# Final - Ancillary Structures Evaluation

## 43rd Street West Right Turn Lane North of Cortez Road

***County Project No: 307-6076861***
***Agreement No. 15-0909JE***
***Work Assignment No. 27***

*Manatee County, Florida*

*Prepared For:*
*Manatee County Public Works*
*Project Management Division*

*1022 26th Avenue East*
*Bradenton, FL 34206*

**January 2022**

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Prepared For:

Manatee County Public Works
Project Management Division
1022 26th Avenue East
Bradenton, FL 34206

Prepared By:

**HDR Engineering, Inc.**
2601 Cattlemen Road, Suite 400
Sarasota, FL 34232

The official record of this package has been electronically signed and sealed using a Digital Signature as required by 61G15-23.004 F.A.C. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Chester A Smith III 2022.01.21 17:13:14-05'00'

Chester A. Smith, P.E.
P.E. No. 70756

# Contents



# Tables



# Figures



# Appendices

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# 1 Listing of Ancillary Structures

## 1.1 Location

The intersection of 43rd Street and Cortez Road West (SR 684) consists of four (4) signal structures. The assigned FDOT Structure Number is TSMA 13M126.

These mast arm structures will remain in place with modifications made to the signalization layout as provided in Appendix A – Proposed Signal Plans.

**Figure 1-1. Location Map**

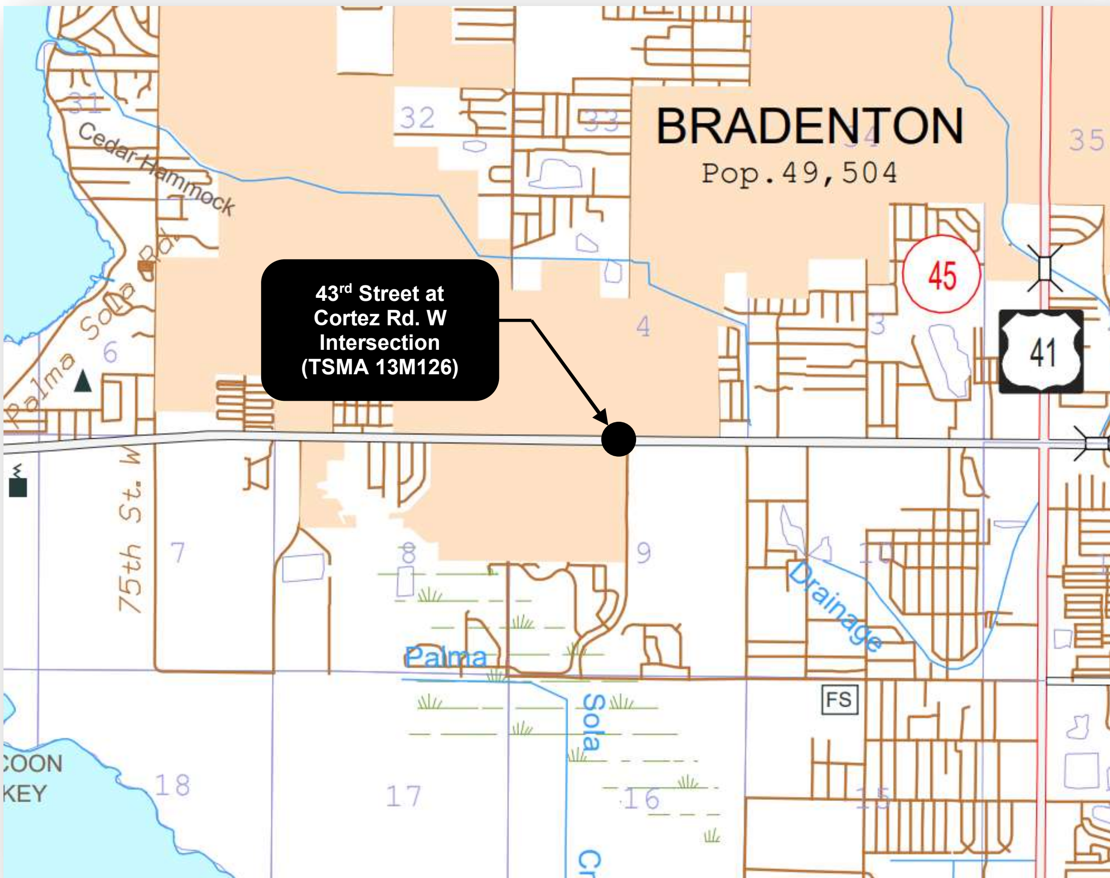


**Figure 1-2. North View Along 43rd Street**

## 1.2 Category Classification

This intersection is classified as Category 1 – Analytical Evaluation without Proposed Additional Loading based on the review of Appendix B. Existing Signalization Plans.

# 2 Condition Evaluation

## 2.1 Assessment

A field review was conducted to document the physical and functional assessment of the existing signal structures at this intersection by performing a visual inspection of accessible components. The inspection data, provided in Appendix F. Inspection Report, was further reviewed for identifying elements requiring repair that reduce the integrity of the structure. Overall, there are no noticeable issues that would result in a reduction in service life or design capacity.

**Figure 2-1. Pole 1 – NE Quadrant**


**Figure 2-2. Pole 2 – SE Quadrant**

**Figure 2-3. Pole 3 – SW Quadrant**


**Figure 2-4. Pole 4 – NW Quadrant**


# 3 Analytical Evaluation

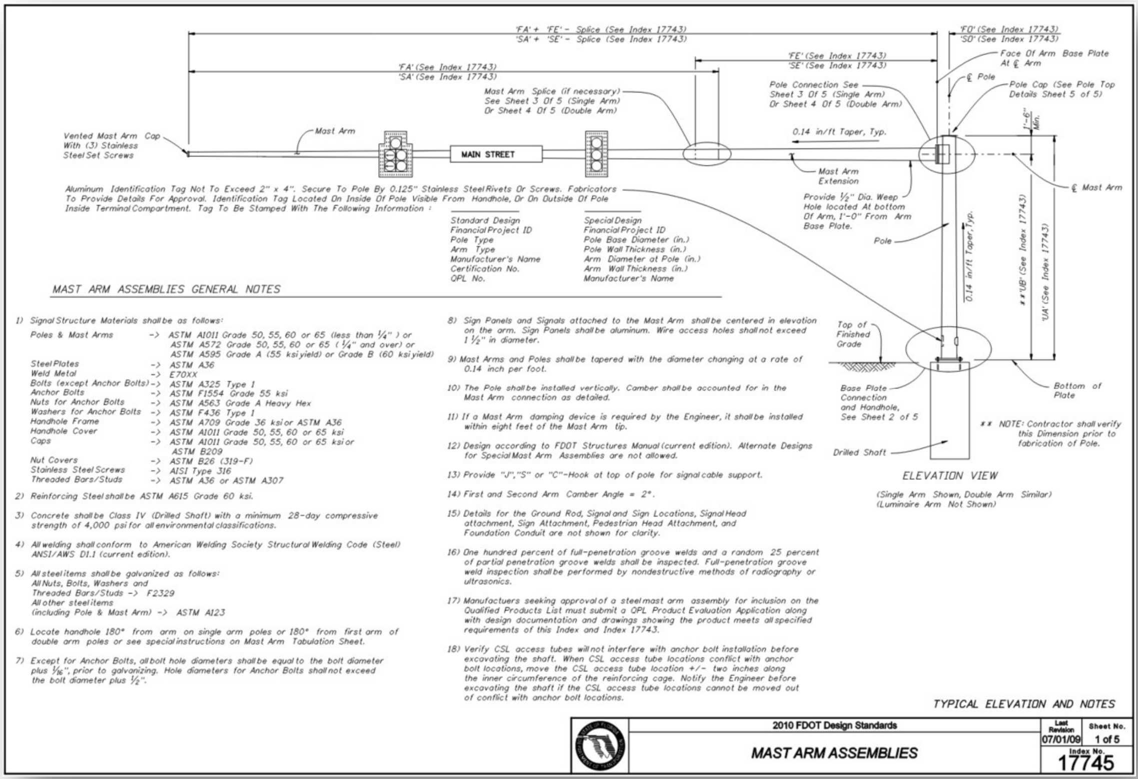
## 3.1 Standards & Specifications

- FDOT Design Manual, 2021
- FDOT Structures Manual, January 2021
- FDOT Design Standards, July 2010

## 3.2 Information

Existing plans from 2010 are utilized to complete the analytical evaluation as they contain relevant information and dimensions for the mast arms including the layout for the "Possible Future Load" configuration. The structures at this intersection are designed as Special Mast Arm Assemblies. Based on the Governing Standards and Specifications note listed on the Key Sheet of the existing plans, the July 2010 Design Standards are used in conjunction with the variables defined on the Special Mast Arm Assemblies sheet for the analysis.

**Figure 3-1. Applicable Design Standard Index**




## 3.3 Analysis Approach

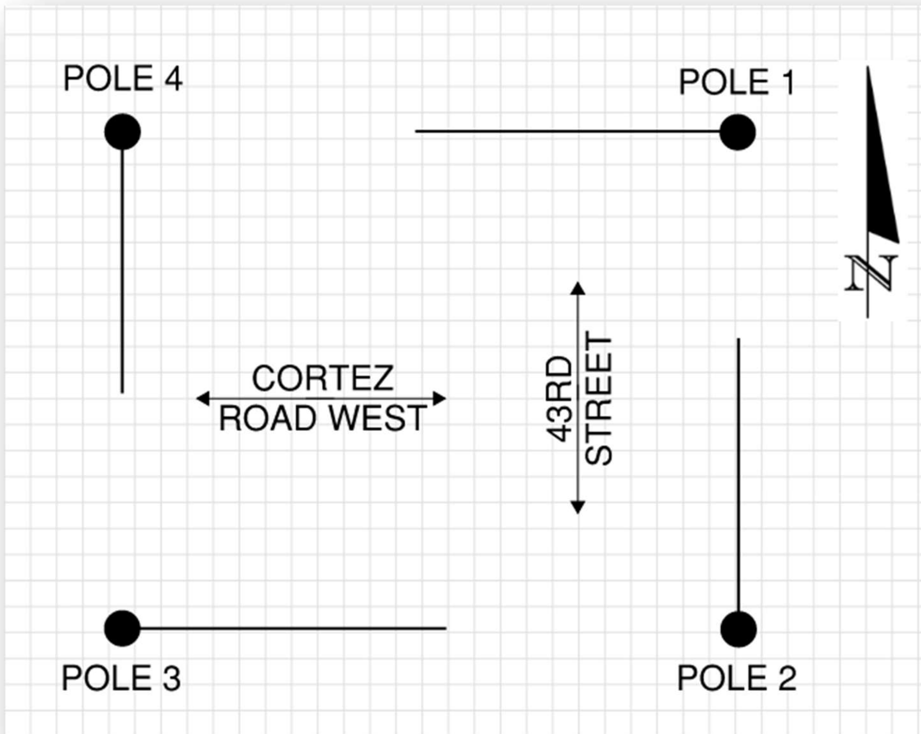
An analytical comparative analysis is performed to show the mast arms are being modified with equivalent components as required for a Category 1 evaluation. This will ensure the proposed signalization layout does not produce loads on any component or connection that exceed the existing design loading when utilizing the "Possible Future Load" configuration. In accordance with Structures Manual – Vol. 3 FDOT Modifications to LRFDLTS-1 (FDOT LTS) Provision 18.2, Category 1 structures do not require fatigue or foundation evaluations.

The FDOT MastArm-LRFDv1.2 signal support program is used to perform these analytical evaluations.

The mast arm located in the northeast corner of the intersection, defined as Pole 1, was previously evaluated by Manatee County Public Works for signalization modifications in

June of 2018 and subsequently approved by FDOT District 1. See Appendix D for supplementary information for this pole. With the proposed modification of replacing the existing 5-section head located at 34 ft. with a 4-section head, while noting the reduction in signal area from 13.69 sq. ft. to 12.33 sq. ft., it is deemed no additional analysis for this modification is warranted due to the reduction in loading, therefore this mast arm is excluded from the Analytical Results section of this report.

**Figure 3-2. Intersection Schematic**




## 3.4 Analytical Results

The Demand/Capacity, Combined Stress Ratios, and Combined Force Interaction are provided in Table 3-1 at the prescribed component check points using the mast arm signal support program for Poles 2 thru 4. The results confirm that the proposed signalization layout does not produce forces acting on individual components that are greater than the "Possible Future Load" configuration from the existing plans.

**Table 3-1. Capacity, Stress, and Force Ratios**

| Component | Pole 2 | | Pole 3 | | Pole 4 | |
|---|---|---|---|---|---|---|
| | Proposed [a] | Existing [b] | Proposed [a] | Existing [b] | Proposed [a] | Existing [b] |
| Mast Arm | 0.53 | 0.55 | 0.42 | 0.55 | 0.58 | 0.58 |
| Upright | 0.53 | 0.56 | 0.44 | 0.50 | 0.58 | 0.59 |

| Component | Pole 2 | | Pole 3 | | Pole 4 | |
|---|---|---|---|---|---|---|
| | Proposed [a] | Existing [b] | Proposed [a] | Existing [b] | Proposed [a] | Existing [b] |
| Arm Connection | 0.73 | 0.73 | 1.00 | 1.00 | 0.73 | 0.73 |
| | 0.36 | 0.38 | 0.49 | 0.61 | 0.39 | 0.40 |
| | 0.31 | 0.32 | 0.30 | 0.45 | 0.34 | 0.34 |
| Anchor Bolt | 0.22 | 0.23 | 0.47 | 0.60 | 0.24 | 0.24 |

Source: Appendix E. Supporting Analytical Calculations – Poles 2 thru 4

[a] Based on modifications provided in Appendix A. Proposed Signalization Plans

[b] Based on “Possible Future Load” configuration shown in Appendix B. Existing Signalization Plans

# 4 Conclusions

By inspection the proposed signalization modification for Pole 1 located at this intersection will result in a decrease of loads compared to the previously approved calculations based on the signal area reduction that results from replacing the existing 5-section signal head with a proposed 4-section signal head.

In addition, proposed changes for Poles 2 thru 4 will result in Demand/Capacity, Combined Stress Ratios, and Combined Force Interactions that are equal to or less than values associated with the “Possible Future Loading” previously defined for these poles in the existing plans based on the outcome of the comparative analysis using 6” backplates. At the recommendation of FDOT District One Structures Office this intersection will utilize 2.5” flexible backplates to reduce the load on the existing mast arms.

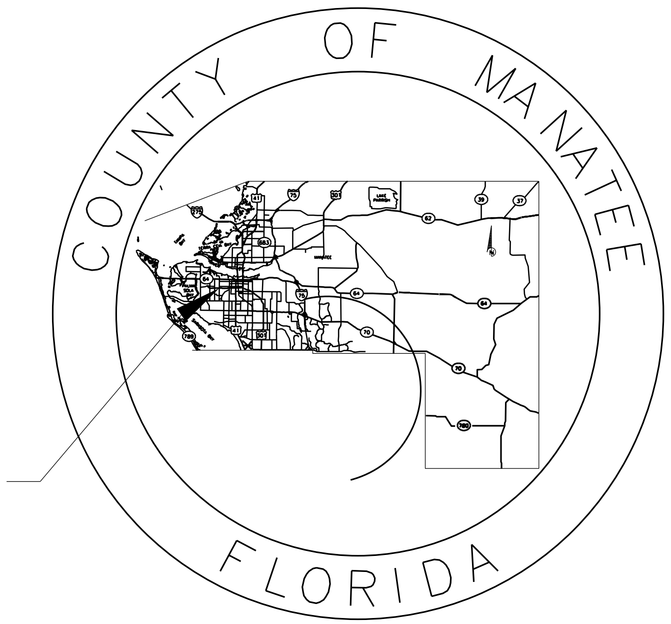
Therefore, the modifications as outlined in Appendix A. Proposed Signalization Plans can be implemented at this intersection.

# Appendix A. Proposed Signalization Plans

# STATE OF FLORIDA

# COUNTY OF MANATEE

## PROPOSED SIGNALIZATION PLANS FOR
## 43RD STREET WEST RIGHT TURN LANE
## NORTH OF CORTEZ ROAD



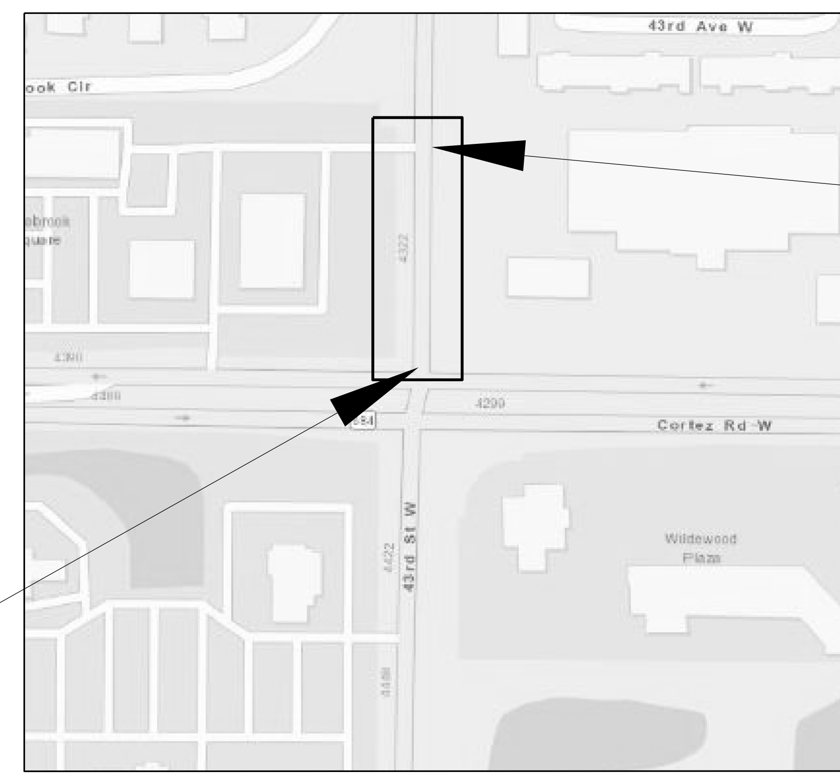

LOCATION OF PROJECT

## MANATEE COUNTY PROJECT No: 307-6076861
## FPID 437145-1-54-01 (D1)
## FDOT MILE POST: 5.862

JANUARY 2022

INDEX OF SIGNALIZATION PLANS






END PROJECT
STA. 307+60.00

BEGIN PROJECT
STA. 301+34.00

N.T.S

**NAVD 88**

ATTENTION IS DIRECTED TO THE FACT THAT THESE PLANS MAY HAVE BEEN ENLARGED IN SIZE BY REPRODUCTION. THIS MUST BE CONSIDERED WHEN OBTAINING SCALED DATA.

Manatee County FLORIDA

811 Know what's below Call before you dig

SIGNALIZATION PLANS
PROFESSIONAL OF RECORD: MICHAEL J. OATES, P.E.
FLORIDA P.E. # 49282

HDR ENGINEERING INC.
2601 CATTLEMEN RD, SUITE 400
SARASOTA, FL 34232
(813) 282-2300

SHEET NO.
T-1

# TABULATION OF QUANTITIES

| PAY ITEM NO. | DESCRIPTION | UNIT | SHEET NUMBERS T-5 PLAN | T-5 FINAL | T-8 PLAN | T-8 FINAL | T-9 PLAN | T-9 FINAL | T-10 PLAN | T-10 FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | TOTAL THIS SHEET PLAN | TOTAL THIS SHEET FINAL | GRAND TOTAL PLAN | GRAND TOTAL FINAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 630-2-11 | CONDUIT, FURNISH & INSTALL, OPEN TRENCH | LF | 60 | | | | | | 25 | | | | | | | | 85 | | 85 | |
| 632-7-1 | SIGNAL CABLE- REPAIR/REPLACE/OTHER, FURNISH & INSTALL | PI | 1 | | | | | | | | | | | | | | 1 | | 1 | |
| 635-2-11 | PULL & SPLICE BOX, F&I, 17" x 30" COVER SIZE | EA | 1 | | | | | | 1 | | | | | | | | 2 | | 2 | |
| 646-1-40 | ALUMINUM SIGNALS POLE, RELOCATE | EA | 2 | | | | | | | | | | | | | | 2 | | 2 | |
| 650-1-14 | VEHICULAR TRAFFIC SIGNAL, FURNISH & INSTALL ALUMINUM, 3 SECTION, 1 WAY | AS | 4 | | | | | | | | | | | | | | 4 | | 4 | |
| 650-1-16 | VEHICULAR TRAFFIC SIGNAL, FURNISH & INSTALL ALUMINUM, 4 SECTION, 1 WAY | AS | 4 | | | | | | | | | | | | | | 4 | | 4 | |
| 650-1-19 | VEHICULAR TRAFFIC SIGNAL, FURNISH & INSTALL ALUMINUM, 5 SECTION CLUSTER, 1 WAY | AS | 1 | | | | | | | | | | | | | | 1 | | 1 | |
| 650-1-60 | VEHICULAR TRAFFIC SIGNAL, REMOVE- POLES TO REMAIN | AS | 6 | | | | | | | | | | | | | | 6 | | 6 | |
| 660-3-11 | VEHICLE DETECTION SYSTEM- MICROWAVE, FURNISH & INSTALL CABINET EQUIPMENT | EA | 1 | | | | | | | | | | | | | | 1 | | 1 | |
| 660-3-12 | VEHICLE DETECTION SYSTEM- MICROWAVE, FURNISH & INSTALL, ABOVE GROUND EQUIPMENT | EA | 2 | | | | | | | | | | | | | | 2 | | 2 | |
| 660-4-42 | VEHICLE DETECTION SYSTEM- VIDEO, RELOCATE ABOVE GROUND EQUIPMENT | EA | 2 | | | | | | | | | | | | | | 2 | | 2 | |
| 670-5-400 | TRAFFIC CONTROLLER ASSEMBLY, MODIFY | AS | 1 | | | | | | | | | | | | | | 1 | | 1 | |
| 678-1-104 | CONTROLLER ACCESSORIES, REPLACE EXISTING- FURNISH AND INSTALL, LOAD SWITCH | EA | 1 | | | | | | | | | | | | | | 1 | | 1 | |
| 700-1-11 | SINGLE POST SIGN, F&I GROUND MOUNT, UP TO 12 SF | AS | | | 3 | | 2 | | | | | | | | | | 5 | | 5 | |
| 700-1-50 | SINGLE POST SIGN, RELOCATE | AS | | | 1 | | | | | | | | | | | | 1 | | 1 | |
| 700-1-60 | SINGLE POST SIGN, REMOVE | AS | | | 1 | | 1 | | | | | | | | | | 2 | | 2 | |
| 700-3-201 | SIGN PANEL, FURNISH & INSTALL OVERHEAD MOUNT, UP TO 12 SF | EA | 2 | | | | | | | | | | | | | | 2 | | 2 | |
| 700-5-50 | INTERNALLY ILLUMINATED SIGN, RELOCATE | EA | 2 | | | | | | | | | | | | | | 2 | | 2 | |
| 706-1-3 | RAISED PAVEMENT MARKER, TYPE B | EA | | | | | | | | | | | | | | | | | 86 | |
| | (WHITE/RED) | | | | 34 | | | | | | | | | | | | 34 | | | |
| | (YELLOW/YELLOW) | | | | 20 | | 32 | | | | | | | | | | 52 | | | |
| 710-90 | PAINTED PAVEMENT MARKINGS, FINAL SURFACE | LS | | | 1 | | | | | | | | | | | | 1 | | 1 | |
| * | PAINTED PAVEMENT MARKINGS, STANDARD, WHITE, SOLID, 6" | GM | | | 0.250 | | 0.074 | | | | | | | | | | 0.324 | | 0.324 | |
| * | PAINTED PAVEMENT MARKINGS, STANDARD, WHITE, SOLID FOR CROSSWALK AND ROUNDABOUT, 12" | LF | | | 136 | | | | | | | | | | | | 136 | | 136 | |
| * | PAINTED PAVEMENT MARKINGS, STANDARD, WHITE, SOLID FOR STOP LINE OR CROSSWALK, 24" | LF | | | 52 | | | | | | | | | | | | 52 | | 52 | |
| * | PAINTED PAVEMENT MARKINGS, STANDARD, WHITE, 2-4 DOTTED GUIDELINE/ 6-10 DOTTED EXT, 6" | GM | | | 0.009 | | 0.006 | | | | | | | | | | 0.015 | | 0.015 | |
| * | PAINTED PAVEMENT MARKINGS, STANDARD, WHITE, MESSAGE OR SYMBOL (ONLY) | EA | | | 4 | | | | | | | | | | | | 4 | | 4 | |
| * | PAINTED PAVEMENT MARKINGS, STANDARD, WHITE, ARROWS | EA | | | | | | | | | | | | | | | | | 13 | |
| | LEFT | | | | 4 | | | | | | | | | | | | 4 | | | |
| | RIGHT | | | | 4 | | | | | | | | | | | | 4 | | | |
| | THRU | | | | 5 | | | | | | | | | | | | 5 | | | |
| * | PAINTED PAVEMENT MARKINGS, STANDARD, YELLOW, SOLID, 6" | GM | | | 0.156 | | 0.135 | | | | | | | | | | 0.291 | | 0.291 | |
| * | PAINTED PAVEMENT MARKINGS, STANDARD, YELLOW, SOLID, 18" | LF | | | 2 | | 35 | | | | | | | | | | 37 | | 37 | |
| 711-11-123 | THERMOPLASTIC, STANDARD, WHITE, SOLID, 12" FOR CROSSWALK AND ROUNDABOUT | LF | | | 136 | | | | | | | | | | | | 136 | | 136 | |
| 711-11-125 | THERMOPLASTIC, STANDARD, WHITE, SOLID, 24" FOR STOP LINE | LF | | | 52 | | | | | | | | | | | | 52 | | 52 | |
| 711-11-141 | THERMOPLASTIC, STANDARD, WHITE, 2-4 DOTTED GUIDELINE/ 6-10 GAP EXTENSION, 6" | GM | | | 0.009 | | 0.006 | | | | | | | | | | 0.015 | | 0.015 | |
| 711-11-160 | THERMOPLASTIC, STANDARD, WHITE, MESSAGE OR SYMBOL (ONLY) | EA | | | 4 | | | | | | | | | | | | 4 | | 4 | |
| 711-11-170 | THERMOPLASTIC, STANDARD, WHITE, ARROW | EA | | | | | | | | | | | | | | | | | 13 | |
| | LEFT | | | | 4 | | | | | | | | | | | | 4 | | | |
| | RIGHT | | | | 4 | | | | | | | | | | | | 4 | | | |
| | THRU | | | | 5 | | | | | | | | | | | | 5 | | | |
| 711-11-224 | THERMOPLASTIC, STANDARD, YELLOW, SOLID, 18" FOR DIAGONAL OR CHEVRON | LF | | | 2 | | 35 | | | | | | | | | | 37 | | 37 | |
| 711-16-101 | THERMOPLASTIC, STANDARD-OTHER SURFACES, WHITE, SOLID, 6" | GM | | | 0.250 | | 0.074 | | | | | | | | | | 0.324 | | 0.324 | |
| 711-16-201 | THERMOPLASTIC, STANDARD-OTHER SURFACES, YELLOW, SOLID, 6" | GM | | | 0.156 | | 0.135 | | | | | | | | | | 0.291 | | 0.291 | |
| 715-1-12 | LIGHTING CONDUCTORS, F&I, INSULATED, NO.8 - 6 | LF | | | | | | | 300 | | | | | | | | 300 | | 300 | |
| 715-1-60 | LIGHTING CONDUCTORS, REMOVE & DISPOSE, CONTRACTOR OWNS | LF | | | | | | | 300 | | | | | | | | 300 | | 300 | |
| 715-4-60 | LIGHT POLE COMPLETE, RELOCATE | EA | | | | | | | 1 | | | | | | | | 1 | | 1 | |
| 715-500-1 | POLE CABLE DISTRIBUTION SYSTEM, FURNISH AND INSTALL, CONVENTIONAL | EA | | | | | | | 1 | | | | | | | | 1 | | 1 | |

* THESE QUANTITIES ARE PAID FOR UNDER PAINTED PAVEMENT MARKINGS (FINAL SURFACE), LUMP SUM ITEM NO. 710-90. THE QUANTITIES SHOWN ARE FOR ONE APPLICATION: SEE SPECIFICATION 710 FOR THE NUMBER OF APPLICATIONS REQUIRED.

| NUMBER | DESCRIPTION | DATE |
|---|---|---|
| | | |

| | | | | |
|---|---|---|---|---|
| PROJECT # | 307-6076861 | SURVEYED | FDC | 07/14/20 |
| SURVEY # | 0577-0038 | DESIGNED | GAS | 08/13/21 |
| SEC./TWN./RGE | 04/35/17 | DRAWN | GAS | 08/13/21 |
| SCALE | | CHECKED | MJO | 08/13/21 |

MICHAEL J. DATES, P.E.
FLORIDA P.E. #49282

SIGNATURE AND DATE

Manatee County FLORIDA

HDR Engineering, Inc.
4830 W Kennedy Blvd., Suite 400
Tampa, FL 33609

43RD STREET WEST RIGHT TURN LANE
NORTH OF CORTEZ ROAD

TABULATION OF QUANTITIES

SHEET NO.
T-2

11:01:43 AM 1/13/2022 PW:\

GENERAL NOTES

1. THE CONTRACTOR SHALL CONTACT THE ENGINEER, IN CONJUNCTION WITH MANATEE COUNTY'S PROJECT MANAGEMENT DIVISION BEFORE STARTING WORK.

2. THE CONTRACTOR SHALL COORDINATE WITH THE ENGINEER, IN CONJUNCTION WITH MANATEE COUNTY'S TRAFFIC ENGINEERING DIVISION (941-749-3502 EXT. 7817), AT LEAST TWO WEEKS BEFORE ANY CABINET MODIFICATIONS ARE TO BE PERFORMED. THE ENGINEER, IN CONJUNCTION WITH MANATEE COUNTY ENGINEERING DIVISION PERSONNEL WILL REVIEW, ASSIST AND PROVIDE TECHNICAL SUPPORT RELEVANT TO ANY FIELD MODIFICATIONS THAT ARE NECESSARY.

3. AT LEAST TWO (2) FULL BUSINESS DAYS PRIOR TO BEGINNING THE TRAFFIC SIGNAL INSTALLATION, PERMITTEE TO CONTACT THE TRAFFIC SIGNAL INSPECTOR/LIAISON:

   MANATEE COUNTY PROJECT MANAGEMENT DIVISION
   MIKE STURM
   1022 26TH AVENUE EAST
   BRADENTON, FLORIDA 34208
   PHONE: 941-708-7450 EXT. 7332

4. ONE WEEK PRIOR TO THE BEGINNING OF THE TRAFFIC SIGNAL INSTALLATION OR TURN ON OF A NEW SIGNAL, THE CONTRACTOR SHALL NOTIFY THE ENGINEER:

   MANATEE COUNTY PROJECT MANAGEMENT DIVISION
   MIKE STURM
   1022 26TH AVENUE EAST
   BRADENTON, FLORIDA 34208
   PHONE: 941-708-7450 EXT. 7332

   MANATEE COUNTY TRAFFIC ENGINEERING DIVISION
   VISHAL KAKKAD
   2101 47TH TERRACE EAST
   BRADENTON, FLORIDA 34203
   PHONE: 941-749-3500 EXT. 7812

5. AT THE COMPLETION OF THE PROJECT PROVIDE AS-BUILT PLANS IN ELECTRONIC FORM (PDF) TO:

   FDOT TRAFFIC OPERATIONS
   RENJAN JOSEPH, P.E., TSM&O ENGINEER
   801 N. BROADWAY AVE
   P.O. BOX 1249
   BARTOW, FL 33830-1249
   EMAIL: RENJAN.JOSEPH@DOT.STATE.FL.US
   PHONE: 863-519-2746

6. DELIVER THREE SETS OF RECORD DRAWINGS, TWO SETS OF IMSA INSPECTION FORMS AND ONE COMPACT DISC OF RECORD DRAWINGS TO MR. AARON BURKETT, THE MANATEE COUNTY TRAFFIC OPERATIONS DIVISION MANAGER AT 2904 12TH ST CT E, BRADENTON, FL 34208. RECORD DRAWINGS MUST BE DELIVERED TO THE COUNTY 5 BUSINESS DAYS PRIOR TO SCHEDULING THE FINAL INSPECTION.

7. UPON PASSING THE FINAL INSPECTION THE CONTRACTOR SHALL SEND A WRITTEN REQUEST TO THE PROJECT MANAGEMENT DIVISION AND THE TRANSPORTATION DIVISION TO TRANSFER MAINTENANCE FROM THE CONTRACTOR TO MANATEE COUNTY. MANATEE COUNTY WILL RESPOND WITHIN 5 WORKING DAYS TO ESTABLISH A TIME TABLE FOR THE TRANSFER OF MAINTENANCE RESPONSIBILITY.

8. THE LOCATION OF UTILITIES SHOWN ON THE PLANS ARE APPROXIMATE ONLY. THE EXACT LOCATIONS SHALL BE DETERMINED BY THE CONTRACTOR, VIA SUNSHINE STATE ONE CALL OF FLORIDA, INC AT 811 OR 1-800-432-4770, IN COORDINATION WITH UNDERGROUND AND OVERHEAD UTILITY OWNERS. THE CONTRACTOR SHALL NOTIFY UTILITY OWNERS/AGENCIES LISTED WITHIN OR IMPACTED BY THESE PLANS, NOT LESS THAN TWO (2) FULL BUSINESS DAYS IN ADVANCE OF BEGINNING CONSTRUCTION.

9. THE CONTRACTOR SHALL NOTIFY THE APPROPRIATE UTILITY COMPANIES AT LEAST 72 HOURS IN ADVANCE OF POLE SETTING OPERATIONS WHERE CONFLICT WITH OVERHEAD ELECTRICAL CONDUCTORS IS EXPECTED AND IN ALL CASES WHERE JOINT USE POLES ARE CALLED FOR.

   THE CONTRACTOR SHALL CONTACT THE LOCAL POWER COMPANY FOR THEIR ASSISTANCE IN PERFORMING ALL NECESSARY WORK UNDER POWER LINES AT SIGNAL POLES SUCH AS THE INSTALLATION OF SIGNAL CABLE, FIBERGLASS INSULATORS, AND SIGNAL POLES.

   AT LOCATIONS WHERE THE REQUIRED VERTICAL CLEARANCE TO THE POWER LINES CANNOT BE MAINTAINED, A QUALIFIED REPRESENTATIVE FROM THE POWER COMPANY SHALL BE PRESENT DURING ALL WORK UNDER POWER LINES. ANY COST ASSOCIATED WITH THIS SHALL BE INCLUDED IN THE RELATED PAY ITEMS.

10. THE CONTRACTOR SHALL HAND DIG THE FIRST 48 INCHES OF THE HOLE FOR THE POLE FOUNDATION OR CONDUIT RUN WHERE UTILITIES ARE IN CLOSE PROXIMITY.

11. THE CONTRACTOR IS TO DE-WATER THE POLE FOUNDATION EXCAVATION IF THE ELEVATION OF WATER IS HIGHER THAN THE ELEVATION OF THE FOUNDATION BASE.

12. ALL MATERIALS, EQUIPMENT, AND OTHER CONTRACTOR SUPPLIED ITEMS SHALL BE INSTALLED AND MAINTAINED ACCORDING TO THE MANUFACTURERS RECOMMENDATIONS, UNLESS SPECIFICALLY DIRECTED OTHERWISE BY THE ENGINEER.

13. #14 XHHW PULL WIRE SHALL BE INSTALLED IN ALL CONDUITS. AT LEAST 2 FEET OF PULL WIRE SHALL BE ACCESSIBLE AT EACH CONDUIT TERMINATION AND SECURED IN THE PULL BOX OR PLACE OF TERMINATION.

14. ALL ELECTRICAL WIRING SHALL COMPLY WITH ALL APPLICABLE PROVISIONS OF THE LATEST EDITION OF THE NATIONAL ELECTRICAL CODE PUBLISHED BY THE NATIONAL FIRE PROTECTION ASSOCIATION.

15. GROUNDING: ALL COSTS FOR GROUNDING SHALL BE INCLUDED IN THE COST OF THE ITEM BEING GROUNDED. ALL GROUND ROD ASSEMBLIES FOR POLES, SERVICES, CABINETS, AND OTHER RELATED EQUIPMENT SHALL BE BONDED TOGETHER TO FORM AN INTEGRATED GROUNDING SYSTEM USING #6 AWG THHN COPPER WIRE. THE UPPER END OF ALL GROUND RODS SHALL BE 18 INCHES BELOW GROUND ELEVATION. MARK GROUND ROD LOCATION WITH PERMANENT MARKER SUCH AS AN EPOXIED STICKER LOCATED ON THE NEAREST CURB, AND PROVIDE AS-BUILT DRAWINGS WITH THE LOCATION OF GROUND RODS MARKED. GROUNDING CONDUCTOR MUST BE #6 OR LARGER INSULATED COPPER.

    CONNECTING DEVICES SHALL BE NON-CORROSIVE SPLIT BOLTS, CLAMPS, PRESSURE CONNECTORS, OR OTHER APPROVED MEANS TO ENSURE A POSITIVE CONNECTION.

    GROUND RESISTANCE TESTER, OR OTHER APPROVED MEANS SHALL BE USED TO ACQUIRE THE GROUND ROD RESISTANCE. THE ENGINEER, OR A REPRESENTATIVE OF THE ENGINEER FROM THE TRAFFIC OPERATIONS DIVISION STAFF SHALL BE PRESENT DURING THE TEST.

16. IT SHOULD BE NOTED THAT NO TEST BORINGS WERE MADE WHERE CONDUIT RUNS ARE TO BE INSTALLED BY JACKING OR BORING.

17. CONTRACTOR SHALL SUPPLY ALL MATERIAL SUBMITTALS TO THE ENGINEER PRIOR TO CONSTRUCTION FOR APPROVAL.

18. CONTRACTOR SHALL UTILIZE FDOT STANDARD PLANS INDEX 102-600, 102-615, 102-616, 102-617 AND 102-660 AS APPLICABLE DURING MAINTENANCE OF TRAFFIC OPERATIONS.

19. EXISTING SPEED LIMITS ARE AS FOLLOWS:
    45 MPH ON CORTEZ ROAD
    40 MPH ON 43RD AVENUE EAST (TO THE NORTH)
    35 MPH ON 43RD AVENUE EAST (TO THE SOUTH)

20. SHOP DRAWINGS SHALL BE SUBMITTED FOR REVIEW FOR ALL EQUIPMENT AND MATERIALS FURNISHED AND INSTALLED. THE CONTRACTOR SHALL FURNISH COPIES OF ALL DRAWINGS, SCHEDULES AND COMPLETE DESCRIPTIVE AND TECHNICAL DATA ON ALL ITEMS TO THE PROJECT MANAGER.

21. THE ACCEPTANCE OF ANY SUBMITTED DATA FOR MATERIALS, EQUIPMENT, APPARATUS, DEVICES, ARRANGEMENTS AND/OR LAYOUTS SHALL NOT RELIEVE THE CONTRACTOR FROM THE RESPONSIBILITY OF PLACING SAME AND PROPER DIMENSIONS, CAPACITIES, SIZES, QUANTITY AND INSTALLATIONS DETAILS TO EFFICIENTLY PERFORM THE REQUIREMENTS AND INTENT OF THE CONTRACT. SUCH ACCEPTANCE SHALL NOT RELIEVE THE CONTRACTOR FROM RESPONSIBILITY FOR ERRORS OF ANY SORT ON THE SUBMITTAL DATA.

22. CONTRACTOR TO CONTACT TRAFFIC ENGINEERING DIVISION: MUKUNDA GOPALAKRISHNA (941-749-3500 EXT. 7813) TO OBTAIN IP ADDRESSES FOR FIELD DEVICES AND ETHERNET SWITCH CONFIGURATION INFORMATION.

23. WHEN A CONTRACTOR IS WORKING ON A SIGNAL IN AN INTERSECTION (INSTALLING CONDUIT IN THE STREET, REMOVING EXISTING SIGNAL EQUIPMENT, LOOPS, HOMERUNS OR TURNING ON OF NEW SIGNAL) WHERE A LANE IS CLOSED, THE ENGINEER MAY REQUIRE AN OFF DUTY LAW ENFORCEMENT OFFICER TO DIRECT TRAFFIC. THE HOURLY RATE FOR AN OFF DUTY LAW ENFORCEMENT OFFICER CAN BE OBTAINED FROM THE LOCAL LAW ENFORCEMENT OFFICE. THE COST OF THE OFFICER SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR AND INCLUDED IN PAY ITEM 102-1-104.

CONDUIT NOTES

1. ALL HDPE CONDUIT CONNECTIONS SHALL BE JOINED WITH A FUSION COUPLER OR FUSION SPLICE.

2. THE CONTRACTOR SHALL ADJUST THE CONDUIT RUNS, DEVICE POLES, BORES AND SERVICE POLE PLACEMENTS TO AVOID ANY UTILITY CONFLICTS IDENTIFIED BY THE LOCATES. ANY SIGNIFICANT CHANGE SHALL BE APPROVED BY THE ENGINEER.

