
Radial Orientation	0	Deg.
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in

**Results**

	Shaft At		Arm#1		Arm#2		Lum#1	Lum#2	Tip Deflection (in)	
	Base	Flange	Root	Joint	Root	Joint	Root	Root	Arm #1	Arm #2
GP I CSR	0.35	0.46	0.49	0.41	0.23				29.75	2.54
GP II CSR	0.62	0.69	0.71	0.64	0.42					
GP III CSR	0.59	0.69	0.70	0.62	0.37				48.74	4.47
Nat.Wind (psi)	3529	673	6735	5793	3987					

Arm #1 Flange Bolt (Max.) CSR	0.56
Arm #1 Flange Bolt Fatigue CSR	0.45
Arm #1 Flange Plate (Max.) CSR	0.60
Arm #2 Flange Bolt (Max.) CSR	0.12
Arm #2 Flange Bolt Fatigue CSR	0.11
Arm #2 Flange Plate (Max.) CSR	0.16
Handhole at Root (Fatigue) CSR	0.81
Handhole at Toe (Fatigue) CSR	0.53
Minimum Qty of Vertical Reinf. Bars	7

Fatigue Allowable - Shaft to Baseplate	4.5 ksi
Fatigue Allowable - Arm#1 to Flange	7 ksi
Fatigue Allowable - Arm#2 to Flange	7 ksi
Anchor Bolt Max. CSR	0.56
Anchor Bolt Max. Fatigue Stress Ratio	0.34
Base Plate Max. CSR	0.67
Anchorage Capacity S.F.	1.55
Concrete Pull Out Capacity S.F.	1.47

**Ground Line Reactions**

Axial (lbs)	Shear (lbs)	Bending (ft-lbs)	Torsion (ft-lbs)
7575	4553	173846	141396



16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/30' Arms

Input Loads

Fixture Input Data

Member	Fixture	Load Type	Location (ft)	Front Area (sq.ft.)	Side Area (sq.ft)	Sign Width (ft)	Sign Length (ft)	Bottom Area (sq.ft.)	Ice Area (sq.ft.)	Weight (lbs)	Cd
For Shaft	#1	Ped Head	10.5	2.4	1			1	6	30	1.20
	#2	Ped Head	10.5	2.4	1			1	6	30	1.20
	#3	5 Section Head w/BP	15	13.75	4			2	42	105	1.20
	#4										
Lum #1	#1										
Lum #2	#1										
For Arm #1	#1	Camera	4	1	1			1	3	22	1.20
	#2	15'x2.5' Sign	12			15	2.5	1	37.5	88.5	1.21
	#3	5 Section Head w/BP	25	13.75	4			2	42	105	1.20
	#4	2.5'x3' Sign	29			2.5	3	1	7.5	22.5	1.13
	#5	3 Section Head w/BP	36	8.7	4			1	26	65	1.20
	#6	Camera	40	1	1			1	3	22	1.20
	#7	2.5'x3' Sign	44			2.5	3	1	7.5	22.5	1.13
	#8	3 Section Head w/BP	47	8.7	4			1	26	65	1.20
	#9	2.5'x3' Sign	55			2.5	3	1	7.5	22.5	1.13
	#10	3 Section Head w/BP	58	8.7	4			1	26	65	1.20
	#11	Camera	62	1	1			1	3	22	1.20
	#12	3'x3.5' Sign	66			3	3.5	1	10.5	26.7	1.13
	#13	4 Section Head w/BP	69	11	5			1	34	80	1.20
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										
For Arm #2	#1	Camera	4	1	1			1	3	22	1.20
	#2	12'x2.5' Sign	7			12	2.5	1	30	66	1.20
	#3	Camera	10	1	1			1	3	22	1.20
	#4	2.5'x3' Sign	15			2.5	3	1	7.5	22.5	1.13
	#5	5 Section Head w/BP	19	13.75	4			2	42	105	1.20
	#6	Camera	21	1	1			1	3	22	1.20
	#7	3'x3.5' Sign	26			3	3.5	1	10.5	26.7	1.13
	#8	4 Section Head w/BP	29	11	5			1	34	80	1.20
	#9										
	#10										
	#11										
	#12										
	#13										
	#14										
	#15										
	#16										
	#17										
	#18										
	#19										
	#20										



16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/30' Arms

Shaft Analysis

Sect. Num.	Mem Type	Sect. Lgth (ft)	Cumm. Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Cent. Loc. (ft)	Mom. Arm (ft)	Projected Area Vert (sq.ft.)	Ice Wght (lbs)	Kz
1	I	1.06	0.00	19.000	18.852	65.84	0.5287	0.53	1.670	16.24	0.80
2	I	1.06	1.06	18.852	18.704	65.31	0.5287	1.59	1.657	16.11	0.80
3	I	1.06	2.12	18.704	18.555	64.79	0.5287	2.65	1.644	15.99	0.80
4	I	1.06	3.18	18.555	18.407	64.27	0.5287	3.71	1.631	15.87	0.80
5	I	1.06	4.24	18.407	18.259	63.74	0.5287	4.76	1.618	15.74	0.80
6	I	1.06	5.29	18.259	18.111	63.22	0.5287	5.82	1.605	15.62	0.80
7	I	1.06	6.35	18.111	17.962	62.69	0.5287	6.88	1.591	15.50	0.80
8	I	1.06	7.41	17.962	17.814	62.17	0.5287	7.94	1.578	15.37	0.80
9	I	1.06	8.47	17.814	17.666	61.64	0.5287	9.00	1.565	15.25	0.80
10	I	1.06	9.53	17.666	17.518	61.12	0.5287	10.06	1.552	15.13	0.80
11	I	1.06	10.59	17.518	17.369	60.59	0.5287	11.12	1.539	15.00	0.80
12	I	1.06	11.65	17.369	17.221	60.07	0.5287	12.18	1.526	14.88	0.80
13	I	1.06	12.71	17.221	17.073	59.55	0.5286	13.23	1.513	14.76	1.00
14	I	1.06	13.76	17.073	16.925	59.02	0.5286	14.29	1.500	14.63	1.00
15	I	1.06	14.82	16.925	16.776	58.50	0.5286	15.35	1.487	14.51	1.00
16	I	1.06	15.88	16.776	16.628	57.97	0.5286	16.41	1.474	14.39	1.00
17	I	1.06	16.94	16.628	16.480	57.45	0.5286	17.47	1.461	14.27	1.00
18	J	0.50	18.00	16.480	16.410	26.95	0.2498	18.25	0.685	6.69	1.00
19	I	0.50	18.50	16.410	16.340	26.83	0.2498	18.75	0.682	6.67	1.00
20	I	0.50	19.00	16.340	16.270	26.71	0.2498	19.25	0.679	6.64	1.00
						1129					

Fix. #1	30	10.50	2.40	18.00	0.80
Fix. #2	30	10.50	2.40	18.00	0.80
Fix. #3	105	15.00	13.75	126.00	1.00
Fix. #4	0	0.00	0.00	0.00	0.80

Shaft Section Values	At Shaft Base	18.00 Lower Arm	18.00 Upper Arm	Shaft Top
Moment of Inertia (in <sup>4</sup> )	800.47	518.34	518.34	498.41
Section Modulus (in <sup>3</sup> )	85.67	64.12	64.12	
Cross-Section Area (in <sup>2</sup> )	18.34	15.86	15.86	
Width-Thickness Ratio	60.80	52.74	52.74	
Compact Limit	68.55	68.55	68.55	
Non-Compact Limit	137.09	137.09	137.09	
Maximum Limit	237.27	237.27	237.27	
Allow. Bending Stress (ksi)	36.300	36.300	36.300	
Allow. Compressive Str (ksi)	19.983	19.983	19.983	
Allow. Shear Stress (ksi)	18.150	18.150	18.150	

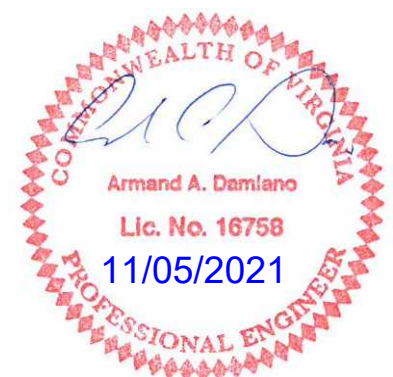
Shaft Deflection From Arm#1 GP I Load (in)	1.186
Shaft Deflection From Arm#2 GP I Load (in)	0.212



16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/30' Arms

## Shaft Analysis Continued

Sect. Num.	Group 2 Analysis				Group 3	Natural Wind		
	Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Tip Deflect (in)	Wind Load (lbs)	Drag Coeff	Press. (psf)	Load (lbs)
1	0.450	7.64	12.76	0.000	20.87	1.100	4.576	7.64
2	0.450	7.64	12.66	0.000	20.71	1.100	4.576	7.58
3	0.450	7.64	12.56	0.000	20.55	1.100	4.576	7.52
4	0.450	7.64	12.46	0.000	20.38	1.100	4.576	7.46
5	0.450	7.64	12.36	0.000	20.22	1.100	4.576	7.40
6	0.450	7.64	12.26	0.000	20.06	1.100	4.576	7.34
7	0.450	7.64	12.16	0.000	19.89	1.100	4.576	7.28
8	0.450	7.64	12.06	0.001	19.73	1.100	4.576	7.22
9	0.450	7.64	11.96	0.001	19.57	1.100	4.576	7.16
10	0.450	7.64	11.86	0.001	19.40	1.100	4.576	7.10
11	0.450	7.64	11.76	0.001	19.24	1.100	4.576	7.04
12	0.450	7.64	11.66	0.001	19.08	1.100	4.576	6.98
13	0.450	9.54	14.43	0.002	18.91	1.100	4.576	6.92
14	0.450	9.54	14.31	0.002	18.75	1.100	4.576	6.86
15	0.450	9.54	14.18	0.002	18.59	1.100	4.576	6.80
16	0.450	9.54	14.06	0.002	18.42	1.100	4.576	6.74
17	0.450	9.54	13.93	0.002	18.26	1.100	4.576	6.68
18	0.450	9.54	6.54	0.001	8.57	1.100	4.576	3.14
19	0.450	9.54	6.51	0.001	8.53	1.100	4.576	3.12
20	0.450	9.54	6.48	0.001	8.49	1.100	4.576	3.11
Fix. #1	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #2	1.200	20.36	48.86	0.003	30.00	1.200	4.992	11.98
Fix. #3	1.200	25.44	349.80	0.047	174.90	1.200	4.992	68.64
Fix. #4	0.000	0.00	0.00	0.000	0.00	0.000	0.000	0.00





16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/30' Arms

Arm #1 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	3.68	0.00	17.500	16.985	167.0	1.8300	1.83	5.285	5.285	51.55
2	I	3.68	3.68	16.985	16.470	162.0	1.8297	5.51	5.127	5.127	50.06
3	I	3.68	7.36	16.470	15.955	156.9	1.8294	9.19	4.970	4.970	48.57
4	I	3.68	11.04	15.955	15.440	151.9	1.8291	12.86	4.812	4.812	47.08
5	I	3.68	14.71	15.440	14.925	146.8	1.8288	16.54	4.654	4.654	45.59
6	I	3.68	18.39	14.925	14.410	141.7	1.8284	20.22	4.496	4.496	44.11
7	J	2.93	22.07	14.790	14.380	194.1	1.4581	23.53	3.561	3.561	34.94
8	O	3.46	25.00	14.380	13.895	97.0	1.7205	26.72	4.077	4.077	40.06
9	O	3.46	28.46	13.895	13.411	93.7	1.7202	30.18	3.938	3.938	38.74
10	O	3.46	31.92	13.411	12.926	90.3	1.7198	33.64	3.798	3.798	37.42
11	O	3.46	35.38	12.926	12.442	86.9	1.7194	37.10	3.658	3.658	36.11
12	O	3.46	38.84	12.442	11.957	83.5	1.7189	40.56	3.518	3.518	34.79
13	O	3.46	42.30	11.957	11.473	80.2	1.7185	44.02	3.379	3.379	33.47
14	O	3.46	45.76	11.473	10.988	76.8	1.7179	47.48	3.239	3.239	32.16
15	O	3.46	49.23	10.988	10.504	73.4	1.7174	50.94	3.099	3.099	30.84
16	O	3.46	52.69	10.504	10.019	70.1	1.7168	54.40	2.959	2.959	29.52
17	O	3.46	56.15	10.019	9.535	66.7	1.7161	57.86	2.820	2.820	28.21
18	O	3.46	59.61	9.535	9.050	63.3	1.7153	61.32	2.680	2.680	26.89
19	O	3.46	63.07	9.050	8.566	60.0	1.7145	64.78	2.540	2.540	25.57
20	O	3.46	66.53	8.566	8.081	56.6	1.7136	68.24	2.400	2.400	24.25
		<u>69.99</u>				<u>2119</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	88.5	12.00	37.500	1.000	112.50
Fix. #3	105	25.00	13.750	2.000	126.00
Fix. #4	22.5	29.00	7.500	1.000	22.50
Fix. #5	65	36.00	8.700	1.000	78.00
Fix. #6	22	40.00	1.000	1.000	9.00
Fix. #7	22.5	44.00	7.500	1.000	22.50
Fix. #8	65	47.00	8.700	1.000	78.00
Fix. #9	22.5	55.00	7.500	1.000	22.50
Fix. #10	65	58.00	8.700	1.000	78.00
Fix. #11	22	62.00	1.000	1.000	9.00
Fix. #12	26.7	66.00	10.500	1.000	31.50
Fix. #13	80	69.00	11.000	1.000	102.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#1 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	58.397	31.467
Cross-Section Area (in^2)	13.541	8.620
Width-Thickness Ratio	70.00	78.67
Compact Limit	68.55	68.55
Non-Compact Limit	137.09	137.09
Maximum Limit	237.27	237.27
Allow. Bending Stress (ksi)	35.991	34.389
Allow. Shear Stress (ksi)	18.150	17.040