3. THE CONDUITS TO BE INSTALLED ARE TO BE PLACED SO AS TO TOTALLY AVOID ANY CONFLICTS WITH EXISTING UTILITIES ALONG THE ROUTE. IT IS THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN THE NECESSARY INFORMATION REQUIRED TO PLAN THE WORK AHEAD FOR THE INSTALLATION OF THE REQUIRED CONDUITS WITHIN DESIGN OR SPECIFIED PARAMETERS, AND HIS TIME FRAME. THE CONTRACTOR SHALL ADJUST CONDUIT VERTICALLY OR HORIZONTALLY TO AVOID CONFLICT WITH UNDERGROUND UTILITIES. THE CONTRACTOR SHALL USE HAND EXCAVATION METHODS WHEN EXCAVATING NEAR EXISTING UTILITIES, NO SEPARATE PAYMENT SHALL BE MADE FOR THIS WORK. EXTREME CAUTION SHALL BE USED BY THE CONTRACTOR WHEN EXCAVATING, INSTALLING, BACK FILLING AND COMPACTING AROUND EXISTING UTILITIES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE TO ANY UTILITY.

4. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO FIELD LOCATE ALL ABOVEGROUND AND UNDERGROUND CONFLICTS IN ADVANCE OF THE PLACEMENT OF ANY CONDUIT OR OTHER FACILITIES. THE CONTRACTOR SHALL FIELD MARK THE PROPOSED ALIGNMENT FOR REVIEW AND CONCURRENCE BY THE ENGINEER PRIOR TO TRENCHING AND/OR PLACEMENT. NO PULL BOXES SHALL BE LOCATED IN DRAINAGE SWALES, OR PAVED SHOULDERS.

5. WHEN TRENCHING FOR INSTALLATION, THE CONTRACTOR MAY RUN COMMUNICATIONS AND POWER SERVICE IN THE SAME TRENCH. THE POWER SERVICE SHALL HAVE SEPARATE PULL BOXES FOR ACCESS. THE CONTRACTOR SHALL NOT INSTALL COMMUNICATIONS AND POWER SERVICE IN THE SAME CONDUIT, PULL BOX OR MANHOLE.

6. THE CONTRACTOR SHALL PLACE ALL CONDUITS IN A MANNER THAT MINIMIZES DEFLECTION BOTH HORIZONTALLY AND VERTICALLY, THUS MINIMIZING STRESS ON CABLES DURING CABLE INSTALLATION.

7. THE CONDUIT DETAILS GIVEN ARE MEANT TO BE SCHEMATIC IN NATURE. DUE TO ACTUAL FIELD CONDITIONS AND/OR NEEDS, DEVIATIONS MAY BE NECESSARY. DIMENSIONAL DISTANCES FOR CONDUIT LOCATIONS ARE PROVIDED TO ASSIST THE CONTRACTOR WITH CONDUIT PLACEMENT. THE CONTRACTOR SHALL TAKE THIS INTO ACCOUNT WHEN PLACING CONDUIT. THE CONTRACTOR IS RESPONSIBLE FOR FIELD LOCATING CONDUIT AROUND EXISTING UTILITIES AND OBSTRUCTIONS.

8. ALL CONDUIT TRENCHES SHALL BE BACKFILLED COMPLETELY TO PROVIDE SAFE CROSSING BY THE END OF THE WORKING DAY OR WHENEVER THE WORK ZONE BECOMES INACTIVE. DO NOT OPEN ANY AREA THAT CANNOT BE BACKFILLED IN THE SAME DAY/ NIGHT OPERATION.

   BRACKETS AND SPACERS WHICH ARE REQUIRED TO OFFSET THE RIGID METAL CONDUIT FROM THE MOUNTING, SHALL BE OF SIMILAR MATERIALS TO PREVENT CATHODIC REACTION.

9. ALL NEW CONDUIT SHALL BE PLACED AT A MINIMUM DEPTH OF 30" UNLESS PLACED IN AN AREA OF NEW FILL, IN WHICH CASE THE CONDUIT SHALL BE 48".

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| PROJECT # | 307-6076861 | SURVEYED | FDC | 07/14/20 |
| SURVEY # | 0577-0038 | DESIGNED | GAS | 08/13/21 |
| SEC./TWN./RGE | 04/35/17 | DRAWN | GAS | 08/13/21 |
| SCALE | | CHECKED | MJO | 08/13/21 |

MICHAEL J. DATES, P.E.
FLORIDA P.E. #49282

SIGNATURE AND DATE

Manatee County FLORIDA

HDR Engineering, Inc.
4830 W Kennedy Blvd., Suite 400
Tampa, FL 33609

43RD STREET WEST RIGHT TURN LANE
NORTH OF CORTEZ ROAD

SIGNALIZATION GENERAL NOTES

SHEET NO.
T-3

PAY ITEM NOTES

1. 630-2-11:
#14 XHHW PULL WIRE SHALL BE INSTALLED IN ALL CONDUITS. AT LEAST 2 FEET OF PULL WIRE SHALL BE ACCESSIBLE. ALL CONDUIT RUNS SHOWN ON THE PLANS ARE SCHEMATIC AND FIELD ADJUSTMENTS MAY BE NECESSARY. WITH THE EXCEPTION OF ELECTRICAL POWER SERVICE DUCTS, JACK & BORE SLEEVES, AND DIRECTIONAL BORE CONDUITS, ALL UNDERGROUND AND UNDER PAVEMENT CONDUITS SHALL BE SCHEDULE 40 PVC WITH A MINIMUM SIZE OF 2" UNLESS OTHERWISE SPECIFIED IN THE PLANS. COST OF PULL WIRE SHALL BE INCLUDED UNDER THIS PAY ITEM.

2. 632-7-1:
USE A MINIMUM OF 7 CONDUCTOR SIGNAL CABLES FOR SIGNAL HEADS AND PEDESTRIAN HEADS. THIS ITEM ONLY INCLUDES ANY ADDITIONAL WIRING NECESSARY TO CONSTRUCT THE PROJECT. THE INTENT IS NOT TO REWIRE THE ENTIRE INTERSECTION.

EACH PHASE/MOVEMENT SHALL BE WIRED FROM THE SIGNAL DISPLAY TO THE CONTROLLER AS A SEPARATE PHASE/MOVEMENT. THIS INCLUDES THE LEFT TURN MOVEMENT WHICH SHALL HAVE CONDUCTORS AVAILABLE FOR EITHER PROTECTED OR PERMISSIVE MOVEMENTS. THE CONTRACTOR SHALL VERIFY COLOR CODES FOR SIGNAL CABLE WITH THE MANATEE COUNTY BEFORE ORDERING, AND WIRE THE SIGNAL IN ACCORDANCE WITH THAT COLOR CODE AND F.D.O.T. SPECIFICATIONS. THERE SHALL BE ONE NEUTRAL PER APPROACH. THIS PAY ITEM INCLUDES FURNISHING AND INSTALLING THE REQUIRED CABLING FOR THE PROPOSED PEDESTRIAN AND VEHICULAR SIGNAL ASSEMBLIES. ALL PEDESTRIAN DETECTORS SHALL BE WIRED USING SEPARATE CABLE UTILIZING LOW VOLTAGE CONDUIT AND PULL BOXES.

3. 635-2-11:
PULL BOXES SHALL BE TRAFFIC BEARING, ALL POLYMER CONSTRUCTION (NOT CONCRETE), PULL BOXES AND LIDS (QUAZITE OR ANOTHER EQUIVALENT FDOT APPROVED MANUFACTURER). PULL BOXES ARE TO BE PLACED BEHIND CURB AND GUTTER. IF THERE IS NO CURB AND GUTTER, PULL BOXES SHALL BE PLACED A MINIMUM OF 7' FROM THE EDGE OF PAVEMENT.

STANDARD PULL BOX DIMENSIONS SHALL BE 17" X 30" X 12" AND THE LID SHALL BE STAMPED "MANATEE COUNTY TRAFFIC SIGNAL" ON THE COVER. STANDARD FIBER OPTIC COMMUNICATIONS PULL BOX DIMENSIONS SHALL BE 24" X 36" X 24" AND THE LID SHALL BE STAMPED "MANATEE COUNTY COMMUNICATIONS" ON THE COVER.

4. 646-1-60:
INCLUDES ALL ATTACHMENTS WITH THE RELOCATION (FOUNDATION, POLE, DETECTOR AND SIGNAL HEADS).

5. 650-1-14, 650-1-16 & 650-1-19:
USE SIGNAL HEAD SUPPORTING HANGER THAT IS CAPABLE OF ADJUSTING VERTICALLY A MINIMUM OF 1.5'.

ALL SIGNAL HEADS SHALL HAVE FLEXIBLE BACKPLATES INSTALLED.
ALL EXISTING SIGNAL HEADS SHALL ALSO RECEIVE FLEXIBLE BACKPLATES, INCIDENTAL TO THIS PAY ITEM. BACKPLATES SHALL BE MANUFACTURED FOR THE SIGNAL HEADS USED & INSTALLED AS PER MANUFACTURER'S RECOMMENDATIONS. THE BACKPLATE SHALL HAVE A 2" YELLOW REFLECTORIZED (TYPE III REFLECTIVITY) OUTER EDGE BORDER UNLESS SPECIFIED OTHERWISE IN THE PLANS.

THE EXTERNAL COLOR OF SIGNAL HOUSING SHALL BE BLACK. ALL TRAFFIC SIGNAL HEAD INDICATIONS SHALL BE 12" LED. ALL SIGNAL HEADS SHALL HAVE TUNNEL VISORS. THE COST FOR THE TUNNEL VISORS SHALL BE INCLUDED UNDER THIS PAY ITEM.

INSTALL ALL SIGNAL HEADS AT A MINIMUM OF 17.5' VERTICAL HEIGHT ABOVE THE PAVEMENT SURFACE.

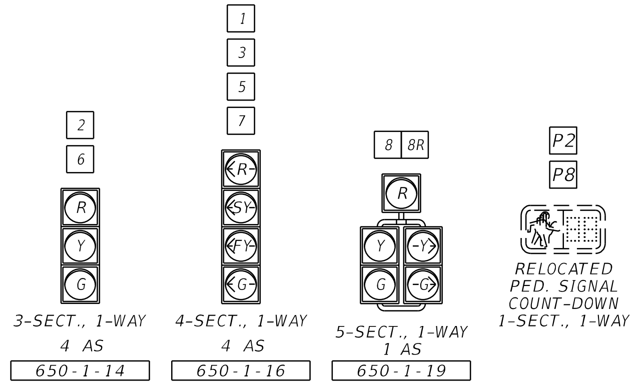
6. 660-3-11:
SHALL INCLUDE ALL NECESSARY WAVETRONIX CLICKS UNITS FOR A COMPLETE AND OPERATIONAL SETUP.

7. 660-3-12:
SHALL INCLUDE WAVETRONIX SMARTSENSOR HD ADVANCE MVDS AS NOTED IN PLANS. THIS PAY ITEM WILL INCLUDE ALL NECESSARY MOUNTING BRACKETS AND CLAMPING EQUIPMENT. SHALL INCLUDE ANY COST ASSOCIATED WITH PHYSICAL INSTALLATION OF SENSOR AND ANY SOFTWARE NECESSARY TO PROGRAM THE SENSOR.

8. 670-5-400:
INCLUDES MODIFYING THE EXISTING SIGNAL TIMINGS AND ADJUSTMENT / ADDITION OF THE NEW SIGNAL EQUIPMENT TO ACCOMMODATE THE PROPOSED INTERSECTION DESIGN.

REQUEST UPDATED SIGNAL TIMINGS FROM FDOT TSM&O ENGINEER - ARTERIALS (863-519-2216) WHEN ALL LANES, STRIPING, SIGNALS AND PEDESTRIAN FACILITIES ARE IN THEIR FINAL CONFIGURATION AND THE SIGNAL IS OPERATING AS DESIGNED. PROVIDE FDOT WITH ALL 'AS-BUILT' INFORMATION NECESSARY TO DEVELOP THE BASIC SIGNAL TIMING PARAMETERS AND ALLOW THREE (3) WEEKS FOLLOWING THE REQUEST FOR FDOT TO DEVELOP THE UPDATED TIMINGS. PROGRAM THE CONTROLLER PER THE TIMINGS PROVIDED BY FDOT.

9. 715-4-60:
RELOCATED POLES INCLUDE THE REMOVAL OF THE EXISTING FOUNDATION AND A NEW FOUNDATION AT THE PROPOSED LOCATION.




| CONTROLLER TIMINGS (SECONDS) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | MOVEMENT NUMBER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | DIRECTION | EBL | WB | SBL | NB | WBL | EB | NBL | SB |
| | TURN TYPE | PROT/ PERM | | PROT/ PERM | | PROT/ PERM | | PROT/ PERM | |
| TIMING FUNCTION | MINIMUM GREEN | 5 | 15 | 5 | 7 | 5 | 15 | 5 | 7 |
| | EXTENSION | 3.0 | 5.0 | 3.0 | 3.0 | 3.0 | 5.0 | 3.0 | 3.0 |
| | YELLOW | 4.8 | 4.8 | 4.4 | 4.4 | 4.8 | 4.8 | 4.4 | 4.4 |
| | ALL RED | 4.1 | 4.1 | 2.7 | 2.7 | 4.1 | 4.1 | 2.7 | 2.7 |
| | MAX I | 15 | 30 | 20 | 20 | 15 | 30 | 20 | 20 |
| | MAX II | 25 | 115 | 25 | 35 | 25 | 115 | 25 | 35 |
| | WALK | | 7 | | 7 | | 7 | | 7 |
| | FLASHING DON'T WALK | | 18 | | 30 | | 22 | | 32 |
| | DETECTOR MEMORY | | | | | | | | |
| | DET. CROSS SWITCH. | Ø6 | | Ø8 | | Ø2 | | Ø4 | |
| | DUAL ENTRY | | ON | | ON | | ON | | ON |
| | VEHICLE RECALL | | MIN | | | | MIN | | |

INTERSECTION NOTES:

1. THE POSTED SPEED LIMIT IS AS FOLLOWS:
   CORTEZ ROAD = 45 MPH
   43RD AVENUE EAST = 35 MPH (TO THE SOUTH)
   43RD AVENUE EAST = 40 MPH (TO THE NORTH)

CONTROLLER OPERATIONS:

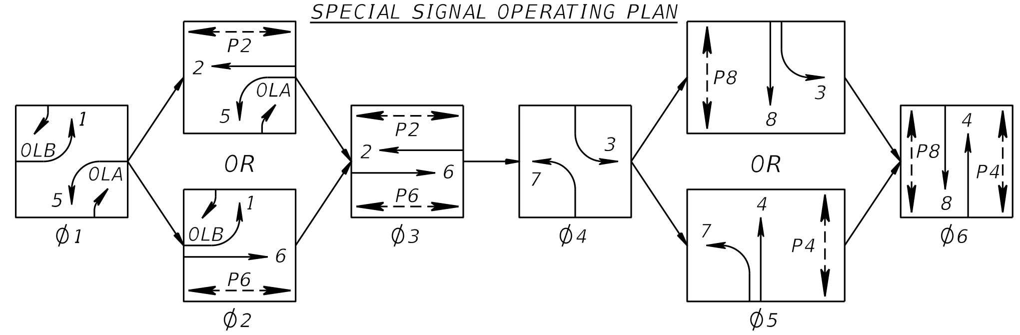
1. MAJOR STREET IS CORTEZ ROAD (SR 684), MOVEMENTS 2 & 6, MINOR STREET IS 43RD STREET W, MOVEMENTS 4 & 8.
2. MODIFY THE EXISTING SIGNAL OPERATING PLAN (SOP) 10 TO ADD OVERLAP B (OLB) AS SHOWN IN THE DIAGRAM BELOW. OLB = OVERLAP FOR MOVEMENT 8R TO COME UP WITH MOVEMENT 1 WITH MIN. GREEN = 5 SEC., YELLOW = 4.4 SEC., ALL RED = 2.7 SEC. THE EXISTING OVERLAP A (OLA) FOR MOVEMENT 4R COMES UP WITH MOVEMENT 5 WITH MIN. GREEN = 5 SEC., YELLOW = 4.4 SEC., ALL RED = 2.7 SEC.
   A) OVERLAP OLA SHALL BE OMITTED WHEN P4 IS ACTIVE.
   B) OVERLAP OLB SHALL BE OMITTED WHEN P8 IS ACTIVE.
3. PROGRAM PHASE RESTRICTIONS TO OMIT MOVEMENT 1 AND REDIRECT CALLS FROM MOVEMENT 1 TO MOVEMENT 6, WHEN MOVEMENT 2 IS GREEN AND TO OMIT MOVEMENT 5 AND REDIRECT CALLS FROM MOVEMENT 5 TO MOVEMENT 2, WHEN MOVEMENT 6 IS GREEN.
4. CONFIGURE THE PHASE SEQUENCE, PHASE CONCURRENCY AND OVERLAP PROGRAMMING TO COMPLY WITH THE MUTCD.
5. MOVEMENTS 2 AND 6 SHALL FLASH YELLOW. ALL OTHER MOVEMENTS SHALL FLASH RED. MOVEMENT 8R SHALL BE TURNED OFF DURING FLASHING OPERATION.

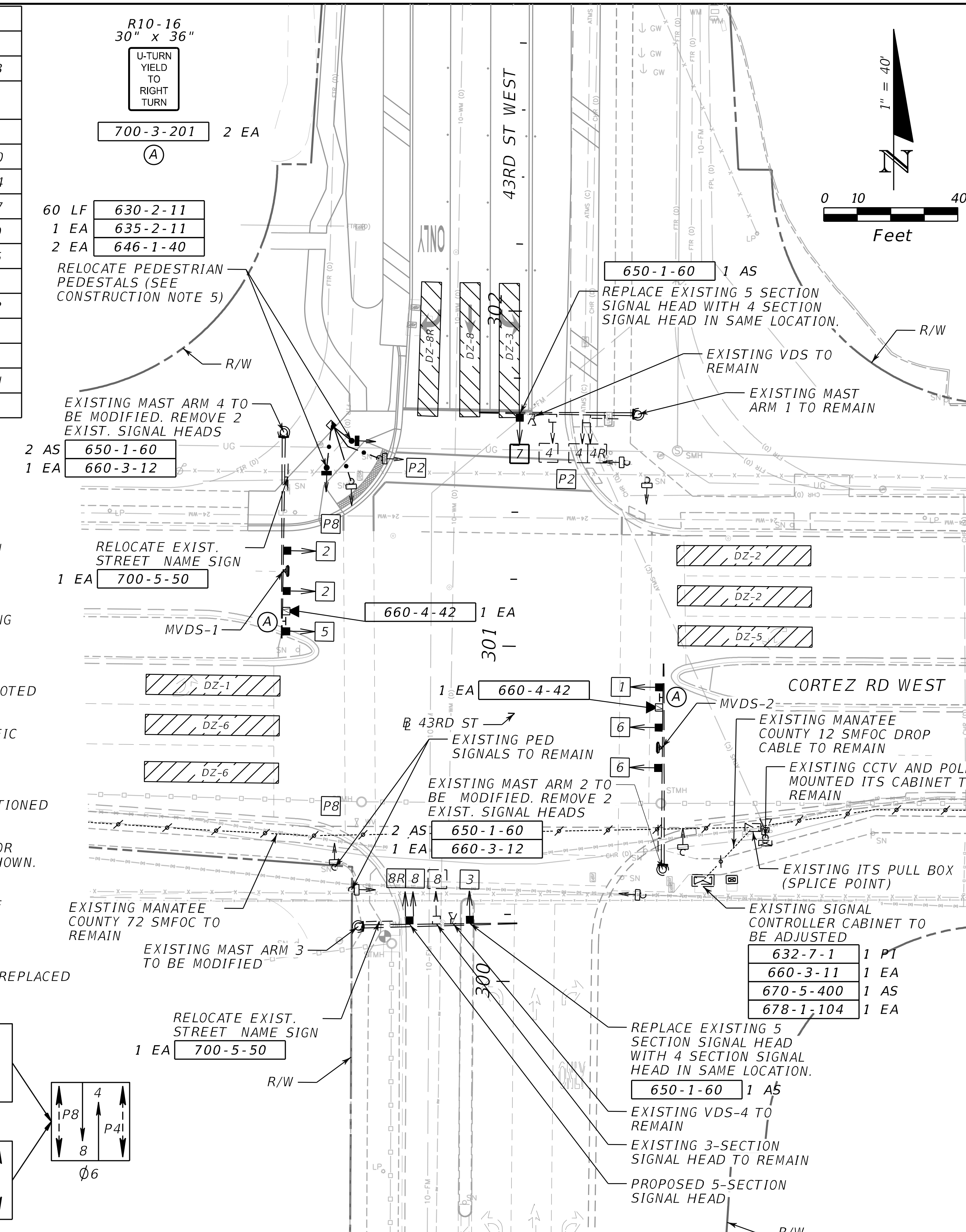
CONSTRUCTION NOTES:

1. EXISTING SIGNAL PHASING TO BE REVISED TO ADD OLB PER THE SOP SHOWN. THE SIGNAL TIMINGS SHOULD BE REVISED PER THE TIMINGS NOTED IN CONTROLLER TIMING CHART.
2. EXISTING MAST ARMS SHOWN ARE FOR GRAPHICAL PURPOSES ONLY, CONTRACTOR SHALL VERIFY LENGTH OF MAST ARM AND POSITION OF TRAFFIC SIGNAL HEADS BEFORE PERFORMING ANY WORK.
3. EXISTING VIDEO VEHICLE IMAGING DETECTION SYSTEM, AND STREET NAME SIGNS ON THE MAST ARMS TO REMAIN EXCEPT NOTED OTHERWISE.
4. RE-CONFIGURE EXISTING VIDEO VEHICLE DETECTION CAMERAS TO DETECT THE ZONES AS SHOWN. DETECTION ZONES SHALL BE 6' X 40' POSITIONED 2' BEYOND STOP BAR. COST SHALL BE INCLUDED UNDER PAY ITEM 670-5-400.
5. RELOCATE THE TWO EXISTING ALUMINUM PEDESTRIAN SIGNALS (PEDESTALS) IN THE NW QUADRANT AS SHOWN. INCLUDE A NEW FOUNDATION FOR BOTH RELOCATED PEDESTALS. INSTALL PROPOSED CONDUIT FROM THE NEW PEDESTAL LOCATIONS AND CONNECT TO EXISTING CONDUITS AS SHOWN.
6. MODIFY EXISTING SIGNAL CABINET AND CONTROLLER TO INCLUDE THE PEDESTRIAN TIMING, WIRING AND ASSIGNING DETECTION FOR THE OLB MOVEMENT. NOTE THAT THE PEDESTRIAN SIGNAL TIMING CHANGES MUST ALSO BE REFLECTED IN THE AUDIBLE PEDESTRIAN SIGNALS FOR THE CROSSWALKS OF ALL PEDESTRIAN SIGNALS FOR P2 AND P8.
7. SEE MAST ARM TABULATION SHEET FOR ADVANCE MVDS DILEMMA ZONE DETECTION DETAIL.
8. BACKPLATES ON ALL PROPOSED SIGNAL HEADS SHALL BE FLEXIBLE TYPE. THE RIGID BACKPLATES ON EXISTING TO REMAIN HEADS SHALL BE REPLACED WITH FLEXIBLE BACKPLATES.

| VIDEO VEHICLE DETECTION ASSIGNMENTS | | | |
|---|---|---|---|
| VIDEO DETECTION | DETECTION ZONE | DELAY TIME (SECS.) | CONNECT TO MOVEMENT |
| VDS-4 | DZ-3 | 3 | 3 |
| VDS-4 | DZ-8 | | 8 |
| VDS-4 | DZ-8R | 8 | 8 |

SPECIAL SIGNAL OPERATING PLAN

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MICHAEL J. OATES, P.E.
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SIGNATURE AND DATE


Manatee County FLORIDA


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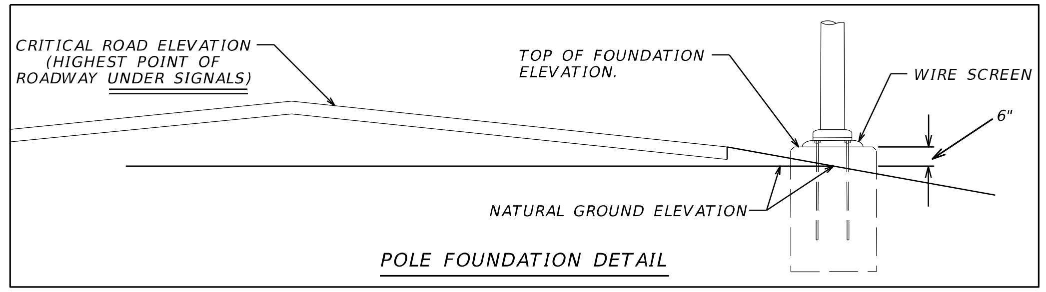
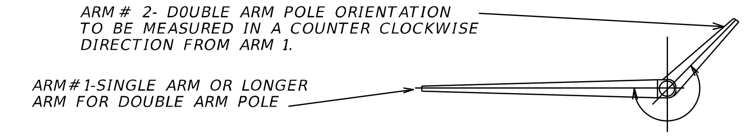
43RD STREET WEST RIGHT TURN LANE
NORTH OF CORTEZ ROAD

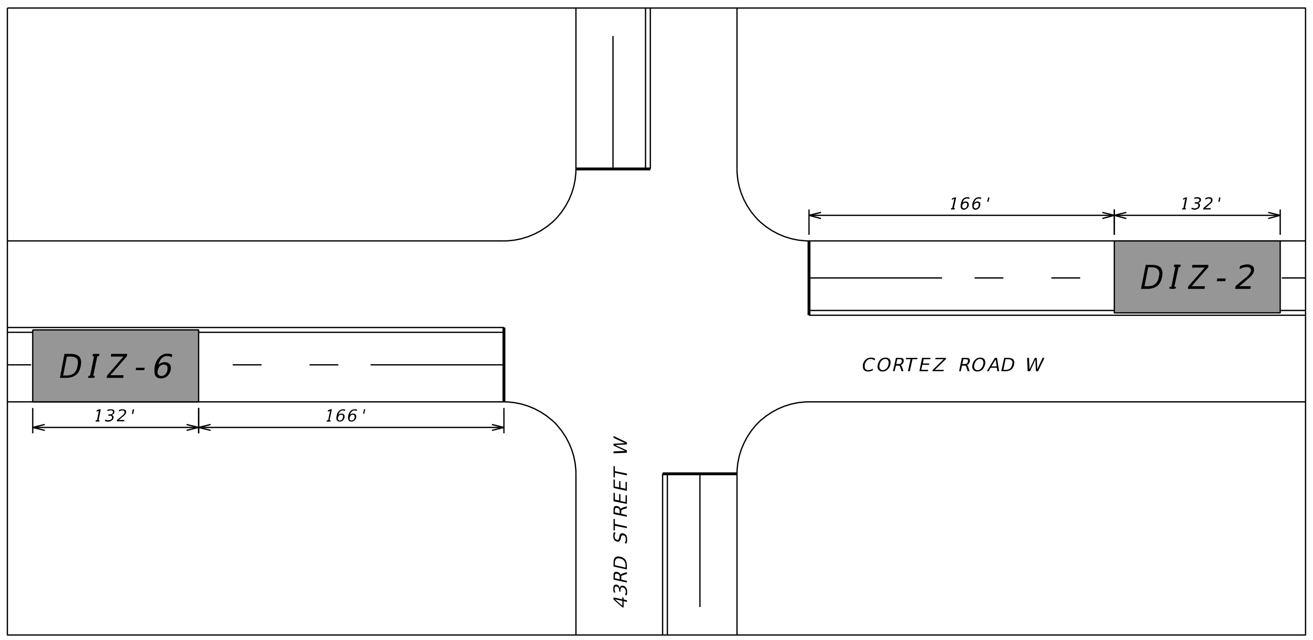
SIGNALIZATION PLAN

SHEET NO.
T-5

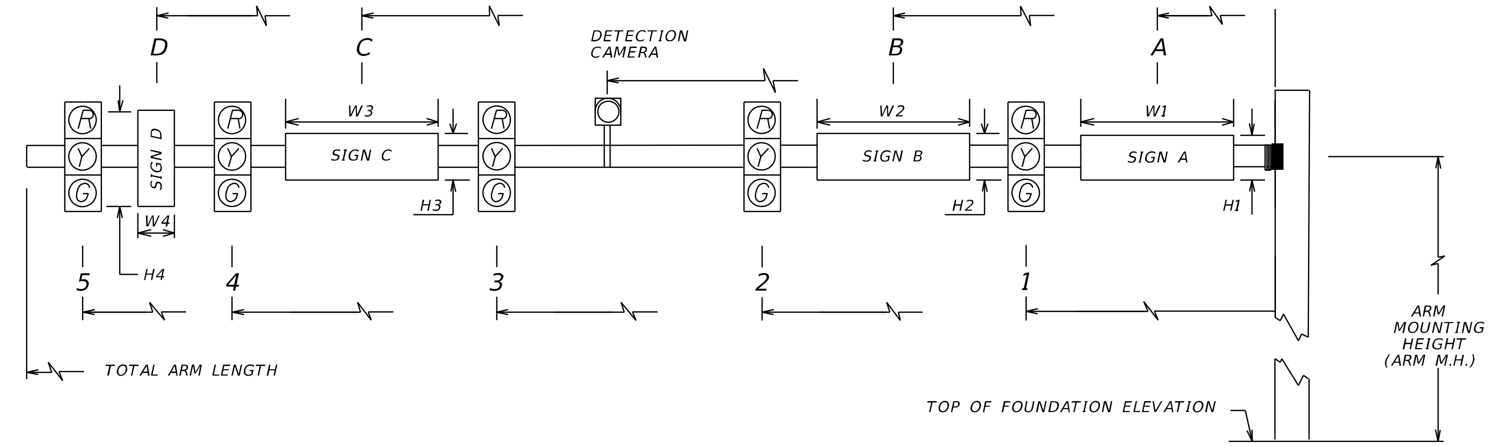



DILEMMA ZONE DETAIL




INTERNALLY ILLUMINATED SIGNS SHALL BE RIGID MOUNTED ON MAST ARM.




NOTE

-IN SIGN DATA TABLE, SIGN DESIGNATION (A, B, C, D, E) IS FOR POSITION REFERENCE ONLY. PLAN SHEETS AND SIGN DETAILS SHOULD BE REFERENCED FOR THE EXACT SIGNS TO BE INSTALLED ON MAST ARMS.

\+ BACKPLATES ON ALL PROPOSED SIGNAL HEADS SHALL BE FLEXIBLE TYPE. THE RIGID BACKPLATES ON EXISTING TO REMAIN HEADS SHALL BE REPLACED WITH FLEXIBLE BACKPLATES.

* DENOTES NUMBER OF SECTIONS IN SIGNAL HEAD ASSEMBLY

** DENOTES EXISTING TO REMAIN

| STRUCT. ID NO. | POLE ID NO. | SHEET NO. | LOCATION BY STA. | TOP OF FOUNDATION ELEV. | CRITICAL ROAD ELEV. | RDWY ARM NO. | SIGNAL DATA: SIGNAL V/H | BACK PLATES Y/N + | PED. SIGNAL Y/N | DISTANCE FROM POLE 1 | * | 2 | * | 3 | * | 4 | * | TOTAL ARM LENGTH | ARM M.H. | ANGLE BETWEEN DUAL ARMS 90/270 | SIGN DATA: DISTANCE FROM POLE / HEIGHT AND WIDTH OF SIGN A | H1 | W1 | B | H2 | W2 | C | H3 | W3 | D | H4 | W4 | E | H5 | W5 | F | H6 | W6 | BLUE-TOAD | VVDS DISTANCE FROM POLE 1 | MVDS DISTANCE FROM POLE 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13M126 | 1 | T-5 | 301+69.9, RT | 21.90' | 21.90' | 1 | V | Y | N | 14.0** | 5 | 24.0** | 3 | 34.0 | 4 | | | 46 | 21.5 | | 8.5** | 2.5 | 8 | | | | | | | | | | | | | | | | | 30.5** | |
| --- | ---- | ---- | ------------ | ------- | ------- | | | | | | | | | | | | | | | ----- | | | | | | | | | | | | | | | | | | | | | |
| 13M126 | 2 | T-5 | 300+34.2, RT | 22.15' | 22.10' | 1 | V | Y | N | 29 | 3 | 41 | 3 | 53 | 4 | | | 60 | 21.5 | | 8** | 2.5 | 8 | 50 | 3 | 2.5 | | | | | | | | | | | | | | 47 | 35 |
| --- | ---- | ---- | ------------ | ------- | ------- | | | | | | | | | | | | | | | ----- | | | | | | | | | | | | | | | | | | | | | |
| 13M126 | 3 | T-5 | 300+15.6, LT | 22.40' | 22.40' | 1 | V | Y | N | 14 | 5 | 22** | 3 | 32 | 4 | | | 46 | 21.5 | | 5 | 2.5 | 8 | | | | | | | | | | | | | | | | | 27** | |
| --- | ---- | ---- | ------------ | ------- | ------- | | | | | | | | | | | | | | | ----- | | | | | | | | | | | | | | | | | | | | | |
| 13M126 | 4 | T-5 | 301+62.6, LT | 23.18' | 22.50' | 1 | V | Y | N | 34 | 3 | 46 | 3 | 58 | 4 | | | 60 | 21.5 | | 12 | 2.5 | 8 | 55 | 3 | 2.5 | | | | | | | | | | | | | | 52 | 40 |
| --- | ----- | ---- | ------------ | ------ | ------ | | | | | | | | | | | | | | | ----- | | | | | | | | | | | | | | | | | | | | | |

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43RD STREET WEST RIGHT TURN LANE
NORTH OF CORTEZ ROAD

# MAST ARM TABULATION

SHEET NO.
T-6

## SIGNING AND PAVEMENT MARKING GENERAL NOTES:

1. ALL FLORIDA ROUTE MARKERS MUST CONFORM TO F.D.O.T. STANDARD PLANS INDEX NO. 700-102.
2. PAVEMENT MARKINGS SHALL BE PLACED AS SHOWN IN THE PLANS AND THE APPROPRIATE F.D.O.T. STANDARD PLANS.
3. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY THE LENGTH OF SIGN COLUMN SUPPORTS IN THE FIELD PRIOR TO FABRICATION.
4. REFER TO F.D.O.T. STANDARD PLANS INDEX NO. 706-001 FOR RETRO-REFLECTIVE PAVEMENT MARKER PLACEMENT DETAILS.
5. CAUTION SHALL BE EXERCISED WHILE RELOCATING EXISTING SIGNS SO AS TO PREVENT DAMAGE TO THE SIGNS. IF THE SIGNS ARE DAMAGED BEYOND USE, AS DETERMINED BY THE ENGINEER, THEY SHALL BE REPLACED BY THE CONTRACTOR AT HIS EXPENSE.
6. THE SIGN LOCATIONS ARE APPROXIMATE AND MAY REQUIRE FIELD ADJUSTMENT AS DIRECTED BY THE ENGINEER.
7. ANY EXISTING SIGN TO REMAIN THAT IS DISTURBED DURING CONSTRUCTION OR RELOCATED SHALL BE RESET TO CURRENT STANDARDS FOR HEIGHT, OFFSET, AND METHOD OF INSTALLATION. COST OF THIS WORK SHALL BE REFLECTED IN THE PAY ITEM NO. 102-1 IN THE SUMMARY OF ROADWAY PAY ITEMS.
8. COLUMNS (POSTS) FOR SINGLE COLUMN SIGNS ON CORTEZ ROAD SHALL BE ALUMINUM ROUND TUBE. SIGNS ON 43RD STREET WEST SHALL BE U-CHANNEL POST.
9. ALL SINGLE COLUMN SIGNS WITHIN THE LIMITS OF CLEARING AND GRUBBING SHALL BE REMOVED UNLESS OTHERWISE NOTED IN THE PLANS. PAYMENT SHALL BE REFLECTED IN THE PAY ITEM NO. 110-1-1 IN THE SUMMARY OF ROADWAY PAY ITEMS.
10. AT LOCATIONS WHERE UNDERGROUND UTILITIES ARE IN CLOSE PROXIMITY TO SIGN FOUNDATIONS AS DETERMINED BY THE CONTRACTOR, THE CONTRACTOR SHALL HAND DIG THE FIRST FOUR FEET OF THE HOLE FOR THE MULTI POST FOUNDATIONS.
11. UNLESS OTHERWISE NOTED ON PLAN SHEETS, ALL CROSSWALKS SHALL BE EIGHT FEET (8') IN WIDTH TO MATCH THE EXISTING CROSSWALKS. MEASUREMENTS SHALL BE FROM INSIDE TO INSIDE OF 12" STRIPES.