16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/30' Arms

Arm #1 Analysis Continued

Sec. Num.	Kz	Group 2			Group 3	Natural Wind Gust			Truck Induced Gust				Gallop Loads (lbs)
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Hght Corr. Factor = 1.000 Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	50.42	66.07	1.100	4.576	24.19	0	0.484	0.00	0.00	
2	1.00	0.450	9.54	48.92	64.09	1.100	4.576	23.46	0	0.503	0.00	0.00	
3	1.00	0.450	9.54	47.41	62.12	1.100	4.576	22.74	0	0.524	0.00	0.00	
4	1.00	0.450	9.54	45.90	60.15	1.100	4.576	22.02	0	0.546	0.00	0.00	
5	1.00	0.450	9.54	44.40	58.17	1.100	4.576	21.30	0	0.571	0.00	0.00	
6	1.00	0.450	9.54	42.89	56.20	1.100	4.576	20.57	0	0.597	0.00	0.00	
7	1.00	0.450	9.54	33.97	44.51	1.100	4.576	16.30	0	0.601	0.00	0.00	
8	1.00	0.450	9.54	38.90	50.97	1.100	4.576	18.66	0	0.626	0.00	0.00	
9	1.00	0.450	9.54	37.56	49.22	1.100	4.576	18.02	0	0.655	0.00	0.00	
10	1.00	0.450	9.54	36.23	47.47	1.100	4.576	17.38	0	0.686	0.00	0.00	
11	1.00	0.450	9.54	34.90	45.73	1.100	4.576	16.74	0	0.721	0.00	0.00	
12	1.00	0.450	9.54	33.56	43.98	1.100	4.576	16.10	0	0.758	0.00	0.00	
13	1.00	0.450	9.54	32.23	42.23	1.100	4.576	15.46	0	0.799	0.00	0.00	
14	1.00	0.450	9.54	30.90	40.49	1.100	4.576	14.82	0	0.844	0.00	0.00	
15	1.00	0.461	9.78	30.31	38.74	1.100	4.576	14.18	0	0.894	0.00	0.00	
16	1.00	0.489	10.38	30.72	36.99	1.100	4.576	13.54	0	0.949	0.00	0.00	
17	1.00	0.521	11.06	31.19	35.25	1.100	4.576	12.90	1	1.011	0.00	0.00	
18	1.00	0.557	11.81	31.65	33.50	1.100	4.576	12.26	1	1.080	0.00	0.00	
19	1.00	0.597	12.66	32.16	31.75	1.100	4.576	11.62	1	1.100	0.00	0.00	
20	1.00	0.643	13.63	32.72	30.01	1.100	4.576	10.98	1	1.100	0.00	0.00	

Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.206	25.57	958.88	479.44	1.206	5.017	188.14	0	1.206	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	0	1.134	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	0	1.200	0.00	0.00	0.00
Fix. #9	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #10	1.00	1.200	25.44	221.33	110.66	1.200	4.992	43.43	1	1.200	0.00	0.00	0.00
Fix. #11	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #12	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #13	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



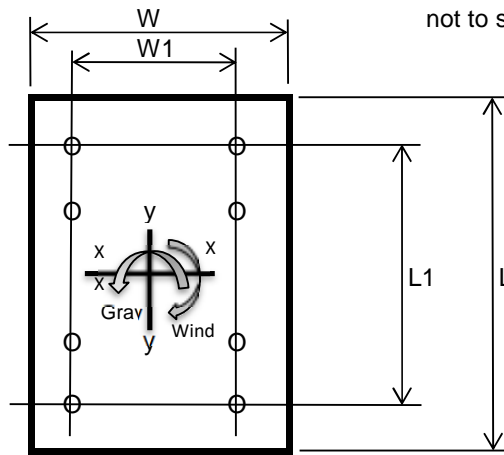
Flange Analysis - Arm #1

Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	2748	4188	-	lbs
Shear (Wind)	3869	2515	-	lbs
Torsion (Arm Rise)	14190	9223	-	ft-lbs
Moment (Gravity)	85085	136444	-	ft-lbs
Moment (Wind)	137184	86250	-	ft-lbs
Nat. Wind Moment	-	-	32771	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	17.50	in
Tube Wall Thick.	0.25	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	19.42	24.58	ksi
Bolt Shear Stress - fv	1.79	1.34	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.45	0.56	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	3.1	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.45	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	13.77	22.08	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	22.58	14.20	ksi
Combined applied stress for interaction (SRSS)	26.45	26.25	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/30' Arms

Arm #2 Analysis

Sec. Num.	Mem Type	Sect. Lgth (ft)	Cumm Lgth (ft)	Bottom Dia. (in)	Top Dia. (in)	Wght (lbs)	Centroid Loc. (ft)	Mom. Arm (ft)	Projected Area		Ice Wght (lbs)
									In Elev (sq.ft.)	In Plan (sq.ft.)	
1	I	1.50	0.00	13.000	12.790	36.6	0.7480	0.75	1.612	1.612	15.90
2	I	1.50	1.50	12.790	12.580	36.0	0.7479	2.25	1.586	1.586	15.65
3	I	1.50	3.00	12.580	12.370	35.4	0.7479	3.75	1.559	1.559	15.40
4	I	1.50	4.50	12.370	12.160	34.7	0.7479	5.25	1.533	1.533	15.16
5	I	1.50	6.00	12.160	11.950	34.1	0.7478	6.75	1.507	1.507	14.91
6	I	1.50	7.50	11.950	11.740	33.5	0.7478	8.25	1.481	1.481	14.66
7	I	1.50	9.00	11.740	11.530	32.9	0.7477	9.75	1.454	1.454	14.41
8	I	1.50	10.50	11.530	11.320	32.3	0.7477	11.25	1.428	1.428	14.17
9	I	1.50	12.00	11.320	11.110	31.7	0.7477	12.75	1.402	1.402	13.92
10	I	1.50	13.50	11.110	10.900	31.1	0.7476	14.25	1.376	1.376	13.67
11	I	1.50	15.00	10.900	10.690	30.5	0.7476	15.75	1.349	1.349	13.42
12	I	1.50	16.50	10.690	10.480	29.9	0.7475	17.25	1.323	1.323	13.18
13	I	1.50	18.00	10.480	10.270	29.3	0.7475	18.75	1.297	1.297	12.93
14	I	1.50	19.50	10.270	10.060	28.7	0.7474	20.25	1.271	1.271	12.68
15	I	1.50	21.00	10.060	9.850	28.1	0.7474	21.75	1.244	1.244	12.43
16	I	1.50	22.50	9.850	9.640	27.5	0.7473	23.25	1.218	1.218	12.19
17	I	1.50	24.00	9.640	9.430	26.9	0.7472	24.75	1.192	1.192	11.94
18	I	1.50	25.50	9.430	9.220	26.3	0.7472	26.25	1.166	1.166	11.69
19	I	1.50	27.00	9.220	9.010	25.7	0.7471	27.75	1.139	1.139	11.45
20	I	1.50	28.50	9.010	8.800	25.1	0.7471	29.25	1.113	1.113	11.20
		<u>30.00</u>				<u>616</u>					

Fix. #1	22	4.00	1.000	1.000	9.00
Fix. #2	66	7.00	30.000	1.000	90.00
Fix. #3	22	10.00	1.000	1.000	9.00
Fix. #4	22.5	15.00	7.500	1.000	22.50
Fix. #5	105	19.00	13.750	2.000	126.00
Fix. #6	22	21.00	1.000	1.000	9.00
Fix. #7	26.7	26.00	10.500	1.000	31.50
Fix. #8	80	29.00	11.000	1.000	102.00
Fix. #9	0	0.00	0.000	0.000	0.00
Fix. #10	0	0.00	0.000	0.000	0.00
Fix. #11	0	0.00	0.000	0.000	0.00
Fix. #12	0	0.00	0.000	0.000	0.00
Fix. #13	0	0.00	0.000	0.000	0.00
Fix. #14	0	0.00	0.000	0.000	0.00
Fix. #15	0	0.00	0.000	0.000	0.00
Fix. #16	0	0.00	0.000	0.000	0.00
Fix. #17	0	0.00	0.000	0.000	0.00
Fix. #18	0	0.00	0.000	0.000	0.00
Fix. #19	0	0.00	0.000	0.000	0.00
Fix. #20	0	0.00	0.000	0.000	0.00

Arm#2 Section Values		
Property	Inboard	Outboard
Section Modulus (in^3)	23.135	0.000
Cross-Section Area (in^2)	7.218	0.000
Width-Thickness Ratio	72.50	0.00
Compact Limit	68.55	0.00
Non-Compact Limit	137.09	0.00
Maximum Limit	237.27	0.00
Allow. Bending Stress (ksi)	35.489	0.000
Allow. Shear Stress (ksi)	18.150	0.000



16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/30' Arms

Arm #2 Analysis Continued

Sec. Num.	Kz	Truck Induced Gust											Gallop Loads (lbs)
		Group 2			Group 3	Natural Wind Gust			Hght Corr. Factor = 1.00				
		Drag Coeff	Vel. Press. (psf)	Wind Load (lbs)	Wind Load (lbs)	Drag Coeff.	Press. (psf)	Load (lbs)	Used 1=Yes 0=No	Drag Coeff	Press. (psf)	Load (lbs)	
1	1.00	0.450	9.54	15.38	20.15	1.100	4.576	7.38	0	0.705	0.00	0.00	
2	1.00	0.450	9.54	15.13	19.82	1.100	4.576	7.26	0	0.721	0.00	0.00	
3	1.00	0.450	9.54	14.88	19.49	1.100	4.576	7.14	0	0.737	0.00	0.00	
4	1.00	0.450	9.54	14.63	19.16	1.100	4.576	7.02	0	0.753	0.00	0.00	
5	1.00	0.450	9.54	14.38	18.84	1.100	4.576	6.90	0	0.770	0.00	0.00	
6	1.00	0.450	9.54	14.13	18.51	1.100	4.576	6.78	0	0.788	0.00	0.00	
7	1.00	0.450	9.54	13.87	18.18	1.100	4.576	6.66	0	0.806	0.00	0.00	
8	1.00	0.450	9.54	13.62	17.85	1.100	4.576	6.54	0	0.826	0.00	0.00	
9	1.00	0.450	9.54	13.37	17.52	1.100	4.576	6.41	0	0.846	0.00	0.00	
10	1.00	0.450	9.54	13.12	17.20	1.100	4.576	6.29	0	0.867	0.00	0.00	
11	1.00	0.458	9.72	13.12	16.87	1.100	4.576	6.17	1	0.889	0.00	0.00	
12	1.00	0.470	9.97	13.19	16.54	1.100	4.576	6.05	1	0.912	0.00	0.00	
13	1.00	0.483	10.23	13.27	16.21	1.100	4.576	5.93	1	0.936	0.00	0.00	
14	1.00	0.496	10.51	13.35	15.88	1.100	4.576	5.81	1	0.961	0.00	0.00	
15	1.00	0.509	10.80	13.44	15.55	1.100	4.576	5.69	1	0.988	0.00	0.00	
16	1.00	0.523	11.10	13.52	15.23	1.100	4.576	5.57	1	1.015	0.00	0.00	
17	1.00	0.539	11.42	13.61	14.90	1.100	4.576	5.45	1	1.045	0.00	0.00	
18	1.00	0.554	11.76	13.71	14.57	1.100	4.576	5.33	1	1.075	0.00	0.00	
19	1.00	0.571	12.11	13.80	14.24	1.100	4.576	5.21	1	1.100	0.00	0.00	
20	1.00	0.589	12.48	13.89	13.91	1.100	4.576	5.09	1	1.100	0.00	0.00	
Fix. #1	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #2	1.00	1.199	25.43	762.90	381.45	1.199	4.990	149.70	0	1.199	0.00	0.00	0.00
Fix. #3	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	0	1.200	0.00	0.00	0.00
Fix. #4	1.00	1.134	24.05	180.38	93.75	1.134	4.718	35.39	1	1.134	0.00	0.00	0.00
Fix. #5	1.00	1.200	25.44	349.80	174.90	1.200	4.992	68.64	1	1.200	0.00	0.00	0.00
Fix. #6	1.00	1.200	25.44	25.44	12.72	1.200	4.992	4.99	1	1.200	0.00	0.00	0.00
Fix. #7	1.00	1.132	24.00	252.00	131.25	1.132	4.708	49.43	1	1.132	0.00	0.00	0.00
Fix. #8	1.00	1.200	25.44	279.84	139.92	1.200	4.992	54.91	1	1.200	0.00	0.00	0.00
Fix. #9	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #10	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #11	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #12	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #13	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #14	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #15	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #16	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #17	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #18	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #19	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00
Fix. #20	1.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00	0	0.000	0.00	0.00	0.00