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43RD STREET WEST RIGHT TURN LANE
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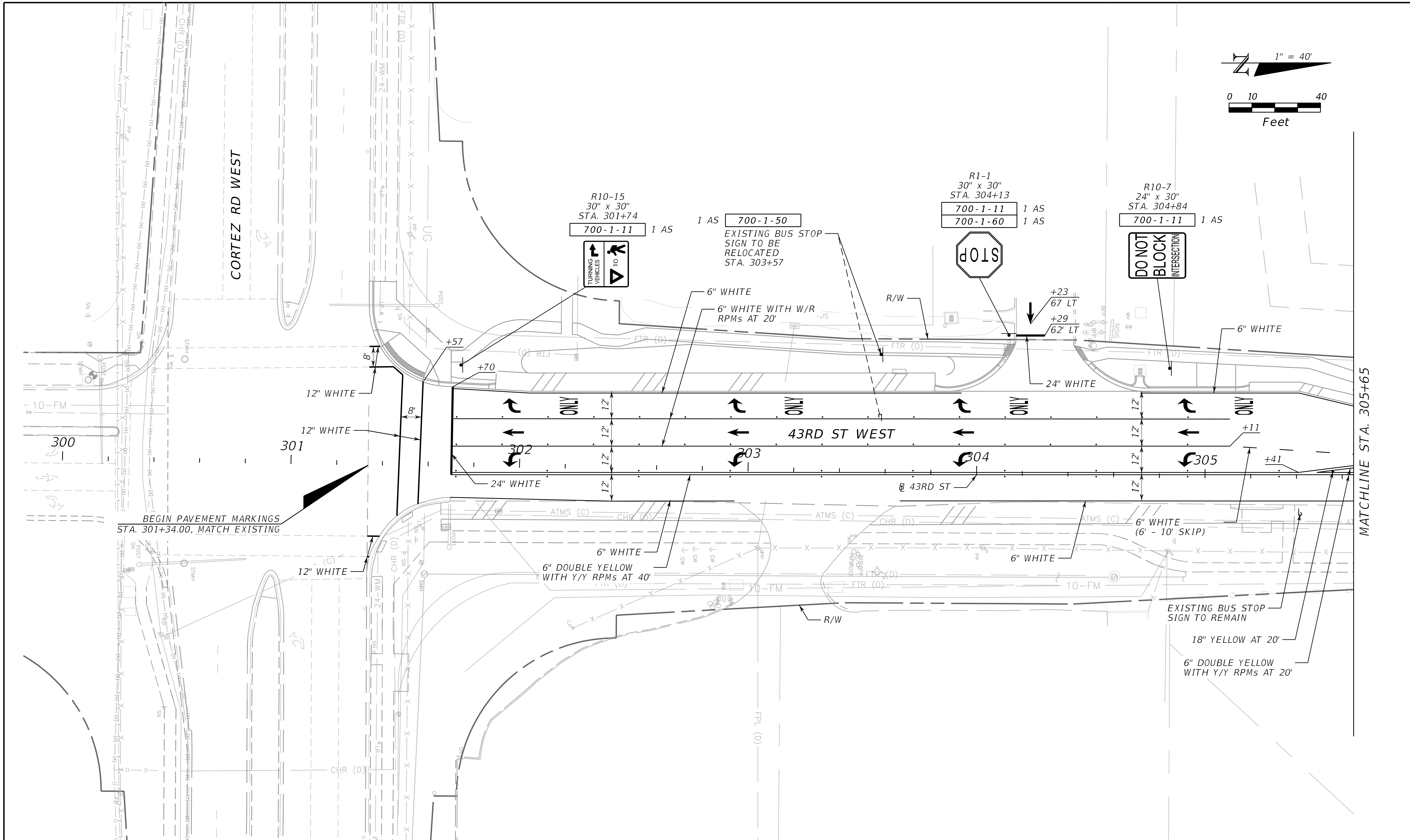
SIGNING AND PAVEMENT MARKING GENERAL NOTES

SHEET NO. T-7

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43RD STREET WEST RIGHT TURN LANE
NORTH OF CORTEZ ROAD

SIGNING AND PAVEMENT MARKING PLANS

SHEET NO.
T-8

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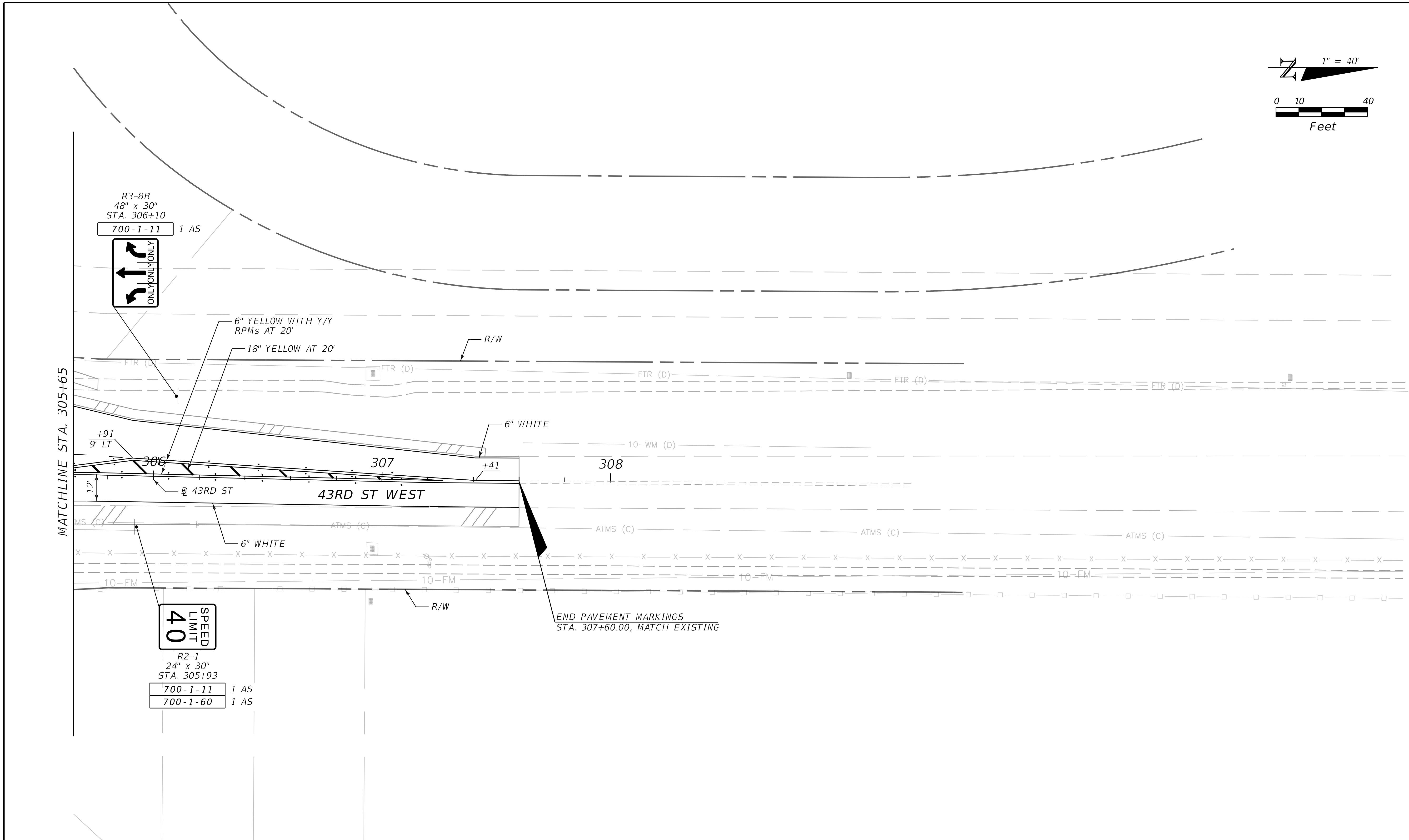


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| PROJECT # | 307-6076861 | SURVEYED | FDC | 07/14/20 |
| SURVEY # | 0577-0038 | DESIGNED | GAS | 08/13/21 |
| SEC./TWN./RGE | 04/35/17 | DRAWN | GAS | 08/13/21 |
| SCALE | | CHECKED | MJO | 08/13/21 |

MICHAEL J. DATES, P.E.
FLORIDA P.E. #49282

SIGNATURE AND DATE

Manatee County FLORIDA

HDR Engineering, Inc.
4830 W Kennedy Blvd., Suite 400
Tampa, FL 33609

43RD STREET WEST RIGHT TURN LANE
NORTH OF CORTEZ ROAD

SIGNING AND PAVEMENT MARKING PLANS

SHEET NO.
T-9

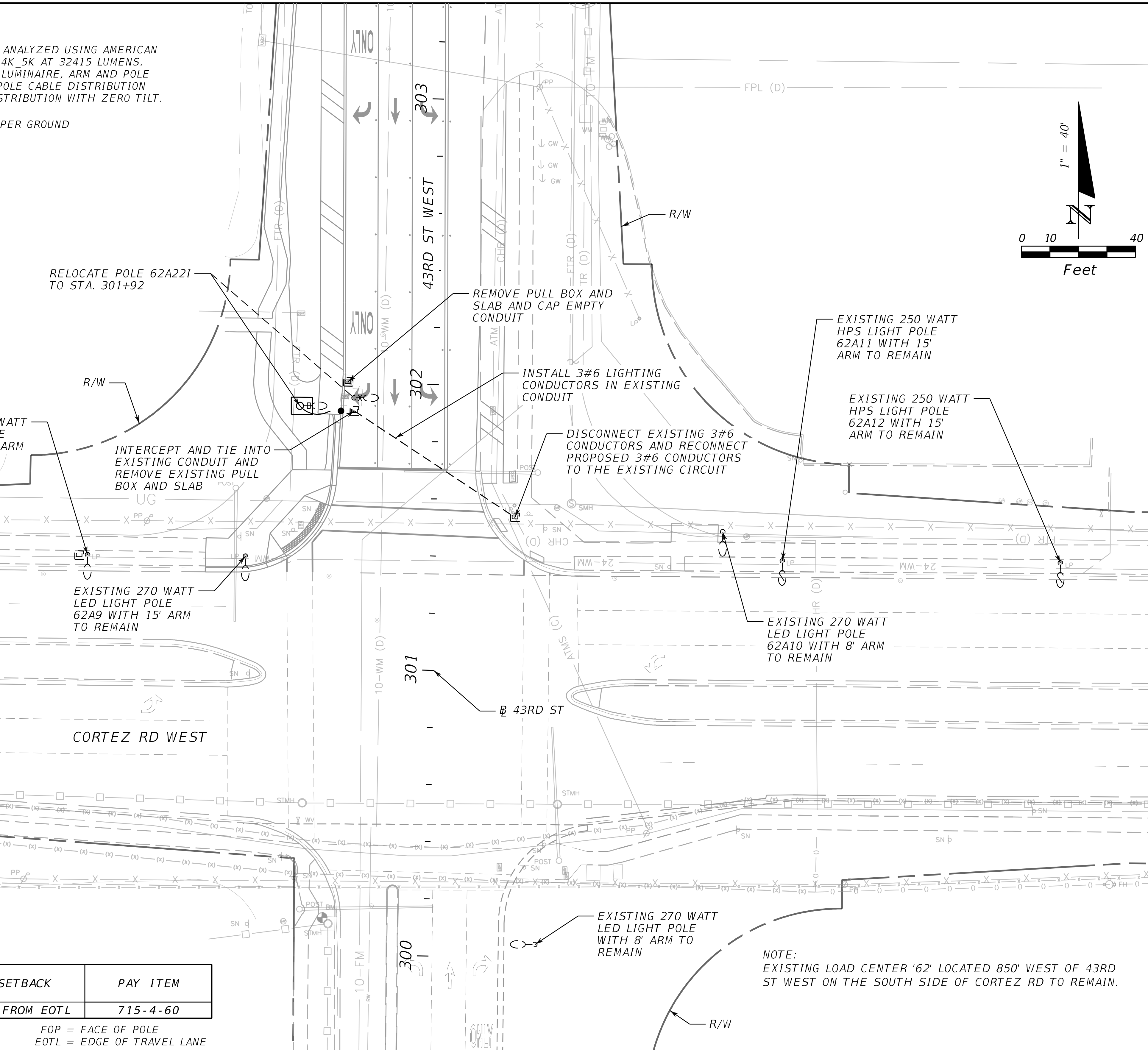
11:03:18 AM 1/13/2022 PW:\

# LEGEND

| SYMBOLS | DESCRIPTION |
|---|---|
| | RELOCATED 270 WATT LED LUMINAIRE AND CONVENTIONAL SHOULDER MOUNTED LIGHT POLE. ANALYZED USING AMERICAN ELECTRIC LIGHTING LUMINAIRE, PHOTOMETRIC CURVE NUMBER ATB2_80BLEDE10_XXXXX_R3_4K_5K AT 32415 LUMENS. POLE MOUNTING HEIGHT IS 35 FT AND ARM LENGTH IS 8 FT. SYMBOL INCLUDES RELOCATED LUMINAIRE, ARM AND POLE WITH PROPOSED STANDARD FOUNDATION, PULL BOX, BREAKAWAY TRANSFORMER BASE, AND POLE CABLE DISTRIBUTION SYSTEM. THE LUMINAIRE IS A CUTOFF FIXTURE DESIGNED FOR MEDIUM THROW TYPE III DISTRIBUTION WITH ZERO TILT. |
| — • — | CONDUIT INSTALLED BY OPEN TRENCH METHOD WITH CONDUCTORS INSIDE. RUN ONE (1) COPPER GROUND BONDING CONDUCTOR (GREEN INSULATION) INSIDE WITH OTHER CONDUCTORS. |
| – – – – | EXISTING CONDUIT |
| | EXISTING LIGHTING PULL BOX |
| | EXISTING LIGHT POLE TO BE RELOCATED. |
| | EXISTING LIGHT POLES TO REMAIN. |

## CONVENTIONAL LIGHTING DESIGN CRITERIA FOR SIGNALIZED INTERSECTION

| | |
|---|---|
| DESIGN WIND SPEED | 140 MPH |
| AVERAGE HORIZONTAL INITIAL ILLUMINATION | 1.5 H.F.C. STD / 1.0 H.F.C. MIN |
| AVERAGE VERTICAL INITIAL ILLUMINATION | 1.5 V.F.C. STD / 1.0 V.F.C. MIN |
| AVERAGE TO MIN. | 4:1 OR LESS |
| MAX TO MIN. | 10:1 OR LESS |




NOTE:
EXISTING LOAD CENTER '62' LOCATED 850' WEST OF 43RD ST WEST ON THE SOUTH SIDE OF CORTEZ RD TO REMAIN.

## POLE DATA

| POLE NO. | CIRCUIT | STATION | DIST. OR ARM | LUMINAIRE WATTAGE | MOUNTING HEIGHT | POLE SETBACK | PAY ITEM |
|---|---|---|---|---|---|---|---|
| 62A22I | 62A | 301+92, LT | 8' | 270 | 35' | FOP 14' FROM EOTL | 715-4-60 |

FOP = FACE OF POLE
EOTL = EDGE OF TRAVEL LANE

| NUMBER | DESCRIPTION | DATE |
|---|---|---|
| | | |

| | | | | |
|---|---|---|---|---|
| PROJECT # | 307-6076861 | SURVEYED | FDC | 07/14/20 |
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| SEC./TWN./RGE | 04/35/17 | DRAWN | GAS | 08/13/21 |
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MICHAEL J. OATES, P.E.
FLORIDA P.E. #49282

SIGNATURE AND DATE

Manatee County FLORIDA

HDR Engineering, Inc.
4830 W Kennedy Blvd., Suite 400
Tampa, FL 33609

43RD STREET WEST RIGHT TURN LANE
NORTH OF CORTEZ ROAD

LIGHTING PLAN

SHEET NO.
T-10

# Appendix B. Existing Signalization Plans

**CONTRACT DRAWINGS**

# CORTEZ ROAD WEST (SR 684) AT 43RD STREET WEST INTERSECTION IMPROVEMENTS

FOR

MANATEE COUNTY, FLORIDA

COUNTY PROJECT NUMBER: 6076860

FINANCIAL PROJECT ID: 425530-1-58-01

(FEDERAL FUNDS)

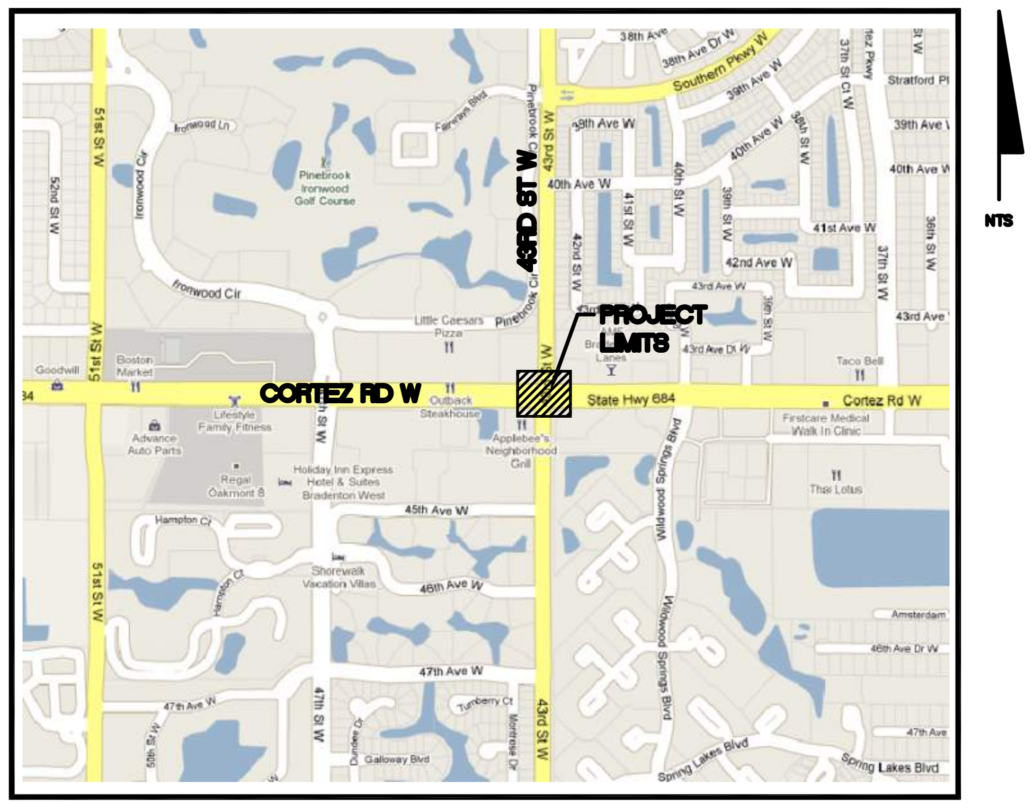
SIGNALIZATION PLANS

SIGNAL ID NUMBER: 446

GOVERNING STANDARDS AND SPECIFICATIONS:

FLORIDA DEPARTMENT OF TRANSPORTATION DESIGN STANDARDS, DATED 2010 AND APPLICABLE SECTIONS, ARTICLES AND SUBARTICLES OF DIVISION I AND ALL DIVISION II & III OF THE FLORIDA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, DATED 2010, INCLUDING ALL SUPPLEMENTAL SPECIFICATIONS, AS AMENDED BY CONTRACT DOCUMENTS.

APPLICABLE DESIGN STANDARDS MODIFICATIONS: 7-1-10. FOR DESIGN STANDARDS MODIFICATIONS CLICK ON "DESIGN STANDARDS" AT THE FOLLOWING WEB SITE: HTTP://WWW.DOT.STATE.FL.US/RDDESIGN/.




ATTENTION IS DIRECTED TO THE FACT THAT THESE PLANS MAY HAVE BEEN REDUCED IN SIZE BY REPRODUCTION. THIS MUST BE CONSIDERED WHEN OBTAINING SCALED DATA.

## UTILITY WARNING NOTE

ABOVE GROUND AND / OR UNDERGROUND UTILITIES MAY BE IN THE AREA OF THIS PROJECT – PROCEED WITH CAUTION – THE CONTRACTOR SHALL CALL SUNSHINE STATE "ONE CALL" AT 1-800-432-4770 AND THE UTILITY OWNERS IN ADVANCE OF BEGINNING WORK, IN ACCORDANCE WITH CHAPTER 556, FLORIDA STATUTES.

| SUMMARY OF REVISIONS | |
|---|---|
| DATE | DESCRIPTION |
| | |

INDEX OF PLANS



SHOP DRAWINGS TO BE SUBMITTED TO:


UPIK Y. SUWARNO, P.E.
CARDNO TBE
380 PARK PLACE BLVD., SUITE 300
CLEARWATER, FLORIDA 33759
(727) 531-3505


48 HOURS BEFORE DIGGING
"CALL SUNSHINE"
1-800-432-4770

PLANS PREPARED BY:


Cardno TBE
380 Park Place Blvd., Suite 300, Clearwater, Florida 33759
www.cardnotbe.com - 727.531.3505
Certificate of Authorization No. 3843


ENGINEER OF RECORD

UPIK Y. SUWARNO, PE — FL. LICENSE NO. 62995

DATE

# 100% SUBMITTAL

DATE: 11-03-10
SCALE: HORIZ: N/A VERT: N/A
SHEET: T-1

DATE: 01/12/10 TIME: 10:54 SCALE: 40 FILENAME: U:\ROH\CORTEZ.DWG

# TABULATION OF QUANTITIES

| PAY ITEM NO. | DESCRIPTION | UNIT | SHEET NUMBERS | | | | | | | | | | | | | | | | | | | | TOTAL THIS SHEET | | GRAND TOTAL | | REF. SHEET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | T-5 | | T-9 | | T-11 | | | | | | | | | | | | | | | | | | | | |
| | | | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | |
| 101-1 | MOBILIZATION | LS | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 102-1 | MAINTENANCE OF TRAFFIC | LS | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 110-4 | REMOVAL OF EXISTING CONCRETE PAVEMENT | SY | | | | | 93.4 | | | | | | | | | | | | | | | | 93.4 | | 93.4 | | |
| 520-1-10 | CONCRETE CURB & GUTTER, TYPE F CURB | LF | | | | | 104 | | | | | | | | | | | | | | | | 104 | | 104 | | |
| 522-2 | 6" CONCRETE SIDEWALK | SY | | | | | 165.5 | | | | | | | | | | | | | | | | 165.5 | | 165.5 | | |
| 555-1-2 | DIRECTIONAL BORE (6" TO <12") (2" HDPE) | LF | 315 | | | | | | | | | | | | | | | | | | | | 315 | | 315 | | |
| 630-1-12 | CONDUIT (F&I) (UNDERGROUND) (1.25") | LF | 5 | | | | | | | | | | | | | | | | | | | | 5 | | 5 | | |
| 630-1-12 | CONDUIT (F&I) (UNDERGROUND) (2") | LF | 580 | | | | | | | | | | | | | | | | | | | | 580 | | 580 | | |
| 630-1-13 | CONDUIT (F&I) (UNDERPAVEMENT) | LF | 70 | | | | | | | | | | | | | | | | | | | | 70 | | 70 | | |
| 632-7-1 | CABLE (SIGNAL) (F&I) | PI | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 635-1-11 | PULL & JUNCTION BOXES (F&I) (PULL BOX) | EA | 10 | | | | | | | | | | | | | | | | | | | | 10 | | 10 | | |
| 639-1-22 | ELECTRICAL POWER SERVICE (UNDERGROUND) | AS | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| | (PURCHASED BY CONTRACTOR FROM POWER CO) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 639-2-1 | ELECTRICAL SERVICE WIRE (F&I) | LF | 840 | | | | | | | | | | | | | | | | | | | | 840 | | 840 | | |
| 641-2-12 | PRESTRESSED CONCRETE POLE (F&I) | EA | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| | (TYPE P-11 SERVICE POLE) (12FT) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 649-31-202 | STEEL MAST ARM ASSEMBLY (F&I)(130 MPH)(46') | EA | 2 | | | | | | | | | | | | | | | | | | | | 2 | | 2 | | |
| 649-31-203 | STEEL MAST ARM ASSEMBLY (F&I)(130 MPH)(60') | EA | 2 | | | | | | | | | | | | | | | | | | | | 2 | | 2 | | |
| 650-51-311 | TRAFFIC SIGNAL (F&I) (3-SECT.) (1-WAY) (LED) | AS | 4 | | | | | | | | | | | | | | | | | | | | 4 | | 4 | | |
| 650-51-511 | TRAFFIC SIGNAL (F&I) (5-SECT.) (1-WAY) (LED) | AS | 4 | | | | | | | | | | | | | | | | | | | | 4 | | 4 | | |
| 653-191 | PEDESTRIAN SIGNAL (F&I) (LED COUNTDOWN) (1 WAY) | AS | 8 | | | | | | | | | | | | | | | | | | | | 8 | | 8 | | |
| 659-101 | SIGNAL HEAD AUXIL. (F&I) (BACKPLATES, 3-SECT) | EA | 4 | | | | | | | | | | | | | | | | | | | | 4 | | 4 | | |
| 659-106 | SIGNAL HEAD AUXIL. (F&I) (TUNNEL VISOR) | EA | 32 | | | | | | | | | | | | | | | | | | | | 32 | | 32 | | |
| 659-107 | SIGNAL HEAD AUXIL. (F&I) (ALUMINUM PEDESTAL) | EA | 8 | | | | | | | | | | | | | | | | | | | | 8 | | 8 | | |
| 659-118 | SIGNAL HEAD AUXIL. (F&I) (BACKPLATES, 5-SECT) | EA | 4 | | | | | | | | | | | | | | | | | | | | 4 | | 4 | | |
| 663-74-15 | VEHICLE DETECTOR ASSEMBLIES (F&I) (VIDEO) | EA | 4 | | | | | | | | | | | | | | | | | | | | 4 | | 4 | | |
| 665-13 | PEDESTRIAN DETECTOR (F&I) (WITH SIGN ONLY) | EA | 8 | | | | | | | | | | | | | | | | | | | | 8 | | 8 | | |
| 670-5-110 | TRAFFIC CONTROLLER ASSEMBLY (F&I) (NEMA) | AS | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| | (NO PREEMPTION) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 685-106 | UNINTERRUPTIBLE POWER SOURCE (UPS) | EA | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 690-10 | REMOVE SIGNAL HEAD ASSEMBLY | EA | 8 | | | | | | | | | | | | | | | | | | | | 8 | | 8 | | |
| 690-33-1 | REMOVE POLE (DEEP) (DIRECT BURIAL) | LF | 40 | | | | | | | | | | | | | | | | | | | | 40 | | 40 | | |
| 690-50 | REMOVE CONTROLLER ASSEMBLY | EA | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 690-60 | REMOVE VEHICLE DETECTOR ASSEMBLY | EA | 10 | | | | | | | | | | | | | | | | | | | | 10 | | 10 | | |
| 690-80 | REMOVE SPAN WIRE ASSEMBLY | EA | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 690-90 | REMOVE CONDUIT & CABLING | PI | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 690-100 | REMOVE MISCELLANEOUS SIGNAL EQUIPMENT | PI | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 699-1-1 | INTERNALLY ILLUMINATED SIGN (F&I)(EDGE LIT LED) | EA | 4 | | | | | | | | | | | | | | | | | | | | 4 | | 4 | | |
| 700-48-60 | SIGN PANEL (REMOVE) | EA | 3 | | | | | | | | | | | | | | | | | | | | 3 | | 3 | | |
| 711-11-121 | THERMOPLASTIC PAVEMENT MARKINGS (6" WHITE) | LF | | | 72 | | | | | | | | | | | | | | | | | | 72 | | 72 | | |
| 711-11-123 | THERMOPLASTIC PAVEMENT MARKINGS (12" WHITE) | LF | | | 465 | | | | | | | | | | | | | | | | | | 465 | | 465 | | |
| 711-17 | REMOVE THERMOPLASTIC PAVEMENT MARKINGS | SF | | | 525 | | | | | | | | | | | | | | | | | | 525 | | 525 | | |
| 783-1-121 | ITS FIBER OPTIC CABLE (F&I) | LF | 65 | | | | | | | | | | | | | | | | | | | | 65 | | 65 | | |
| 783-2-31 | ITS FIBER OPTIC (INSTALL) (SPLICE) | EA | 4 | | | | | | | | | | | | | | | | | | | | 4 | | 4 | | |
| 784-1-1 | ITS FIELD ETHERNET SWITCH | EA | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

MANATEE COUNTY

CORTEZ ROAD WEST AND 43RD STREET WEST

Cardno TBE
12481 Telecom Drive, Tampa, Florida 33637
www.cardnotbe.com - 813.221.0048
Certificate of Authorization No. 3843

UPIK Y. SUWARNO DATE
LIC. NO.: 62995

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

TABULATION OF QUANTITIES

PROJECT NO: 00193-008-05
DATE: 11-03-10
SHEET NO: T-2

FILE: J:\JOB\0193\00193-008-05\ACAD\TABQSG01.dwg LAST SAVED: Wed, 11/03/10-4:05p PLOTTED: Wed, 11/03/10-4:05p BY: JTP

## GENERAL NOTES

1. THE CONTRACTOR SHALL CONTACT THE ENGINEER, IN CONJUNCTION WITH THE MANATEE COUNTY PROJECT MANAGEMENT DIVISION BEFORE STARTING WORK. COUNTY STANDARD UPDATES OR OTHER INFORMATION SHALL BE OBTAINED.

2. ONE WEEK PRIOR TO THE BEGINNING OF THE TRAFFIC SIGNAL INSTALLATION, LOOP CUTTING, OR TURN ON OF A NEW SIGNAL, THE CONTRACTOR SHALL NOTIFY:

   PUBLIC WORKS DEPARTMENT
   MANATEE COUNTY PROJECT MANAGEMENT DIVISION
   1026 26TH AVENUE EAST
   BRADENTON, FLORIDA 34208
   PHONE: 941-708-7510

   PUBLIC WORKS DEPARTMENT
   MANATEE COUNTY TRAFFIC ENGINEERING DIVISION
   2101 47TH TERRACE EAST
   BRADENTON, FLORIDA 34203
   PHONE: 941-749-3502

3. THE CONTRACTOR SHALL COORDINATE WITH MANATEE COUNTY'S TRAFFIC ENGINEERING DIVISION (941-749-3502), AT LEAST TWO WEEKS, BEFORE ANY CABINET MODIFICATIONS ARE TO BE PERFORMED. MANATEE COUNTY ENGINEERING DIVISION PERSONNEL WILL REVIEW, ASSIST AND PROVIDE TECHNICAL SUPPORT RELEVANT TO ANY FIELD MODIFICATIONS THAT ARE NECESSARY. THE CONTRACTOR MAY OPTION OUT OF THIS PROPOSITION, IF THEY FEEL ASSISTANCE AND OVERSIGHT ARE NOT NECESSARY.

4. THE PRIME CONTRACTOR SHALL BE RESPONSIBLE FOR THE SIGNAL MAINTENANCE, TIMING AND OPERATION OF ALL SIGNALS AND SIGNAGE FROM THE COMMENCEMENT OF WORK TO FINAL ACCEPTANCE OF THE PROJECT (I.E. EXISTING LOOPS CUT AND TEMPORARY DETECTION REQUIRED, SYSTEM COMMUNICATION TERMINATED, LANE OR PAVEMENT MODIFICATIONS, PEDESTRIAN MODIFICATIONS). MANATEE COUNTY WILL ASSIST IN PROVIDING EXISTING SYSTEM TIMING WHEN POSSIBLE.

5. THE CONTRACTOR SHALL HAVE I.M.S.A. CERTIFIED LEVEL II PERSONNEL (ELECTRONICS OR ELECTRICAL TECHNICIAN) ON THE JOB SITE AT ALL TIMES WHILE WORK IS BEING PERFORMED. ALL SIGNAL INSTALLATION TECHNICIANS SHALL HAVE A MINIMUM OF I.M.S.A. LEVEL I CERTIFICATION. CERTIFICATIONS OF ALL TECHNICIANS SHALL BE PROVIDED TO THE ENGINEER, IN CONJUNCTION WITH THE COUNTY PRIOR TO BEGINNING WORK. THE CONTRACTOR SHALL MAINTAIN ADEQUATE REPAIR INVENTORY, EQUIPMENT AND NEARBY PERSONNEL TO RESPOND AND CORRECT TRAFFIC SIGNAL MALFUNCTIONS AND MOT RELATED PHASING AND TIMING ISSUES FOR THE DURATION OF THE PROJECT.

   THE SIGNAL CONTRACTOR SHALL BE AVAILABLE TO RESPOND TO TROUBLE CALLS WITHIN A MINIMUM OF TWO HOURS, TWENTY-FOUR HOURS A DAY, SEVEN DAYS A WEEK FOR THE DURATION OF THE PROJECT. THE PRIME CONTRACTOR SHALL PROVIDE CONTACT NUMBERS OF THE SIGNAL CONTRACTOR TO THE ENGINEER, IN CONJUNCTION WITH THE MANATEE COUNTY TRAFFIC ENGINEERING DIVISION AT COMMENCEMENT OF THE PROJECT. FURTHERMORE, WITHIN TWO HOURS OF NOTIFICATION OR DOCUMENTED ATTEMPTED NOTIFICATIONS, THE SIGNAL CONTRACTOR SHALL BE ON SITE MAKING NEEDED REPAIRS OR MODIFICATIONS. FAILURE TO MEET THE TIME REQUIREMENTS SHALL GIVE THE ENGINEER, IN CONJUNCTION WITH THE COUNTY, AT ITS DISCRETION, THE RIGHT TO REQUEST ASSISTANCE FROM THE MANATEE COUNTY SHERIFF'S DEPARTMENT TO CONTROL TRAFFIC FOR THE PERIOD OF TIME UNTIL THE CONTRACTOR RESPONDS AND MAKES THE NEEDED REPAIRS. THE COST FOR THE MANATEE COUNTY SHERIFF'S OFFICE SHALL BE THE CONTRACTOR'S RESPONSIBILITY.

6. PRIOR TO ORDERING MATERIALS, THE SIGNAL CONTRACTOR SHALL CONTACT THE ENGINEER, IN CONJUNCTION WITH THE MANATEE COUNTY TRAFFIC OPERATIONS DIVISION THROUGH THE PROJECT MANAGEMENT DIVISION AND VERIFY CURRENT COLOR CODES TO BE USED FOR SIGNAL AND INTERCONNECT CABLE.

7. FIVE WORKING DAYS PRIOR TO THE FINAL INSPECTION THE CONTRACTOR SHALL FURNISH THE ENGINEER, IN CONJUNCTION WITH THE COUNTY TWO COMPLETE SETS OF AS-BUILT PLANS AND I.M.S.A. INSPECTION FORMS. ONE COMPLETE SET SHALL ALSO BE FURNISHED TO THE PROJECT MANAGEMENT DIVISION AND TRAFFIC ENGINEERING DIVISION. THE AS-BUILT PLANS SHALL CLEARLY INDICATE THE LOCATION OF THE INSTALLED POLES, CONDUIT, PULL BOXES, GROUND RODS, VIRTUAL LOOPS, ETC. MEG READINGS FOR GROUND RODS SHALL ALSO BE INCLUDED.

8. UPON PASSING THE FINAL INSPECTION THE CONTRACTOR SHALL SEND A WRITTEN REQUEST TO THE PROJECT MANAGEMENT DIVISION AND THE TRAFFIC ENGINEERING DIVISION TO TRANSFER MAINTENANCE FROM THE CONTRACTOR TO MANATEE COUNTY. MANATEE COUNTY WILL RESPOND WITHIN 5 WORKING DAYS TO ESTABLISH A TIME TABLE FOR THE TRANSFER OF MAINTENANCE RESPONSIBILITY.

9. THE LOCATION OF UTILITIES SHOWN ON THE PLANS ARE BASED ON LIMITED INVESTIGATION TECHNIQUES AND SHOULD BE CONSIDERED APPROXIMATE THE LOCATION OF UTILITIES SHOWN ON THE PLANS ARE APPROXIMATE ONLY. THE EXACT LOCATIONS SHALL BE DETERMINED BY THE CONTRACTOR, VIA SUNSHINE STATE ONE CALL OF FLORIDA, INC., IN COORDINATION WITH UNDERGROUND AND OVERHEAD UTILITY OWNERS. A MINIMUM OF 2 FULL BUSINESS DAYS PRIOR TO DIGGING IS REQUIRED. THE CONTRACTOR SHALL ALSO CONTACT MANATEE COUNTY FOR COUNTY OWNED UTILITIES.

10. THE CONTRACTOR SHALL NOTIFY THE APPROPRIATE UTILITY COMPANIES AT LEAST 72 HOURS IN ADVANCE OF POLE SETTING OPERATIONS WHERE CONFLICT WITH OVERHEAD ELECTRICAL CONDUCTORS IS EXPECTED AND IN ALL CASES WHERE JOINT USE POLES ARE CALLED FOR.

    EXISTING UTILITIES ARE TO REMAIN IN PLACE UNLESS OTHERWISE NOTED.

11. THE CONTRACTOR SHALL HAND DIG THE FIRST 60 INCHES (5 FEET) OF THE HOLE FOR THE POLE FOUNDATION OR CONDUIT RUN WHERE UTILITIES ARE IN CLOSE PROXIMITY.

12. THE CONTRACTOR IS TO DE-WATER THE POLE FOUNDATION EXCAVATION IF THE ELEVATION OF WATER IS HIGHER THAN THE ELEVATION OF THE FOUNDATION BASE.

13. #14 XHHW PULL WIRE SHALL BE INSTALLED IN ALL CONDUITS. AT LEAST 2 FEET OF PULL WIRE SHALL BE ACCESSIBLE AT EACH CONDUIT TERMINATION AND SECURED IN THE PULL BOX OR PLACE OF TERMINATION.

14. UNLESS OTHERWISE NOTED ALL REMOVED EQUIPMENT EXCEPT CONCRETE POLES SHALL BE TURNED OVER TO MANATEE COUNTY AND DELIVERED TO THE TRAFFIC OPERATIONS DIVISION, LOCATED AT 2404 12TH STREET COURT EAST, BRADENTON, FLORIDA 34208, AS DIRECTED BY THE COUNTY PROJECT MANAGER. CONCRETE POLES SHALL BE DISPOSED OF BY THE SIGNAL CONTRACTOR IN AREAS PROVIDED BY THE CONTRACTOR.

15. THE CONTRACTOR SHALL CONTACT THE LOCAL POWER COMPANY FOR ITS ASSISTANCE IN PERFORMING ALL NECESSARY WORK UNDER POWER LINES AT SIGNAL POLES, SUCH AS THE INSTALLATION AND/OR REMOVAL OF SIGNAL CABLE, FIBERGLASS INSULATORS AND SIGNAL POLES.

16. THE CONTRACTOR SHALL CONTACT MANATEE COUNTY FOR THE ASSIGNMENT OF THE PHYSICAL ADDRESS ONCE THE SERVICE DROP LOCATION HAS BEEN ESTABLISHED.

17. ALL COSTS FOR GROUNDING SHALL BE INCLUDED IN THE COST OF THE ITEM BEING GROUNDED. ALL GROUND ROD ASSEMBLIES FOR POLES, SERVICES, CABINETS, AND OTHER RELATED EQUIPMENT SHALL BE BONDED TOGETHER TO FORM AN INTEGRATED GROUNDING SYSTEM USING #6 AWG THHN COPPER WIRE. THE UPPER END OF ALL GROUND RODS SHALL BE 6 INCHES BELOW GROUND ELEVATION. GROUND ROD LOCATIONS SHALL BE MARKED WITH PERMANENT MARKER SUCH AS AN EPOXIED STICKER LOCATED ON THE NEAREST CURB, ALSO ACCURATE GROUNDING ARRAY AND GROUND ROD LOCATIONS ON SIGNAL AS-BUILT DRAWINGS SHALL BE PROVIDED. GROUNDING CONDUCTOR MUST BE #6 OR LARGER THHN BARE COPPER.

18. GROUND ROD TO CONDUCTOR CONNECTING DEVICES SHALL BE NON-CORROSIVE SPLIT BOLTS, CLAMPS, PRESSURE CONNECTORS, OR OTHER APPROVED MEANS TO ENSURE A POSITIVE CONNECTION.

19. GROUND RESISTANCE TESTER, OR OTHER APPROVED MEANS WILL BE USED TO ACQUIRE THE GROUND ROD RESISTANCE. A MEMBER OF THE TRAFFIC OPERATIONS DIVISION STAFF SHALL BE PRESENT DURING THE TEST.

20. ELEVATION OF THE TOP OF THE MAST ARM FOUNDATION SHALL BE SIX INCHES ABOVE EXISTING GRADE. IF LOCATED DIRECTLY BACK OF SIDEWALK, THE FOUNDATION ELEVATION SHALL MATCH SIDEWALK GRADE.

21. IT SHOULD BE NOTED THAT NO TEST BORINGS WERE MADE WHERE CONDUIT RUNS ARE TO BE INSTALLED BY JACKING OR BORING.

22. CONTRACTOR SHALL SUPPLY ALL MATERIAL SUBMITTALS TO THE ENGINEER, IN CONJUNCTION WITH MANATEE COUNTY PROJECT MANAGEMENT DIVISION PRIOR TO CONSTRUCTION FOR APPROVAL.

23. THE TYPE OF EQUIPMENT USED IN THE INSTALLATION OF MAST ARMS/ FOUNDATIONS, OVERHEAD CANTILEVER SIGNS/ FOUNDATIONS, AND THE MOVEMENT/INSTALLATION OF STRAIN POLES SHALL MEET THE FOLLOWING REQUIREMENTS: 1) OVERHEAD LINES SHALL STAY IN PLACE BOTH VERTICALLY AND HORIZONTALLY AND; 2) CONTRACTOR SHALL MEET ALL APPLICABLE OSHA REQUIREMENTS (20 FOOT MINIMUM DISTANCE MAINTAINED BETWEEN THE EQUIPMENT AND THE ELECTRICAL OVERHEAD FACILITY). ANY COST ASSOCIATED WITH THE TYPE OF EQUIPMENT REQUIRED FOR THIS INSTALLATION IS INCLUDED IN THE RELATED PAY ITEMS.

24. EXISTING SIGNALIZATION SHALL REMAIN IN PLACE TO THE EXTENT POSSIBLE, INCLUDING VEHICLE ACTUATION AND PEDESTRIAN SIGNAL OPERATION, AND SHALL BE USED FOR MAINTENANCE OF TRAFFIC AS REQUIRED.

25. THE CONTRACTOR SHALL COORDINATE WITH MANATEE COUNTY TRAFFIC ENGINEERING DIVISION ABOUT THE ON GOING MANATEE ATMS PROJECT THAT INCLUDES THIS INTERSECTION PRIOR TO START OF CONSTRUCTION AND ORDERING MATERIAL.

26. THE CONTRACTOR SHALL FIELD VERIFY ALL CRITICAL ELEVATIONS PRIOR TO ORDERING MAST ARMS.

27. ALL LONG VIDEO DETECTOR LOOPS SHALL BE 6' X 40', PLACED 2' IN FRONT OF THE STOP BAR. THE ADVANCE LOOPS ARE 6' X 6' PLACED 25' UPSTREAM OF THE STOP BAR.

28. WHEN A CONTRACTOR IS WORKING ON A SIGNAL IN AN INTERSECTION (INSTALLING CONDUIT IN THE STREET, REMOVING EXISTING SIGNAL EQUIPMENT, INSTALLING SIGNAL EQUIPMENT, LOOPS, HOMERUNS OR TURNING ON OF NEW SIGNAL) WHERE A LANE IS CLOSED, THE ENGINEER MAY REQUIRE AN OFF DUTY LAW ENFORCEMENT OFFICER TO DIRECT TRAFFIC. THE HOURLY RATE OF PAY FOR AN OFF DUTY LAW ENFORCEMENT OFFICER CAN BE OBTAINED FROM THE LOCAL LAW ENFORCEMENT OFFICE. THE COST OF THE OFFICER SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

29. MINIMUM FIBER OPTIC PULL BOX SIZE SHALL BE 2 FT WIDE BY 3 FT LONG BY 3 FT DEEP. THIS REQUIREMENT SHALL APPLY TO TWISTED PAIR COMMUNICATIONS CABLES AS WELL AS FIBER OPTIC CABLE.

30. 2 INCH PVC SCHEDULE 40 CONDUIT SHALL BE USED FOR UNDERGROUND COMMUNICATION CONDUIT INSTALLATIONS. THE INSTALLATION AND TERMINATION OF THE CONDUIT SHALL ADHERE TO INDEX 18202 AND INDEX 18204 OF THE 2010 FDOT DESIGN STANDARDS.

31. COAT ALL CONDUIT THREADS WITH AN ANTI-SEIZE LUBRICANT.

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

MANATEE COUNTY

CORTEZ ROAD AND 43RD STREET WEST

Cardno TBE
12481 Telecom Drive, Tampa, Florida 33637
www.cardnotbe.com - 813.221.0048
Certificate of Authorization No. 3843

UPIK Y. SUWARNO DATE
LIC. NO.: 62995

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

GENERAL NOTES

PROJECT NO: 00193-008-05
DATE: 11-03-10
SHEET NO: T-3

PAY ITEM FOOTNOTES:

1. 555-1-2:
CONDUIT INSTALLED WITH THE DIRECTIONAL BORE METHOD SHALL BE HPDE WITH A MINIMUM SIZE OF TWO INCHES UNLESS OTHERWISE NOTED IN THE PLANS. COST FOR PULL WIRE IS INCLUDED UNDER THIS PAY ITEM.

A MINIMUM OF 3" IN DIAMETER CONDUIT FOR FIBER OPTIC INTERCONNECT CABLE (COMMUNICATION) SHALL BE PROVIDED.

2. 630-1-12, 630-1-13:
ALL CONDUIT RUNS SHOWN ON THE PLANS ARE SCHEMATIC AND FIELD ADJUSTMENTS MAY BE NECESSARY. WITH THE EXCEPTION OF ELECTRICAL POWER SERVICE DUCTS, JACK AND BORE SLEEVES, AND DIRECTIONAL BORE CONDUITS, ALL UNDERGROUND AND UNDER PAVEMENT CONDUITS SHALL BE SCHEDULE 40 PVC WITH A MINIMUM SIZE OF TWO INCHES UNLESS OTHERWISE SPECIFIED IN THE PLANS. COST FOR PULL WIRE IS INCLUDED UNDER THIS PAY ITEM.

THREE SEPARATE UNDERGROUND CONDUIT RUNS LOCATED 120 DEGREES APART ARE REQUIRED FOR ALL STRAIN POLES AND MAST ARMS. THE CONDUITS ARE FOR HIGH VOLTAGE, LOW VOLTAGE AND GROUND. THERE SHALL BE A MINIMUM OF TWO RUNS OF TWO INCH CONDUIT BETWEEN THE LAST LOW VOLTAGE PULL BOX LOCATED NEAR THE CONTROLLER CABINET AND THE CONTROLLER CABINET ITSELF.

USE A MINIMUM OF 3" DIAMETER CONDUIT FOR FIBER OPTIC INTERCONNECT CABLE.

3. 632-7-1:
VERIFY THE COLOR CODE OF SIGNAL CABLE WITH THE MAINTAINING AGENCY PRIOR TO WIRING INTERSECTION. USE A MINIMUM OF 7 CONDUCTOR SIGNAL CABLE FOR SIGNAL HEADS AND PEDESTRIAN HEADS.

4. 635-1-11:
ALL PULL BOXES AND LIDS SHALL BE OF TRAFFIC BEARING, POLYMER CONCRETE CONSTRUCTION EQUAL TO QUAZITE OR ANOTHER EQUIVALENT FDOT APPROVED MANUFACTURER. PULL BOXES SHALL BE PLACED BEHIND CURB AND GUTTER. WHERE THERE IS NO CURB AND GUTTER PULL BOXES SHALL BE PLACED A MINIMUM OF 7 FEET FROM THE EDGE OF THE PAVEMENT. THE TOP OF THE LID SHALL READ "TRAFFIC SIGNAL" IN STAMPED RAISED LETTERS.

5. 639-1-22:
POWER SERVICE ASSEMBLY DOES NOT REQUIRE A METER BASE. AN ADDITIONAL BREAKER SHALL BE ADDED FOR THE POWER TO THE CCTV. THE BREAKERS SHALL BE CLEARLY MARKED.

USE ALUMINUM RIGID ABOVE GROUND CONDUIT FOR ELECTRICAL POWER SERVICE.

6. 639-2-1:
USE A BONDING WIRE FROM ELECTRICAL SERVICE POINT TO CONTROLLER. THE PAYMENT OF THIS ITEM SHALL BE BASED ON THE LINEAR FOOT OF A SINGLE CONDUCTOR.

7. 649-31-202 & 649-31-203:
THE CONTRACTOR SHALL CONTACT THE LOCAL POWER COMPANY FOR THEIR ASSISTANCE IN PERFORMING ALL NECESSARY WORK UNDER POWER LINES AT SIGNAL POLE(S), SUCH AS THE INSTALLATION OF MAST ARM FOUNDATIONS OR POLES.

THE CONDUIT SHALL BE CAPPED IN THE NEAREST PULL BOX. THE ELEVATION OF THE TOP OF THE MAST ARM BASE(S) SHALL BE SIX INCHES ABOVE EXISTING GRADE. IF LOCATED DIRECTLY BEHIND SIDEWALK, AT SIDEWALK GRADE.

USE THREE 2" AND ONE 3/4" CONDUITS STUBBED OUT THROUGH THE MAST ARM POLE FOUNDATION AND TEMPORARILY SEAL.

8. 650-51-311 & 650-51-511:
USE SIGNAL HEAD SUPPORTING TUBE THAT IS CAPABLE OF ADJUSTING VERTICALLY A MINIMUM OF 1.5 FEET.

THE EXTERNAL COLOR OF SIGNAL HOUSING SHALL BE BLACK. ALL TRAFFIC SIGNAL HEAD INDICATIONS SHALL BE 12 INCH LED. ALL SIGNAL HEADS SHALL HAVE TUNNEL VISORS.

DO NOT USE PLASTIC GARBAGE BAGS AS A COVERING FOR CONCEALNG SIGNAL HEADS.

9. 653-191:
PEDESTRIAN SIGNAL HEADS TO BE 16" INTERNATIONAL SYMBOL, LED COUNTDOWN TYPE.

10. 659-101 AND 659-118:
ALL SIGNAL HEADS SHALL HAVE ALUMINUM LOUVERED BACK PLATES INSTALLED. BACK PLATES SHALL BE MANUFACTURED FOR THE SIGNAL HEADS USED AND INSTALLED AS PER MANUFACTURER'S RECOMMENDATIONS. THE BACK PLATE SHALL HAVE A 2 INCH YELLOW REFLECTORIZED (TYPE III REFLECTIVITY) OUTER EDGE BORDER UNLESS SPECIFIED OTHERWISE IN THE PLANS.

11. 659-107:
USE BREAKAWAY ALUMINUM SQUARE BASE ASSEMBLIES WITH ALUMINUM DOORS FOR PEDESTRIAN PEDESTALS. INSIDE DIAMETER OF PEDESTALS SHALL BE FOUR INCHES (4").

USE LOCKING COLLARS WHEN MOUNTING PEDESTRIAN SIGNAL HEADS TO PEDESTRIAN PEDESTALS. USE LOCKING COLLARS WHEN MOUNTING ALUMINUM PEDESTRIAN POLES TO PEDESTRIAN PEDESTAL BASES.

12. 665-13:
SHALL INCLUDE ADDITIONAL COST OF LABOR AND MATERIALS REQUIRED FOR INSTALLATION OF PEDESTRIAN SIGNAL SIGN R10-3E. THIS SIGN SHALL BE MOUNTED ABOVE EACH PEDESTRIAN DETECTOR. ALL PEDESTRIAN PUSH BUTTONS SHALL BE A.D.A COMPLIANT. STREET NAMES SHALL BE IN ACCORDANCE WITH THE STREET NAMES ON THE PLAN SHEETS.

13. 670-5-110:
THE SIGNAL CONTROLLER ASSEMBLY SHALL BE NEMA TS2 TYPE 1 AND FULLY COMPATIBLE WITH THE MANATEE COUNTY'S ATMS SYSTEM (NAZTEC'S ATMS.NOW). ALL SIGNAL CONTROLLER CABINETS SHALL BE FDOT APPROVED. THE CABINETS SHALL BE FULLY EQUIPPED WITH ALL THE NECESSARY SYSTEM COMPONENTS TO INTEGRATE INTO MANATEE COUNTY'S ETHERNET BASED FIBER OPTIC NETWORK. CONTACT MAINTAINING AGENCY PRIOR TO ORDERING CONTROLLER ASSEMBLY.

THIS ITEM SHALL INCLUDE THE INSTALLATION OF CONCRETE BASES FOR THE CONTROLLER ASSEMBLY AND FOR MOUNTING OF AN EMERGENCY GENERATOR CABINET. THE CONTROLLER ASSEMBLY FOUNDATION SHALL HAVE A MINIMUM OF (4) - 2" CONDUIT SPARES. TWO OF THE SPARES SHALL BE TERMINATED IN THE NEAREST FIBER OPTIC PULL BOX AND FITTED WITH A WEATHERPROOF CAP. THE OTHER TWO SPARES SHALL BE TERMINATED IN THE SIGNAL CABLE AND LOW VOLTAGE PULL BOXES. THE EMERGENCY GENERATOR CABINET (EGC) BASE SHALL HAVE DIMENSIONS OF 48" X 36" FOR CABINET MOUNTING WITH A FDOT STANDARD TECHNICIAN PAD OR STEPS. IT SHALL BE LOCATED ADJACENT TO THE CONTROLLER BASE WITH (2) - 2" CONDUITS AND (1) - 1-1/4" CONDUITS INSTALLED DIRECTLY TO THE CONTROLLER BASE. MANATEE COUNTY WILL FURNISH THE GENERATOR CABINET TO THE CONTRACTOR.

THE HEIGHT OF THE MOUNTING BASE FOR THE SIGNAL CONTROLLER CABINET SHALL BE EQUAL TO OR GREATER THAN THE ELEVATION OF THE CENTER CROWN OF THE ROADWAY.

THE CONTRACTOR SHALL COORDINATE WITH MANATEE COUNTY TO PICK UP AND INSTALL THE GENERATOR CABINET ON THE NEW FOUNDATION. ALL COSTS OF LABOR, CONCRETE AND OTHER MATERIALS FOR THE CONTROLLER ASSEMBLY AND EGC BASES, TECHNICIAN PADS, STEPS AS REQUIRED, AND INSTALLATION OF THE GENERATOR CABINET ARE INCLUDED IN THIS ITEM.THE CONTROLLER AND EGC BASE SHALL BE AT LEAST 2' HIGH OR THE SAME ELEVATION AS THE CROWN OF THE ROADWAY, WHICHEVER IS GREATER. THE MAXIMUM DISTANCE FROM THE TECHNICIAN PAD OR STEP TO THE FOUNDATION TOP IS 4". THE CABINET DOORS SHALL OPEN TOWARDS OR PARALLEL TO THE RIGHT-OF-WAY LINE AND AWAY FROM TRAFFIC.

WHEN INSTALLING GROUND WIRE IN THE CONTROLLER CABINET, THE COPPER GROUND WIRE SHALL NOT COME IN CONTACT WITH THE ALUMINUM CABINET, EXCEPT AT THE TERMINATION POINT.

THE CABINET FIELD WIRING, INCLUDING SIGNAL HEAD WIRING AND LEAD-INS (CABLES, NEUTRALS AND SPARES) SHALL BE IDENTIFIED FOR DIRECTION AND/OR PHASE WITH CLEARLY MARKED WEATHERPROOF TAGS. THE PROPOSED TAGGING SYSTEM SHALL BE IN ACCORDANCE WITH THE F.D.O.T.'S STANDARD SPECIFICATIONS. WHERE APPLICABLE, ALL CONDUCTORS SHALL BE LABELED TO INDICATE THE DIRECTION OF TRAVEL, THE MOVEMENT, PHASE AND INDIVIDUAL LANE SERVED. ONLY WHITE AND WHITE/BLACK CONDUCTORS WILL BE USED AS A NEUTRAL RETURN.

ALL CONTROLLER DOOR DIAGRAMS SHALL REFLECT CURRENT DATA.

A MANUAL PUSH BUTTON CORD AND CABINET KEYS SHALL BE FURNISHED FOR THE CONTROLLER CABINET.

14. 685-106:
INCLUDE AN UNINTERRUPTED POWER SUPPLY UNIT (UPS) WITH AN 8 HOUR RUN TIME AT 450 WATTS. ATTACH UPS UNIT TO THE OUTSIDE OF THE CONTROLLER CABINET. INSTALL UPS UNIT IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS. UPS EQUIPMENT SHALL BE COMPATIBLE WITH MAINTAINING AGENCY EXISTING SYSTEM AND SHALL INCLUDE ETHERNET CONNECTION AND SNMP V3 SUPPORT.

15. 690-33-1:
COST OF REPLACING ANY DAMAGED SIDEWALK DUE TO POLE REMOVAL SHALL BE INCLUDED UNDER THIS PAY ITEM.

16. 690-100:
THIS PAY ITEM INCLUDES THE COST OF REMOVING EXISTING PULL BOXES.

17. 699-1-1:
ALL INTERNALLY ILLUMINATED STREET NAME SIGNS SHALL BE EDGE LIT LED TYPE AND SHALL BE LISTED IN THE FDOT APPROVED PRODUCT LIST. THE SIGNS SHALL BE POWERED USING IMSA 50-2 CABLE. THE INSTALLATION OF THE PHOTOCELL ON THE SERVICE POLE SHALL BE PAID FOR UNDER 639-1-22.

CONDUIT LEGEND

LV = SIGNAL LOW VOLTAGE CONDUIT (INCLUDES VID CABLE)
HV = SIGNAL HIGH VOLTAGE CONDUIT
SP = SPARE CONDUIT

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

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Certificate of Authorization No. 3843

UPIK Y. SUWARNO DATE
LIC. NO.: 62995

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

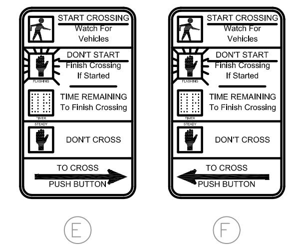
PAY ITEM NOTES

PROJECT NO: 00193-008-05
DATE: 11-03-10
SHEET NO: T-4

FILE: O:\JOB\0193\00193-008-05\ACAD\GN19300118-1SIG.dwg LAST SAVED: Wed, 11/03/10-11:25a PLOTTED: Wed, 11/03/10-3:02p BY: uys

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 650-51-311 | 4 AS | 650-51-511 | 4 AS | 653-191 | 8 AS | | |
| 659-101 | 4 EA | 659-106 | 20 EA | | | | |
| 659-106 | 12 EA | 659-118 | 4 EA | | | | |

R10-3E
9" X 15"




* SIGNAL BACKPLATES SHALL BE PROVIDED WITH RETRO-REFLECTIVE BORDER MATERIAL

CONTROLLER NOTES:

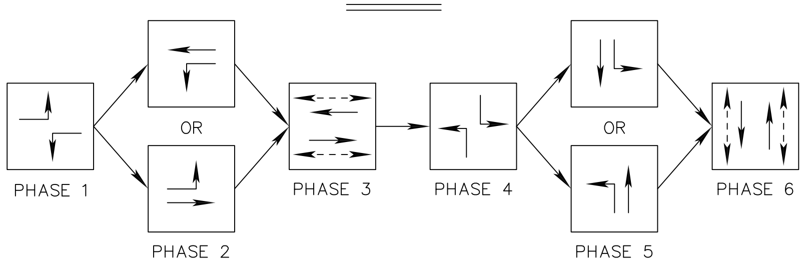
1. MAJOR STREET IS CORTEZ RD. WEST (MOVEMENTS 1, 2, 5 & 6). MINOR STREET IS 43RD ST. WEST (MOVEMENTS 3, 4, 7 & 8).
2. THE CONTROLLER CABINET SHALL BE WIRED FOR SOP 10.
3. FLASHING OPERATION IS YELLOW FOR MOVEMENTS 2 & 6 AND RED FOR ALL OTHER MOVEMENTS.
4. EACH PHASE/ MOVEMENT SHALL BE WIRED FROM THE SIGNAL DISPLAY TO THE CONTROLLER AS A SEPARATE PHASE/ MOVEMENT. THIS INCLUDES LEFT TURN MOVEMENTS. EACH LEFT TURN MOVEMENT SHALL HAVE CONDUCTORS AVAILABLE FOR PROTECTED AND PERMISSIVE OPERATION.
5. THE SIGNAL SHALL BE INCORPORATED INTO THE MANATEE COUNTY ATMS SYSTEM.

SIGNAL HEAD LEGEND:

F POSSIBLE FUTURE HEAD FOR MAST ARM CALCULATION

PROPOSED SIGNAL HEAD

S.O.P. 10




REMOVAL NOTE:
REMOVE ENTIRE EXISTING SIGNAL SYSTEM

REMOVAL ITEMS:

| | |
|---|---|
| 690-10 | 8 EA |
| 690-33-1 | 40 LF |
| 690-50 | 1 EA |
| 690-60 | 10 EA |
| 690-80 | 1 EA |
| 690-90 | 1 PI |
| 690-100 | 1 PI |
| 700-48-60 | 3 EA |

CONTROLLER TIMINGS

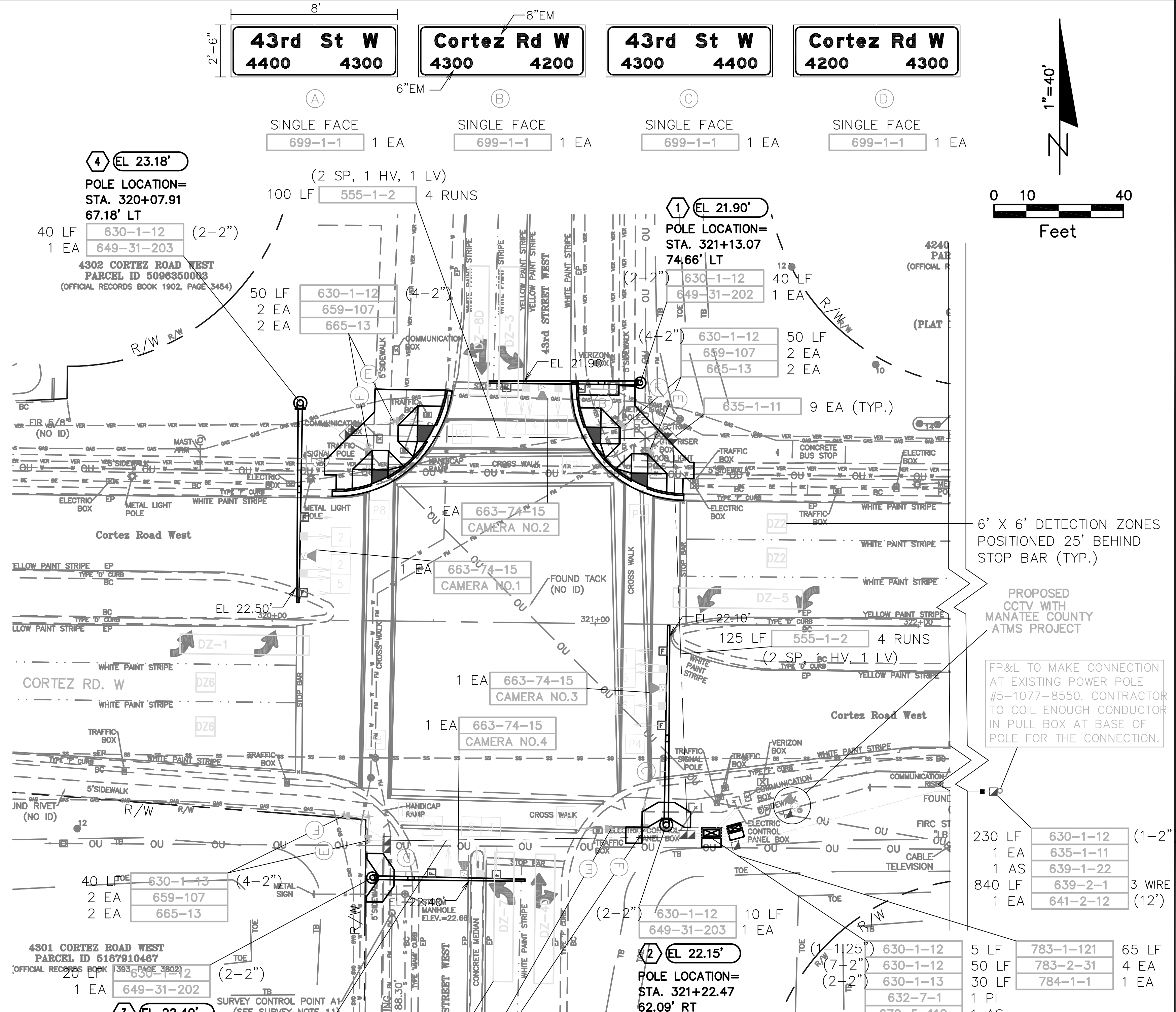
| TIMING FUNCTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MOVEMENT NUMBER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| MINIMUM GREEN | 7 | 20 | 7 | 7 | 7 | 20 | 7 | 7 |
| EXTENSION | 3.0 | 3.0 | 3.0 | 4.0 | 3.0 | 3.0 | 3.0 | 4.0 |
| MAXIMUM GREEN 1 | 12 | 30 | 20 | 18 | 12 | 30 | 20 | 18 |
| MAXIMUM GREEN 2 | 25 | 50 | 35 | 60 | 25 | 50 | 35 | 60 |
| YELLOW CLEARANCE | 3.0 | 4.3 | 3.0 | 4.0 | 3.0 | 4.3 | 3.0 | 4.0 |
| ALL RED | 4.5 | 2.0 | 4.2 | 2.7 | 4.5 | 2.0 | 4.2 | 2.7 |
| PEDESTRIAN WALK | | 7 | | 7 | | 7 | | 7 |
| PED. CLEARANCE | | 25 | | 32 | | 25 | | 32 |
| RECALL | | MIN | | | | MIN | | |

TIMINGS ARE INITIAL AND MAY REQUIRE FIELD ADJUSTING AS DIRECTED BY PROJECT ENGINEER.

VIDEO DETECTOR ZONES

| ZONE LOCATION NO. | VIDEO CAMERA NO. | NO. OF DETECTION ZONES | DELAY TIME (SEC) |
|---|---|---|---|
| DZ-1 | 3 | 1 | 0 |
| DZ-2 | 1 | 2 | 0 |
| DZ-3 | 4 | 1 | 0 |
| DZ-4D | 2 | 1 | 5 |
| DZ-5 | 1 | 1 | 0 |
| DZ-6 | 3 | 2 | 0 |
| DZ-7 | 2 | 1 | 0 |
| DZ-8D | 4 | 1 | 5 |

DELAY TIME IS INITIAL AND MAY REQUIRE FIELD ADJUSTING AS DIRECTED BY PROJECT ENGINEER.




ATMS CONNECTION NOTES:

1. THE CONTRACTOR SHALL CONNECT TO THE EXISTING FIBER OPTIC PULL BOX TO SPLICE TO THE MANATEE ATMS TRUNK LINE. THE CONNECTION SHALL BE DONE WHEN THE SIGNAL IS OPERATIONAL AND IS READY TO BE TURNED ON.
2. THE CONTRACTOR SHALL COORDINATE WITH MANATEE COUNTY TRAFFIC OPERATIONS IF THE PROPOSED FIBER OPTIC TRUNK LINE IS NOT INSTALLED FOR TIME BASED CONTROLLER TIMINGS.
3. THE CONTRACTOR SHALL COORDINATE WITH MANATEE COUNTY TRAFFIC ENGINEERING ON THE FIBER OPTIC SPLICING PLAN.

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

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UPIK Y. SUWARNO

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

SIGNALIZATION PLAN

PROJECT NO. 00193-008-05
DATE 11-03-10
SHEET NO. T-5

SPECIAL NOTES:

A. EACH POLE AND MAST ARM SHALL BE IDENTIFIED WITH A PERMANENT ONE INCH (1") HIGH ENGRAVED OR IMPRESSED MARK WHICH BEARS THE POLE IDENTIFICATION NUMBER SHOWN ON THE PLANS.

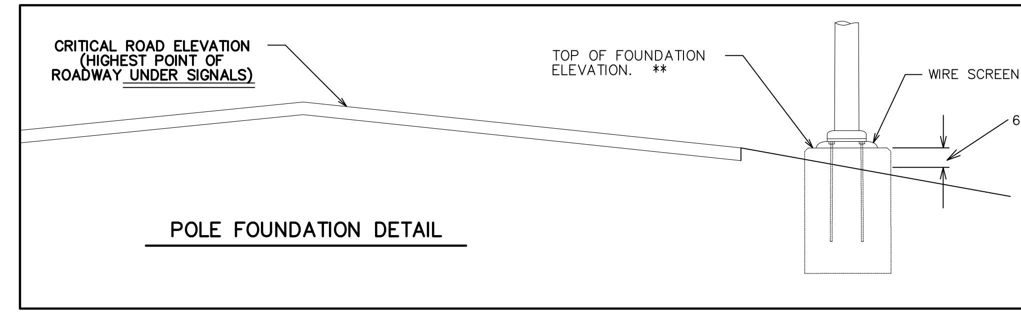
B. ANCHOR BOLT COVERS (ORNAMENTAL, NON-ORNAMENTAL, AND/OR PAINTED) SHALL BE GALVANIZED STEEL OR CAST ALUMINUM AND SHALL BE SECURED BY A MINIMUM OF TWO (2) THREADED FASTENERS. THE BOLT COVERS SHALL BE OF SUFFICIENT SIZE SO THAT THERE IS NO GAP BETWEEN ITSELF AND THE POLE SHAFT.

C. IT SHALL BE THE CONTRACTORS RESPONSIBILITY TO FIELD VERIFY ALL ELEVATIONS LISTED HEREIN.

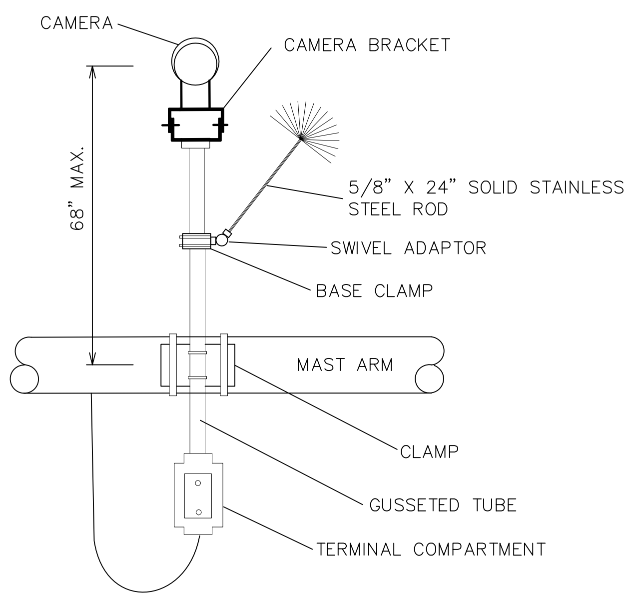
D. INFORMATION BELOW IS FOR DESIGN PURPOSES ONLY. FIELD ADJUSTMENTS MAY BE REQUIRED.

E. SEE APPROPRIATE PLAN SHEET FOR PROPOSED SIGNAL HEAD ALIGNMENTS AND SIGN CONFIGURATION/LOCATION.

F. BACKPLATES REQUIRED FOR ALL SIGNALS HEADS.




POLE FOUNDATION DETAIL




CAMERA MOUNTING DETAIL
(CONTACT MAINTAINING AGENCY FOR MOUNTING PREFERENCES.)

| SPECIAL INSTRUCTIONS | | | | | |
|---|---|---|---|---|---|
| ID NO. | PED. BUTTON | | PED. SIGNALS | | HANDHOLE LOCATION |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
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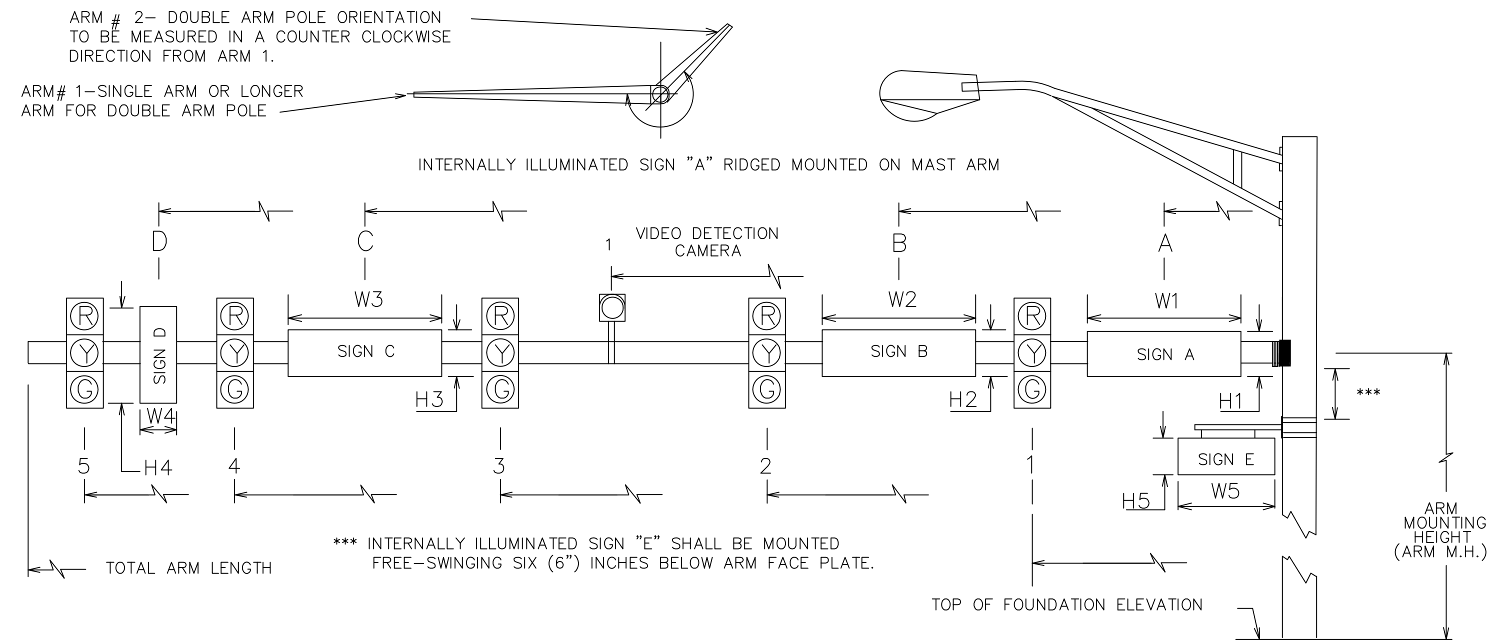


* DENOTES NUMBER OF SECTIONS IN SIGNAL HEAD ASSEMBLY

| STRUCT. ID. NO. | POLE ID. NO. | SHEET NO. | LOCATION BY STA. | CRITICAL ROAD EL. | # FOUNDATION OUT OF GROUND | ** TOP OF FOUNDATION ELEVATION | RDWY ARM NO. | SIGNAL DATA: SIGNAL V/H | BACK PLATES Y/N | PED. SIGNAL Y/N | DISTANCE FROM POLE: 1 | * | 2 | * | 3 | * | 4 | * | 5 | * | 6 | * | 7 | * | 8 | * | TOTAL ARM LENGTH | ARM M.H. | ∠ BETWEEN DUAL ARMS 90/270 | SIGN DATA: DISTANCE FROM POLE / HEIGHT AND WIDTH OF SIGN: A | H1 | W1 | B | H2 | W2 | C | H3 | W3 | D | H4 | W4 | E | H5 | W5 | VIDEO DISTANCE FROM POLE: 1 | 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| – | 1 | T–5 | 321+13.07 | 21.90’ | 0.5 | 21.90’ | A | V | Y | N | 24.0 | 3 | 34.0 | 5 | | | | | | | | | | | | | 46 | 21.5 | | 12.0 | 2.5 | 8 | | | | | | | | | | | | | 29 | |
| | | | | | – | | B | V | Y | N | | | | | | | | | | | | | | | | | | – | – | | | | | | | | | | | | | | | | | |
| – | 2 | T–5 | 321+22.47 | 22.10’ | 0.5 | 22.15’ | B | V | Y | N | 35.0 | 3 | 46.5 | 5 | | | | | | | | | | | | | 60 | 21.5 | | 15.0 | 2.5 | 8 | | | | | | | | | | | | | 40.5 | |
| | | | | | – | – | A | V | Y | N | | | | | | | | | | | | | | | | | | – | – | | | | | | | | | | | | | | | | | |
| – | 3 | T–5 | 320+31.96 | 22.40’ | 0.5 | 22.40’ | A | V | Y | N | 22.0 | 3 | 32.0 | 5 | | | | | | | | | | | | | 46 | 21.5 | | 12.0 | 2.5 | 8 | | | | | | | | | | | | | 27 | |
| | | | | | – | – | B | V | Y | N | | | | | | | | | | | | | | | | | | – | – | | | | | | | | | | | | | | | | | |
| – | 4 | T–5 | 320+07.91 | 22.50’ | 0.5 | 23.18’ | – | V | Y | N | 39.5 | 3 | 51 | 5 | | | | | | | | | | | | | 60 | 21.5 | – | 15.5 | 2.5 | 8 | | | | | | | | | | | | | 45.5 | |
| | | | | | – | – | – | – | – | – | | | | | | | | | | | | | | | | | | – | – | | | | | | | | | | | | | | | | | |
| – | | | | | 0.5 | | A | V | Y | N | | | | | | | | | | | | | | | | | | – | | | | | | | | | | | | | | | | | | |
| | – | – | – | | – | – | B | V | Y | N | | | | | | | | | | | | | | | | | | – | – | | | | | | | | | | | | | | | | | |
| – | | | | | 0.5 | | – | V | Y | N | | | | | | | | | | | | | | | | | | – | – | | | | | | | | | | | | | | | | | |
| | | | | | | | – | – | – | – | | | | | | | | | | | | | | | | | | – | | | | | | | | | | | | | | | | | | |
| – | | | | | – | | A | V | Y | N | | | | | | | | | | | | | | | | | | – | | | | | | | | | | | | | | | | | | |
| | – | – | – | | – | – | B | V | Y | N | | | | | | | | | | | | | | | | | | – | – | | | | | | | | | | | | | | | | | |
| – | | | | | 0.5 | | A | V | Y | N | | | | | | | | | | | | | | | | | | – | | | | | | | | | | | | | | | | | | |
| | | | | | | | B | V | Y | N | | | | | | | | | | | | | | | | | | – | | | | | | | | | | | | | | | | | | |

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

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UPIK Y. SUWARNO DATE

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

# MAST ARM TABULATION (DESIGN PLAN CONFIGURATION)

PROJECT NO. 00193-008-05
DATE: 11-03-10
SHEET NO. T-6

SPECIAL NOTES:

A. EACH POLE AND MAST ARM SHALL BE IDENTIFIED WITH A PERMANENT ONE INCH (1") HIGH ENGRAVED OR IMPRESSED MARK WHICH BEARS THE POLE IDENTIFICATION NUMBER SHOWN ON THE PLANS.

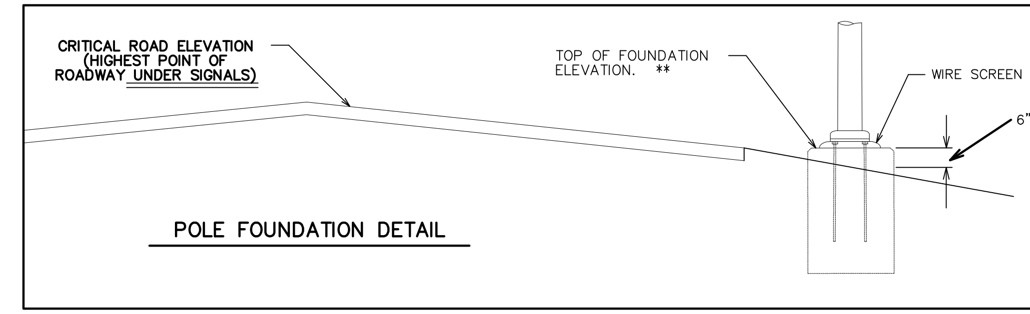
B. ANCHOR BOLT COVERS (ORNAMENTAL, NON-ORNAMENTAL, AND/OR PAINTED) SHALL BE GALVANIZED STEEL OR CAST ALUMINUM AND SHALL BE SECURED BY A MINIMUM OF TWO (2) THREADED FASTENERS. THE BOLT COVERS SHALL BE OF SUFFICIENT SIZE SO THAT THERE IS NO GAP BETWEEN ITSELF AND THE POLE SHAFT.

C. IT SHALL BE THE CONTRACTORS RESPONSIBILITY TO FIELD VERIFY ALL ELEVATIONS LISTED HEREIN.

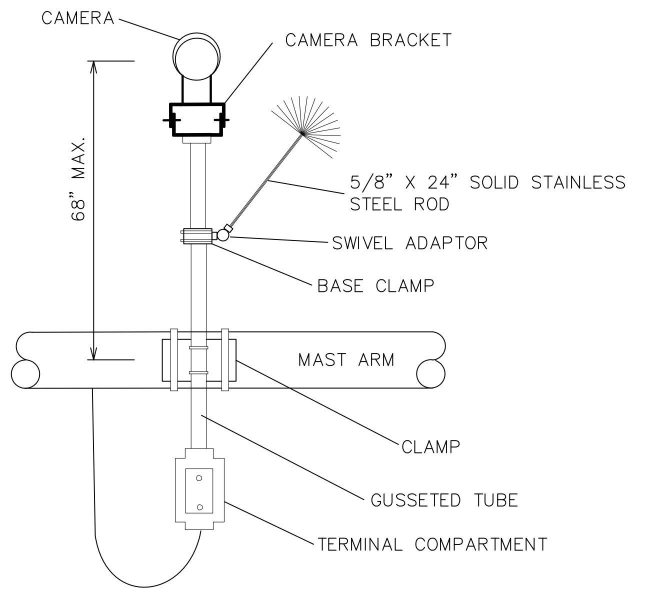
D. INFORMATION BELOW IS FOR DESIGN PURPOSES ONLY. FIELD ADJUSTMENTS MAY BE REQUIRED.

E. SEE APPROPRIATE PLAN SHEET FOR PROPOSED SIGNAL HEAD ALIGNMENTS AND SIGN CONFIGURATION/LOCATION.

F. BACKPLATES REQUIRED FOR ALL SIGNALS HEADS.



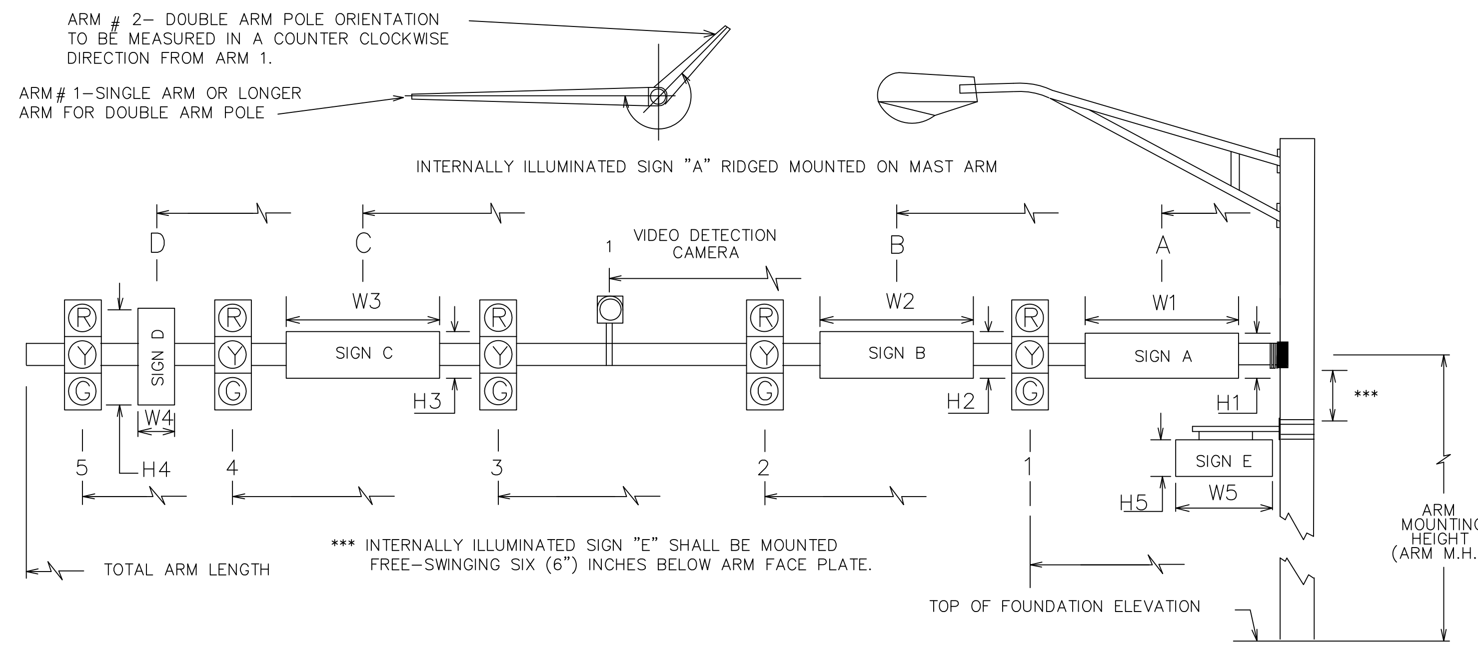

POLE FOUNDATION DETAIL




CAMERA MOUNTING DETAIL
(CONTACT MAINTAINING AGENCY FOR MOUNTING PREFERENCES.)