16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/30' Arms  
Flange Analysis - Arm #2

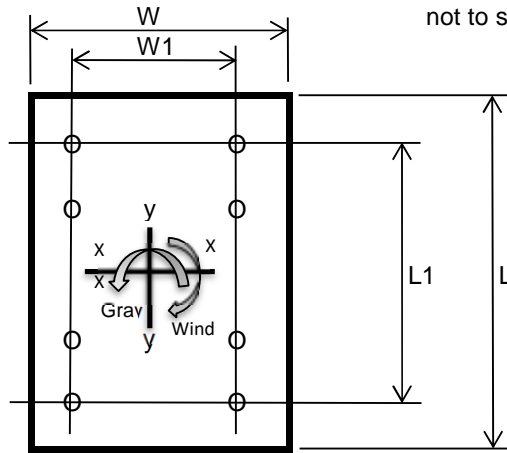
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Applied Loads	Gp II	GpIII	GpIV	
Shear (Gravity)	983	1653	-	lbs
Shear (Wind)	2179	1300	-	lbs
Torsion (Arm Rise)	3425	2044	-	ft-lbs
Moment (Gravity)	15222	26492	-	ft-lbs
Moment (Wind)	34333	20096	-	ft-lbs
Nat. Wind Moment	-	-	7686	ft-lbs
Galloping Moment	-	-	-	ft-lbs
Truck Gust Mom.	-	-	-	ft-lbs

General Inputs		
Diameter of tube	13.00	in
Tube Wall Thick.	0.1793	in
A325 Bolt Dia.	1.50	in
Plate Yield (Fy)	50	ksi
Number of Bolts	8	
GpII & GpIII Allow. Increase	1.33	
Tube-To-Plate Fit Check	OK	

Note: Sketch not to scale

ITEM	PLATE DIM. (in)
Thk.(t)	2.25
W	27
W1	22.50
L	27
L1	22.50
L2 - Dist. between bolts (Typ.)	7.50



Worst Bolt Load (Corner Bolt P1)	Results	Results	
	GpII	GpIII	
Bolt Tensile Stress Area	1.41	1.41	in <sup>2</sup>
Bolt Shear Stress Area	1.29	1.29	in <sup>2</sup>
Mom. Inertia Bolt Grouping About X (Gravity Mom.)	794.39	794.39	in <sup>4</sup>
Mom. Inertia Bolt Grouping About Y (Wind Mom.)	1428.89	1428.89	in <sup>4</sup>
Bolt Tensile Stress - ft	4.15	4.89	ksi
Bolt Shear Stress - fv	0.55	0.4	ksi
Combined Bolt Stress			
Allowable Tensile Stress = Ft =	44.22	44.22	ksi
Allowable Shear Stress = Fv =	22.11	22.11	ksi
$[(fv/Fv)^2 + (ft/Ft)^2]^{.5} \leq 1$	0.1	0.12	CSR
Therefore	<b>OK</b>	<b>OK</b>	
Natural Wind Bolt Tensile Stress	0.73	ksi	
Galloping Bolt Tensile Stress	0	ksi	
Truck Gust Bolt Tensile Stress	0	ksi	
Allowable Fatigue Stress	7	ksi	
Max. Stress Ratio	0.11	<b>OK</b>	

Plate Analysis			
Stress from gravity loads = $2P \cdot e / (W \cdot t^2 / 6)$	2.76	4.80	ksi
Stress from wind loads = $4P \cdot e / (L \cdot t^2 / 6)$	6.33	3.71	ksi
Combined applied stress for interaction (SRSS)	6.91	6.07	ksi
Allow. Plate Stress = $0.66 \cdot Fy \cdot \text{Group Load Incr.}$	43.89	43.89	ksi
Since Allow Stress > Applied Stress Therefore	<b>OK</b>	<b>OK</b>	



## 16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/30' Arms

## Fatigue Allowable - Shaft to Baseplate Weld &amp; Arms to Simplex Plate Weld

**SHAFT TO BASEPLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of shaft	0.3125	in
Dt - Shaft base diameter	19.00	in
Ttp - Thickness of baseplate	2.00	in
Dbc - Bolt circle diameter	26.00	in
Cbc - Bolt circle ratio	1.368421	
Dop - Baseplate center hole diameter	14.25	in
Cop - Center hole to shaft diameter ratio	0.75	
Kf - Fatigue stress concentration factor for finite life	2.41	
Ki - Fatigue stress concentration factor for infinite life	5.32	
Fatigue Allowable	4.5	ksi

**ARM 1 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.25	in
Dt - Arm base diameter	17.50	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	1.82	
Dop - Baseplate center hole diameter	6	in
Cop - Center hole to arm diameter ratio	0.342857	
Kf - Fatigue stress concentration factor for finite life	1.76	
Ki - Fatigue stress concentration factor for infinite life	3.33	
Fatigue Allowable	7	ksi

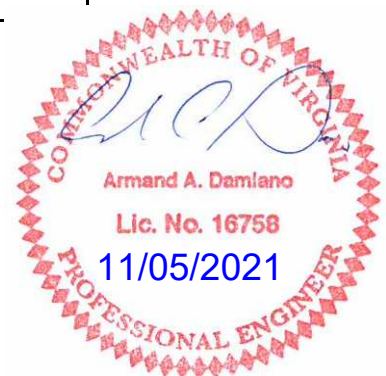
Note: Maximum diagonal distance between bolts used as bolt circle

**ARM 2 TO SIMPLEX PLATE**

Full Penetration groove welded tube-to-transverse-plate connection

Tt - Thickness of arm inboard	0.1793	in
Dt - Arm base diameter	13.00	in
Ttp - Thickness of baseplate	2.25	in
Dbc - Bolt circle diameter	31.82	in
Cbc - Bolt circle ratio	2.447677	
Dop - Baseplate center hole diameter	6	in
Cop - Center hole to arm diameter ratio	0.461538	
Kf - Fatigue stress concentration factor for finite life	1.79	
Ki - Fatigue stress concentration factor for infinite life	3.16	
Fatigue Allowable	7	ksi

Note: Maximum diagonal distance between bolts used as bolt circle



## 16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/30' Arms

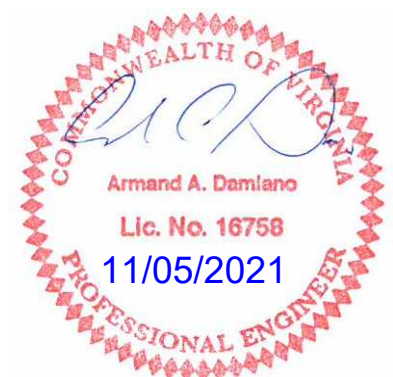
## Hand Hole Stresses

**INPUTS**

Handhole Width	6.00	in
Handhole Height	24.50	in
Distance From Base Plate To Hand Hole Center Line	37	in
Radial Orientation	0	Degrees
Rim Thickness	0.75	in
Rim Depth	5.00	in
Rim Projection	1.00	in
Shaft Diameter (At hand hole location)	18.57	in
Shaft Thickness	0.313	in
Total Area	23.0768	in <sup>2</sup>
Ix	848	in <sup>4</sup>
Iy	944	in <sup>4</sup>
Controlling Moment - Natural Wind Gust	25196	ft-lbs

**CHECK**

Allowable - Stress at Root	16.0	ksi
Actual Stress at Root	13.02	ksi
CSR	0.81	
Allowable - Stress at Toe	7.0	ksi
Actual Stress at Toe	3.70	ksi
CSR	0.53	
Therefore	<b>OK</b>	





16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70'/30' Arms

Summary

Location	LOADS							STRESSES			CSR
	Direct Shear			Bending Moments			Torsional Shear (ft-lbs)	Shear (psi)	Bending (psi)	Torsion (psi)	
	Vert Shr (lbs)	Horz Shr (lbs)	Resultant Shr (lbs)	Grav Mom (ft-lbs)	Wind Mom (ft-lbs)	Resultant Mom (ft-lbs)					

Arm#1 Base											
Gp I	2748		2748	85085		85086		406	17485		0.49
Gp II	2748	3869	4746	85085	137184	161428	14190	701	33173	1458	0.71
Gp III	4188	2515	4885	136444	86250	161419	9223	722	33171	948	0.70
Gp IV Natural		956	956		32771	32771	3506	142	6735	361	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#1 Joint											
Gp I	1711		1711	36293		36293		397	13841		0.41
Gp II	1711	2605	3117	36293	65102	74535	9553	724	28425	1822	0.64
Gp III	2743	1656	3204	60422	39990	72457	6072	744	27632	1158	0.62
Gp IV Natural		628	628		15191	15191	2305	146	5793	440	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Base											
Gp I	983		983	15222		15222		273	7896		0.23
Gp II	983	2179	2390	15222	34333	37556	3425	663	19480	889	0.42
Gp III	1653	1300	2103	26492	20096	33253	2044	583	17248	531	0.37
Gp IV Natural		498	498		7686	7686	783	138	3987	204	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Arm#2 Joint											
Gp I	0		0	0		0		0	0		0.00
Gp II	0	0	0	0	0	0	0	0	0	0	0.00
Gp III	0	0	0	0	0	0	0	0	0	0	0.00
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Lum#1 Base											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-

Lum#2 Base											
Gp I	0		0	0		0		0	0		0
Gp II	0	0	0	0	0	0	0	0	0	0	0
Gp III	0	0	0	0	0	0	0	0	0	0	0
Gp IV Natural		0	0		0	0	0	0	0	0	-
Gp IV Truck	0		0	0		0		0	0		-
Gp IV Gallop	0		0	0		0		0	0		-



16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/30' Arms

## Summary - Continued

Location	ENVELOPED LOADS (Wind Around The Pole)						STRESSES				CSR
	Axial (lbs)	Shear Resultant (lbs)	Bending			Torsion Mz Mom. (ft-lbs)	Axial (psi)	Shear (psi)	Bending (psi)	Torsion (psi)	
			Mx Mom (ft-lbs)	My Mom (ft-lbs)	Resultant (ft-lbs)						

Shaft Base											
Gp I	5024		85085	15222	86436		274		12107		0.35
Gp II	5024	4553	83042	118791	144939	141396	274	497	20302	9903	0.62
Gp III	7575	3108	60036	163151	173846	88543	413	339	24351	6201	0.59
Gp IV Natural			23236	9742	25196				3529		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9961										

Shaft At Arm											
Gp I	3811		85085	15222	86436		240		16176		0.46
Gp II	3811	3888	26404	87209	91118	141396	240	491	17052	13231	0.69
Gp III	5921	2540	33346	137831	141807	88543	373	321	26538	8285	0.69
Gp IV Natural			3512	782	3598				673		-
Gp IV Truck			0		0				0		-
Gp IV Gallop			0		0				0		-
CA	0.9961										



16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/30' Arms

## Anchor Bolt &amp; Base Plate Analysis

**INPUTS**

Shear Force	4553 lbs
Bending Moment	173846 ft-lbs
Torsion Moment	141396 ft-lbs
Num. Anchor Bolts	8
Bolt Circle	26 in
Bolt Diameter	2.00 in
Bolt Yield Stress	55 ksi
Baseplate Width or Diameter	32 in
Baseplate Thickness	2.00 in
Baseplate Shape	Circular
Baseplate Yield Stress	36 ksi
Pole Shaft Base Diameter	19.00 in

**ANALYSIS - ANCHOR BOLTS**

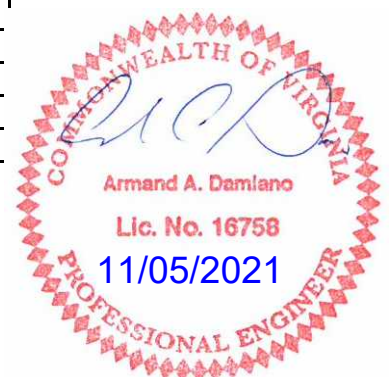
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Bolt Shear Stress Area	2.3 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	16.01 ksi
Bolt Direct Shear Stress	0.248 ksi
Bolt Torsion Shear Stress	7.094 ksi
Combined Bolt Stress	
$F_v = .3 F_y \text{ * Allowable Increase Factor}$	21.945 ksi
$F_t = .5 F_y \text{ * Allowable Increase Factor}$	36.575 ksi
$f_t =$	16.01 ksi
$f_v =$	7.342 ksi
$[(f_v/F_v)^2 + (f_t/F_t)^2]^{.5} \leq 1$	0.56 CSR
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case I)**