SPECIAL INSTRUCTIONS

| ID NO. | PED. BUTTON | | PED. SIGNALS | | HANDHOLE LOCATION |
|---|---|---|---|---|---|
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |




* DENOTES NUMBER OF SECTIONS IN SIGNAL HEAD ASSEMBLY

| STRUCT. ID. NO. | POLE ID. NO. | SHEET NO. | LOCATION BY STA. | CRITICAL ROAD EL. | # FOUNDATION OUT OF GROUND | ** TOP OF FOUNDATION ELEVATION | RDWY ARM NO. | SIGNAL DATA: SIGNAL V/H | BACK PLATES Y/N | PED. SIGNAL Y/N | DISTANCE FROM POLE: 1 | * | 2 | * | 3 | * | 4 | * | 5 | * | 6 | * | 7 | * | 8 | * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| – | 1 | T–5 | 321+13.07 | 21.90' | 0.5 | 21.90' | A | V | Y | N | 17.0 | 3 | 29.0 | 3 | 40.0 | 4 | | | | | | | | | | |
| | | | | | – | | B | V | Y | N | | | | | | | | | | | | | | | | |
| – | 2 | T–5 | 321+22.47 | 22.10' | 0.5 | 22.15' | B | V | Y | N | 29.0 | 3 | 40.5 | 3 | 52.0 | 4 | | | | | | | | | | |
| | | | | | – | | A | V | Y | N | | | | | | | | | | | | | | | | |
| – | 3 | T–5 | 320+31.96 | 22.40' | 0.5 | 22.40' | A | V | Y | N | 17.0 | 3 | 27.0 | 3 | 37.0 | 4 | | | | | | | | | | |
| | | | | | – | | B | V | Y | N | | | | | | | | | | | | | | | | |
| – | 4 | T–5 | 320+07.91 | 22.50' | 0.5 | 23.18' | – | V | Y | N | 33.5 | 3 | 45.5 | 3 | 57.0 | 4 | | | | | | | | | | |
| | | | | | – | | – | – | – | – | | | | | | | | | | | | | | | | |
| – | | | | | 0.5 | | A | V | Y | N | | | | | | | | | | | | | | | | |
| | | | | | – | | B | V | Y | N | | | | | | | | | | | | | | | | |
| – | | | | | 0.5 | | – | V | Y | N | | | | | | | | | | | | | | | | |
| | | | | | | | – | – | – | – | | | | | | | | | | | | | | | | |
| – | | | | | – | | A | V | Y | N | | | | | | | | | | | | | | | | |
| | | | | | – | | B | V | Y | N | | | | | | | | | | | | | | | | |
| – | | | | | 0.5 | | A | V | Y | N | | | | | | | | | | | | | | | | |
| | | | | | | | B | V | Y | N | | | | | | | | | | | | | | | | |

| POLE ID. NO. | RDWY ARM NO. | TOTAL ARM LENGTH | ARM M.H. | ∠ BETWEEN DUAL ARMS 90/270 | SIGN DATA (DISTANCE FROM POLE / HEIGHT AND WIDTH OF SIGN): A | H1 | W1 | B | H2 | W2 | C | H3 | W3 | D | H4 | W4 | E | H5 | W5 | VIDEO DISTANCE FROM POLE: 1 | 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | A | 46 | 21.5 | | 10.0 | 2.5 | 8 | | | | | | | | | | 45 | 3 | 2.5 | 34 | |
| | B | | | | | | | | | | | | | | | | | | | | |
| 2 | B | 60 | 21.5 | | 15.0 | 2.5 | 8 | | | | | | | | | | 59 | 3 | 2.5 | 46.5 | |
| | A | | | | | | | | | | | | | | | | | | | | |
| 3 | A | 46 | 21.5 | | 9.0 | 2.5 | 8 | | | | | | | | | | 45 | 3 | 2.5 | 32 | |
| | B | | | | | | | | | | | | | | | | | | | | |
| 4 | – | 60 | 21.5 | | 15.5 | 2.5 | 8 | | | | | | | | | | 59 | 3 | 2.5 | 51 | |
| | – | | | | | | | | | | | | | | | | | | | | |
| | A | | | | | | | | | | | | | | | | | | | | |
| | B | | | | | | | | | | | | | | | | | | | | |
| | – | | | | | | | | | | | | | | | | | | | | |
| | – | | | | | | | | | | | | | | | | | | | | |
| | A | | | | | | | | | | | | | | | | | | | | |
| | B | | | | | | | | | | | | | | | | | | | | |
| | A | | | | | | | | | | | | | | | | | | | | |
| | B | | | | | | | | | | | | | | | | | | | | |

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

MANATEE COUNTY

CORTEZ ROAD AND 43RD STREET WEST

Cardno TBE
12481 Telecom Drive, Tampa, Florida 33637
www.cardnotbe.com - 813.221.0048
Certificate of Authorization No. 3843

UPIK Y. SUWARNO DATE

DESIGNED JTP
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Q.C.
APPROVED

# MAST ARM TABULATION (POSSIBLE FUTURE LOAD)

PROJECT NO. 00193-008-05
DATE: 11-03-10
SHEET NO. T–7

## SPECIAL MAST ARM ASSEMBLIES DATA TABLE

| NUMBER OF LOCATIONS | STRUCTURE NUMBER | FIRST ARM | | | | FIRST ARM EXTENSION | | | | SECOND ARM | | | | SECOND ARM EXTENSION | | | | POLE | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FA(ft) | FB(in) | FC(in) | FD(in) | FE(ft) | FF(in) | FG(in) | FH(in) | SA(ft) | SB(in) | SC(in) | SD(in) | SE(ft) | SF(in) | SG(in) | SH(in) | UA(ft) | UB(ft) | UC(in) | UD(in) | UE(in) | UF(deg) | UG(ft) |
| 2 | ID. No.1 & 3 | 36.3 | 7.06 | 12.14 | 0.25 | 11.7 | 11.4 | 13 | 0.375 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21.5 | 20 | 13 | 16 | 0.375 | 0 | 0 |
| 2 | ID. No.4 & 2 | 36 | 6.35 | 1.4 | 0.375 | 26 | 10.4 | 14 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21.5 | 20 | 16 | 19 | 0.375 | 0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |

## SPECIAL MAST ARM ASSEMBLIES DATA TABLE (CONT.)

| STRUCTURE NUMBER | FIRST ARM CONNECTION (in) First Arm Camber Angle = 2 Degrees | | | | | | | | | | | | | SECOND ARM CONNECTION (in) Second Arm Camber Angle = 2 Degrees | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | #Bolts | HT | FJ | FK | FL | FM | FN | FO | FP | FQ | FR | FS | FT | #Bolts | HT | SJ | SK | SL | SM | SN | SO | SP | SQ | SR | SS | ST |
| ID. No.1 & 3 | 6 | 22 | 23 | 2 | 0.5 | 0.313 | 0.375 | 14 | 1 | 0.438 | 2 | 9 | 0.375 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ID. No.4 & 2 | 6 | 30 | 32 | 2.75 | 0.75 | 0.438 | 0.375 | 19.5 | 1.25 | 0.563 | 2 | 12.5 | 0.375 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |

## SPECIAL MAST ARM ASSEMBLIES DATA TABLE (CONT.)

| STRUCTURE NUMBER | POLE BASE CONNECTION (in) | | | | | | | SHAFT AND REINF. | | | | LUMINAIRE AND LUMINAIRE CONNECTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | #Bolts | BA | BB | BC | BD | BE | BF | DA(ft) | DB(ft) | RA | RB | LA(ft) | LB(ft) | LC(in) | LD(in) | LE | LF(ft) | LG(in) | LH(in) | LJ(in) | LK(in) | LL(deg) |
| ID. No.1 & 3 | 6 | 28 | 1.75 | 1.5 | 0.375 | 0.313 | 36 | 14 | 3.5 | 11 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ID. No.2 & 4 | 6 | 35 | 1.75 | 2 | 0.375 | 0.313 | 40 | 15 | 4 | 11 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |

NOTES:
1. Work with Index 17745.
2. Design Wind Speed = 130 mph
3. Contractor shall coordinate anchor bolt requirements with fabricator.
4. Contractor shall identify Structures Numbers and submit detailed shop drawings.

FOUNDATION NOTES:

1. Design based on Borings taken and sealed by Martin E. Millburg, P.E. with Professional Service Industries, Inc.
2. Assumptions and Values used in design:
   Soil Type = Sand
   Soil Layer Thickness = 20 ft.
   Soil Friction Angle = 30 deg.
   Soil Weight = 42.6 pcf
   Design Water Table is 0.0 ft. below surface.

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

MANATEE COUNTY

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MIGUEL A. VILLEGAS DATE

DESIGNED JTP
DRAWN JTP
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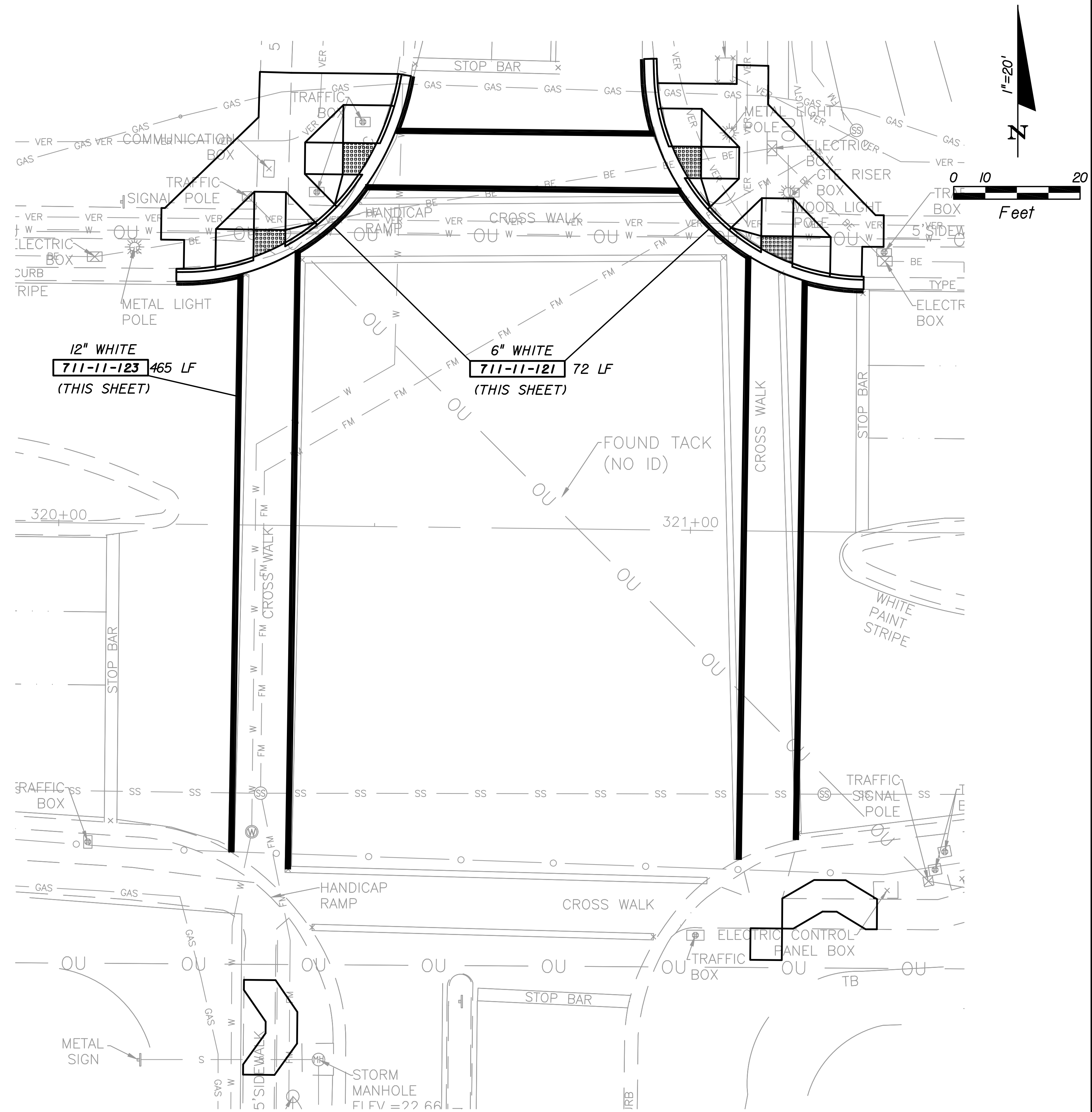
**TABLE OF VARIABLES FOR STANDARD MAST ARM ASSEMBLIES (INDEX S-1700)**

PROJECT NO. 00193-008-05
DATE: 11-03-10
SHEET NO. T-8

**NOTES:**

1. THE CONTRACTOR SHALL REMOVE ALL THE EXISTING MARKINGS BEING REPLACED.

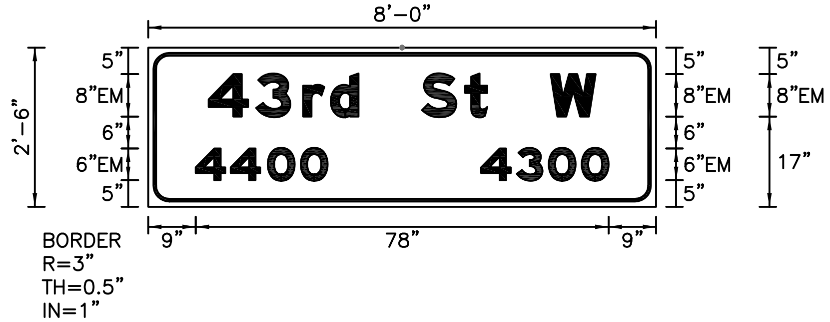
711-17 525 SF
(THIS SHEET)



| SIGN NAME | A | QTY | 1 | SIGN NUMBER | STATION(S) |
|---|---|---|---|---|---|
| PANEL | | BORDER | | | none |
| WIDTH | 8'-0" | WIDTH | 0.5" | | |
| HEIGHT | 2'-6" | RADII | 3" | | |
| LEGEND | White | COLOR | White | | |
| COLOR | Green | | | | |

| SYMBOL(S) | ANGLE | X | Y | WID | HT |
|---|---|---|---|---|---|
| | | | | | |

| SIGN NUMBER | NUMBER OF POSTS | CLEARANCE Edge Of Lane | COLUMN SIZE | | AVERAGE LENGTH |
|---|---|---|---|---|---|
| | | | | | |



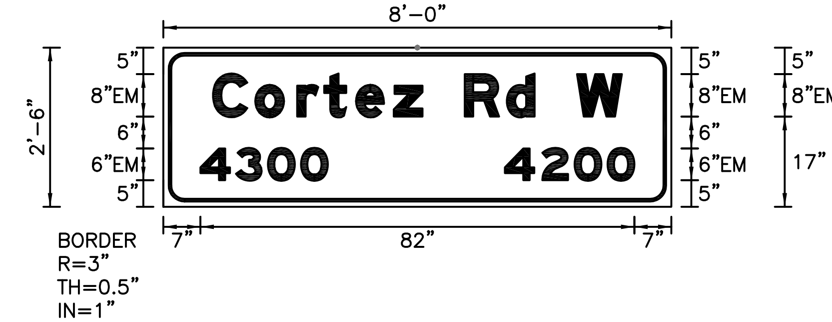

| NO. OF LIGHT FIXTURES | | FIXTURE SPACING | | PHOTOMETRIC CURVE | | WATT | | VOLTAGE | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COPY | | 4 | 3 | r | d | | S | t | | W | | L |
| SPACE | 11.4 | 9 | 8.9 | 5.2 | 5.3 | 12 | 8.2 | 4.2 | 12 | 8.5 | 11.4 | 73.1 |
| COPY | | 4 | 4 | 0 | 0 | | 4 | 3 | 0 | 0 | | L |
| SPACE | 9 | 6.6 | 7 | 6.2 | 5 | 29 | 6.7 | 6.1 | 6.2 | 5 | 9 | 78 |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |

| SIGN NAME | B | QTY | 1 | SIGN NUMBER | STATION(S) |
|---|---|---|---|---|---|
| PANEL | | BORDER | | | none |
| WIDTH | 8'-0" | WIDTH | 0.5" | | |
| HEIGHT | 2'-6" | RADII | 3" | | |
| LEGEND | White | COLOR | White | | |
| COLOR | Green | | | | |

| SYMBOL(S) | ANGLE | X | Y | WID | HT |
|---|---|---|---|---|---|
| | | | | | |

| SIGN NUMBER | NUMBER OF POSTS | CLEARANCE Edge Of Lane | COLUMN SIZE | | AVERAGE LENGTH |
|---|---|---|---|---|---|
| | | | | | |



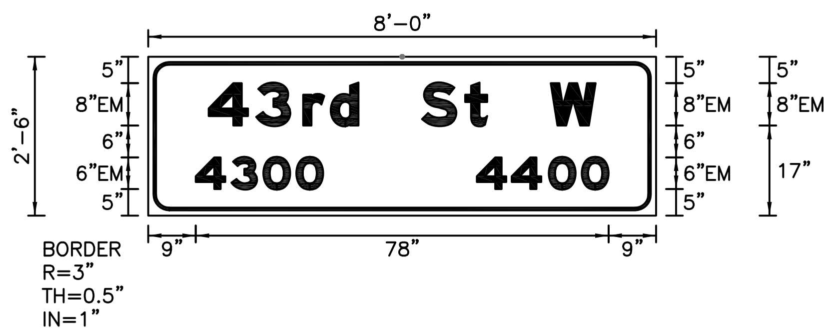

| NO. OF LIGHT FIXTURES | | FIXTURE SPACING | | PHOTOMETRIC CURVE | | WATT | | VOLTAGE | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COPY | | C | o | r | t | e | z | | R | d | | W | | L |
| SPACE | 9.4 | 8 | 7.9 | 5.1 | 6 | 7.1 | 5.4 | 8 | 7.9 | 5.3 | 8 | 8.5 | 9.4 | 77.3 |
| COPY | | 4 | 3 | 0 | 0 | | 4 | 2 | 0 | 0 | | L | | |
| SPACE | 7 | 6.7 | 6.1 | 6.2 | 5 | 33.5 | 7.1 | 6.1 | 6.2 | 5 | 7 | 82 | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |

| SIGN NAME | C | QTY | 1 | SIGN NUMBER | STATION(S) |
|---|---|---|---|---|---|
| PANEL | | BORDER | | | none |
| WIDTH | 8'-0" | WIDTH | 0.5" | | |
| HEIGHT | 2'-6" | RADII | 3" | | |
| LEGEND | White | COLOR | White | | |
| COLOR | Green | | | | |

| SYMBOL(S) | ANGLE | X | Y | WID | HT |
|---|---|---|---|---|---|
| | | | | | |

| SIGN NUMBER | NUMBER OF POSTS | CLEARANCE Edge Of Lane | COLUMN SIZE | | AVERAGE LENGTH |
|---|---|---|---|---|---|
| | | | | | |



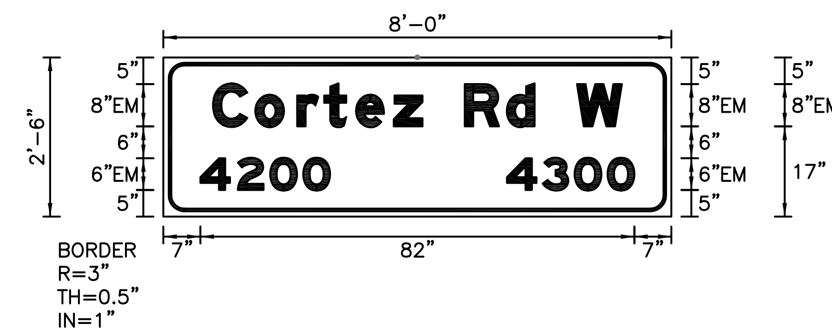

| NO. OF LIGHT FIXTURES | | FIXTURE SPACING | | PHOTOMETRIC CURVE | | WATT | | VOLTAGE | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COPY | | 4 | 3 | r | d | | S | t | | W | | L |
| SPACE | 11.4 | 9 | 8.9 | 5.2 | 5.3 | 12 | 8.2 | 4.2 | 12 | 8.5 | 11.4 | 73.1 |
| COPY | | 4 | 3 | 0 | 0 | | 4 | 4 | 0 | 0 | | L |
| SPACE | 9 | 6.7 | 6.1 | 6.2 | 5 | 29 | 6.6 | 7 | 6.2 | 5 | 9 | 78 |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |

| SIGN NAME | D | QTY | 1 | SIGN NUMBER | STATION(S) |
|---|---|---|---|---|---|
| PANEL | | BORDER | | | none |
| WIDTH | 8'-0" | WIDTH | 0.5" | | |
| HEIGHT | 2'-6" | RADII | 3" | | |
| LEGEND | White | COLOR | White | | |
| COLOR | Green | | | | |

| SYMBOL(S) | ANGLE | X | Y | WID | HT |
|---|---|---|---|---|---|
| | | | | | |

| SIGN NUMBER | NUMBER OF POSTS | CLEARANCE Edge Of Lane | COLUMN SIZE | | AVERAGE LENGTH |
|---|---|---|---|---|---|
| | | | | | |




| NO. OF LIGHT FIXTURES | | FIXTURE SPACING | | PHOTOMETRIC CURVE | | WATT | | VOLTAGE | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COPY | | C | o | r | t | e | z | | R | d | | W | | L |
| SPACE | 9.4 | 8 | 7.9 | 5.1 | 6 | 7.1 | 5.4 | 8 | 7.9 | 5.3 | 8 | 8.5 | 9.4 | 77.3 |
| COPY | | 4 | 2 | 0 | 0 | | 4 | 3 | 0 | 0 | | L | | |
| SPACE | 7 | 7.1 | 6.1 | 6.2 | 5 | 33.5 | 6.7 | 6.1 | 6.2 | 5 | 7 | 82 | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|
| | | | |

MANATEE COUNTY

CORTEZ ROAD AND
43RD STREET WEST

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www.cardnotbe.com - 813.221.0048
Certificate of Authorization No. 3843

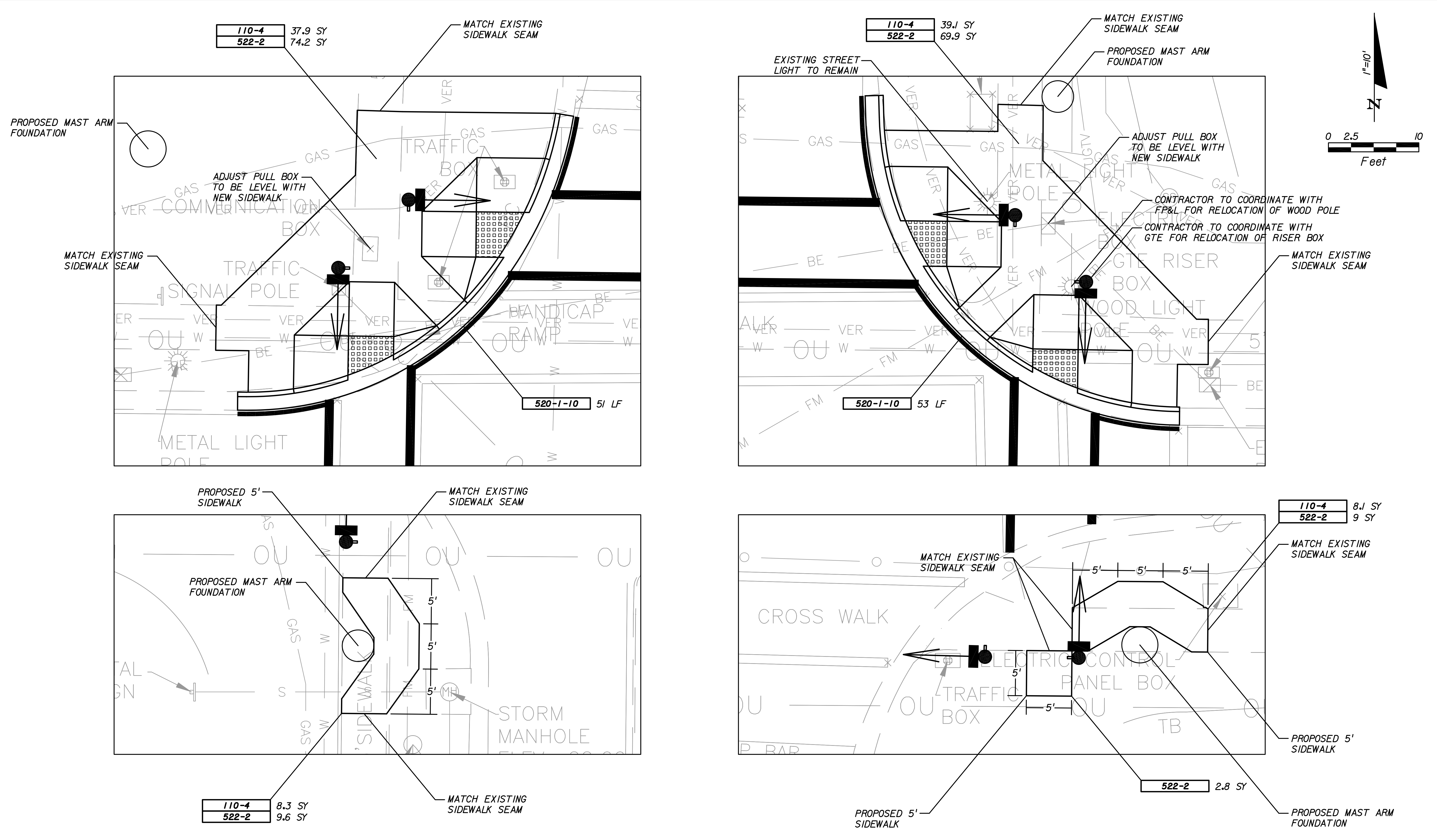
UPIK Y. SUWARNO DATE
LIC. NO.: 62995

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

GUIDESIGN WORKSHEET

PROJECT NO: 00193-008-05
DATE: 11-03-10
SHEET NO: T-10

FILE: O:\JOB\0193\00193-008-05\ACAD\GSWKSG01.dwg LAST SAVED: Fri, 10/29/10-2:56a PLOTTED: Wed, 11/03/10-2:56p BY: uys




| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|
| | | | |

**MANATEE COUNTY**

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UPIK Y. SUWARNO DATE
LIC. NO.: 62995

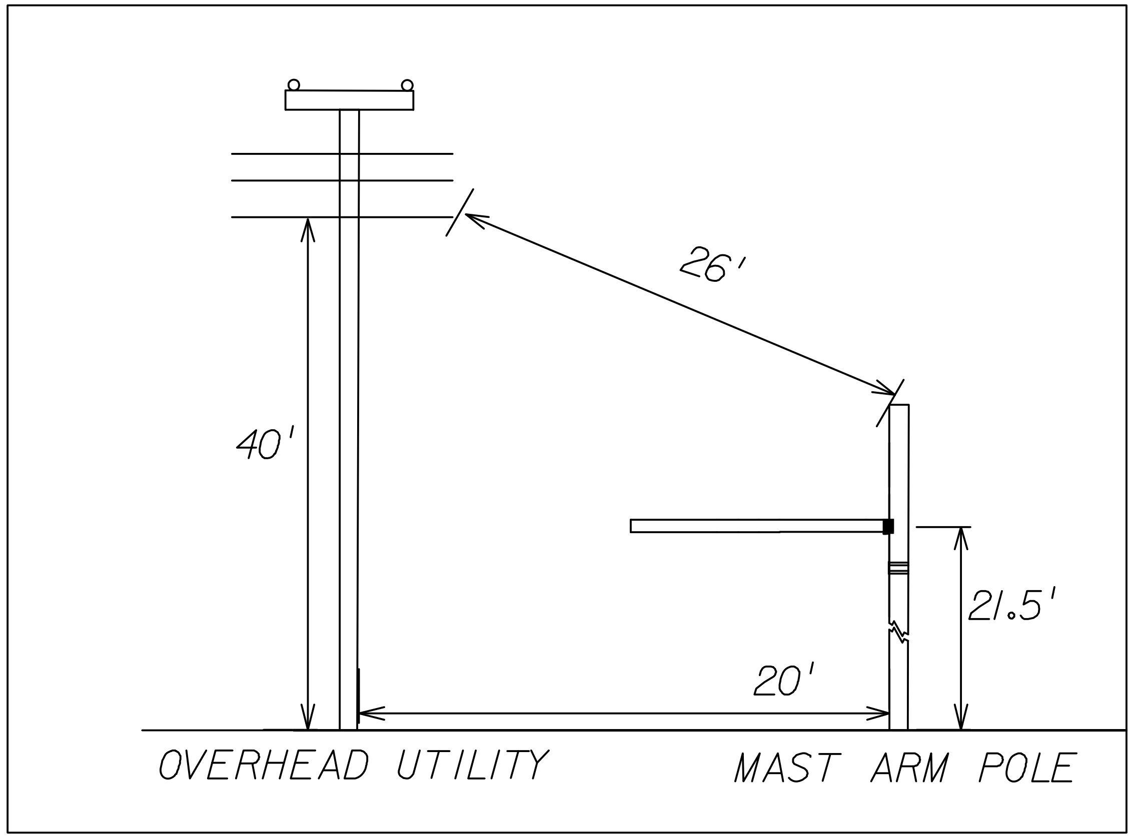
DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

**CONSTRUCTION DETAILS**

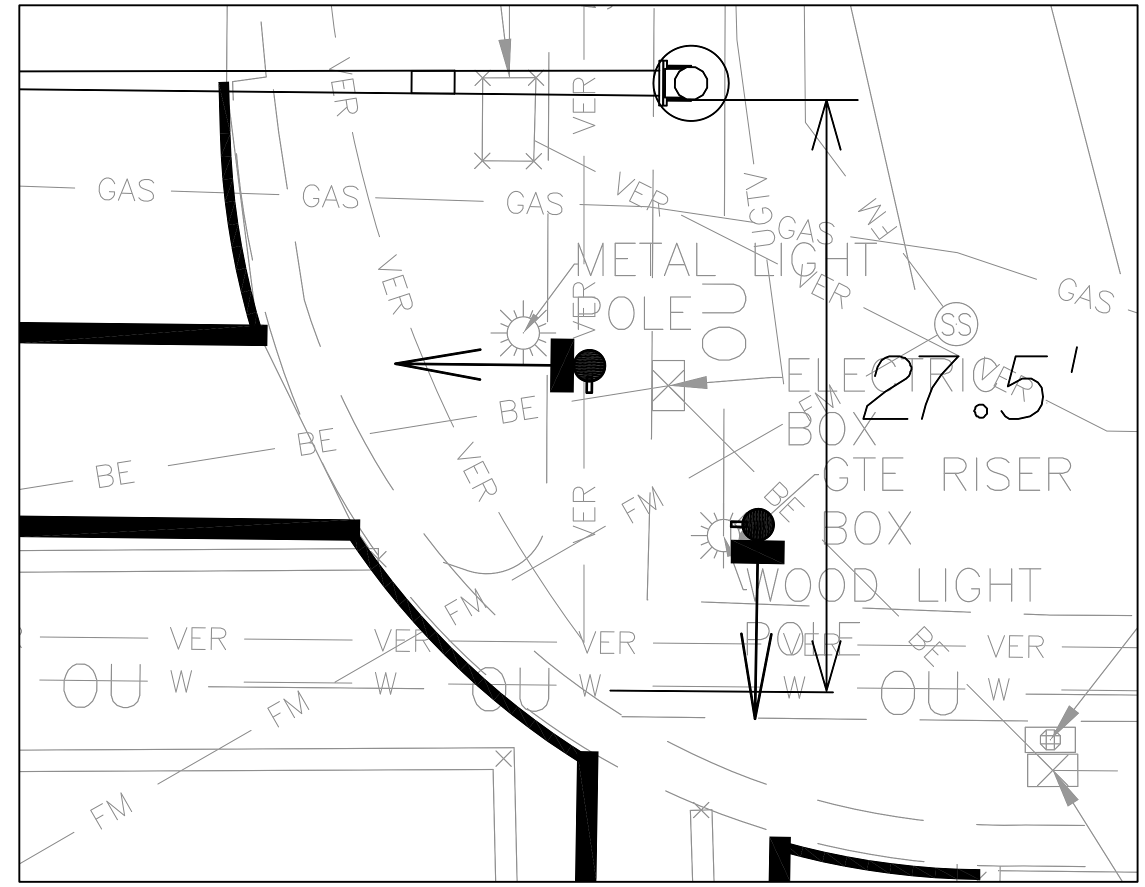
PROJECT NO: 00193-008-05
DATE: 11-03-10
SHEET NO: T-11

FILE: J:\JOB\0193\00193-008-05\ACAD\RAMP.dwg LAST SAVED: Wed, 11/03/10-3:55p PLOTTED: Wed, 11/03/10-3:55p BY: JTP

POLE NO. 1
NORTHWEST CORNER




POLE NO. 2
NORTHEAST CORNER

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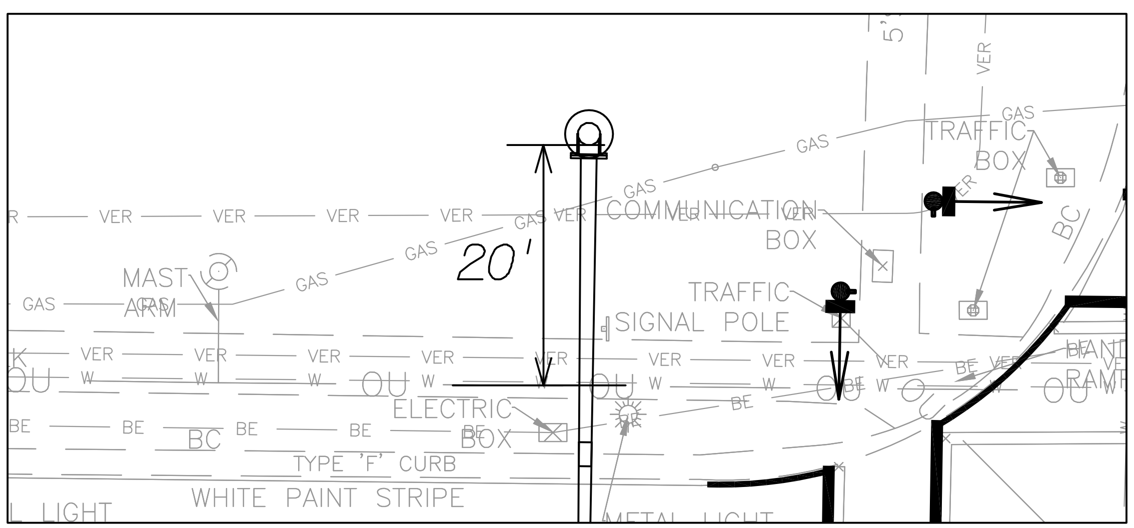
N.T.S.




POLE NO. 1
NORTHWEST CORNER

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

MANATEE COUNTY

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UPIK Y. SUWARNO DATE
LIC. NO.: 62995

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

OVERHEAD UTILITY
PROFILES (1)

PROJECT NO: 00193-008-05
DATE: 11-03-10
SHEET NO: T-12

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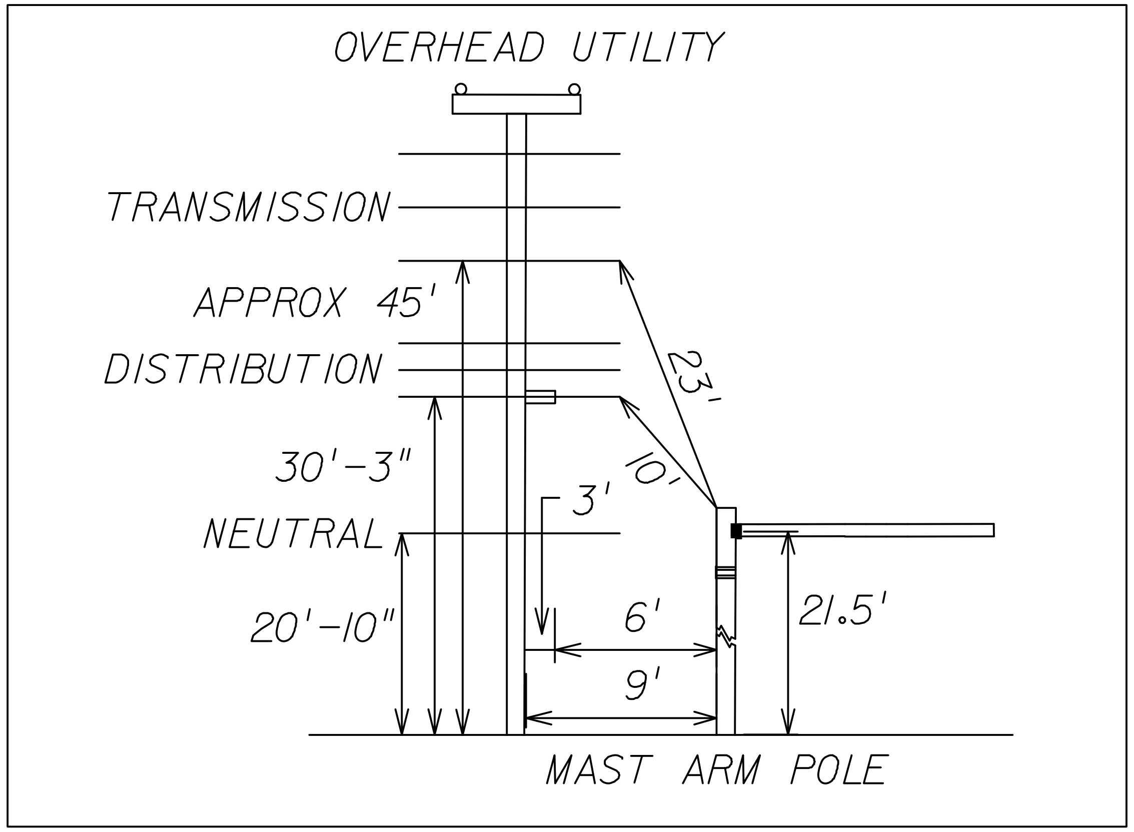
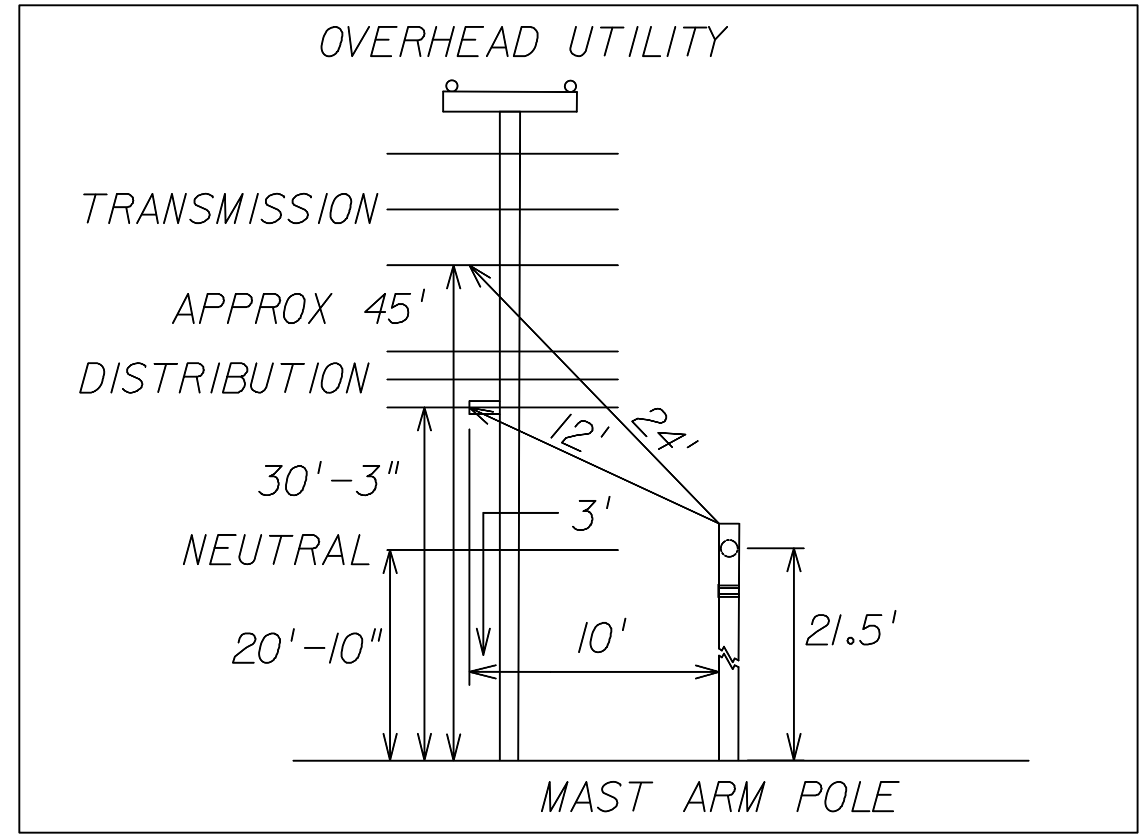
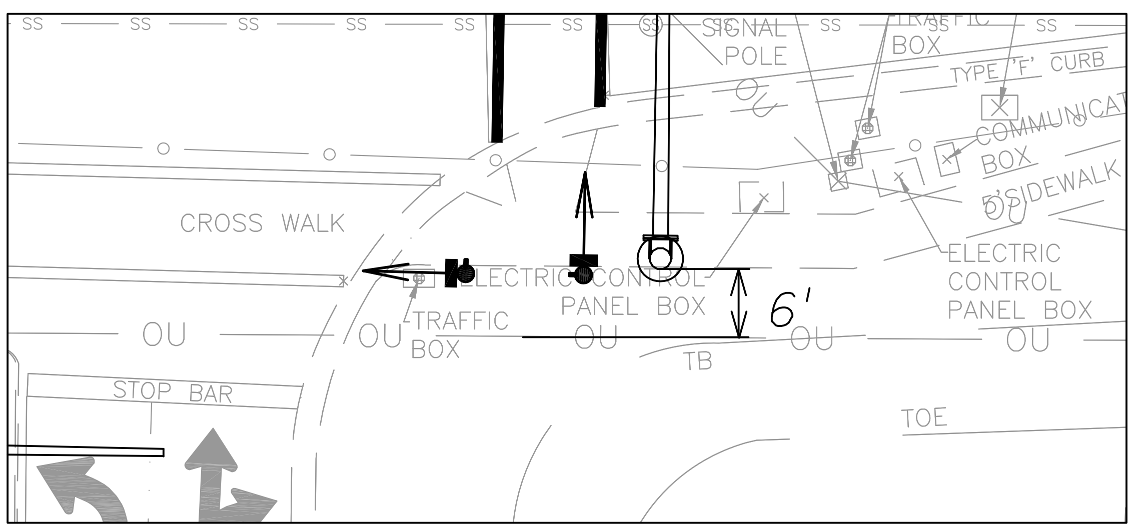
POLE NO. 3
SOUTHEAST CORNER



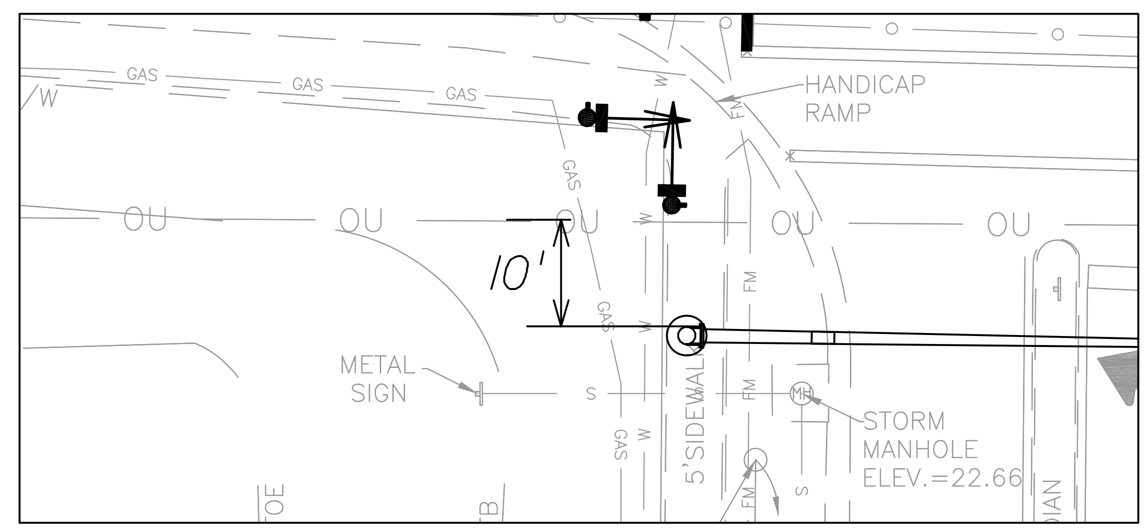

POLE NO. 4
SOUTHWEST CORNER




N
N.T.S.