Length of "Failure Line" On Base Plate	9.941 in
Dist. Shaft Face To Bolt Center	3.5 in
Design Moment	141 in-kip
Section Modulus of Failure Plane	6.62 in <sup>3</sup>
Applied Plate Stress	21.3 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>

**ANALYSIS - BASEPLATE (Case II)**

Length of "Failure Line" On Base Plate	9.475 in
Dist From Shaft To Nut Face	1.938 in
Design Moment	78 in-kip
Section Modulus of Failure Plane	6.31 in <sup>3</sup>
Applied Plate Stress	12.37 ksi
Allowable Plate Stress = $.66 F_y \text{ * Allow. Incr.}$	31.6 ksi
Therefore	<b>OK</b>



16362-1-24 - VA - 70 MPH - MP-3 Standard Loads - Type C - 70/30' Arms

## Anchor Bolt &amp; Base Plate Analysis

**ANALYSIS - ANCHOR BOLTS - FATIGUE**

Bending Moment	25196 ft-lbs
Bolt Tensile Stress Area	2.5 in <sup>2</sup>
Mom. Inertia Bolt Grouping	1693.98 in <sup>4</sup>
c Dist. (Section 5.17.7)	13.00 in
Bolt Tensile Stress	2.33 ksi
<b>Bolt Stress</b>	
Ft = .Stress Allowable	7.00 ksi
Fatigue Stress Ratio	0.34
Therefore	<b>OK</b>

**ANCHORAGE CAPACITY CHECK - Drilled Pier Foundation**

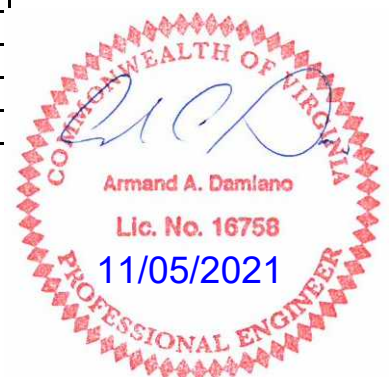
Anchor Bolt Length	60.0 in
Anchor Bolt Projection above Fdn.	11 in
Minimum Embedment Length	30 in
Foundation Diameter	48 in
Concrete Cover (in)	4 in
f'c = 28 Day Concrete Comp. Strength	3000 psi
Vertical Reinforcing Bar Size #	8
Rebar Yield Strength fy	60 ksi
Capacity Reduction For Group Action	50%
$T = 140 A_b \sqrt{f'_c} [0.7 + \ln(2C' / (D_w - D))]$	124231 lbs
T = Anchorage Tensile Capacity	
A <sub>b</sub> = Net Bearing Area	4.528 in <sup>2</sup>
D <sub>w</sub> = Diameter of anchorage device (or) Flat-to-flat of nut	3.125 in
D = Diameter of Bolt	2 in
C' = Clear Cover To Bolt	10 in
T Reduced For Group Action	62115 lbs
Maximum Applied Tensile Load	40025 lbs
Computed Factor-of Safety	1.55 <b>OK</b>

**CONCRETE PULL OUT CAPACITY**

Maximum Applied Tensile Load Per Bolt	40025 lbs
Total Tensile Load	320200 lbs
Concrete Failure Surface Area	4310.27 in <sup>2</sup>
Concrete Shear Strength	472166 psi
Computed Factor-of Safety	1.47 <b>OK</b>

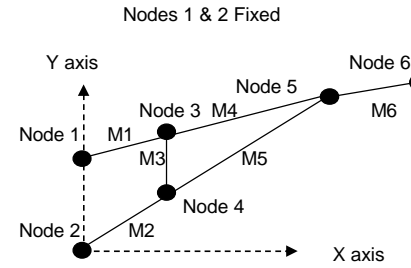
**LOAD TRANSFER TO REINFORCEMENT CAGE**

Maximum Applied Tensile Load Per Bolt	40025 lbs
Total Tensile Load	320200 lbs
Reinforcing Development Length	32.86 in
Anchor Bolt Embedment For Full Devel.(Min.)	44.65 in
Tensile Capacity per Bar	47123 lbs
Minimum Qty. of Vertical Reinforcement Bars	7 Qty.



16362-1 - Northern Virginia, VA - On-Call Signal - VDOT - MP-3 Std. Loads - 12' Luminaire Arm - Group II

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-8.15	-10.3	0	0	0
Node #2	0	0	0	0	-10.01	-12.7	0	0	0
Node #3	48	50.5	0	0	-15.82	-20.1	0	0	0
Node #4	48	44.8	0	0	-17.92	-22.7	0	0	0
Node #5	96	61	0	0	-22.63	-28.6	0	0	0
Node #6	144	69	0	0	-64.42	-51.8	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



Member #3 is a bar computed as equivalent pipe section to the weak axis

	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.375	0.154	53.44	0.88	1.075	-16.29	1.1	1	-20.55	0.666	0.666	1.332	11000000	29000000
Member #2	2.375	0.154	65.66	1.08	1.075	-20.01	1.1	1	-25.25	0.666	0.666	1.332	11000000	29000000
Member #3	0.682	0.1296	5.70	0.03	0.225	-0.36	1.1	1	-0.63	0.01	0.01	0.02	11000000	29000000
Member #4	2.375	0.154	49.14	0.81	1.075	-14.98	1.1	1	-18.90	0.666	0.666	1.332	11000000	29000000
Member #5	2.375	0.154	50.66	0.84	1.075	-15.44	1.1	1	-19.48	0.666	0.666	1.332	11000000	29000000
Member #6	2.375	0.154	48.66	0.80	1.075	-14.83	1.1	1	-18.72	0.666	0.666	1.332	11000000	29000000
Fixture Node 6				2		-57.00	1	1	-42.40					

AASHTO Gp	2
Mntg Hght =	28.5
Datum =	0

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	5347 psi
Fa Member 3	16999 psi
Fa Member 4	21600 psi
Fa Member 5	8982 psi
Fa Member 6	9720 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-589.5	lbs
P1y	-354.8	lbs
P1z	109.8	lbs
M1x	2767.7	in-lbs
M1y	-7739.3	in-lbs
M1z	-1505.3	in-lbs
P2x	589.5	lbs
P2y	493.7	lbs
P2z	36.4	lbs
M2x	1895.7	in-lbs
M2y	-4519.9	in-lbs
M2z	-1343.3	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-641	223	14810	-770	0.43
#2	708	101	8541	-1424	0.36
#3	961	1491	16636	-295	0.55
#4	-715	64	6115	-61	0.17
#5	737	87	6701	-153	0.27
#6	10	153	7114	-1	0.22

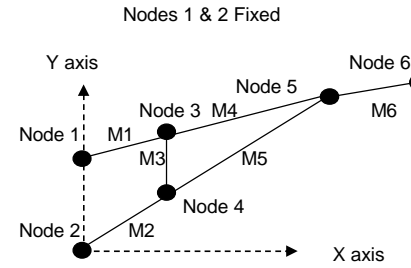
Arm Tip Displacement At Node 6	
X dir	0.080 (in)
Y dir	-0.463 (in)
Z dir	-2.526 (in)

V09.19.15



16362-1 - Northern Virginia, VA - On-Call Signal - VDOT - MP-3 Std. Loads - 12' Luminaire Arm - Group III

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-11.27	-5.6	0	0	0
Node #2	0	0	0	0	-13.85	-6.8	0	0	0
Node #3	48	50.5	0	0	-21.96	-10.8	0	0	0
Node #4	48	44.8	0	0	-24.85	-12.2	0	0	0
Node #5	96	61	0	0	-31.3	-15.4	0	0	0
Node #6	144	69	0	0	-91.26	-30.1	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



Member #3 is a bar computed as equivalent pipe section to the weak axis

	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.375	0.154	53.44	0.88	1.075	-22.53	1.1	1	-11.02	0.666	0.666	1.332	11000000	29000000
Member #2	2.375	0.154	65.66	1.08	1.075	-27.69	1.1	1	-13.54	0.666	0.666	1.332	11000000	29000000
Member #3	0.682	0.1296	5.70	0.03	0.225	-0.65	1.1	1	-0.34	0.01	0.01	0.02	11000000	29000000
Member #4	2.375	0.154	49.14	0.81	1.075	-20.72	1.1	1	-10.13	0.666	0.666	1.332	11000000	29000000
Member #5	2.375	0.154	50.66	0.84	1.075	-21.36	1.1	1	-10.44	0.666	0.666	1.332	11000000	29000000
Member #6	2.375	0.154	48.66	0.80	1.075	-20.52	1.1	1	-10.03	0.666	0.666	1.332	11000000	29000000
Fixture Node 6				2		-81.00	1	1	-25.00					

AASHTO Gp	3
Mntg Hght =	28.5
Datum =	0

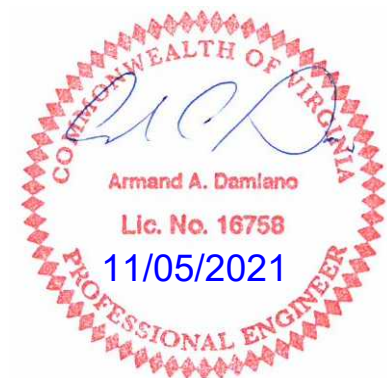
ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	5347 psi
Fa Member 3	16999 psi
Fa Member 4	21600 psi
Fa Member 5	8982 psi
Fa Member 6	9720 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-830.5	lbs
P1y	-500.5	lbs
P1z	61.1	lbs
M1x	1550.6	in-lbs
M1y	-4362.7	in-lbs
M1z	-2130.1	in-lbs
P2x	830.5	lbs
P2y	695.0	lbs
P2z	19.8	lbs
M2x	1060.3	in-lbs
M2y	-2554.1	in-lbs
M2z	-1900.4	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-904	204	9039	-441	0.25
#2	998	131	5729	-812	0.31
#3	1352	2044	22608	-162	0.75
#4	-1009	37	5086	-36	0.12
#5	1039	50	4989	-89	0.24
#6	14	177	8236	-1	0.25

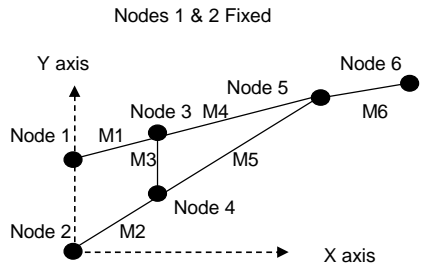
Arm Tip Displacement At Node 6	
X dir	0.113 (in)
Y dir	-0.656 (in)
Z dir	-1.435 (in)

V09.19.15



16362-1 - Northern Virginia, VA - On-Call Signal - VDOT - MP-3 Std. Loads - 15' Luminaire Arm - Group II

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-9.94	-12.6	0	0	0
Node #2	0	0	0	0	-11.04	-14	0	0	0
Node #3	60	52.47	0	0	-19.56	-24.9	0	0	0
Node #4	60	40.5	0	0	-21.08	-26.8	0	0	0
Node #5	120	61	0	0	-28.13	-35.5	0	0	0
Node #6	180	69	0	0	-66.23	-54.1	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



Member #3 is a bar computed as equivalent pipe section to the weak axis

	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.375	0.154	65.18	1.08	1.075	-19.87	1.1	1	-25.07	0.666	0.666	1.332	11000000	29000000
Member #2	2.375	0.154	72.39	1.19	1.075	-22.07	1.1	1	-27.84	0.666	0.666	1.332	11000000	29000000
Member #3	0.682	0.1296	11.97	0.06	0.225	-0.76	1.1	1	-1.32	0.01	0.01	0.02	11000000	29000000
Member #4	2.375	0.154	60.60	1.00	1.075	-18.47	1.1	1	-23.31	0.666	0.666	1.332	11000000	29000000
Member #5	2.375	0.154	63.41	1.05	1.075	-19.33	1.1	1	-24.39	0.666	0.666	1.332	11000000	29000000
Member #6	2.375	0.154	60.53	1.00	1.075	-18.45	1.1	1	-23.28	0.666	0.666	1.332	11000000	29000000
Fixture Node 6				2		-57.00	1	1	-42.40					

AASHTO Gp	2
Mntg Hght =	28.5
Datum =	0

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	4399 psi
Fa Member 3	11129 psi
Fa Member 4	21600 psi
Fa Member 5	5734 psi
Fa Member 6	6291 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-709.4	lbs
P1y	-312.8	lbs
P1z	110.1	lbs
M1x	2989.8	in-lbs
M1y	-9965.4	in-lbs
M1z	-719.5	in-lbs
P2x	709.4	lbs
P2y	468.8	lbs
P2z	57.8	lbs
M2x	2667.3	in-lbs
M2y	-7134.6	in-lbs
M2z	-698.3	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-725	186	18484	-958	0.54
#2	786	88	13264	-1494	0.54
#3	934	379	8599	-365	0.32
#4	-699	94	7508	80	0.21
#5	719	100	8220	-360	0.34
#6	9	159	9182	-1	0.28

Arm Tip Displacement At Node 6	
X dir	0.063 (in)
Y dir	-0.508 (in)
Z dir	-4.968 (in)

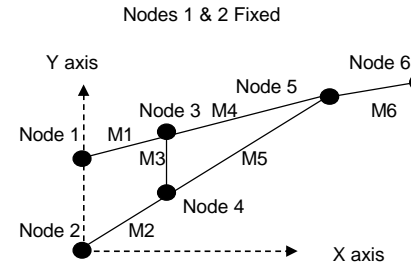
V09.19.15





16362-1 - Northern Virginia, VA - On-Call Signal - VDOT - MP-3 Std. Loads - 15' Luminaire Arm - Group III

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-13.75	-6.8	0	0	0
Node #2	0	0	0	0	-15.27	-7.5	0	0	0
Node #3	60	52.47	0	0	-27.21	-13.4	0	0	0
Node #4	60	40.5	0	0	-29.32	-14.4	0	0	0
Node #5	120	61	0	0	-38.91	-19.1	0	0	0
Node #6	180	69	0	0	-93.77	-31.3	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



Member #3 is a bar computed as equivalent pipe section to the weak axis

	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.375	0.154	65.18	1.08	1.075	-27.48	1.1	1	-13.44	0.666	0.666	1.332	11000000	29000000
Member #2	2.375	0.154	72.39	1.19	1.075	-30.52	1.1	1	-14.92	0.666	0.666	1.332	11000000	29000000
Member #3	0.682	0.1296	11.97	0.06	0.225	-1.37	1.1	1	-0.71	0.01	0.01	0.02	11000000	29000000
Member #4	2.375	0.154	60.60	1.00	1.075	-25.55	1.1	1	-12.49	0.666	0.666	1.332	11000000	29000000
Member #5	2.375	0.154	63.41	1.05	1.075	-26.74	1.1	1	-13.07	0.666	0.666	1.332	11000000	29000000
Member #6	2.375	0.154	60.53	1.00	1.075	-25.52	1.1	1	-12.48	0.666	0.666	1.332	11000000	29000000
Fixture Node 6				2		-81.00	1	1	-25.00					

AASHTO Gp	3
Mntg Hght =	28.5
Datum =	0

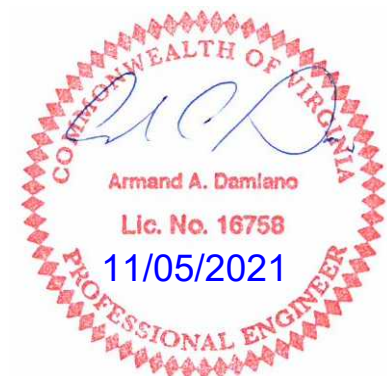
ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	4399 psi
Fa Member 3	11129 psi
Fa Member 4	21600 psi
Fa Member 5	5734 psi
Fa Member 6	6291 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-998.7	lbs
P1y	-441.1	lbs
P1z	60.9	lbs
M1x	1666.0	in-lbs
M1y	-5588.0	in-lbs
M1z	-1027.6	in-lbs
P2x	998.7	lbs
P2y	659.3	lbs
P2z	31.6	lbs
M2x	1485.5	in-lbs
M2y	-4006.0	in-lbs
M2z	-996.5	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1021	114	10494	-545	0.29
#2	1106	65	7613	-847	0.42
#3	1314	407	9296	-203	0.37
#4	-984	84	4379	44	0.1
#5	1013	82	4749	-206	0.27
#6	12	183	10586	-1	0.32

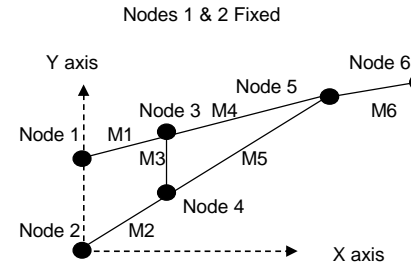
Arm Tip Displacement At Node 6	
X dir	0.089 (in)
Y dir	-0.720 (in)
Z dir	-2.808 (in)

V09.19.15



16362-1 - Northern Virginia, VA - On-Call Signal - VDOT - MP-3 Std. Loads - 18' Luminaire Arm - Group II

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-10.52	-9.7	0	0	0
Node #2	0	0	0	0	-11.4	-10.5	0	0	0
Node #3	48	41.7	0	0	-31.56	-29.4	0	0	0
Node #4	48	25.6	0	0	-33.36	-31.1	0	0	0
Node #5	144	61	0	0	-57.15	-52.5	0	0	0
Node #6	216	69	0	0	-72.19	-56.4	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



Member #3 is a bar computed as equivalent pipe section to the weak axis

	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.375	0.218	50.20	0.83	1.478	-21.04	1.1	1	-19.31	0.868	0.868	1.736	11000000	29000000
Member #2	2.375	0.218	54.40	0.90	1.478	-22.80	1.1	1	-20.92	0.868	0.868	1.736	11000000	29000000
Member #3	0.682	0.1296	16.10	0.08	0.225	-1.03	1.1	1	-1.78	0.01	0.01	0.02	11000000	29000000
Member #4	2.375	0.218	97.92	1.62	1.478	-41.04	1.1	1	-37.66	0.868	0.868	1.736	11000000	29000000
Member #5	2.375	0.218	102.32	1.69	1.478	-42.88	1.1	1	-39.35	0.868	0.868	1.736	11000000	29000000
Member #6	2.375	0.218	72.44	1.19	1.478	-30.36	1.1	1	-27.86	0.868	0.868	1.736	11000000	29000000
Fixture Node 6				2		-57.00	1	1	-42.40					

AASHTO Gp	2
Mntg Hght =	28.5
Datum =	0

ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	7384 psi
Fa Member 3	6379 psi
Fa Member 4	21600 psi
Fa Member 5	2087 psi
Fa Member 6	4164 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-1070.4	lbs
P1y	-341.8	lbs
P1z	124.3	lbs
M1x	2946.2	in-lbs
M1y	-12857.6	in-lbs
M1z	-991.2	in-lbs
P2x	1070.4	lbs
P2y	557.9	lbs
P2z	65.3	lbs
M2x	3075.8	in-lbs
M2y	-9788.8	in-lbs
M2z	-969.9	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-763	159	18051	-596	0.52
#2	814	80	13861	-1189	0.5
#3	611	299	9027	-310	0.34
#4	-756	87	10292	-4	0.29
#5	780	77	10064	-432	0.57
#6	6	124	9045	1	0.28

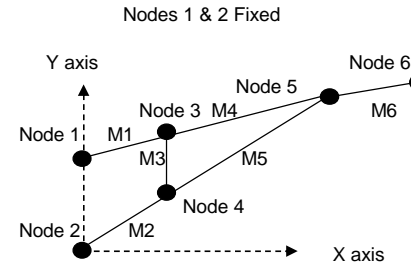
Arm Tip Displacement At Node 6	
X dir	0.089 (in)
Y dir	-0.739 (in)
Z dir	-6.755 (in)

V09.19.15



16362-1 - Northern Virginia, VA - On-Call Signal - VDOT - MP-3 Std. Loads - 18' Luminaire Arm - Group III

Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-10.59	-5.2	0	0	0
Node #2	0	0	0	0	-11.47	-5.7	0	0	0
Node #3	48	41.7	0	0	-32.15	-15.8	0	0	0
Node #4	48	25.6	0	0	-33.96	-16.7	0	0	0
Node #5	144	61	0	0	-57.49	-28.2	0	0	0
Node #6	216	69	0	0	-96.28	-32.5	0	0	0
K Node #1	300	150	0						
K Node #2	120	10	0						
Fixture EPA	2	sq.ft.							
Fixture Wght	-57	lbs							



Member #3 is a bar computed as equivalent pipe section to the weak axis

	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Ch	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.375	0.154	50.20	0.83	1.075	-21.17	1.1	1	-10.35	0.666	0.666	1.332	11000000	29000000
Member #2	2.375	0.154	54.40	0.90	1.075	-22.94	1.1	1	-11.22	0.666	0.666	1.332	11000000	29000000
Member #3	0.682	0.1296	16.10	0.08	0.225	-1.84	1.1	1	-0.95	0.01	0.01	0.02	11000000	29000000
Member #4	2.375	0.154	97.92	1.62	1.075	-41.29	1.1	1	-20.19	0.666	0.666	1.332	11000000	29000000
Member #5	2.375	0.154	102.32	1.69	1.075	-43.14	1.1	1	-21.09	0.666	0.666	1.332	11000000	29000000
Member #6	2.375	0.154	72.44	1.19	1.075	-30.55	1.1	1	-14.94	0.666	0.666	1.332	11000000	29000000
Fixture Node 6				2		-81.00	1	1	-25.00					

AASHTO Gp	3
Mntg Hght =	28.5
Datum =	0

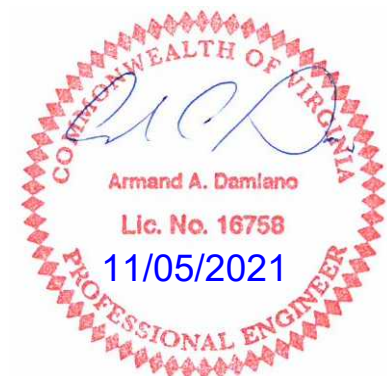
ALLOWABLES	
Gp II Increase	1.4
Fy =	36000 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Fa Member 1	21600 psi
Fa Member 2	7789 psi
Fa Member 3	6379 psi
Fa Member 4	21600 psi
Fa Member 5	2202 psi
Fa Member 6	4392 psi

RESULTS		
ITEM	GLOBAL AXIS REACTIONS	
P1x	-1302.0	lbs
P1y	-426.4	lbs
P1z	69.7	lbs
M1x	1636.5	in-lbs
M1y	-7209.7	in-lbs
M1z	-1476.2	in-lbs
P2x	1302.0	lbs
P2y	668.4	lbs
P2z	34.4	lbs
M2x	1670.3	in-lbs
M2y	-5431.1	in-lbs
M2z	-1430.1	in-lbs

RESULTS					
AASHTO STRESSES, LOCAL AXIS					
Member	Axial (psi)	Shear (psi)	Bending (in-lbs)	Torsion (in-lbs)	CSR
#1	-1278	139	13408	-459	0.37
#2	1357	82	10268	-908	0.44
#3	732	343	10500	-227	0.4
#4	-1275	89	7504	-7	0.19
#5	1315	81	7427	-325	0.66
#6	10	189	13054	-1	0.4

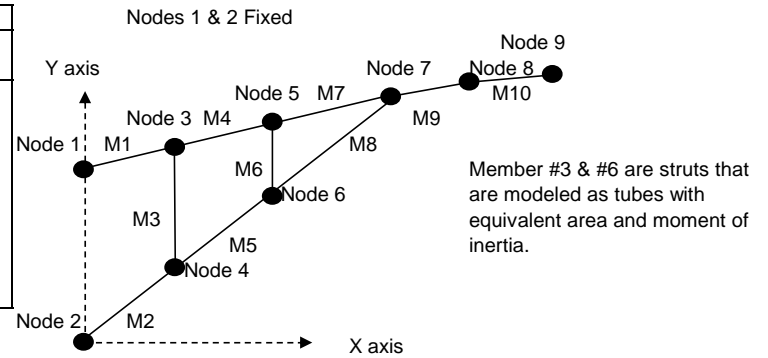
Arm Tip Displacement At Node 6	
X dir	0.154 (in)
Y dir	-1.287 (in)
Z dir	-4.949 (in)

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16' Luminaire Arm

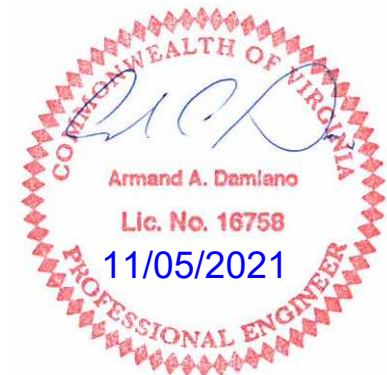
Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)						
	70	X	Y	Z	Fx	Fy grav.	Fz wind	Mx	My	Mz
	(in)	(in)	(in)	(lbs)	(lbs)	(lbs)	(in-lbs)	(in-lbs)	(in-lbs)	(in-lbs)
Node #1	0	27	0	0	-7.78	-9.9	0	0	0	0
Node #2	0	0	0	0	-8.3	-10.5	0	0	0	0
Node #3	48	43.94	0	0	-17.67	-22.4	0	0	0	0
Node #4	48	25.5	0	0	-18.61	-23.57	0	0	0	0
Node #5	96	63.05	0	0	-16.54	-20.93	0	0	0	0
Node #6	96	51.04	0	0	-17.1	-21.64	0	0	0	0
Node #7	144	61	0	0	-18.55	-23.4	0	0	0	0
Node #8	168	65	0	0	-14.94	-19.98	0	0	0	0
Node #9	192	69	0	0	-60.72	-47.1	0	0	0	0
K Node #1	36	240	0							
K Node #2	360	360	0							
K Node #3	300	0	0							