POLE NO. 3
SOUTHEAST CORNER




POLE NO. 4
SOUTHWEST CORNER

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

MANATEE COUNTY

CORTEZ ROAD AND
43RD STREET WEST

Cardno TBE
12481 Telecom Drive, Tampa, Florida 33637
www.cardnotbe.com • 813.221.0048
Certificate of Authorization No. 3843

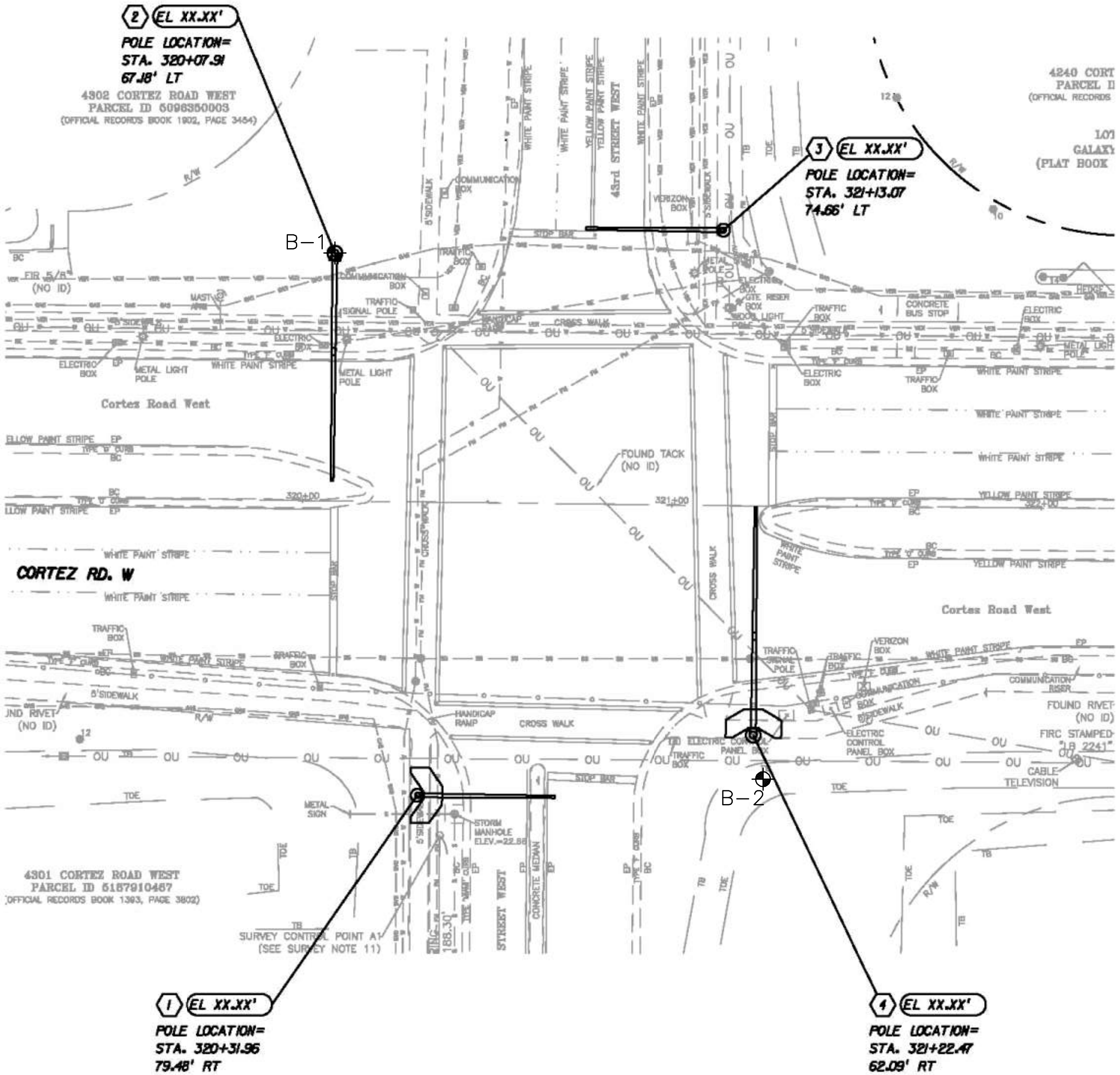
UPIK Y. SUWARNO DATE
LIC. NO.: 62995

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

OVERHEAD UTILITY
PROFILES (2)

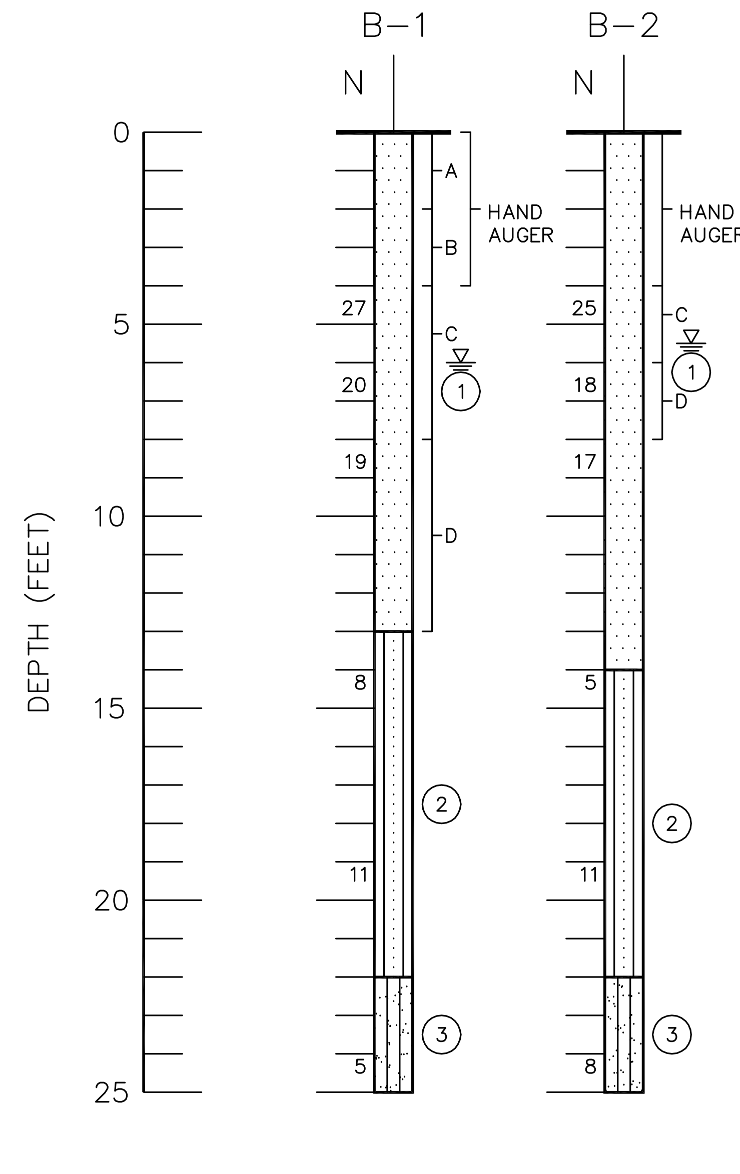
PROJECT NO: 00193-008-05
DATE: 11-03-10
SHEET NO: T-13

FILE: J:\JOB\0193\00193-008-05\ACAD\utility_profile.dwg LAST SAVED: Wed, 11/03/10-3:47p PLOTTED: Wed, 11/03/10-3:50p BY: JTP




BORING LOCATION PLAN

0 40'
PLAN SCALE




SOIL PROFILES

0 5'
VERTICAL SCALE

## LEGEND

| | |
|---|---|
| ① | Light to dark brown, gray fine SAND to slightly silty fine SAND (SP/SP–SM) |
| ② | Silty to Sandy Shell fragments (SP–SM) |
| ③ | Shell fragments with silty SAND (Bay Bottom) (SM) |
| SP | Unified Soil Classification System (ASTM D 2487) group symbol as determined by visual review |
| ▽ | Groundwater level, August 2010 |
| N | SPT N–value in blows/foot |
| A | With gravel fragments |
| B | With trace roots |
| C | Organic staining |
| D | With trace organics |
| ⊕ | Approximate SPT boring location |

| | |
|---|---|
| DRAWN | DJG |
| CHECKED | JH |
| APPROVED | MEM |
| SCALE | NOTED |

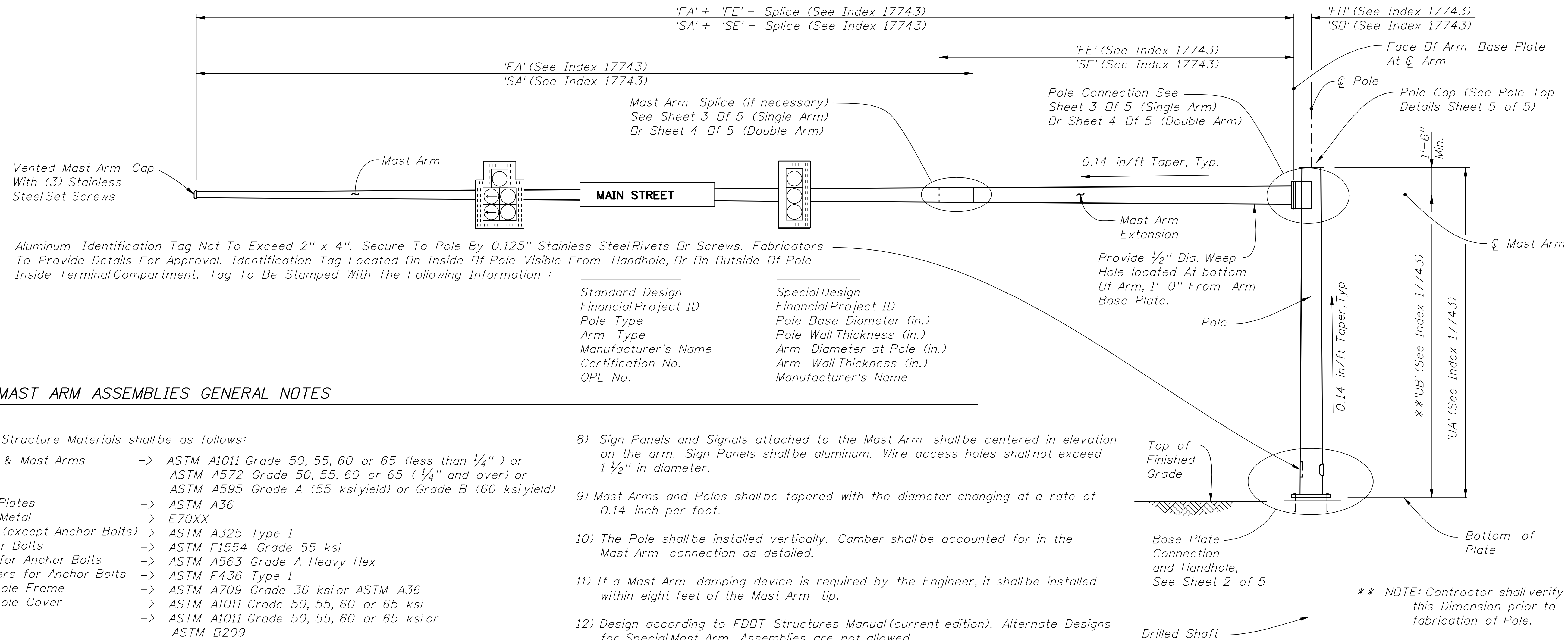
GEOTECHNICAL SERVICES
MAST ARM SIGNAL POLES
CORTEZ ROAD WEST & 43RD STREET WEST
BRADENTON, FLORIDA

psi Information To Build On
Engineering • Consulting • Testing

| DATE | PROJ. NO. | |
|---|---|---|
| AUG 10 | 0775733 | SHEET T-14 |

P:\775–Geo\0775733 Cardno Cortez & 43rd St Manatee Co\cad\0775733

# Appendix C. 2010 FDOT Design Standards Index




## ELEVATION VIEW

(Single Arm Shown, Double Arm Similar)
(Luminaire Arm Not Shown)

## MAST ARM ASSEMBLIES GENERAL NOTES

1) Signal Structure Materials shall be as follows:

| | | |
|---|---|---|
| Poles & Mast Arms | -> | ASTM A1011 Grade 50, 55, 60 or 65 (less than ¼" ) or ASTM A572 Grade 50, 55, 60 or 65 ( ¼" and over) or ASTM A595 Grade A (55 ksi yield) or Grade B (60 ksi yield) |
| Steel Plates | -> | ASTM A36 |
| Weld Metal | -> | E70XX |
| Bolts (except Anchor Bolts) | -> | ASTM A325 Type 1 |
| Anchor Bolts | -> | ASTM F1554 Grade 55 ksi |
| Nuts for Anchor Bolts | -> | ASTM A563 Grade A Heavy Hex |
| Washers for Anchor Bolts | -> | ASTM F436 Type 1 |
| Handhole Frame | -> | ASTM A709 Grade 36 ksi or ASTM A36 |
| Handhole Cover | -> | ASTM A1011 Grade 50, 55, 60 or 65 ksi |
| Caps | -> | ASTM A1011 Grade 50, 55, 60 or 65 ksi or ASTM B209 |
| Nut Covers | -> | ASTM B26 (319-F) |
| Stainless Steel Screws | -> | AISI Type 316 |
| Threaded Bars/Studs | -> | ASTM A36 or ASTM A307 |

2) Reinforcing Steel shall be ASTM A615 Grade 60 ksi.

3) Concrete shall be Class IV (Drilled Shaft) with a minimum 28-day compressive strength of 4,000 psi for all environmental classifications.

4) All welding shall conform to American Welding Society Structural Welding Code (Steel) ANSI/AWS D1.1 (current edition).

5) All steel items shall be galvanized as follows:
All Nuts, Bolts, Washers and
Threaded Bars/Studs -> F2329
All other steel items
(including Pole & Mast Arm) -> ASTM A123

6) Locate handhole 180° from arm on single arm poles or 180° from first arm of double arm poles or see special instructions on Mast Arm Tabulation Sheet.

7) Except for Anchor Bolts, all bolt hole diameters shall be equal to the bolt diameter plus ¹⁄₁₆", prior to galvanizing. Hole diameters for Anchor Bolts shall not exceed the bolt diameter plus ½".

8) Sign Panels and Signals attached to the Mast Arm shall be centered in elevation on the arm. Sign Panels shall be aluminum. Wire access holes shall not exceed 1 ½" in diameter.

9) Mast Arms and Poles shall be tapered with the diameter changing at a rate of 0.14 inch per foot.

10) The Pole shall be installed vertically. Camber shall be accounted for in the Mast Arm connection as detailed.

11) If a Mast Arm damping device is required by the Engineer, it shall be installed within eight feet of the Mast Arm tip.

12) Design according to FDOT Structures Manual (current edition). Alternate Designs for Special Mast Arm Assemblies are not allowed.

13) Provide "J","S" or "C"-Hook at top of pole for signal cable support.

14) First and Second Arm Camber Angle = 2°.

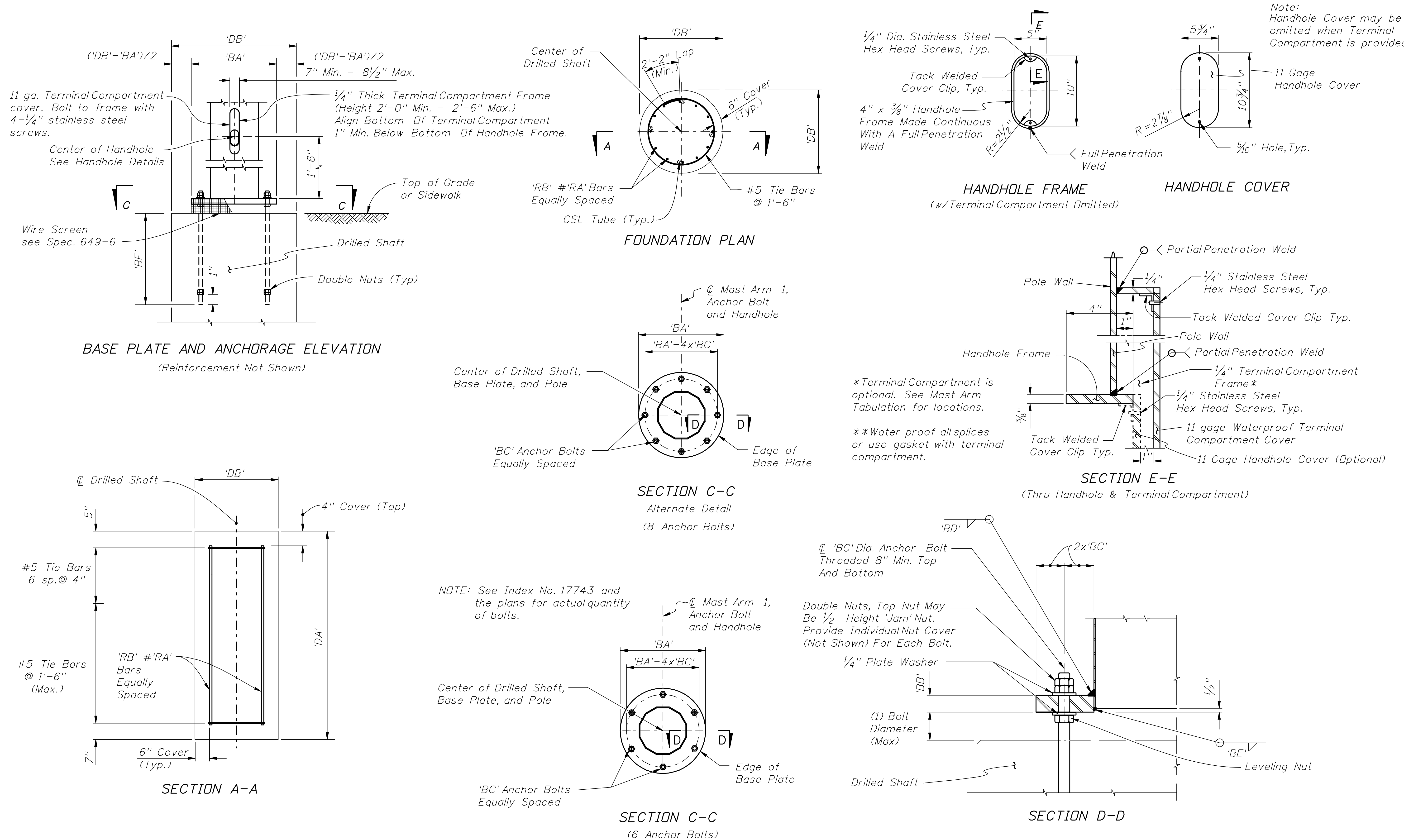
15) Details for the Ground Rod, Signal and Sign Locations, Signal Head attachment, Sign Attachment, Pedestrian Head Attachment, and Foundation Conduit are not shown for clarity.

16) One hundred percent of full-penetration groove welds and a random 25 percent of partial penetration groove welds shall be inspected. Full-penetration groove weld inspection shall be performed by nondestructive methods of radiography or ultrasonics.

17) Manufactuers seeking approval of a steel mast arm assembly for inclusion on the Qualified Products List must submit a QPL Product Evaluation Application along with design documentation and drawings showing the product meets all specified requirements of this Index and Index 17743.

18) Verify CSL access tubes will not interfere with anchor bolt installation before excavating the shaft. When CSL access tube locations conflict with anchor bolt locations, move the CSL access tube location +/- two inches along the inner circumference of the reinforcing cage. Notify the Engineer before excavating the shaft if the CSL access tube locations cannot be moved out of conflict with anchor bolt locations.

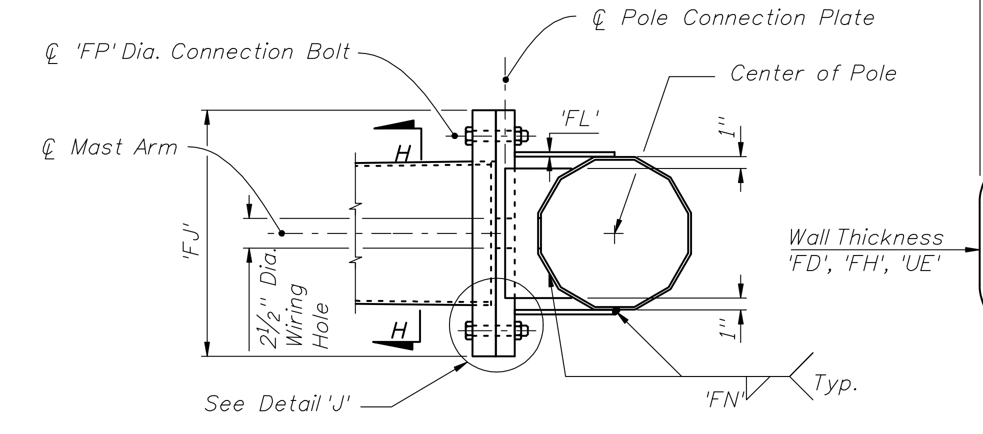
## TYPICAL ELEVATION AND NOTES



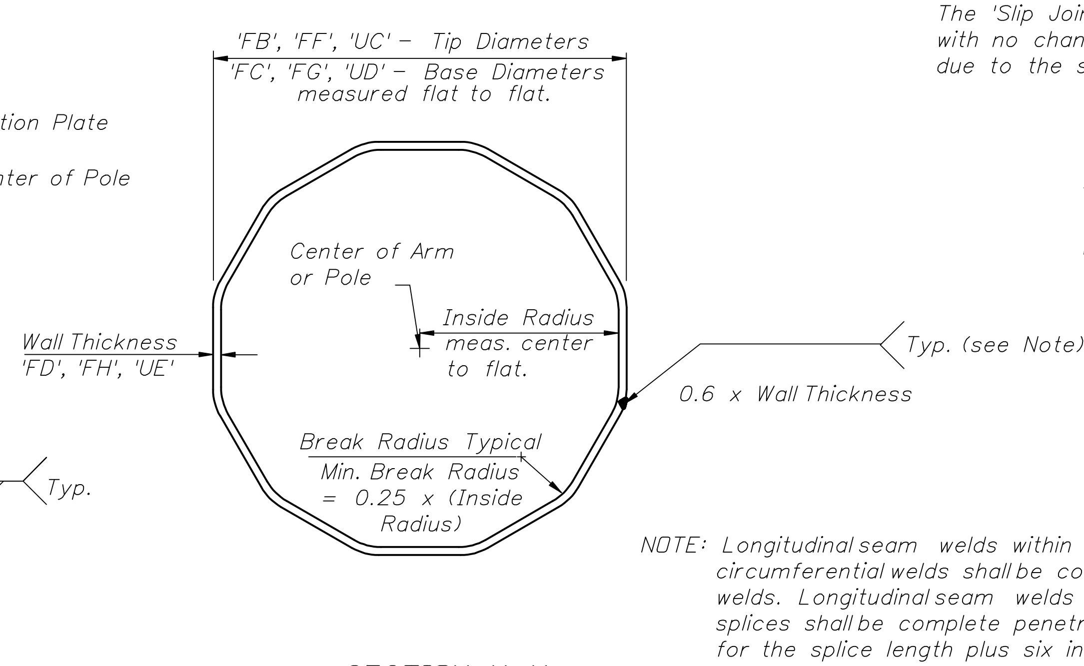

TYPICAL FOUNDATION AND BASE PLATE DETAILS

| | | | |
|---|---|---|---|
| STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION | 2010 FDOT Design Standards | Last Revision 07/01/09 | Sheet No. 2 of 5 |
| | MAST ARM ASSEMBLIES | | Index No. 17745 |

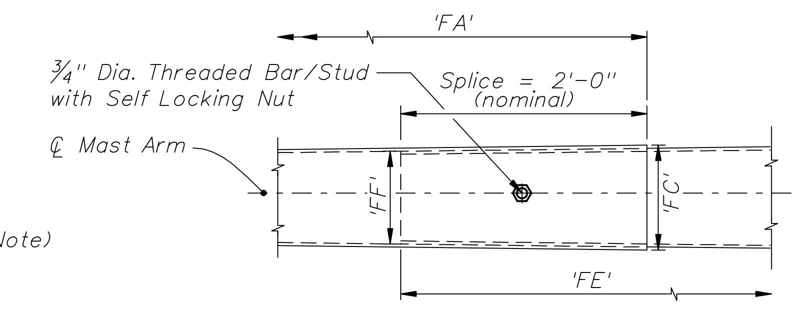
The 'Slip Joint' splice shall be a tight fit with no change in the Mast Arm slope due to the splice.




SECTION F-F

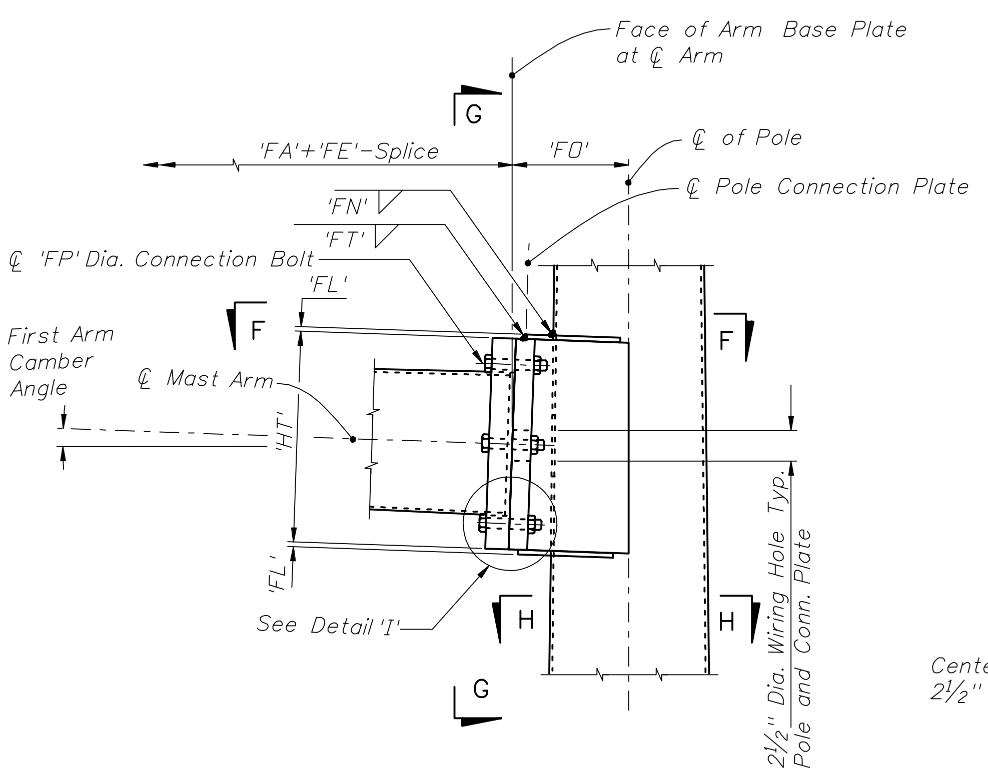



SECTION H-H



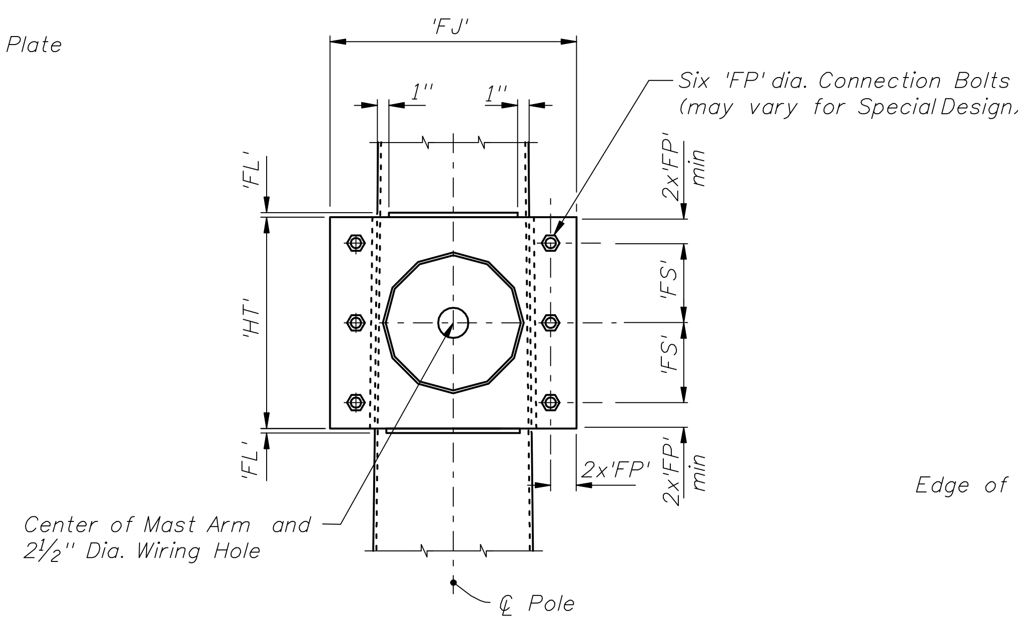

Arm Splice Detail

NOTE: Longitudinal seam welds within six inches of circumferential welds shall be complete penetration welds. Longitudinal seam welds at telescopic field splices shall be complete penetration welds for the splice length plus six inches. For tubes greater than 70" in circumference, two longitudinal seam welds are allowed.

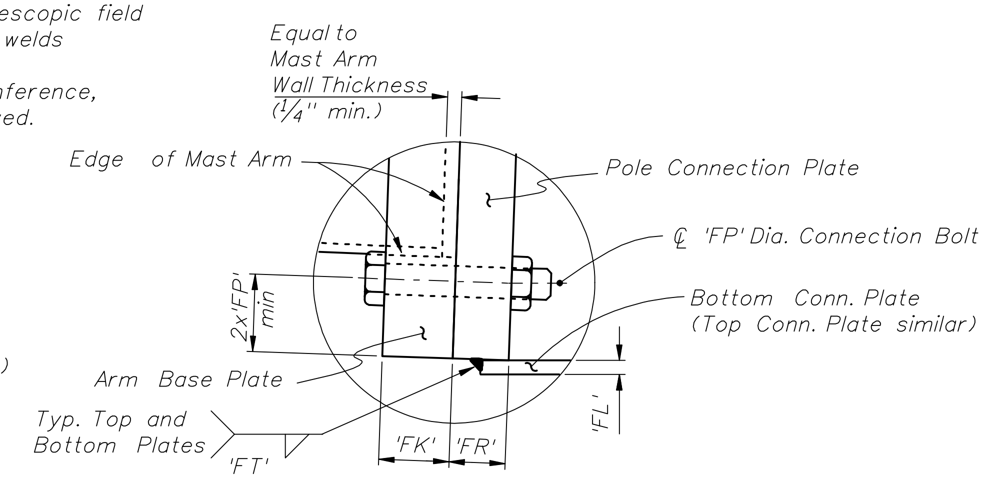



ELEVATION

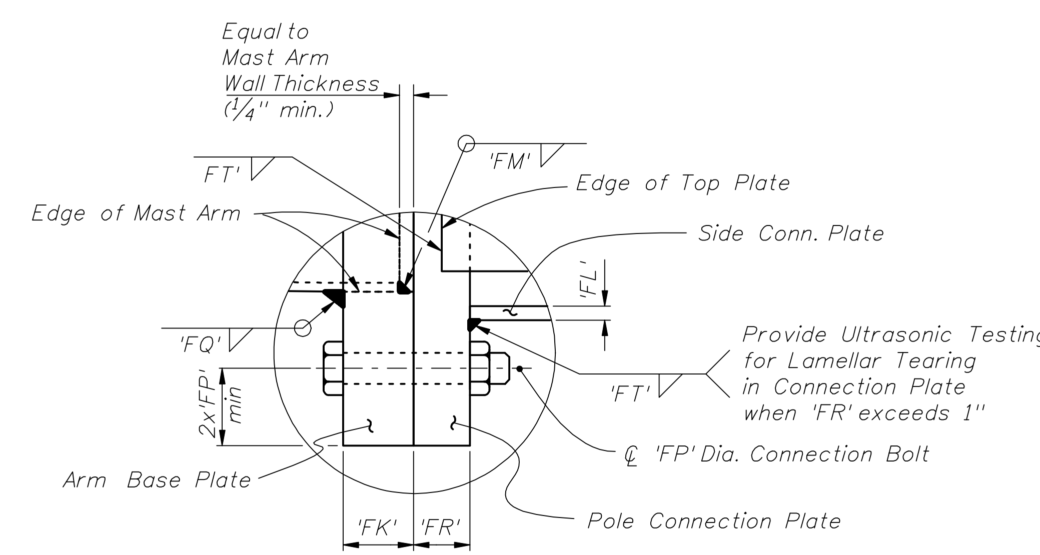
(Single Arm Connection)




SECTION G-G




DETAIL 'I'



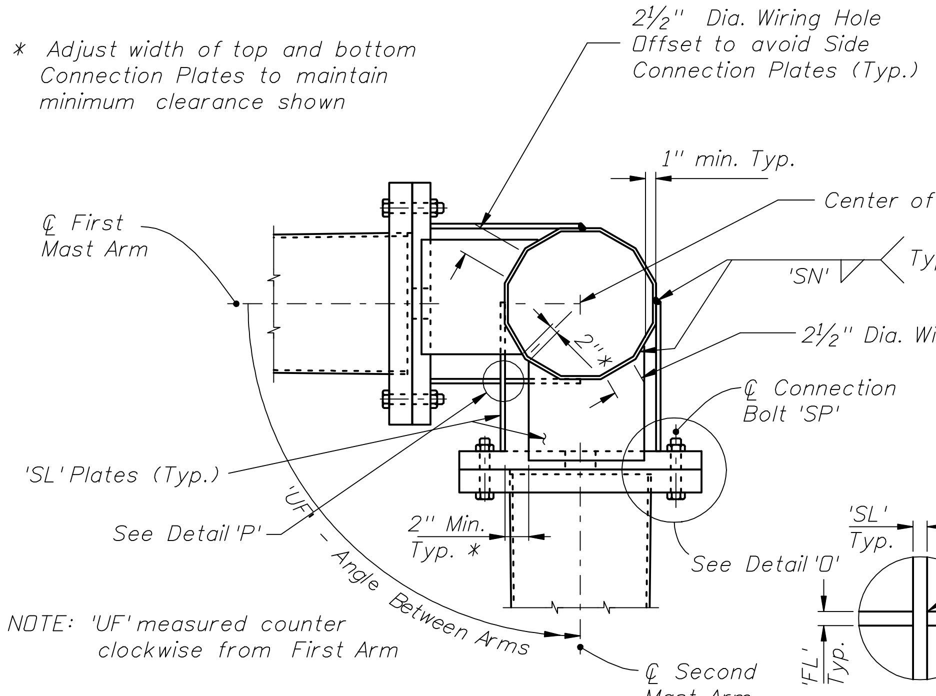

DETAIL 'J'

NOTE:
1. Details shown on this sheet are for 12 sided pole sections. However, sections with more than 12 sides and round sections are permitted provided outside diameter and wall thickness are not reduced.

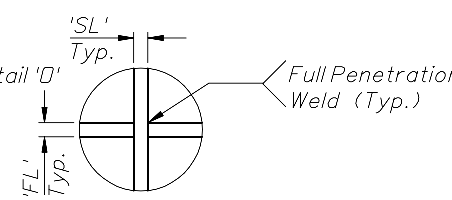
2. Mast Arm and Connection Plates shall be match marked to ensure proper assembly.

TYPICAL SINGLE ARM CONNECTION DETAILS

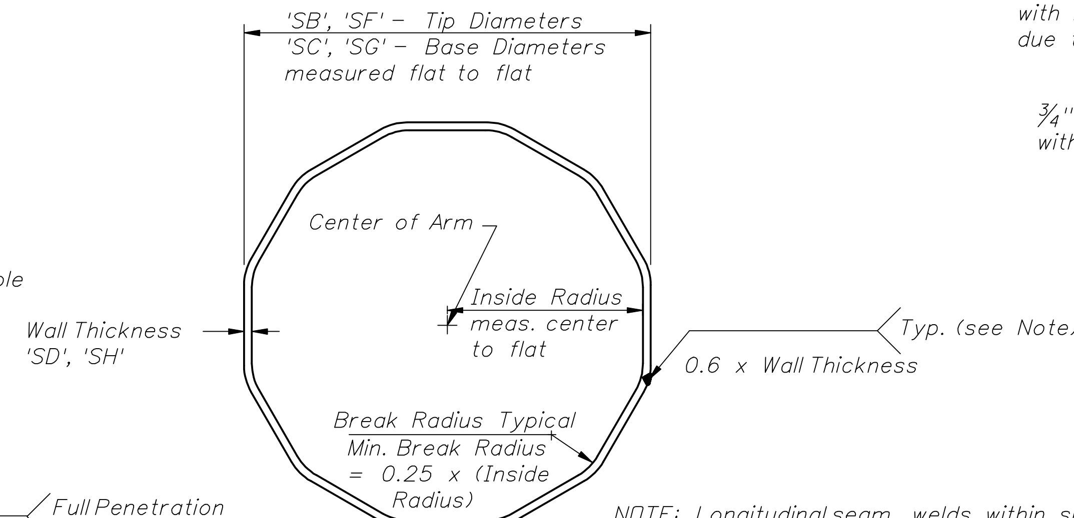
| | | | |
|---|---|---|---|
| STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION | 2010 FDOT Design Standards | Last Revision 07/01/05 | Sheet No. 3 of 5 |
| | MAST ARM ASSEMBLIES | | Index No. 17745 |




SECTION K-K



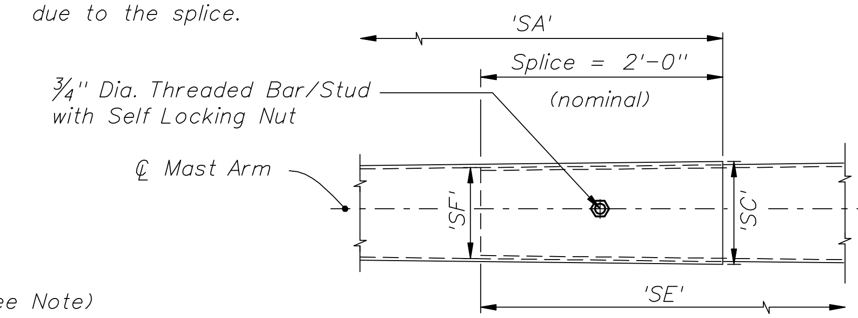

DETAIL 'P'



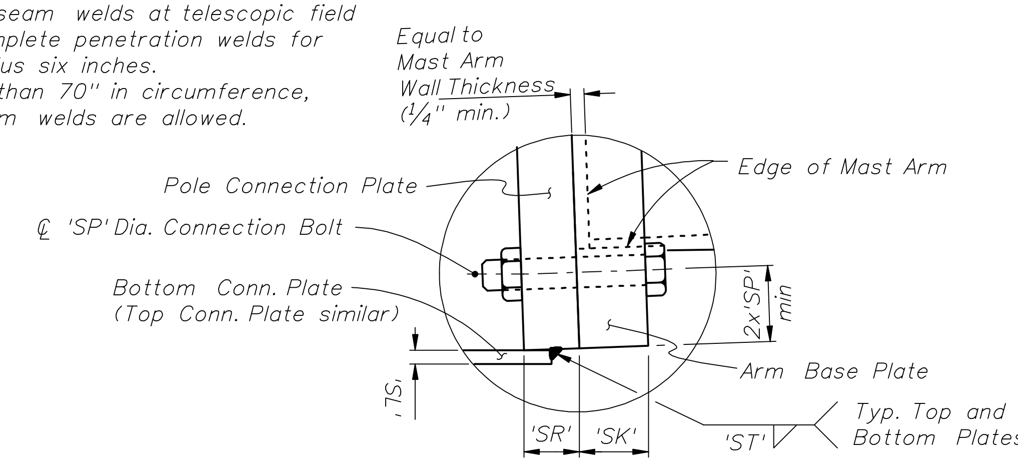

SECTION M-M

NOTE: Longitudinal seam welds within six inches of circumferential welds shall be complete penetration welds. Longitudinal seam welds at telescopic field splices shall be complete penetration welds for the splice length plus six inches.
For tubes greater than 70" in circumference, two longitudinal seam welds are allowed.

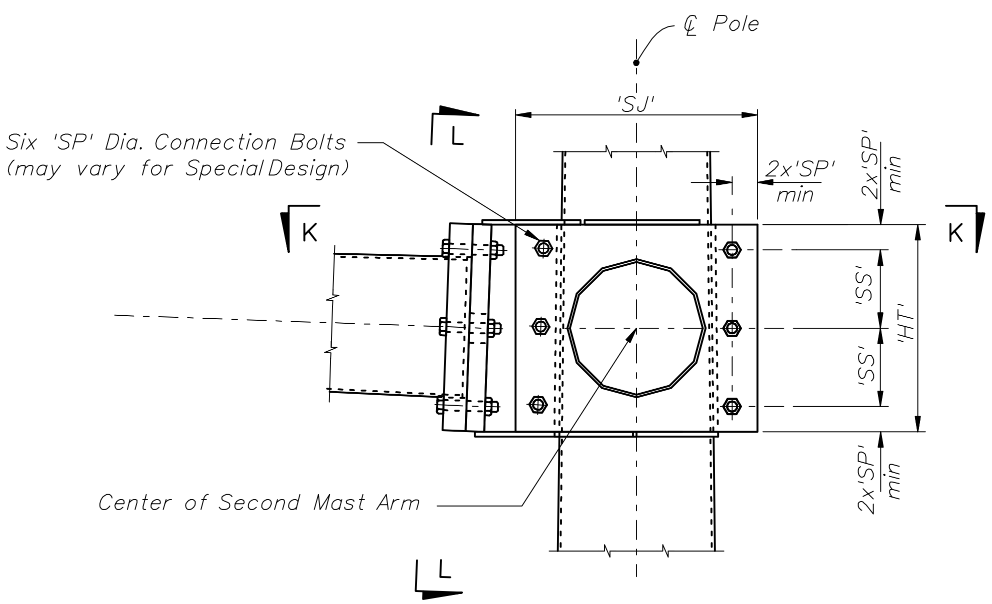
The 'Slip Joint' splice shall be a tight fit with no change in the Mast Arm slope due to the splice.




Arm Splice Detail

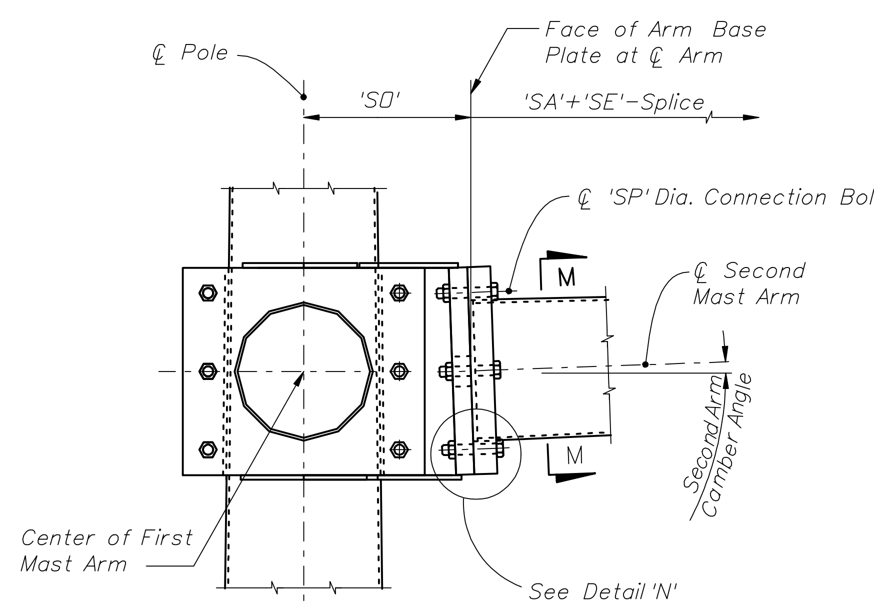



DETAIL 'N'

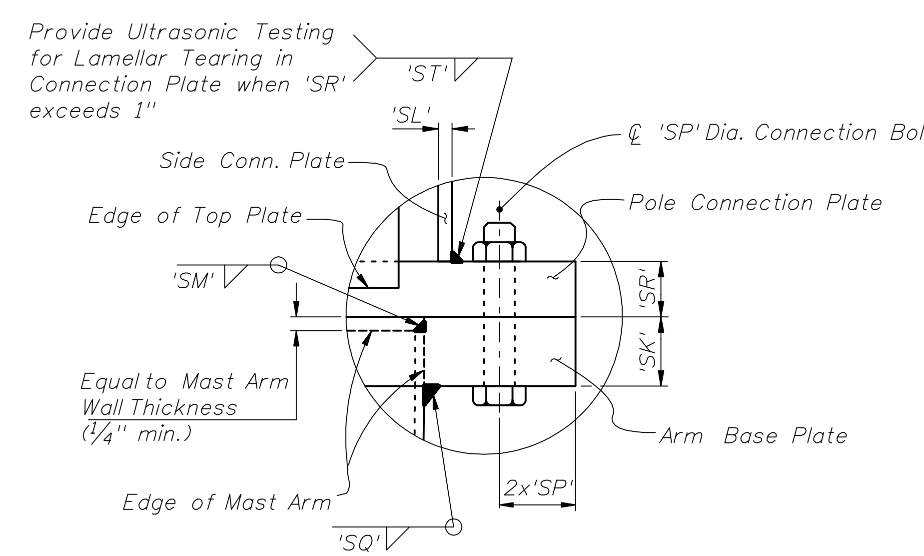



ELEVATION

(Double Arm Connection)




SECTION L-L



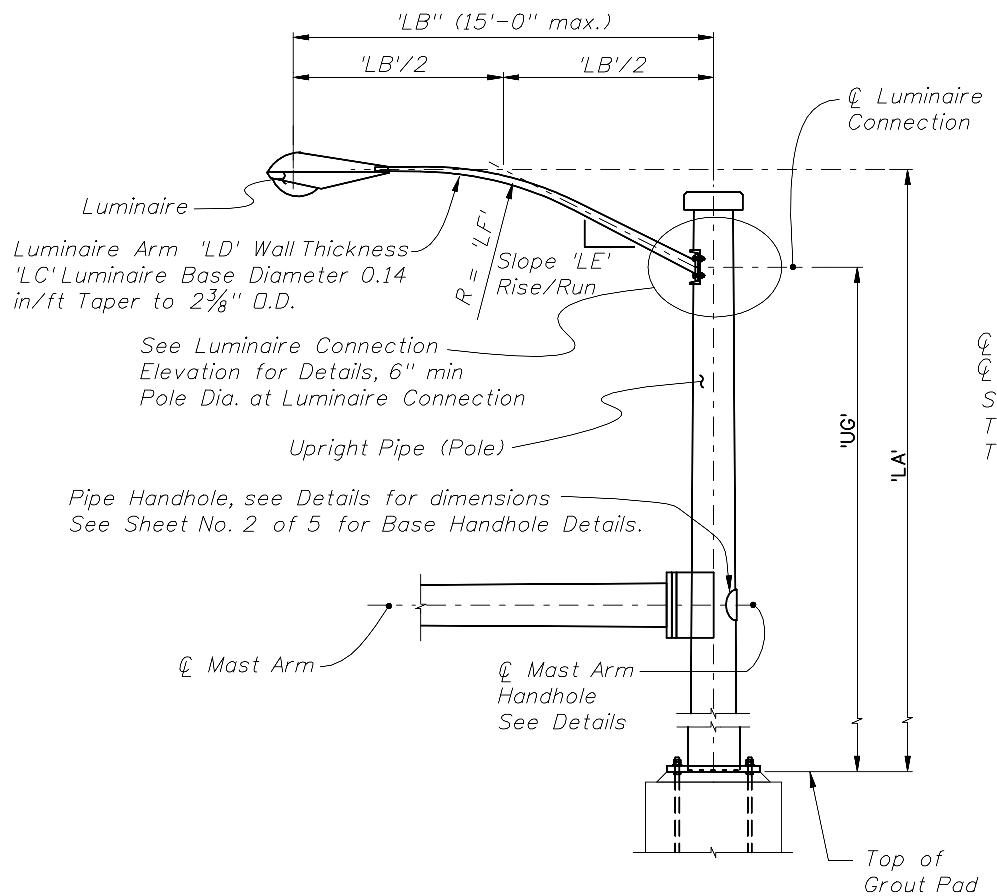

DETAIL 'O'

NOTE:
1. Details shown on this sheet are for 12 sided pole sections. However, sections with more than 12 sides and round sections are permitted provided outside diameter and wall thickness are not reduced.

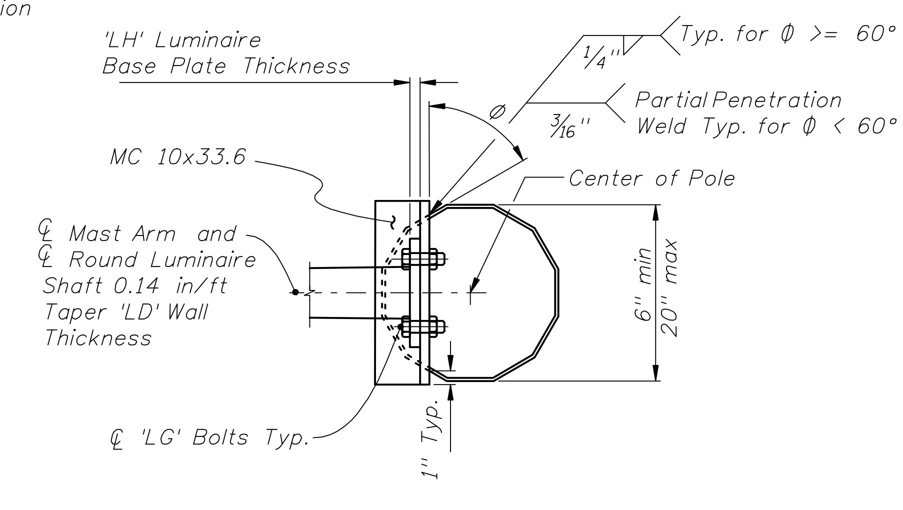
2. Mast Arm and Connection Plates shall be match marked to ensure proper assembly.

TYPICAL DOUBLE ARM CONNECTION DETAILS

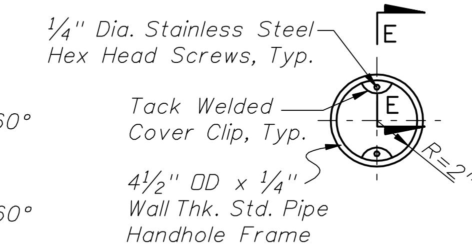
| STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION | 2010 FDOT Design Standards | Last Revision 07/01/05 | Sheet No. 4 of 5 |
|---|---|---|---|
| | MAST ARM ASSEMBLIES | | Index No. 17745 |



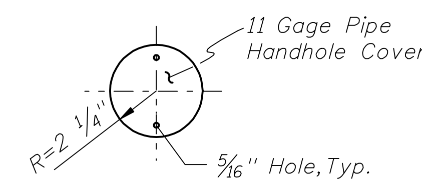

LUMINAIRE ELEVATION



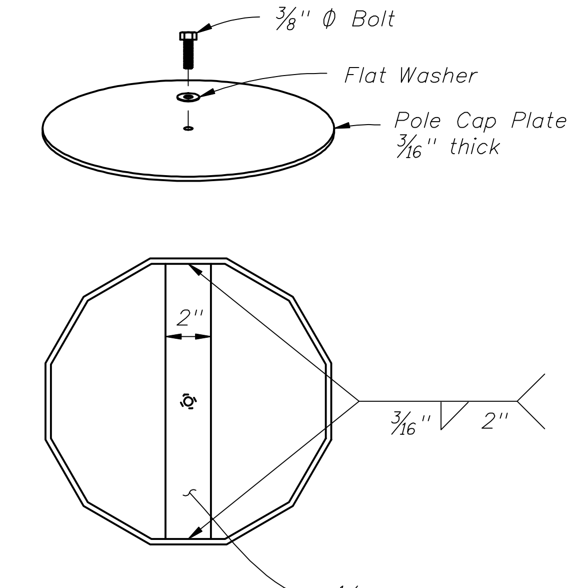

SECTION A-A



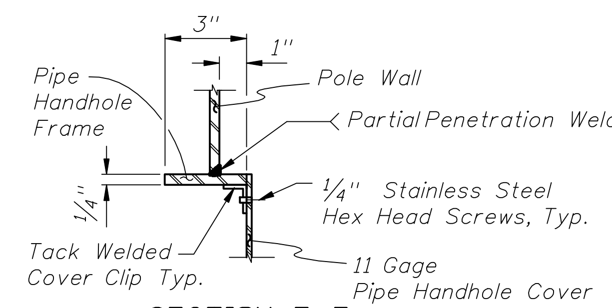

Pipe Handhole Frame



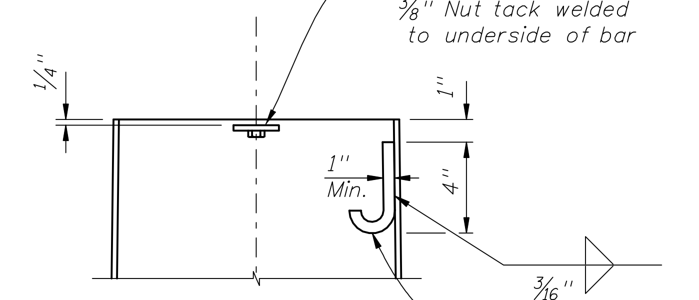

Pipe Handhole Cover



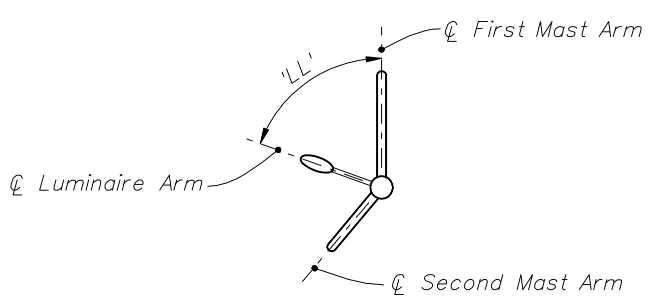

TOP VIEW



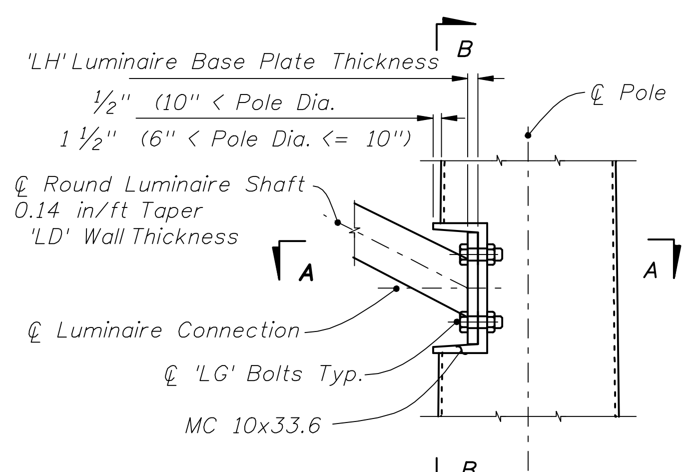

SECTION E-E
(thru Pipe Handhole)



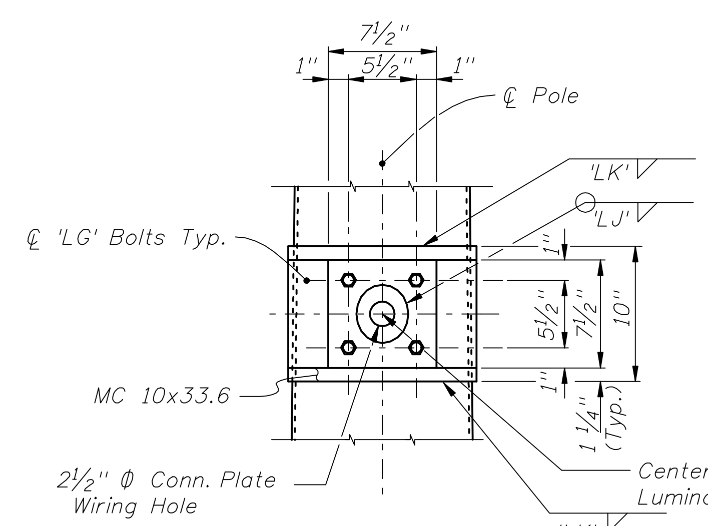

POLE TOP CUT-AWAY
(Option 'a')



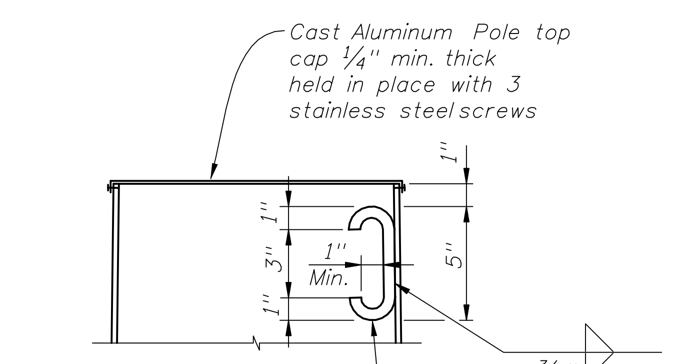

LUMINAIRE ORIENTATION




LUMINAIRE CONNECTION ELEVATION




SECTION B-B




POLE TOP CUT-AWAY
(Option 'b')

POLE TOP DETAILS

NOTE: The Pole shown on this sheet is a 12 sided section. However, sections with more than 12 sides and round sections are permitted provided outside diameter and wall thickness are not reduced

NOTE: The Fabricator may substitute a ½'' thick bent plate with the same flange width, height, and length as the MC 10x33.6 Channel section.

NOTE:
Any combination of the above two options may be used, provided both lifting and wiring is accommodated.

NOTES:

1. Luminaire type and Luminaire to Arm Connection Details can be found elsewhere.
2. Align Luminaire Arm with single Mast Arm or first Arm of Double Mast Arm unless indicated otherwise in plans.

TYPICAL LUMINAIRE ARM AND CONNECTION DETAILS

| STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION | 2010 FDOT Design Standards | Last Revision | Sheet No. |
|---|---|---|---|
| | MAST ARM ASSEMBLIES | 07/01/07 | 5 of 5 |
| | | Index No. | 17745 |

# Appendix D. Supplementary Information – Pole 1

# Cortez Rd (SR 684 - 44th Ave W) at 43rd St W

## (TSMA No. 13M126)

## NE Mast Arm Structural Evaluation

**Date: 06/21/2018**

**(Revision 1)**

STEVEN M. LANEY
LICENSE
No 46449
STATE OF
FLORIDA
PROFESSIONAL ENGINEER
6/21/18

Steven M. Laney, PE. 46449
Date: 06/21/2018

**Executive Summary:**

- As part of an intersection improvement project on Cortez Rd (SR 684 – 44th Ave W) and 43rd St W, the northeast (NE) existing mast arm of TSMA 13M126 will be modified to accommodate a right turn lane from 43rd St W northbound to Cortez Rd W eastbound.

- The modified configuration of the existing mast arm includes the addition of a 5-head signal while moving the existing street sign toward the upright. Plans are available for the mast arm showing the existing signal and sign configuration that is presently in place and a possible future configuration that the structure is to be cable of supporting as well.

- The results of the analysis indicate that the existing mast arm structure is sufficient for the modified loading for the additional 5-head signal. The existing sign is required to be moved toward the upright in order for the new signal to be installed. The is to be centered at 6' from the upright.

## Table of Contents

## Introduction:

- As part of an intersection improvement project on Cortez Rd (SR 684 – 44th Ave W) and 43rd St W, the northeast (NE) existing mast arm of TSMA 13M126 will be modified to accommodate a right turn lane from 43rd St W northbound to Cortez Rd W eastbound. The intent for the mast arm update is to provide a 5-head signal to the existing mast arm for the turn lane addition. Refer to Photo 1 below for a view of the existing mast arm to be updated.


*Photo 1 - NE Mast Arm Elevation View*

- The mast arm system at the intersection was designed in 2010 and constructed around 2012 replacing a single span wire signal system. Design plans are available and show that the NE corner mast arm is designated as Mast Arm No. 1. The existing mast arm is a single arm structure supporting a 5-head signal, a 3-head signal and a street sign.

- The design of the mast arms were based on the 2001 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals and for Manatee County with a 130 mph wind speed. As such, the analysis will be provided using a Mathcad program that is based on the 2001 Specifications to evaluate the differences between the existing condition and the proposed.

**Introduction (Cont'd):**

- The intent of the analysis is to verify the change in the capacity of the mast arm with minor modifications. Although additional loading is anticipated for the existing configuration, a future configuration with heavier loading was provided and included in the plan set. As such, the existing mast arm is to be evaluated where the existing design configuration and the future configuration is compared to the proposed configuration. Note that the analysis will follow the procedures according to the FDOT Design Manual (FDM) in Section 261.7, Evaluating Existing Sign, Signal, Lighting 261.7 and ITS Support Structures. The analysis will provide a report on the Performance Rations (PRs), Demand/Capacity (D/C) ratios and Combined Stress Ratios (CSRs) and the results from the comparison between the existing and proposed conditions. The intent of the analysis is to retain the structure unless it is considerably overstressed.

- This Traffic Signal Mast Arm (TSMA) is part of the FDOT inspection inventory. The structure number is TSMA 13M126. The most recent inspection was performed on 1027/2016. The FDOT program typically requires TSMAs to be inspected every 5 years unless conditions warrant frequencies more often. The number in the inspection report for the NE mast arm is No. 3. The report noted only minor condition issues. The foundation was noted to have 2 of the 6 anchor bolts loose and the arm and column elements show random areas of minor chips and scrapes in the galvanizing with minor corrosion developing. These conditions would not warrant a reduction in the capacity of the structure.

**Mast Arm Evaluation – Existing Configuration:**

- The available plans for the existing mast arm at the NE corner (Pole ID No. 1) provided data for the proposed configuration and for a future configuration. As previously noted, the design was developed in 2010 based on the 2001 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. The mast arm is a single arm structure that looks to have been designed as an E3-T2 (arm-column) standard mast arm design while resulting with a few special mast arm element adjustments. The standard wind speed for this arm-column configuration is for the 130 mph wind speed.

- The plans indicate that a geotechnical boring was taken for the project and parameters provided. The design for the mast arm is assumed to use the boring data provided and not on standard geotechnical parameters.

**E3-T2 Analysis Input Data**

- The existing mast arm configuration includes 2 signal heads and 1 sign. The plans also show a possible future configuration of 3 signal heads and 2 signs. Refer to the plans and to the following layout as described for the input into the Mathcad program to establish the base stresses and the Performance Rations (PRs), Capacity/Demand (C/D) ratios or Combined Stress Ratios (CSRs):

  Existing Signals:
  - 3 Head at 24’ from Upright
  - 5 Head at 36’ from Upright

  Existing Sign:
  - 2.5’ x 8’ at 12’ from Upright; 20.00 SF

  Future Signals:
  - 3 Head at 17’ from Upright
  - 3 Head at 29’ from Upright
  - 4 Head at 40’ from Upright

  Future Signs:
  - 2.5’ x 8’ at 10’ from Upright; 20.00 SF
  - 3.0’ x 2.5’ at 45’ from Upright; 7.50 SF

- The plans provide the following dimensions and some of the dimensions adjusted from the standards (Refer to the Plans and 2010 Standards):

  - Critical Road Elevation = 21.90’
  - Top of Foundation Elevation = 21.90’
  - Arm Mounting Height = 21.5’
  - Back Plates = Y

**Mast Arm Evaluation – Existing Configuration (Cont'd):**

- The plans provide the following dimensions and some of the dimensions adjusted from the standards (Refer to the Plans and 2010 Standards) (Cont'd):

  – First Arm data – standard dimensions are used.

  – First Arm Extension data – standard dimensions are used except as noted:
    > FH (in) = 0.375

  – Pole data – standard dimensions are used except as noted:
    > UA (ft) = 21.5
    > UB (ft) = 21.5
    > UC (in) = 13.0

  – First Arm Connection data – std. dimensions are used except as noted:
    > FJ (in) = 23
    > FM (in) = 0.313
    > FQ (in) = 0.438

  – Pole Base Connection data – standard dimensions are used.

  – Shaft and Reinforcement data – standard dimensions are used.

  – Foundation data:
    > Soil Type = Sand
    > Soil Layer Thickness = 20 ft.
    > Soil Friction Angle $\varphi_{soil}$ = 30°
    > Soil Weight $\gamma_{soil}$ = 42.6 pcf saturated
    > Water Table = 0.0 ft. below the surface

- The TSMA report provides the following measurements:

  – Mast Arm No. 1 Upright thickness measurement (AH) = 0.379 in.
    (4 ft from the base plate)
    ➔ ***Standard dimension was used in design (UE) = 0.375 in.***

  – Mast Arm No. 1 Arm thickness measurement (FG) = 0.378 in.
    (4 ft from the connection plate)
    ➔ ***Modified dimension was used in design (FH) = 0.375 in.***

**Mast Arm Evaluation – Existing Configuration (Cont'd):**

- The TSMA report provides the following measurements (Cont'd):

  Foundation Measurements for Mast Arm No. 1:
  - No. of anchor bolts = 6 *(Plans call for 6)*
  - Anchor bolt dia. = 1 1/2 in. *(Plans call for 1 1/2 in.)*
  - Base plate thickness = 1 3/4 in. *(Plans call for 1 3/4 in.)*
  - No grout pad.
  - Standoff = 1/2 in.

- Refer to Photo 2 for a view of the existing mast arm:


*Photo 2 - NE Mast Arm*

**Mast Arm Evaluation – Existing Configuration (Cont'd):**

**E3-T2 Analysis Results**

- Existing Configuration Results:

  - Arm Results:
    > Note that FH was input at adjusted value of 0.375 in.
    > Other standard E3 dimensions not modified
    > Arm 1 CSR = 0.571

  - Upright Results:
    > Only upright lengths and mounting dimensions input (UA & UB)
    > Other standard T2 dimensions not modified
    > Upright CSR = 0.531

  - Arm Connection Results:
    > Standard dimensions not modified
    > Bolt Performance Ratio (PR) = 0.636 (6 bolts)
    > Vertical Plate CSR = 0.627 (1/2 in. Plate - FL)
    > Baseplate PR = 0.839 (2.0 in. Plate - FK)
    > Connection Plate PR = 0.998 (1.5 in. Plate - FR)
    (Note that the connection plate (FR) is 2.0 in. in the Standards)

  - Upright Base Plate Results:
    > Rod PR (anchor bolts) = 0.656 (6 – 1 1/2 in bolts)
    > Base Plate PR = 1.00 (2.5 in. Plate – BB)

  - Foundation Results:
    > Shaft diameter required = 4.0 ft.
    > Shaft length required = 11.0 ft.
    > Bar size required = #11
    > No. of bars required = 12
    ***(Note that the above values match the 2010 Interim Standard)***

    > Foundation PR = 0.886

**Mast Arm Evaluation – Existing Configuration (Cont'd):**

**E3-T2 Analysis Results (Cont'd)**

- Future Configuration Results:

  - Arm Results:
    > Note that FH was input at adjusted value of 0.375 in.
    > Other standard E3 dimensions not modified
    > Arm 1 CSR = 0.628

  - Upright Results:
    > Only upright lengths and mounting dimensions input (UA & UB)
    > Other standard T2 dimensions not modified
    > Upright CSR = 0.597

  - Arm Connection Results:
    > Standard dimensions not modified
    > Bolt Performance Ratio (PR) = 0.684 (6 bolts)
    > Vertical Plate CSR = 0.682 (1/2 in. Plate - FL)
    > Baseplate PR = 0.839 (2.0 in. Plate - FK)
    > Connection Plate PR = 0.998 (1.5 in. Plate - FR)
    (Note that the connection plate (FR) is 2.0 in. in the Standards)

  - Upright Base Plate Results:
    > Rod PR (anchor bolts) = 0.722 (6 – 1 1/2 in bolts)
    > Base Plate PR = 1.00 (2.5 in. Plate – BB)

  - Foundation Results:
    > Shaft diameter required = 4.0 ft.
    > Shaft length required = 11.0 ft.
    > Bar size required = #11
    > No. of bars required = 12
    ***(Note that the above values match the 2010 Interim Standard)***

    > Foundation PR = 0.960

**Mast Arm Evaluation – Proposed Configuration:**

- For the addition of the turn lane on the 43st W NB, for a right turn to Cortez Rd W EB, install a 5-head signal to the existing mast arm while moving the existing sign towards the east. Refer to Photo 3 for schematic view of the proposed configuration.

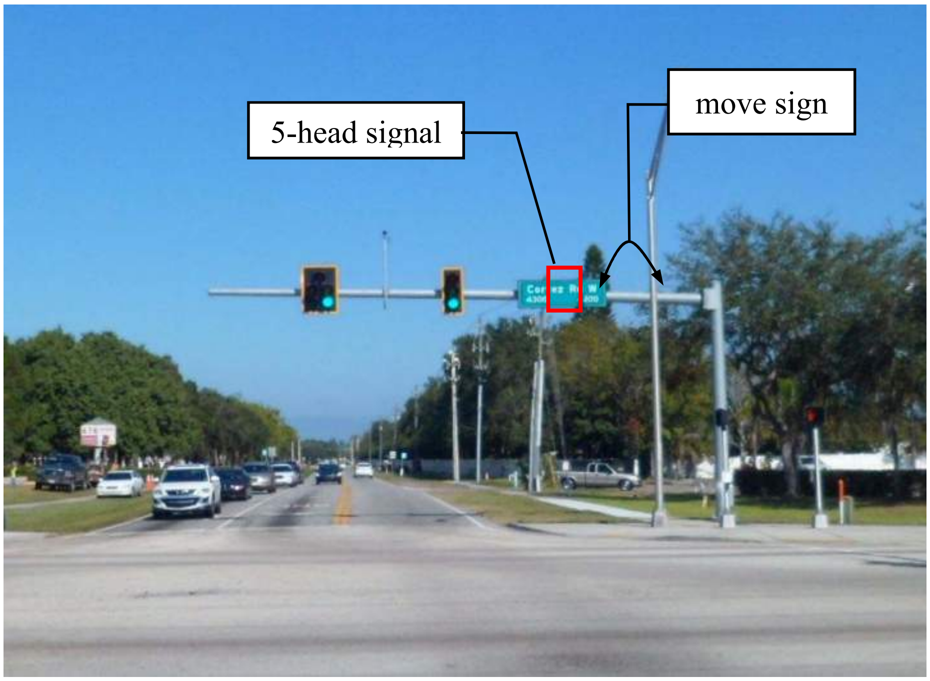



*Photo 3 - Proposed Configuration*

- The following data will be used for the Mathcad program:

  Proposed Signals:
  - 5 Head at 14’ from Upright
  - 3 Head at 24’ from Upright
  - 5 Head at 36’ from Upright

  Proposed Sign:
  - 2.5’ x 8’ at 6’ from Upright; 20.00 SF

**Mast Arm Evaluation – Proposed Configuration (Cont'd):**

**E3-T2 Analysis Results**

- Proposed Configuration Results:

  - Arm Results:
    > No changes from existing/future input or result values
    > Arm 1 CSR = 0.602 < 0.628 OK

  - Upright Results:
    > No changes from existing/future input or result values
    > Upright CSR = 0.619 > 0.597 but < 1.00 OK

  - Arm Connection Results:
    > No changes from existing/future input or result values
    > Bolt Performance Ratio (PR) = 0.663 < 0.684 OK
    > Vertical Plate CSR = 0.661 < 0.682 OK
    > Baseplate PR = 0.839 = 0.839 OK
    > Connection Plate PR = 0.998 = 0.998 OK

  - Upright Base Plate Results:
    > No changes from existing/future input or result values
    > Rod PR (anchor bolts) = 0.722 = 0.722 OK
    > Base Plate PR = 1.00 = 1.00 OK

  - Foundation Results:
    > Shaft diameter required = 4.0 ft. = 4.0 ft. OK
    > Shaft length required = 12.0 ft. > 11.0 ft. ***(Evaluate)***
    > Bar size required = #11 = #11 OK
    > No. of bars required = 12 = 12 OK

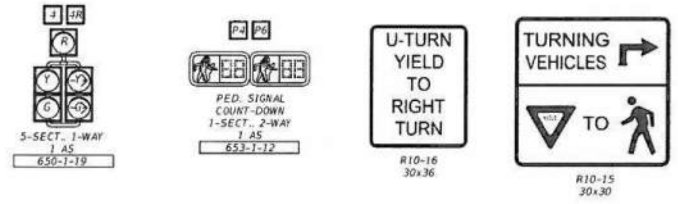
    > Foundation PR = 0.822 < 0.960 OK ***(Evaluate since L > 11.0 ft.)***

    > ***Note that when the shaft length was changed from 12' to 11', there was no change to the PR for the foundation. The PR value remained at 0.822. OK***

- The results of the Mathcad Analysis for the proposed mast arm reconfiguration indicate that the adjustments will be satisfactory. The existing structure will be sufficient for the added signal with the sign moved toward the upright and centered at 6' from the upright.

# Appendix A

Plan Sheet Data




## CONTROLLER OPERATIONS:

1. MAJOR STREET IS CORTEZ ROAD (SR 684), MOVEMENTS 2 & 6. MINOR STREET IS 43RD STREET W, MOVEMENTS 4 & 8.
2. OLA = OVERLAP FOR MOVEMENT 4R TO COME UP WITH PHASE 1, PHASE 5 AND PHASE 6.
3. AT LEAST THREE (3) WEEKS PRIOR TO TIMING IMPLEMENTATION AND PROGRAMMING OF THE CONTROLLER, REQUEST UPDATED SIGNAL TIMINGS (BASIC CONTROLLER AS WELL AS COORDINATION) FROM FDOT TRAFFIC SIGNAL SYSTEM MANAGER (863-519-2746). PROVIDE FDOT WITH ALL 'AS-BUILT' INFORMATION NECESSARY TO DEVELOP THE BASIC SIGNAL TIMING PARAMETERS. PROGRAM THE CONTROLLER AS PER THE TIMINGS PROVIDED BY FDOT.
4. CONFIGURE THE PHASE SEQUENCE, PHASE CONCURRENCY AND OVERLAP PROGRAMMING TO COMPLY WITH THE MUTCD.

## CONSTRUCTION NOTES:

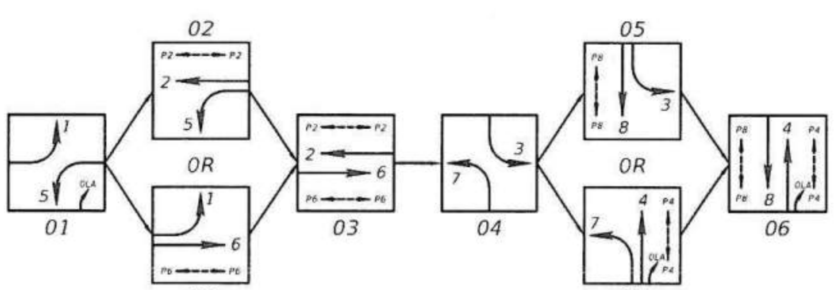
1. WIRE THE PROPOSED 5-SECTION SIGNAL HEAD TO COME UP WITH PHASE 1, PHASE 5 AND PHASE 6 AS OVERLAP.
2. EXISTING SIGNAL PHASING TO BE REVISED TO ADD OLA PER THE SOP SHOWN. THE SIGNAL TIMINGS SHOULD BE REVISED PER THE TIMINGS NOTED IN CONTROLLER TIMING CHART.
3. EXISTING MAST ARMS SHOWN ARE FOR GRAPHICAL PURPOSES ONLY. CONTRACTOR SHALL VERIFY LENGTH OF MAST ARM AND POSITION OF TRAFFIC SIGNAL HEADS BEFORE PERFORMING ANY WORK.
4. EXISTING VIDEO VEHICLE IMAGING DETECTION SYSTEM AND STREET NAME SIGNS ON THE MAST ARMS TO REMAIN EXCEPT NOTED OTHERWISE.
5. INSTALL NEW TWO-WAY ALUMINUM PEDESTRIAN SIGNAL (PEDESTAL) IN THE SE QUADRANT. USE EXISTING CONDUIT AND PULL BOXES TO TERMINATE CONDUCTORS IN CONTROLLER CABINET.
6. RELOCATE THE EXISTING STREET NAME SIGN 8 FEET TOWARDS THE UPRIGHT OF THE MAST ARM IN THE NE QUADRANT AS SHOWN.
7. CONFIGURE EXISTING VIDEO VEHICLE DETECTION CAMERA FOR DZ-4, DZ-7, TO DETECT OVERLAP MOVEMENT (OLA) 4R.
8. RELOCATE EXISTING PEDESTRIAN DETECTOR SIGNS IN SE QUADRANT TO THE PROPOSED POST FOR THE 2-WAY PEDESTRIAN SIGNAL.
9. MODIFY EXISTING SIGNAL CABINET AND CONTROLLER TO INCLUDE THE PEDESTRIAN TIMING, WIRING AND ASSIGNING DETECTION FOR THE OLA MOVEMENT.