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.38	0.154	50.90	0.84	1.077	-15.55	1.1	-19.62	0.671	0.671	1.342	11000000	29000000
Member #2	2.38	0.154	54.35	0.90	1.077	-16.6	1.1	-20.95	0.671	0.671	1.342	11000000	29000000
Member #3	1.75	0.1525	18.44	0.22	0.766	-4.01	1.1	-5.23	0.247	0.247	0.494	11000000	29000000
Member #4	2.38	0.154	51.66	0.85	1.077	-15.78	1.1	-19.92	0.671	0.671	1.342	11000000	29000000
Member #5	2.38	0.154	54.37	0.90	1.077	-16.61	1.1	-20.96	0.671	0.671	1.342	11000000	29000000
Member #6	1.75	0.1525	12.01	0.15	0.766	-2.61	1.1	-3.41	0.247	0.247	0.494	11000000	29000000
Member #7	2.38	0.154	48.04	0.79	1.077	-14.68	1.1	-18.52	0.671	0.671	1.342	11000000	29000000
Member #8	2.38	0.154	49.02	0.81	1.077	-14.98	1.1	-18.9	0.671	0.671	1.342	11000000	29000000
Member #9	2.38	0.154	24.33	0.40	1.077	-7.44	1.1	-9.38	0.671	0.671	1.342	11000000	29000000
Member #10	2.38	0.154	24.33	0.40	1.077	-7.44	1.1	-9.38	0.671	0.671	1.342	11000000	29000000
Camera Node 8				1		-15	1	-21.2					
Fixture Node 9				2		-57	1	-42.4					

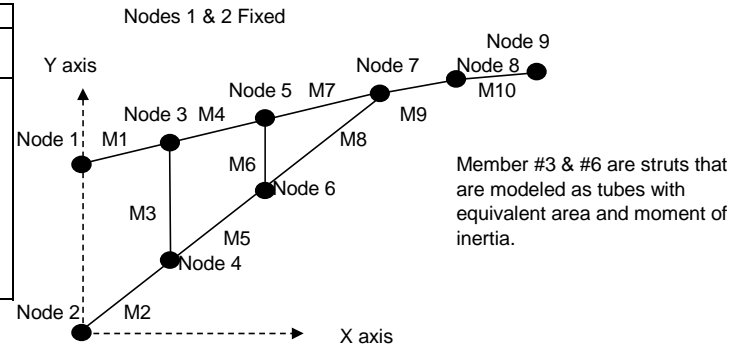
ALLOWABLES		
Fy =	36000	psi
Fa = .60 Fy	21600	psi
Fa Comp.=	7847	psi
Fb = .66 Fy	23760	psi
Fv = .33 Fy	11880	psi
Gp II Increase	1.4	

RESULTS							
ITEM	LOCAL AXIS		AASHTO STRESSES		GLOBAL AXIS		
P1x	-435.2	lbs	Axial	405	psi	-425.2	lbs
P1y	44.3	lbs	Shear	163	psi	-103.0	lbs
P1z	75.7	lbs	Bending	5007	in-lbs	75.7	lbs
M1x	-626.4	in-lbs	Torsion	523	in-lbs	278.3	in-lbs
M1y	-2611.3	in-lbs	CSR	0.17		-2670.9	in-lbs
M1z	1073.1	in-lbs				1073.1	in-lbs
P2x	476.3	lbs	Axial	443	psi	425.2	lbs
P2y	-9.6	lbs	Shear	72	psi	215.0	lbs
P2z	37.4	lbs	Bending	3990	in-lbs	37.4	lbs
M2x	-872.6	in-lbs	Torsion	729	in-lbs	283.5	in-lbs
M2y	-2246.7	in-lbs	CSR	0.17		-2393.5	in-lbs
M2z	115.6	in-lbs				115.6	in-lbs



24' Luminaire Arm

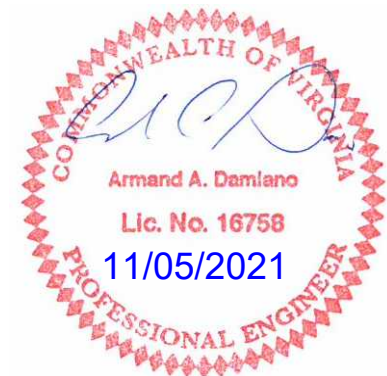
Wind Vel	COORDINATES			NODAL APPLIED LOADS (GLOBAL AXIS)					
	X (in)	Y (in)	Z (in)	Fx (lbs)	Fy grav. (lbs)	Fz wind (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
70									
Node #1	0	27	0	0	-16.4	-11.8	0	0	0
Node #2	0	0	0	0	-16.88	-12.2	0	0	0
Node #3	50	34.29	0	0	-35.64	-26.5	0	0	0
Node #4	50	14.34	0	0	-36.55	-27.14	0	0	0
Node #5	100	41.58	0	0	-51.11	-37.33	0	0	0
Node #6	100	28.06	0	0	-52.45	-38.29	0	0	0
Node #7	200	56.12	0	0	-79.63	-57.24	0	0	0
Node #8	240	62.56	0	0	-33.79	-29.5	0	0	0
Node #9	280	69	0	0	-70.15	-51.9	0	0	0
K Node #1	36	240	0						
K Node #2	360	360	0						
K Node #3	300	0	0						



	OD (in)	Wall (in)	Lgth (in)	PArea (sq.ft.)	Area (in^2)	Wght (lbs)	Cd	Wind (lbs)	Iy (in^4)	Iz (in^4)	Jx (in^4)	G (psi)	E (psi)
Member #1	2.88	0.28	50.53	1.01	2.288	-32.79	1.1	-23.57	1.955	1.955	3.91	11000000	29000000
Member #2	2.88	0.28	52.02	1.04	2.288	-33.75	1.1	-24.26	1.955	1.955	3.91	11000000	29000000
Member #3	1.8	0.2	19.95	0.25	1.006	-5.7	1.1	-5.82	0.327	0.327	0.654	11000000	29000000
Member #4	2.88	0.28	50.53	1.01	2.288	-32.79	1.1	-23.57	1.955	1.955	3.91	11000000	29000000
Member #5	2.88	0.28	51.85	1.04	2.288	-33.64	1.1	-24.19	1.955	1.955	3.91	11000000	29000000
Member #6	1.8	0.2	13.52	0.17	1.006	-3.86	1.1	-3.95	0.327	0.327	0.654	11000000	29000000
Member #7	2.88	0.28	101.05	2.02	2.288	-65.57	1.1	-47.13	1.955	1.955	3.91	11000000	29000000
Member #8	2.88	0.28	103.86	2.08	2.288	-67.39	1.1	-48.44	1.955	1.955	3.91	11000000	29000000
Member #9	2.88	0.28	40.52	0.81	2.288	-26.29	1.1	-18.9	1.955	1.955	3.91	11000000	29000000
Member #10	2.88	0.28	40.52	0.81	2.288	-26.29	1.1	-18.9	1.955	1.955	3.91	11000000	29000000
Camera Node 8				1		-15	1	-21.2					
Fixture Node 9				2		-57	1	-42.4					

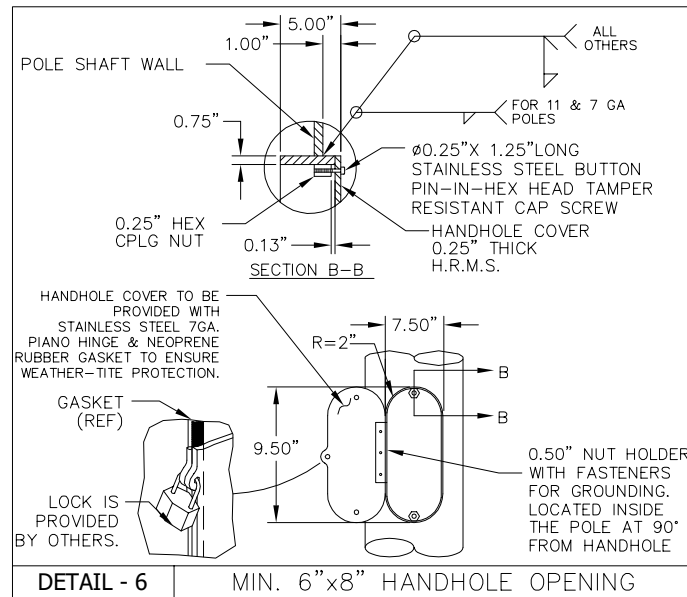
ALLOWABLES	
Fy =	36000 psi
Fa = .60 Fy	21600 psi
Fa Comp.=	11751 psi
Fb = .66 Fy	23760 psi
Fv = .33 Fy	11880 psi
Gp II Increase	1.4

ITEM	RESULTS						
	LOCAL AXIS		AASHTO STRESSES		GLOBAL AXIS		
P1x	-875.9	lbs	Axial	383	psi	-880.6	lbs
P1y	96.0	lbs	Shear	127	psi	-31.3	lbs
P1z	107.9	lbs	Bending	3484	in-lbs	107.9	lbs
M1x	-1046.1	in-lbs	Torsion	353	in-lbs	-456.6	in-lbs
M1y	-4009.9	in-lbs	CSR	0.12		-4118.9	in-lbs
M1z	2506.9	in-lbs				2506.9	in-lbs
P2x	903.7	lbs	Axial	395	psi	880.6	lbs
P2y	-43.3	lbs	Shear	45	psi	207.5	lbs
P2z	27.1	lbs	Bending	2678	in-lbs	27.1	lbs
M2x	-1329.7	in-lbs	Torsion	448	in-lbs	-276.4	in-lbs
M2y	-3633.9	in-lbs	CSR	0.11		-3859.6	in-lbs
M2z	101.2	in-lbs				101.2	in-lbs

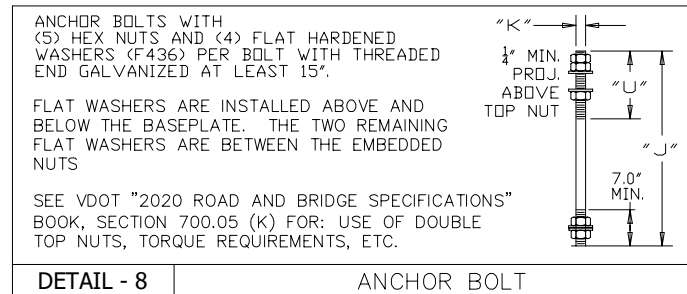




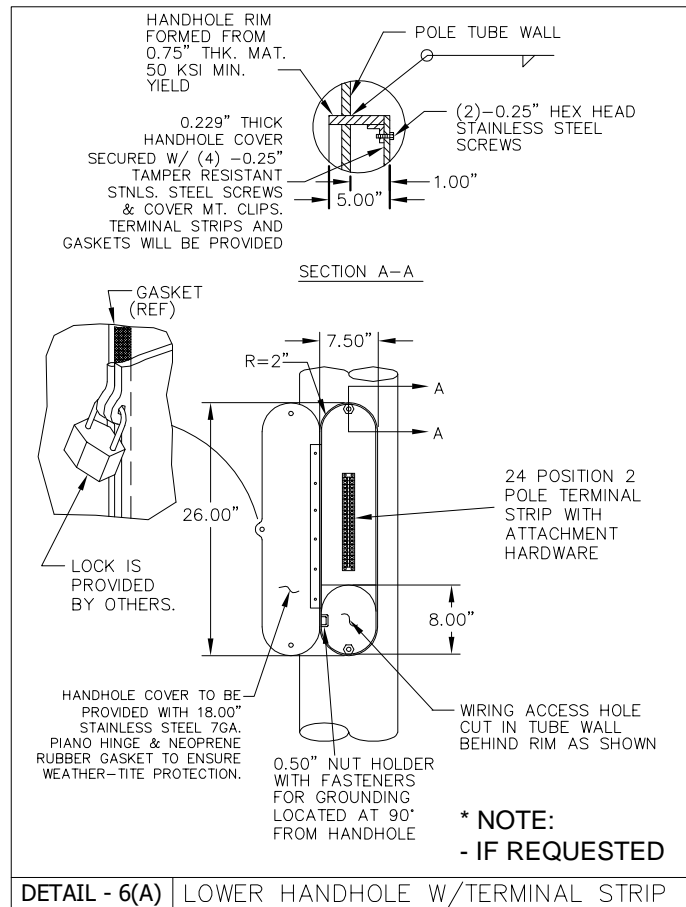




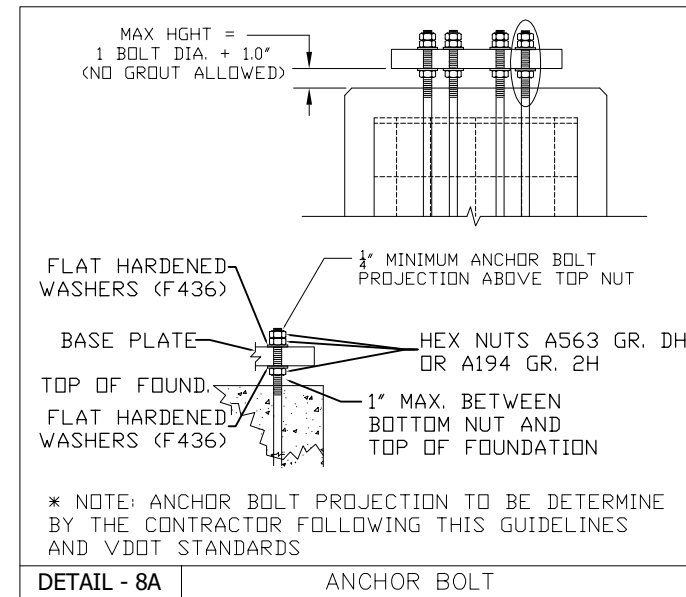
DETAIL - 6 MIN. 6"x8" HANDHOLE OPENING



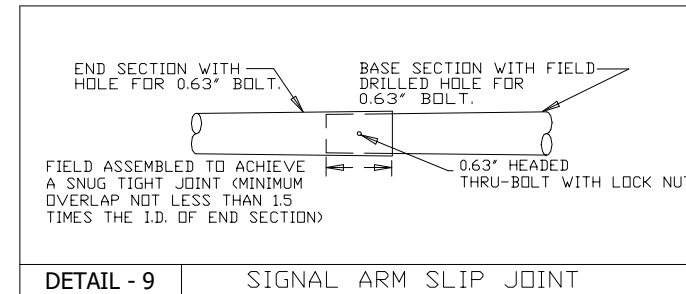
DETAIL - 8 ANCHOR BOLT



DETAIL - 6(A) LOWER HANDHOLE W/TERMINAL STRIP



DETAIL - 8A ANCHOR BOLT



DETAIL - 9 SIGNAL ARM SLIP JOINT

VIRGINIA DEPARTMENT OF TRANSPORTATION  
C.O. STRUCTURE AND BRIDGE  
REVIEW OF WORKING DRAWINGS

Working drawings have been reviewed in accordance with Section 105.10 of the Specifications with the following comments.

Reviewed  Revise and Resubmit  
 Reviewed as Noted

Reviewed by: Karl Larson 11/30/2021



NOTE: DRAWING NOT TO SCALE

REV.	DATE	REVISION		
A:08/08/19:		VDOT REVIEW COMMENTS	ATS-SALES	
B:10/02/19:		VDOT REVIEW COMMENTS		
C:11/05/21:		VDOT REVIEW COMMENTS		
CUSTOMER:			valmont	
DATE:			Valley, NE 68064 POLES (402) 359-2201	
DRAWING:			DATE: 04/04/19 REV:	
16362-1(B)			C	

MAST ARM POLE DETAILS  
70 MPH - MP-3 STANDARDS  
VIRGINIA



SHAFT																			
POLE TYPE	QTY.	SHAFT					BASE PLATE					ANCHOR BOLT			ARM	LUMINAIRE ARM		FLANGE	
		BASE DIA. (IN)	TOP DIA. (IN)	LGTH. "L" (FT)	WALL THICK (IN)	ARM ATTACH ELEV "X" (FT)	DIA. "S" (IN)	BOLT CIRCLE "Y" (IN)	CENTER HOLE DIA. "W" (IN)	THK. "M" (IN)	HOLE "Z" (IN)	QTY.	DIA. "K" (IN)	LGTH. "J" (IN)	THREAD LENGTH "U" (IN)	MAX. ARM SPAN (FT)	MAX LUM. ARM SPAN (FT)	MAX LUM. ARM RISE (FT)	FLANGE ID NO.
A	-	15.00	12.27	19.5	0.250	18.0	30.0	24.0	10.50	2.00	2.25	6 OR 8	2.00	60.0	14.0	49	NA	NA	F1
B1	-	19.50	16.77	19.5	0.313	18.0	32.0	26.0	14.25	2.00	2.25	8	2.00	60.0	14.0	75 Case 1	NA	NA	F2
B2	-	20.50	17.77	19.5	0.313	18.0	32.0	26.0	15.75	2.00	2.25	8	2.00	60.0	14.0	75 Case 2	NA	NA	F3
C	-	19.00	16.27	19.5	0.313	18.0	32.0	26.0	14.25	2.00	2.25	8	2.00	60.0	14.0	70/60	NA	NA	F2
D	-	15.00	11.50	25.0	0.250	18.0	30.0	24.0	10.50	2.00	2.25	6 OR 8	2.00	60.0	14.0	49	24.0	5.0	F1
E1	-	19.50	16.00	25.0	0.313	18.0	32.0	26.0	14.25	2.00	2.25	8	2.00	60.0	14.0	75 Case 1	24.0	5.0	F2
E2	-	20.50	17.00	25.0	0.313	18.0	32.0	26.0	15.75	2.00	2.25	8	2.00	60.0	14.0	75 Case 2	24.0	5.0	F3
F	-	19.00	15.50	25.0	0.313	18.0	32.0	26.0	14.25	2.00	2.25	8	2.00	60.0	14.0	70/60	24.0	5.0	F2

VIRGINIA DEPARTMENT OF TRANSPORTATION  
 C.O. STRUCTURE AND BRIDGE  
 REVIEW OF WORKING DRAWINGS

Working drawings have been reviewed in accordance with Section 105.10 of the Specifications with the following comments.

Reviewed  Revise and Resubmit  
 Reviewed as Noted

Reviewed by: Karl Larson 11/30/2021



REV. DATE	REVISION	ATS-SALES
A:08/08/19:	VDDT REVIEW COMMENTS	
B:10/02/19:	VDDT REVIEW COMMENTS	
C:11/05/21:	VDDT REVIEW COMMENTS	
CUSTOMER:		 Valley, NE 68064 POLES (402) 359-2201
MAST ARM POLE DETAILS 70 MPH - MP-3 STANDARDS VIRGINIA		
DATE:	04/04/19	REV:
DRAWING:	16362-1(C)	C

SIGNAL ARM DATA								
QTY.	ARM SPAN (FT)	SIGNAL ARM TUBE					FLANGE	
		FIXED END DIA. (IN)	FREE END DIA. (IN)	GAUGE OR THK (IN)	SEC. LGTH. (FT)	CENTER HOLE "CH" (IN)	QTY.	FLANGE ID NO.
-	30.0 OPTION A	12.00	7.80	0.179	30.00	6.00	-	F1
-	30.0 OPTION B	13.00	8.80	0.179	30.00	6.00	-	F2
-	40.0 OPTION A	12.00	6.40	0.179	40.00	6.00	-	F1
-	40.0 OPTION B	13.00	7.40	0.179	40.00	6.00	-	F2
-	49.0	13.00	6.14	0.179	49.00	5.00	-	F1
-		-	-	-	-	-	-	F2
-	50.0	13.00	6.00	0.179	50.00	5.00	-	F2
-		-	-	-	-	-	-	F3
-	60.0	15.58	12.27	0.250	23.69	6.00	-	F2
-		13.00	7.54	0.179	39.00		-	F3
-	65.0	16.28	12.27	0.250	28.69	6.00	-	F2
-		13.00	7.54	0.179	39.00		-	F3
-	70.0	17.50	14.00	0.250	25.00	6.00	-	F2
-		14.79	8.09	0.188	47.92		-	F3
-	75.0 - Case 1	18.00	14.08	0.250	28.00	6.00	-	F2
-		14.87	7.88	0.188	49.93		-	F3
-	75.0 - Case 2	19.00	14.80	0.313	30.00	6.00	-	F2
-		15.66	8.94	0.188	48.02		-	F3

FLANGE CONNECTION DATA								
FLANGE PLATES								
ID NO.	NUM OF BOLTS	WIDTH & LENGTH "A" (IN)	BOLT DIST. "B" (IN)	BOLT SPACING "C" (IN)	FLANGE THK. "D" (IN)	GUSSET THK. "E" (IN)	CENTER HOLE "CH" (IN)	BOLT "F" (DIA.X MIN.LGTH.) (IN)
F1	8	24.00	19.50	6.50	2.00	0.375	SEE ARM TABLE	1.50" X 7.00"
F2	8	27.00	22.50	7.50	2.25	0.500	SEE ARM TABLE	1.50" X 7.00"
F3	8	29.50	25.00	8.33	2.75	0.500	SEE ARM TABLE	1.50" X 7.75"

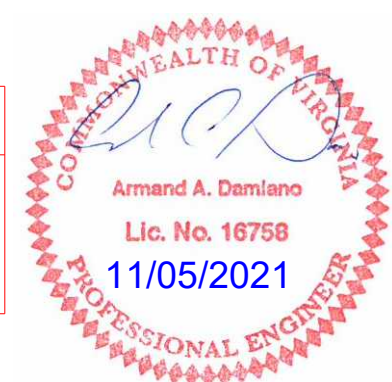
**NOTES:**  
 - ARMS BETWEEN STANDARD LENGTHS MAY BE SUBSTITUTED WITH THE NEXT LONGER ARM AND TRIMMED TO THE CORRECT LENGTH IF THE FLANGE SIZE CORRESPONDS TO WHAT IS REQUIRED BY THE SHAFT.  
 - ACTUAL LENGTH OF FLANGE BOLTS MAY BE ADJUSTED TO ACCOMMODATE CUSTOMIZED WASHERS ASSEMBLY.

VIRGINIA DEPARTMENT OF TRANSPORTATION  
 C.O. STRUCTURE AND BRIDGE  
 REVIEW OF WORKING DRAWINGS

Working drawings have been reviewed in accordance with Section 105.10 of the Specifications with the following comments.

Reviewed  Revise and Resubmit  
 Reviewed as Noted

Reviewed by: Karl Larson 11/30/2021



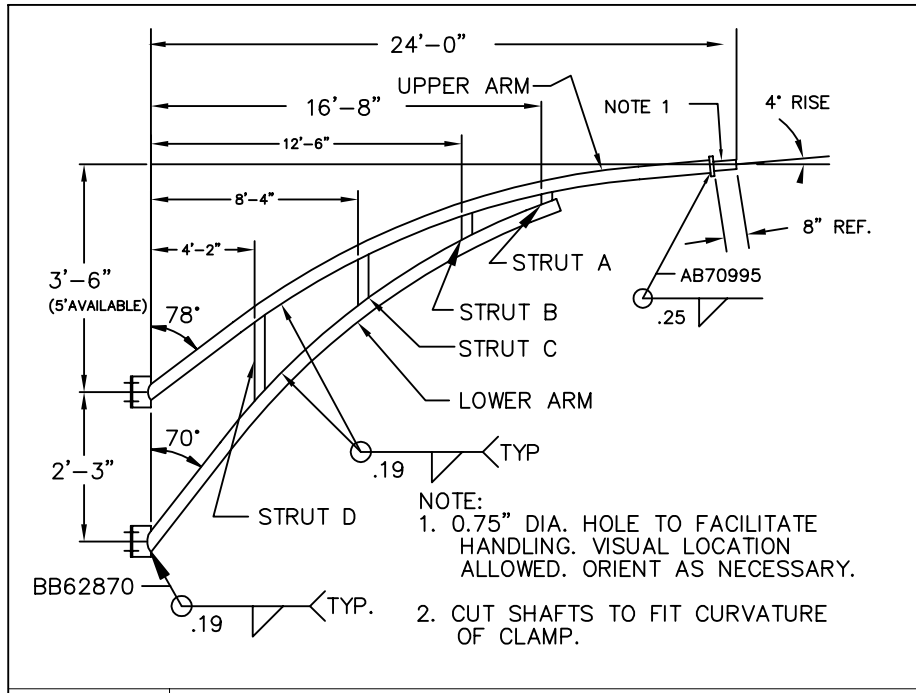
REV.	DATE	REVISION
A	08/08/19	VDDT REVIEW COMMENTS
B	10/02/19	VDDT REVIEW COMMENTS
C	11/05/21	VDDT REVIEW COMMENTS

CUSTOMER: ATS-SALES

**valmont**  
 Valley, NE 68064 POLES  
 (402) 359-2201

DATE: 04/04/19 REV:   
 DRAWING: 16362-1(D) C

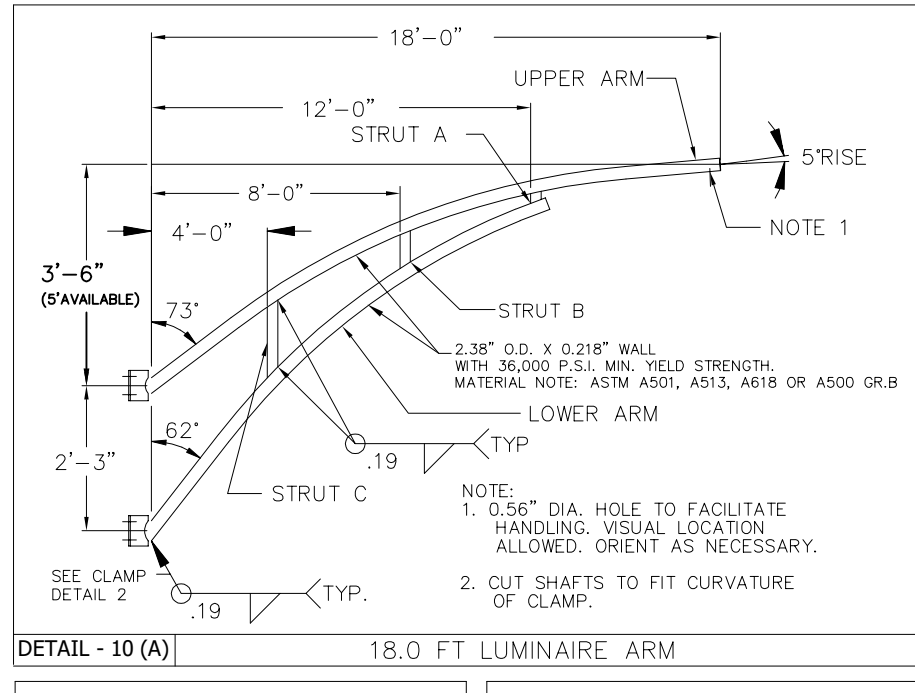
MAST ARM POLE DETAILS  
 70 MPH - MP-3 STANDARDS  
 VIRGINIA



DETAIL - 10 24.0 FT LUMINAIRE ARM

STRUT DATA				
STRUT	THK.	"X"	"Y"	LENGTH
A	0.50"	0.20"	0.43"	0'-2.69"
B	0.50"	0.28"	0.46"	0'-7.11"
C	0.50"	0.36"	0.56"	1'-0.00"
D	0.50"	0.44"	0.67"	1'-5.51"
TOTAL S-70 MATERIAL = 3'-3.31"				

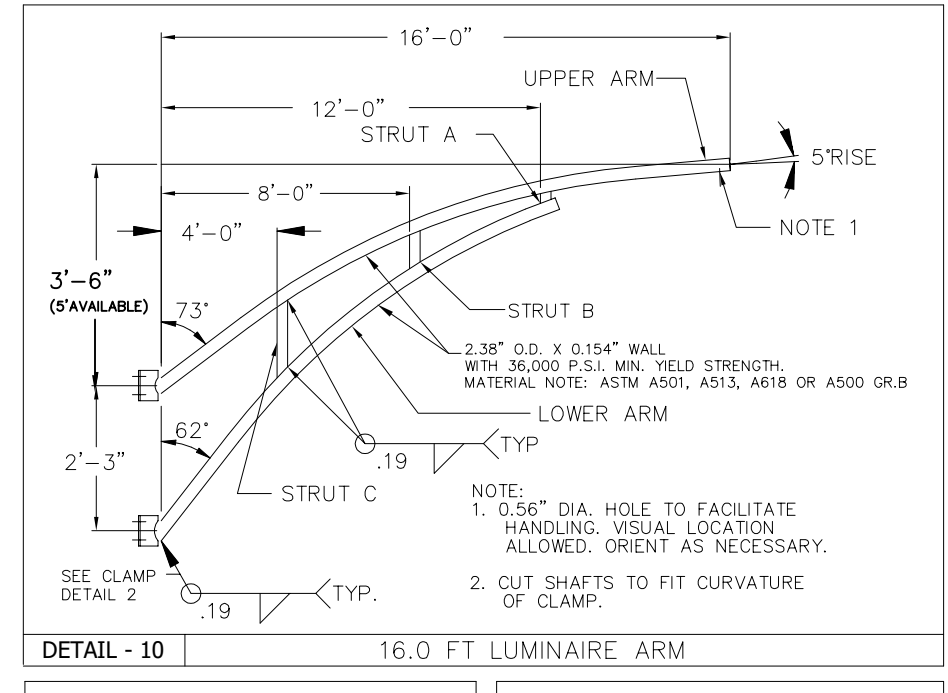
ARM DATA			
ARM	O.D.	WALL	LENGTH
UPPER	2.88"	0.38"	24'- 7.42"
LOWER	2.88"	0.38"	17'- 8.38"
TOTAL S109 MATERIAL= 42'- 3.80"			



DETAIL - 10 (A) 18.0 FT LUMINAIRE ARM

STRUT DATA			
STRUT	THK	WIDTH	LENGTH
A	0.38"	2.00"	4.09"
B	0.38"	2.00"	9.13"
C	0.38"	2.00"	1' - 3.56"
TOTAL A36 MATERIAL= 2'- 4.78"			

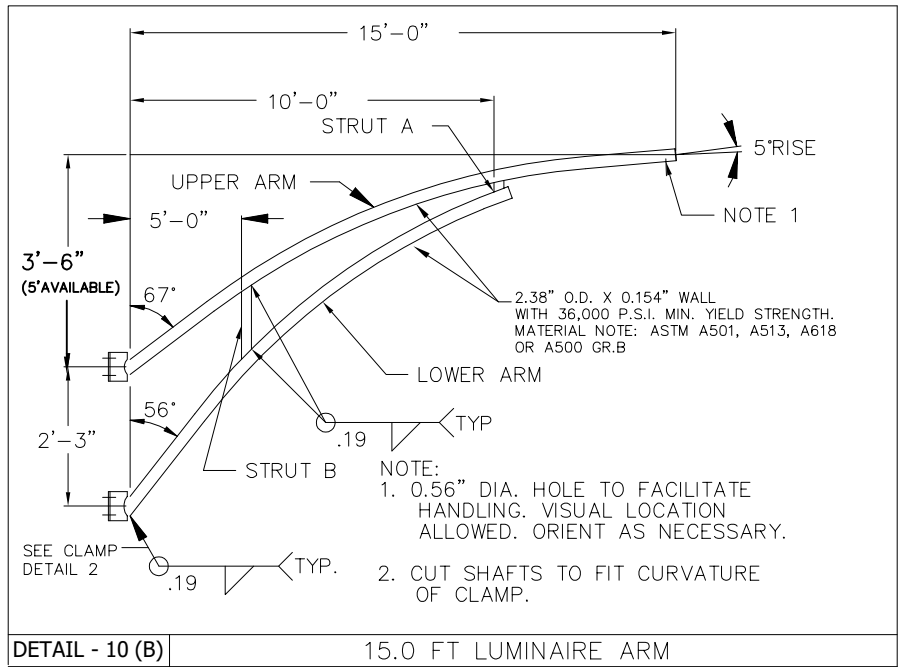
ARM DATA			
ARM	O.D.	WALL	LENGTH
UPPER	2.38"	0.218"	18'- 4.81"
LOWER	2.38"	0.218"	13'- 7.25"
36,000 P.S.I MIN. YIELD STRENGTH			



DETAIL - 10 16.0 FT LUMINAIRE ARM

STRUT DATA			
STRUT	THK	WIDTH	LENGTH
A	0.38"	2.00"	4.09"
B	0.38"	2.00"	9.13"
C	0.38"	2.00"	1' - 3.56"
TOTAL A36 MATERIAL= 2'- 4.78"			

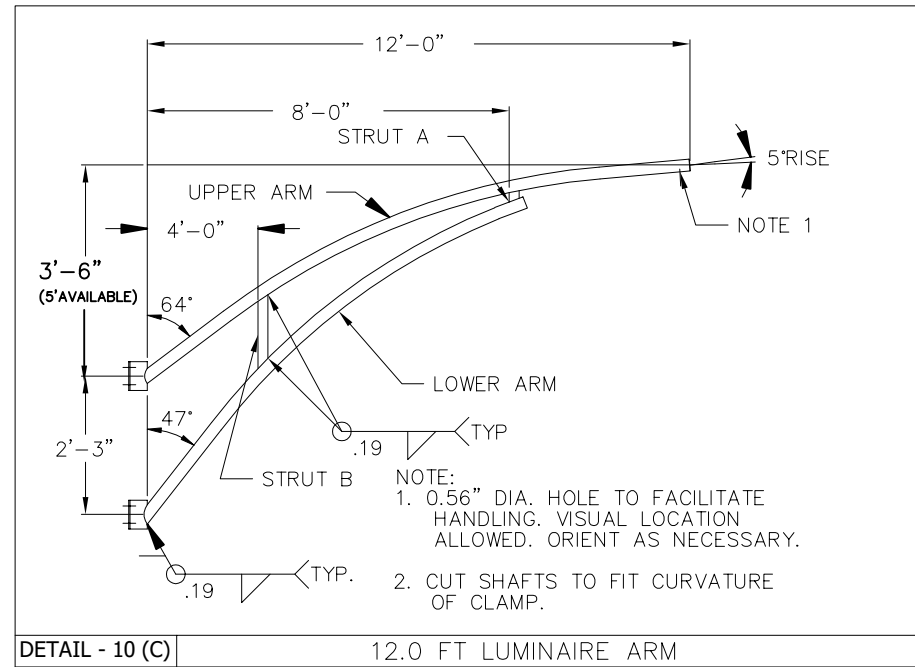
ARM DATA			
ARM	O.D.	WALL	LENGTH
UPPER	2.38"	0.154"	16'- 4.81"
LOWER	2.38"	0.154"	13'- 7.25"
36,000 P.S.I MIN. YIELD STRENGTH			



DETAIL - 10 (B) 15.0 FT LUMINAIRE ARM

STRUT DATA			
STRUT	THK	WIDTH	LENGTH
A	0.38"	2.00"	2.69"
B	0.38"	2.00"	11.13"
TOTAL A36 MATERIAL= 1'- 1.81"			

ARM DATA			
ARM	O.D.	WALL	LENGTH
UPPER	2.38"	0.154"	15'- 6.63"
LOWER	2.38"	0.154"	11'- 7.13"
TOTAL S109 MATERIAL= 27'- 1.75"			



DETAIL - 10 (C) 12.0 FT LUMINAIRE ARM

STRUT DATA			
STRUT	THK	WIDTH	LENGTH
A	0.38"	2.00"	2.38"
B	0.38"	2.00"	9.44"
TOTAL A36 MATERIAL= 0'- 11.82"			

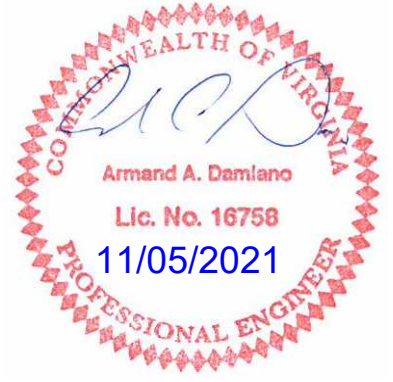
ARM DATA			
ARM	O.D.	WALL	LENGTH
UPPER	2.38"	0.154"	12'- 8.00"
LOWER	2.38"	0.154"	9'- 11.81"
TOTAL S109 MATERIAL= 22'- 7.81"			

VIRGINIA DEPARTMENT OF TRANSPORTATION  
C.O. STRUCTURE AND BRIDGE  
REVIEW OF WORKING DRAWINGS

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Reviewed  Revise and Resubmit  
 Reviewed as Noted

Reviewed by: Karl Larson 11/30/2021



REV.	DATE	REVISION
A	08/08/19	VDDT REVIEW COMMENTS
B	10/02/19	VDDT REVIEW COMMENTS
C	11/05/21	VDDT REVIEW COMMENTS

CUSTOMER: MAST ARM POLE DETAILS  
70 MPH - MP-3 STANDARDS  
VIRGINIA

DATE: 04/04/19 REV: C  
DRAWING: 16362-1(E)

ATS-SALES  
valmont  
Valley, NE 68064 POLES  
(402) 359-2201

**ORDER ENTRY TABLE TO BE COMPLETED AT TIME OF RELEASE FOR: MP-3 70 MPH  
ATS#**

SHAFTS		
QTY	POLE TYPE	QTY OF ANCHOR BOLTS
-	A	-
-	B1	8
-	B2	8
-	C	8
-	D	-
-	E1	8
-	E2	8
-	F	8

TRAFFIC ARMS		
LENGTH (FT)	QTY	FLANGE ID NO.
30.0 Option A	-	F1
30.0 Option B	-	F2
40.0 Option A	-	F1
40.0 Option B	-	F2
49	-	F1
	-	F2

TRAFFIC ARMS		
LENGTH (FT)	QTY	FLANGE ID NO.
50.0	-	F2
	-	F3
60.0	-	F2
	-	F3
65.0	-	F2
	-	F3
70.0	-	F2
	-	F3
75.0 Case 1	-	F2
	-	F3
75.0 Case 2	-	F2
	-	F3

LUMINAIRE ARMS			
LENGTH (FT)	RISE (FT)	QTY	TO FIT SHAFT TYPE
24		-	
		-	
18		-	
		-	
16		-	
		-	
15		-	
		-	
12		-	
		-	

FINISH	
	Galvanized Only
	Powder Coated Over Galv.

VIRGINIA DEPARTMENT OF TRANSPORTATION  
C.O. STRUCTURE AND BRIDGE  
REVIEW OF WORKING DRAWINGS

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Reviewed       Revise and Resubmit  
 Reviewed as Noted

Reviewed by: Karl Larson 11/30/2021



REV.	DATE	REVISION		
A	08/08/19	VDDT REVIEW COMMENTS	ATS-SALES	
B	10/02/19	VDDT REVIEW COMMENTS		
C	11/05/21	VDDT REVIEW COMMENTS		
CUSTOMER:			 Valley, NE 68064 POLES (402) 359-2201	
MAST ARM POLE DETAILS 70 MPH - MP-3 STANDARDS VIRGINIA				
DATE:		04/04/19	REV:	
DRAWING:		16362-1(F) C		