## INTERSECTION NOTES:

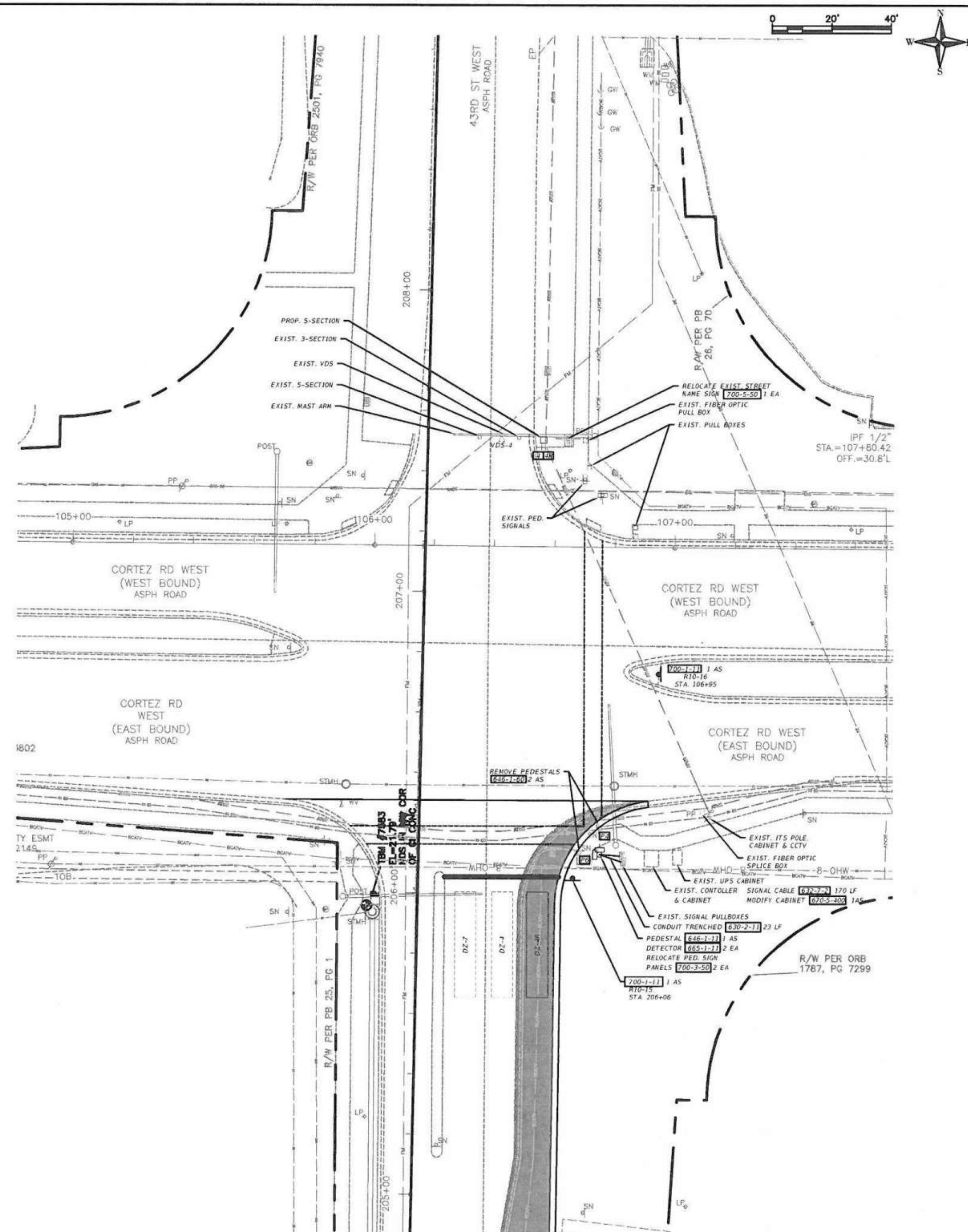
1. THE POSTED SPEED LIMIT IS AS FOLLOWS:
   CORTEZ ROAD = 45 MPH
   43RD AVENUE EAST = 35 MPH

| CONTROLLER TIMINGS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| TIMING FUNCTION | | | | | | | | | |
| MOVEMENT NUMBER | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| TIMING FUNCTION | MINIMUM GREEN | | | | | | | | |
| | EXTENSION | | | | | | | | |
| | MAXIMUM GREEN 1 | | | | | | | | |
| | MAXIMUM GREEN 2 | | | | | | | | |
| | YELLOW CLEARANCE | | | | | | | | |
| | ALL RED | | | | | | | | |
| | PEDESTRIAN WALK | | | | | | | | |
| | PED. CLEARANCE | | | | 29 | | 22 | | |
| | RECALL | | | | | | | | |

| VIDEO VEHICLE DETECTION ASSIGNMENTS | | |
|---|---|---|
| VIDEO DETECTION | DETECTION ZONE | DELAY TIME (SECS.) |
| | | |
| VDS-4 | DZ-7, DZ-4 | |
| | DZ-4R | 7 |




SIGNAL OPERATING PLAN NO. 10




HDR Engineering, Inc.
2601 Cattlemen Road, Suite 400
Sarasota, Florida 34232
Certificate of Authorization No. 4213

# INTERSECTION IMPROVEMENTS OF CORTEZ ROAD AT 43RD STREET WEST
## SIGNALIZATION PLAN

| NO. | REVISION DESCRIPTION | BY | DATE |
|---|---|---|---|
| | | | |

| | | |
|---|---|---|
| PROJECT # | 404-6002870 | |
| SURVEY # | 0577-0038 | |
| SEC./TWN./RGE | 4/9-35S-17E | |
| VERT. SCALE | ##### | |
| HORZ. SCALE | ##### | |
| VERTICAL DATUM | NAVD 1988 | |
| | BY | DATE |
| SURVEYED | FDC | 09/2017 |
| DESIGNED | ERG | 02/2018 |
| DRAWN | JHC | 02/2018 |

BIJAN BEHZADI, P.E.
FLORIDA P.E. # 43868

Signature & Date

SHEET 2

S:\PWD_Engineering_Shore\Highway Engineering\INTERSECTION STUDIES AND IMPROVEMENTS\Cortez Rd @ 43rd Street West\2017 Design\DWG\SOE\Cortez Rd at 43rd St W-SIGNALIZATION.dwg, Signalization Plan, 5/24/2018 8:55 AM Ken Leisher, 1:2, 11x17

# CONTRACT DRAWINGS

# CORTEZ ROAD WEST (SR 684) AT 43RD STREET WEST
# INTERSECTION IMPROVEMENTS

FOR

MANATEE COUNTY, FLORIDA

COUNTY PROJECT NUMBER: 6076860

FINANCIAL PROJECT ID: 425530-1-58-01

(FEDERAL FUNDS)

SIGNALIZATION PLANS

SIGNAL ID NUMBER: 446

GOVERNING STANDARDS AND SPECIFICATIONS:

FLORIDA DEPARTMENT OF TRANSPORTATION DESIGN STANDARDS, DATED 2010 AND APPLICABLE SECTIONS, ARTICLES AND SUBARTICLES OF DIVISION I AND ALL DIVISION II & III OF THE FLORIDA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, DATED 2010, INCLUDING ALL SUPPLEMENTAL SPECIFICATIONS, AS AMENDED BY CONTRACT DOCUMENTS.

APPLICABLE DESIGN STANDARDS MODIFICATIONS: 7-1-10. FOR DESIGN STANDARDS MODIFICATIONS CLICK ON "DESIGN STANDARDS" AT THE FOLLOWING WEB SITE: HTTP://WWW.DOT.STATE.FL.US/RDDESIGN/.


NTS

ATTENTION IS DIRECTED TO THE FACT THAT THESE PLANS MAY HAVE BEEN REDUCED IN SIZE BY REPRODUCTION. THIS MUST BE CONSIDERED WHEN OBTAINING SCALED DATA.

## UTILITY WARNING NOTE

ABOVE GROUND AND / OR UNDERGROUND UTILITIES MAY BE IN THE AREA OF THIS PROJECT – PROCEED WITH CAUTION – THE CONTRACTOR SHALL CALL SUNSHINE STATE "ONE CALL" AT 1-800-432-4770 AND THE UTILITY OWNERS IN ADVANCE OF BEGINNING WORK, IN ACCORDANCE WITH CHAPTER 556, FLORIDA STATUTES.

SUMMARY OF REVISIONS

| DATE | DESCRIPTION |
|---|---|
| | |

## INDEX OF PLANS



SHOP DRAWINGS TO BE SUBMITTED TO:


UPIK Y. SUWARNO, P.E.
CARDNO TBE
380 PARK PLACE BLVD., SUITE 300
CLEARWATER, FLORIDA 33759
(727) 531-3505


48 HOURS BEFORE DIGGING
"CALL SUNSHINE"
1-800-432-4770

PLANS PREPARED BY:


Cardno TBE
380 Park Place Blvd., Suite 300, Clearwater, Florida 33759
www.cardnotbe.com - 727.531.3505
Certificate of Authorization No. 3843


ENGINEER OF RECORD

| UPIK Y. SUWARNO, PE | 62995 FL. LICENSE NO. |
|---|---|

DATE

100% SUBMITTAL

| | |
|---|---|
| DATE: | 11-03-10 |
| SCALE: | HORIZ: N/A VERT: N/A |
| SHEET: | T-1 |

DATE: 01/12/10 TIME: 10:54 SCALE: 40 FILENAME: U:\ROH\CORTEZ.DWG

# TABULATION OF QUANTITIES

| PAY ITEM NO. | DESCRIPTION | UNIT | SHEET NUMBERS | | | | | | | | | | | | | | | | | | | | TOTAL THIS SHEET | | GRAND TOTAL | | REF. SHEET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | T-5 | | T-9 | | T-11 | | | | | | | | | | | | | | | | | | | | |
| | | | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | PLAN | FINAL | |
| 101-1 | MOBILIZATION | LS | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 102-1 | MAINTENANCE OF TRAFFIC | LS | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 110-4 | REMOVAL OF EXISTING CONCRETE PAVEMENT | SY | | | | | 93.4 | | | | | | | | | | | | | | | | 93.4 | | 93.4 | | |
| 520-1-10 | CONCRETE CURB & GUTTER, TYPE F CURB | LF | | | | | 104 | | | | | | | | | | | | | | | | 104 | | 104 | | |
| 522-2 | 6" CONCRETE SIDEWALK | SY | | | | | 165.5 | | | | | | | | | | | | | | | | 165.5 | | 165.5 | | |
| 555-1-2 | DIRECTIONAL BORE (6" TO <12") (2" HDPE) | LF | 315 | | | | | | | | | | | | | | | | | | | | 315 | | 315 | | |
| 630-1-12 | CONDUIT (F&I) (UNDERGROUND) (1.25") | LF | 5 | | | | | | | | | | | | | | | | | | | | 5 | | 5 | | |
| 630-1-12 | CONDUIT (F&I) (UNDERGROUND) (2") | LF | 580 | | | | | | | | | | | | | | | | | | | | 580 | | 580 | | |
| 630-1-13 | CONDUIT (F&I) (UNDERPAVEMENT) | LF | 70 | | | | | | | | | | | | | | | | | | | | 70 | | 70 | | |
| 632-7-1 | CABLE (SIGNAL) (F&I) | PI | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 635-1-11 | PULL & JUNCTION BOXES (F&I) (PULL BOX) | EA | 10 | | | | | | | | | | | | | | | | | | | | 10 | | 10 | | |
| 639-1-22 | ELECTRICAL POWER SERVICE (UNDERGROUND) | AS | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| | (PURCHASED BY CONTRACTOR FROM POWER CO) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 639-2-1 | ELECTRICAL SERVICE WIRE (F&I) | LF | 840 | | | | | | | | | | | | | | | | | | | | 840 | | 840 | | |
| 641-2-12 | PRESTRESSED CONCRETE POLE (F&I) | EA | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| | (TYPE P-II SERVICE POLE) (12FT) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 649-31-202 | STEEL MAST ARM ASSEMBLY (F&I)(130 MPH)(46') | EA | 2 | | | | | | | | | | | | | | | | | | | | 2 | | 2 | | |
| 649-31-203 | STEEL MAST ARM ASSEMBLY (F&I)(130 MPH)(60') | EA | 2 | | | | | | | | | | | | | | | | | | | | 2 | | 2 | | |
| 650-51-311 | TRAFFIC SIGNAL (F&I) (3-SECT.) (1-WAY) (LED) | AS | 4 | | | | | | | | | | | | | | | | | | | | 4 | | 4 | | |
| 650-51-511 | TRAFFIC SIGNAL (F&I) (5-SECT.) (1-WAY) (LED) | AS | 4 | | | | | | | | | | | | | | | | | | | | 4 | | 4 | | |
| 653-191 | PEDESTRIAN SIGNAL (F&I) (LED COUNTDOWN) (1 WAY) | AS | 8 | | | | | | | | | | | | | | | | | | | | 8 | | 8 | | |
| 659-101 | SIGNAL HEAD AUXIL. (F&I) (BACKPLATES, 3-SECT) | EA | 4 | | | | | | | | | | | | | | | | | | | | 4 | | 4 | | |
| 659-106 | SIGNAL HEAD AUXIL. (F&I) (TUNNEL VISOR) | EA | 32 | | | | | | | | | | | | | | | | | | | | 32 | | 32 | | |
| 659-107 | SIGNAL HEAD AUXIL. (F&I) (ALUMINUM PEDESTAL) | EA | 8 | | | | | | | | | | | | | | | | | | | | 8 | | 8 | | |
| 659-118 | SIGNAL HEAD AUXIL. (F&I) (BACKPLATES, 5-SECT) | EA | 4 | | | | | | | | | | | | | | | | | | | | 4 | | 4 | | |
| 663-74-15 | VEHICLE DETECTOR ASSEMBLIES (F&I) (VIDEO) | EA | 4 | | | | | | | | | | | | | | | | | | | | 4 | | 4 | | |
| 665-13 | PEDESTRIAN DETECTOR (F&I) (WITH SIGN ONLY) | EA | 8 | | | | | | | | | | | | | | | | | | | | 8 | | 8 | | |
| 670-5-110 | TRAFFIC CONTROLLER ASSEMBLY (F&I) (NEMA) | AS | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| | (NO PREEMPTION) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 685-106 | UNINTERRUPTIBLE POWER SOURCE (UPS) | EA | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 690-10 | REMOVE SIGNAL HEAD ASSEMBLY | EA | 8 | | | | | | | | | | | | | | | | | | | | 8 | | 8 | | |
| 690-33-1 | REMOVE POLE (DEEP) (DIRECT BURIAL) | LF | 40 | | | | | | | | | | | | | | | | | | | | 40 | | 40 | | |
| 690-50 | REMOVE CONTROLLER ASSEMBLY | EA | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 690-60 | REMOVE VEHICLE DETECTOR ASSEMBLY | EA | 10 | | | | | | | | | | | | | | | | | | | | 10 | | 10 | | |
| 690-80 | REMOVE SPAN WIRE ASSEMBLY | EA | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 690-90 | REMOVE CONDUIT & CABLING | PI | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 690-100 | REMOVE MISCELLANEOUS SIGNAL EQUIPMENT | PI | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |
| 699-1-1 | INTERNALLY ILLUMINATED SIGN (F&I)(EDGE LIT LED) | EA | 4 | | | | | | | | | | | | | | | | | | | | 4 | | 4 | | |
| 700-48-60 | SIGN PANEL (REMOVE) | EA | 3 | | | | | | | | | | | | | | | | | | | | 3 | | 3 | | |
| 711-11-121 | THERMOPLASTIC PAVEMENT MARKINGS (6" WHITE) | LF | | | 72 | | | | | | | | | | | | | | | | | | 72 | | 72 | | |
| 711-11-123 | THERMOPLASTIC PAVEMENT MARKINGS (12" WHITE) | LF | | | 465 | | | | | | | | | | | | | | | | | | 465 | | 465 | | |
| 711-17 | REMOVE THERMOPLASTIC PAVEMENT MARKINGS | SF | | | 525 | | | | | | | | | | | | | | | | | | 525 | | 525 | | |
| 783-1-121 | ITS FIBER OPTIC CABLE (F&I) | LF | 65 | | | | | | | | | | | | | | | | | | | | 65 | | 65 | | |
| 783-2-31 | ITS FIBER OPTIC (INSTALL) (SPLICE) | EA | 4 | | | | | | | | | | | | | | | | | | | | 4 | | 4 | | |
| 784-1-1 | ITS FIELD ETHERNET SWITCH | EA | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | |

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

MANATEE COUNTY

CORTEZ ROAD WEST AND 43RD STREET WEST

Cardno TBE

12481 Telecom Drive, Tampa, Florida 33637
www.cardnotbe.com - 813.221.0048
Certificate of Authorization No. 3843

UPIK Y. SUWARNO DATE
LIC. NO.: 62995

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

TABULATION OF QUANTITIES

PROJECT NO: 00193-008-05
DATE: 11-03-10
SHEET NO: T-2

FILE: J:\JOB\0193\00193-008-05\ACAD\TABQSG01.dwg LAST SAVED: Wed, 11/03/10-4:05p PLOTTED: Wed, 11/03/10-4:05p BY: JTP

## GENERAL NOTES

1. THE CONTRACTOR SHALL CONTACT THE ENGINEER, IN CONJUNCTION WITH THE MANATEE COUNTY PROJECT MANAGEMENT DIVISION BEFORE STARTING WORK. COUNTY STANDARD UPDATES OR OTHER INFORMATION SHALL BE OBTAINED.

2. ONE WEEK PRIOR TO THE BEGINNING OF THE TRAFFIC SIGNAL INSTALLATION, LOOP CUTTING, OR TURN ON OF A NEW SIGNAL, THE CONTRACTOR SHALL NOTIFY:

   PUBLIC WORKS DEPARTMENT
   MANATEE COUNTY PROJECT MANAGEMENT DIVISION
   1026 26TH AVENUE EAST
   BRADENTON, FLORIDA 34208
   PHONE: 941-708-7510

   PUBLIC WORKS DEPARTMENT
   MANATEE COUNTY TRAFFIC ENGINEERING DIVISION
   2101 47TH TERRACE EAST
   BRADENTON, FLORIDA 34203
   PHONE: 941-749-3502

3. THE CONTRACTOR SHALL COORDINATE WITH MANATEE COUNTY'S TRAFFIC ENGINEERING DIVISION (941-749-3502), AT LEAST TWO WEEKS, BEFORE ANY CABINET MODIFICATIONS ARE TO BE PERFORMED. MANATEE COUNTY ENGINEERING DIVISION PERSONNEL WILL REVIEW, ASSIST AND PROVIDE TECHNICAL SUPPORT RELEVANT TO ANY FIELD MODIFICATIONS THAT ARE NECESSARY. THE CONTRACTOR MAY OPTION OUT OF THIS PROPOSITION, IF THEY FEEL ASSISTANCE AND OVERSIGHT ARE NOT NECESSARY.

4. THE PRIME CONTRACTOR SHALL BE RESPONSIBLE FOR THE SIGNAL MAINTENANCE, TIMING AND OPERATION OF ALL SIGNALS AND SIGNAGE FROM THE COMMENCEMENT OF WORK TO FINAL ACCEPTANCE OF THE PROJECT (I.E. EXISTING LOOPS CUT AND TEMPORARY DETECTION REQUIRED, SYSTEM COMMUNICATION TERMINATED, LANE OR PAVEMENT MODIFICATIONS, PEDESTRIAN MODIFICATIONS). MANATEE COUNTY WILL ASSIST IN PROVIDING EXISTING SYSTEM TIMING WHEN POSSIBLE.

5. THE CONTRACTOR SHALL HAVE I.M.S.A. CERTIFIED LEVEL II PERSONNEL (ELECTRONICS OR ELECTRICAL TECHNICIAN) ON THE JOB SITE AT ALL TIMES WHILE WORK IS BEING PERFORMED. ALL SIGNAL INSTALLATION TECHNICIANS SHALL HAVE A MINIMUM OF I.M.S.A. LEVEL I CERTIFICATION. CERTIFICATIONS OF ALL TECHNICIANS SHALL BE PROVIDED TO THE ENGINEER, IN CONJUNCTION WITH THE COUNTY PRIOR TO BEGINNING WORK. THE CONTRACTOR SHALL MAINTAIN ADEQUATE REPAIR INVENTORY, EQUIPMENT AND NEARBY PERSONNEL TO RESPOND AND CORRECT TRAFFIC SIGNAL MALFUNCTIONS AND MOT RELATED PHASING AND TIMING ISSUES FOR THE DURATION OF THE PROJECT.

   THE SIGNAL CONTRACTOR SHALL BE AVAILABLE TO RESPOND TO TROUBLE CALLS WITHIN A MINIMUM OF TWO HOURS, TWENTY-FOUR HOURS A DAY, SEVEN DAYS A WEEK FOR THE DURATION OF THE PROJECT. THE PRIME CONTRACTOR SHALL PROVIDE CONTACT NUMBERS OF THE SIGNAL CONTRACTOR TO THE ENGINEER, IN CONJUNCTION WITH THE MANATEE COUNTY TRAFFIC ENGINEERING DIVISION AT COMMENCEMENT OF THE PROJECT. FURTHERMORE, WITHIN TWO HOURS OF NOTIFICATION OR DOCUMENTED ATTEMPTED NOTIFICATIONS, THE SIGNAL CONTRACTOR SHALL BE ON SITE MAKING NEEDED REPAIRS OR MODIFICATIONS. FAILURE TO MEET THE TIME REQUIREMENTS SHALL GIVE THE ENGINEER, IN CONJUNCTION WITH THE COUNTY, AT ITS DISCRETION, THE RIGHT TO REQUEST ASSISTANCE FROM THE MANATEE COUNTY SHERIFF'S DEPARTMENT TO CONTROL TRAFFIC FOR THE PERIOD OF TIME UNTIL THE CONTRACTOR RESPONDS AND MAKES THE NEEDED REPAIRS. THE COST FOR THE MANATEE COUNTY SHERIFF'S OFFICE SHALL BE THE CONTRACTOR'S RESPONSIBILITY.

6. PRIOR TO ORDERING MATERIALS, THE SIGNAL CONTRACTOR SHALL CONTACT THE ENGINEER, IN CONJUNCTION WITH THE MANATEE COUNTY TRAFFIC OPERATIONS DIVISION THROUGH THE PROJECT MANAGEMENT DIVISION AND VERIFY CURRENT COLOR CODES TO BE USED FOR SIGNAL AND INTERCONNECT CABLE.

7. FIVE WORKING DAYS PRIOR TO THE FINAL INSPECTION THE CONTRACTOR SHALL FURNISH THE ENGINEER, IN CONJUNCTION WITH THE COUNTY TWO COMPLETE SETS OF AS-BUILT PLANS AND I.M.S.A. INSPECTION FORMS. ONE COMPLETE SET SHALL ALSO BE FURNISHED TO THE PROJECT MANAGEMENT DIVISION AND TRAFFIC ENGINEERING DIVISION. THE AS-BUILT PLANS SHALL CLEARLY INDICATE THE LOCATION OF THE INSTALLED POLES, CONDUIT, PULL BOXES, GROUND RODS, VIRTUAL LOOPS, ETC. MEG READINGS FOR GROUND RODS SHALL ALSO BE INCLUDED.

8. UPON PASSING THE FINAL INSPECTION THE CONTRACTOR SHALL SEND A WRITTEN REQUEST TO THE PROJECT MANAGEMENT DIVISION AND THE TRAFFIC ENGINEERING DIVISION TO TRANSFER MAINTENANCE FROM THE CONTRACTOR TO MANATEE COUNTY. MANATEE COUNTY WILL RESPOND WITHIN 5 WORKING DAYS TO ESTABLISH A TIME TABLE FOR THE TRANSFER OF MAINTENANCE RESPONSIBILITY.

9. THE LOCATION OF UTILITIES SHOWN ON THE PLANS ARE BASED ON LIMITED INVESTIGATION TECHNIQUES AND SHOULD BE CONSIDERED APPROXIMATE THE LOCATION OF UTILITIES SHOWN ON THE PLANS ARE APPROXIMATE ONLY. THE EXACT LOCATIONS SHALL BE DETERMINED BY THE CONTRACTOR, VIA SUNSHINE STATE ONE CALL OF FLORIDA, INC., IN COORDINATION WITH UNDERGROUND AND OVERHEAD UTILITY OWNERS. A MINIMUM OF 2 FULL BUSINESS DAYS PRIOR TO DIGGING IS REQUIRED. THE CONTRACTOR SHALL ALSO CONTACT MANATEE COUNTY FOR COUNTY OWNED UTILITIES.

10. THE CONTRACTOR SHALL NOTIFY THE APPROPRIATE UTILITY COMPANIES AT LEAST 72 HOURS IN ADVANCE OF POLE SETTING OPERATIONS WHERE CONFLICT WITH OVERHEAD ELECTRICAL CONDUCTORS IS EXPECTED AND IN ALL CASES WHERE JOINT USE POLES ARE CALLED FOR.

    EXISTING UTILITIES ARE TO REMAIN IN PLACE UNLESS OTHERWISE NOTED.

11. THE CONTRACTOR SHALL HAND DIG THE FIRST 60 INCHES (5 FEET) OF THE HOLE FOR THE POLE FOUNDATION OR CONDUIT RUN WHERE UTILITIES ARE IN CLOSE PROXIMITY.

12. THE CONTRACTOR IS TO DE-WATER THE POLE FOUNDATION EXCAVATION IF THE ELEVATION OF WATER IS HIGHER THAN THE ELEVATION OF THE FOUNDATION BASE.

13. #14 XHHW PULL WIRE SHALL BE INSTALLED IN ALL CONDUITS. AT LEAST 2 FEET OF PULL WIRE SHALL BE ACCESSIBLE AT EACH CONDUIT TERMINATION AND SECURED IN THE PULL BOX OR PLACE OF TERMINATION.

14. UNLESS OTHERWISE NOTED ALL REMOVED EQUIPMENT EXCEPT CONCRETE POLES SHALL BE TURNED OVER TO MANATEE COUNTY AND DELIVERED TO THE TRAFFIC OPERATIONS DIVISION, LOCATED AT 2404 12TH STREET COURT EAST, BRADENTON, FLORIDA 34208, AS DIRECTED BY THE COUNTY PROJECT MANAGER. CONCRETE POLES SHALL BE DISPOSED OF BY THE SIGNAL CONTRACTOR IN AREAS PROVIDED BY THE CONTRACTOR.

15. THE CONTRACTOR SHALL CONTACT THE LOCAL POWER COMPANY FOR ITS ASSISTANCE IN PERFORMING ALL NECESSARY WORK UNDER POWER LINES AT SIGNAL POLES, SUCH AS THE INSTALLATION AND/OR REMOVAL OF SIGNAL CABLE, FIBERGLASS INSULATORS AND SIGNAL POLES.

16. THE CONTRACTOR SHALL CONTACT MANATEE COUNTY FOR THE ASSIGNMENT OF THE PHYSICAL ADDRESS ONCE THE SERVICE DROP LOCATION HAS BEEN ESTABLISHED.

17. ALL COSTS FOR GROUNDING SHALL BE INCLUDED IN THE COST OF THE ITEM BEING GROUNDED. ALL GROUND ROD ASSEMBLIES FOR POLES, SERVICES, CABINETS, AND OTHER RELATED EQUIPMENT SHALL BE BONDED TOGETHER TO FORM AN INTEGRATED GROUNDING SYSTEM USING #6 AWG THHN COPPER WIRE. THE UPPER END OF ALL GROUND RODS SHALL BE 6 INCHES BELOW GROUND ELEVATION. GROUND ROD LOCATIONS SHALL BE MARKED WITH PERMANENT MARKER SUCH AS AN EPOXIED STICKER LOCATED ON THE NEAREST CURB, ALSO ACCURATE GROUNDING ARRAY AND GROUND ROD LOCATIONS ON SIGNAL AS-BUILT DRAWINGS SHALL BE PROVIDED. GROUNDING CONDUCTOR MUST BE #6 OR LARGER THHN BARE COPPER.

18. GROUND ROD TO CONDUCTOR CONNECTING DEVICES SHALL BE NON-CORROSIVE SPLIT BOLTS, CLAMPS, PRESSURE CONNECTORS, OR OTHER APPROVED MEANS TO ENSURE A POSITIVE CONNECTION.

19. GROUND RESISTANCE TESTER, OR OTHER APPROVED MEANS WILL BE USED TO ACQUIRE THE GROUND ROD RESISTANCE. A MEMBER OF THE TRAFFIC OPERATIONS DIVISION STAFF SHALL BE PRESENT DURING THE TEST.

20. ELEVATION OF THE TOP OF THE MAST ARM FOUNDATION SHALL BE SIX INCHES ABOVE EXISTING GRADE. IF LOCATED DIRECTLY BACK OF SIDEWALK, THE FOUNDATION ELEVATION SHALL MATCH SIDEWALK GRADE.

21. IT SHOULD BE NOTED THAT NO TEST BORINGS WERE MADE WHERE CONDUIT RUNS ARE TO BE INSTALLED BY JACKING OR BORING.

22. CONTRACTOR SHALL SUPPLY ALL MATERIAL SUBMITTALS TO THE ENGINEER, IN CONJUNCTION WITH MANATEE COUNTY PROJECT MANAGEMENT DIVISION PRIOR TO CONSTRUCTION FOR APPROVAL.

23. THE TYPE OF EQUIPMENT USED IN THE INSTALLATION OF MAST ARMS/ FOUNDATIONS, OVERHEAD CANTILEVER SIGNS/ FOUNDATIONS, AND THE MOVEMENT/INSTALLATION OF STRAIN POLES SHALL MEET THE FOLLOWING REQUIREMENTS: 1) OVERHEAD LINES SHALL STAY IN PLACE BOTH VERTICALLY AND HORIZONTALLY AND; 2) CONTRACTOR SHALL MEET ALL APPLICABLE OSHA REQUIREMENTS (20 FOOT MINIMUM DISTANCE MAINTAINED BETWEEN THE EQUIPMENT AND THE ELECTRICAL OVERHEAD FACILITY). ANY COST ASSOCIATED WITH THE TYPE OF EQUIPMENT REQUIRED FOR THIS INSTALLATION IS INCLUDED IN THE RELATED PAY ITEMS.

24. EXISTING SIGNALIZATION SHALL REMAIN IN PLACE TO THE EXTENT POSSIBLE, INCLUDING VEHICLE ACTUATION AND PEDESTRIAN SIGNAL OPERATION, AND SHALL BE USED FOR MAINTENANCE OF TRAFFIC AS REQUIRED.

25. THE CONTRACTOR SHALL COORDINATE WITH MANATEE COUNTY TRAFFIC ENGINEERING DIVISION ABOUT THE ON GOING MANATEE ATMS PROJECT THAT INCLUDES THIS INTERSECTION PRIOR TO START OF CONSTRUCTION AND ORDERING MATERIAL.

26. THE CONTRACTOR SHALL FIELD VERIFY ALL CRITICAL ELEVATIONS PRIOR TO ORDERING MAST ARMS.

27. ALL LONG VIDEO DETECTOR LOOPS SHALL BE 6' X 40', PLACED 2' IN FRONT OF THE STOP BAR. THE ADVANCE LOOPS ARE 6' X 6' PLACED 25' UPSTREAM OF THE STOP BAR.

28. WHEN A CONTRACTOR IS WORKING ON A SIGNAL IN AN INTERSECTION (INSTALLING CONDUIT IN THE STREET, REMOVING EXISTING SIGNAL EQUIPMENT, INSTALLING SIGNAL EQUIPMENT, LOOPS, HOMERUNS OR TURNING ON OF NEW SIGNAL) WHERE A LANE IS CLOSED, THE ENGINEER MAY REQUIRE AN OFF DUTY LAW ENFORCEMENT OFFICER TO DIRECT TRAFFIC. THE HOURLY RATE OF PAY FOR AN OFF DUTY LAW ENFORCEMENT OFFICER CAN BE OBTAINED FROM THE LOCAL LAW ENFORCEMENT OFFICE. THE COST OF THE OFFICER SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

29. MINIMUM FIBER OPTIC PULL BOX SIZE SHALL BE 2 FT WIDE BY 3 FT LONG BY 3 FT DEEP. THIS REQUIREMENT SHALL APPLY TO TWISTED PAIR COMMUNICATIONS CABLES AS WELL AS FIBER OPTIC CABLE.

30. 2 INCH PVC SCHEDULE 40 CONDUIT SHALL BE USED FOR UNDERGROUND COMMUNICATION CONDUIT INSTALLATIONS. THE INSTALLATION AND TERMINATION OF THE CONDUIT SHALL ADHERE TO INDEX 18202 AND INDEX 18204 OF THE 2010 FDOT DESIGN STANDARDS.

31. COAT ALL CONDUIT THREADS WITH AN ANTI-SEIZE LUBRICANT.

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

MANATEE COUNTY

CORTEZ ROAD AND 43RD STREET WEST

Cardno TBE
12481 Telecom Drive, Tampa, Florida 33637
www.cardnotbe.com - 813.221.0048
Certificate of Authorization No. 3843

UPIK Y. SUWARNO DATE
LIC. NO.: 62995

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

GENERAL NOTES

PROJECT NO: 00193-008-05
DATE: 11-03-10
SHEET NO: T-3

FILE: O:\JOB\0193\00193-008-05\ACAD\GN19300118-1SIG.dwg LAST SAVED: Wed, 11/03/10-3:17p PLOTTED: Wed, 11/03/10-3:20p BY: uys

PAY ITEM FOOTNOTES:

1. 555-1-2:
CONDUIT INSTALLED WITH THE DIRECTIONAL BORE METHOD SHALL BE HPDE WITH A MINIMUM SIZE OF TWO INCHES UNLESS OTHERWISE NOTED IN THE PLANS. COST FOR PULL WIRE IS INCLUDED UNDER THIS PAY ITEM.

A MINIMUM OF 3" IN DIAMETER CONDUIT FOR FIBER OPTIC INTERCONNECT CABLE (COMMUNICATION) SHALL BE PROVIDED.

2. 630-1-12, 630-1-13:
ALL CONDUIT RUNS SHOWN ON THE PLANS ARE SCHEMATIC AND FIELD ADJUSTMENTS MAY BE NECESSARY. WITH THE EXCEPTION OF ELECTRICAL POWER SERVICE DUCTS, JACK AND BORE SLEEVES, AND DIRECTIONAL BORE CONDUITS, ALL UNDERGROUND AND UNDER PAVEMENT CONDUITS SHALL BE SCHEDULE 40 PVC WITH A MINIMUM SIZE OF TWO INCHES UNLESS OTHERWISE SPECIFIED IN THE PLANS. COST FOR PULL WIRE IS INCLUDED UNDER THIS PAY ITEM.

THREE SEPARATE UNDERGROUND CONDUIT RUNS LOCATED 120 DEGREES APART ARE REQUIRED FOR ALL STRAIN POLES AND MAST ARMS. THE CONDUITS ARE FOR HIGH VOLTAGE, LOW VOLTAGE AND GROUND. THERE SHALL BE A MINIMUM OF TWO RUNS OF TWO INCH CONDUIT BETWEEN THE LAST LOW VOLTAGE PULL BOX LOCATED NEAR THE CONTROLLER CABINET AND THE CONTROLLER CABINET ITSELF.

USE A MINIMUM OF 3" DIAMETER CONDUIT FOR FIBER OPTIC INTERCONNECT CABLE.

3. 632-7-1:
VERIFY THE COLOR CODE OF SIGNAL CABLE WITH THE MAINTAINING AGENCY PRIOR TO WIRING INTERSECTION. USE A MINIMUM OF 7 CONDUCTOR SIGNAL CABLE FOR SIGNAL HEADS AND PEDESTRIAN HEADS.

4. 635-1-11:
ALL PULL BOXES AND LIDS SHALL BE OF TRAFFIC BEARING, POLYMER CONCRETE CONSTRUCTION EQUAL TO QUAZITE OR ANOTHER EQUIVALENT FDOT APPROVED MANUFACTURER. PULL BOXES SHALL BE PLACED BEHIND CURB AND GUTTER. WHERE THERE IS NO CURB AND GUTTER PULL BOXES SHALL BE PLACED A MINIMUM OF 7 FEET FROM THE EDGE OF THE PAVEMENT. THE TOP OF THE LID SHALL READ "TRAFFIC SIGNAL" IN STAMPED RAISED LETTERS.

5. 639-1-22:
POWER SERVICE ASSEMBLY DOES NOT REQUIRE A METER BASE.
AN ADDITIONAL BREAKER SHALL BE ADDED FOR THE POWER TO THE CCTV.
THE BREAKERS SHALL BE CLEARLY MARKED.

USE ALUMINUM RIGID ABOVE GROUND CONDUIT FOR ELECTRICAL POWER SERVICE.

6. 639-2-1:
USE A BONDING WIRE FROM ELECTRICAL SERVICE POINT TO CONTROLLER. THE PAYMENT OF THIS ITEM SHALL BE BASED ON THE LINEAR FOOT OF A SINGLE CONDUCTOR.

7. 649-31-202 & 649-31-203:
THE CONTRACTOR SHALL CONTACT THE LOCAL POWER COMPANY FOR THEIR ASSISTANCE IN PERFORMING ALL NECESSARY WORK UNDER POWER LINES AT SIGNAL POLE(S), SUCH AS THE INSTALLATION OF MAST ARM FOUNDATIONS OR POLES.

THE CONDUIT SHALL BE CAPPED IN THE NEAREST PULL BOX.
THE ELEVATION OF THE TOP OF THE MAST ARM BASE(S) SHALL BE SIX INCHES ABOVE EXISTING GRADE.
IF LOCATED DIRECTLY BEHIND SIDEWALK, AT SIDEWALK GRADE.

USE THREE 2" AND ONE 3/4" CONDUITS STUBBED OUT THROUGH THE MAST ARM POLE FOUNDATION AND TEMPORARILY SEAL.

8. 650-51-311 & 650-51-511:
USE SIGNAL HEAD SUPPORTING TUBE THAT IS CAPABLE OF ADJUSTING VERTICALLY A MINIMUM OF 1.5 FEET.

THE EXTERNAL COLOR OF SIGNAL HOUSING SHALL BE BLACK. ALL TRAFFIC SIGNAL HEAD INDICATIONS SHALL BE 12 INCH LED. ALL SIGNAL HEADS SHALL HAVE TUNNEL VISORS.

DO NOT USE PLASTIC GARBAGE BAGS AS A COVERING FOR CONCEALNG SIGNAL HEADS.

9. 653-191:
PEDESTRIAN SIGNAL HEADS TO BE 16" INTERNATIONAL SYMBOL, LED COUNTDOWN TYPE.

10. 659-101 AND 659-118:
ALL SIGNAL HEADS SHALL HAVE ALUMINUM LOUVERED BACK PLATES INSTALLED. BACK PLATES SHALL BE MANUFACTURED FOR THE SIGNAL HEADS USED AND INSTALLED AS PER MANUFACTURER'S RECOMMENDATIONS. THE BACK PLATE SHALL HAVE A 2 INCH YELLOW REFLECTORIZED (TYPE III REFLECTIVITY) OUTER EDGE BORDER UNLESS SPECIFIED OTHERWISE IN THE PLANS.

11. 659-107:
USE BREAKAWAY ALUMINUM SQUARE BASE ASSEMBLIES WITH ALUMINUM DOORS FOR PEDESTRIAN PEDESTALS. INSIDE DIAMETER OF PEDESTALS SHALL BE FOUR INCHES (4").

USE LOCKING COLLARS WHEN MOUNTING PEDESTRIAN SIGNAL HEADS TO PEDESTRIAN PEDESTALS. USE LOCKING COLLARS WHEN MOUNTING ALUMINUM PEDESTRIAN POLES TO PEDESTRIAN PEDESTAL BASES.

12. 665-13:
SHALL INCLUDE ADDITIONAL COST OF LABOR AND MATERIALS REQUIRED FOR INSTALLATION OF PEDESTRIAN SIGNAL SIGN R10-3E. THIS SIGN SHALL BE MOUNTED ABOVE EACH PEDESTRIAN DETECTOR. ALL PEDESTRIAN PUSH BUTTONS SHALL BE A.D.A COMPLIANT. STREET NAMES SHALL BE IN ACCORDANCE WITH THE STREET NAMES ON THE PLAN SHEETS.

13. 670-5-110:
THE SIGNAL CONTROLLER ASSEMBLY SHALL BE NEMA TS2 TYPE 1 AND FULLY COMPATIBLE WITH THE MANATEE COUNTY'S ATMS SYSTEM (NAZTEC'S ATMS.NOW). ALL SIGNAL CONTROLLER CABINETS SHALL BE FDOT APPROVED. THE CABINETS SHALL BE FULLY EQUIPPED WITH ALL THE NECESSARY SYSTEM COMPONENTS TO INTEGRATE INTO MANATEE COUNTY'S ETHERNET BASED FIBER OPTIC NETWORK. CONTACT MAINTAINING AGENCY PRIOR TO ORDERING CONTROLLER ASSEMBLY.

THIS ITEM SHALL INCLUDE THE INSTALLATION OF CONCRETE BASES FOR THE CONTROLLER ASSEMBLY AND FOR MOUNTING OF AN EMERGENCY GENERATOR CABINET. THE CONTROLLER ASSEMBLY FOUNDATION SHALL HAVE A MINIMUM OF (4) - 2" CONDUIT SPARES. TWO OF THE SPARES SHALL BE TERMINATED IN THE NEAREST FIBER OPTIC PULL BOX AND FITTED WITH A WEATHERPROOF CAP. THE OTHER TWO SPARES SHALL BE TERMINATED IN THE SIGNAL CABLE AND LOW VOLTAGE PULL BOXES. THE EMERGENCY GENERATOR CABINET (EGC) BASE SHALL HAVE DIMENSIONS OF 48" X 36" FOR CABINET MOUNTING WITH A FDOT STANDARD TECHNICIAN PAD OR STEPS. IT SHALL BE LOCATED ADJACENT TO THE CONTROLLER BASE WITH (2) - 2" CONDUITS AND (1) - 1-1/4" CONDUITS INSTALLED DIRECTLY TO THE CONTROLLER BASE. MANATEE COUNTY WILL FURNISH THE GENERATOR CABINET TO THE CONTRACTOR.

THE HEIGHT OF THE MOUNTING BASE FOR THE SIGNAL CONTROLLER CABINET SHALL BE EQUAL TO OR GREATER THAN THE ELEVATION OF THE CENTER CROWN OF THE ROADWAY.

THE CONTRACTOR SHALL COORDINATE WITH MANATEE COUNTY TO PICK UP AND INSTALL THE GENERATOR CABINET ON THE NEW FOUNDATION. ALL COSTS OF LABOR, CONCRETE AND OTHER MATERIALS FOR THE CONTROLLER ASSEMBLY AND EGC BASES, TECHNICIAN PADS, STEPS AS REQUIRED, AND INSTALLATION OF THE GENERATOR CABINET ARE INCLUDED IN THIS ITEM.THE CONTROLLER AND EGC BASE SHALL BE AT LEAST 2' HIGH OR THE SAME ELEVATION AS THE CROWN OF THE ROADWAY, WHICHEVER IS GREATER. THE MAXIMUM DISTANCE FROM THE TECHNICIAN PAD OR STEP TO THE FOUNDATION TOP IS 4". THE CABINET DOORS SHALL OPEN TOWARDS OR PARALLEL TO THE RIGHT-OF-WAY LINE AND AWAY FROM TRAFFIC.

WHEN INSTALLING GROUND WIRE IN THE CONTROLLER CABINET, THE COPPER GROUND WIRE SHALL NOT COME IN CONTACT WITH THE ALUMINUM CABINET, EXCEPT AT THE TERMINATION POINT.

THE CABINET FIELD WIRING, INCLUDING SIGNAL HEAD WIRING AND LEAD-INS (CABLES, NEUTRALS AND SPARES) SHALL BE IDENTIFIED FOR DIRECTION AND/OR PHASE WITH CLEARLY MARKED WEATHERPROOF TAGS. THE PROPOSED TAGGING SYSTEM SHALL BE IN ACCORDANCE WITH THE F.D.O.T.'S STANDARD SPECIFICATIONS. WHERE APPLICABLE, ALL CONDUCTORS SHALL BE LABELED TO INDICATE THE DIRECTION OF TRAVEL, THE MOVEMENT, PHASE AND INDIVIDUAL LANE SERVED. ONLY WHITE AND WHITE/BLACK CONDUCTORS WILL BE USED AS A NEUTRAL RETURN.

ALL CONTROLLER DOOR DIAGRAMS SHALL REFLECT CURRENT DATA.

A MANUAL PUSH BUTTON CORD AND CABINET KEYS SHALL BE FURNISHED FOR THE CONTROLLER CABINET.

14. 685-106:
INCLUDE AN UNINTERRUPTED POWER SUPPLY UNIT (UPS) WITH AN 8 HOUR RUN TIME AT 450 WATTS. ATTACH UPS UNIT TO THE OUTSIDE OF THE CONTROLLER CABINET. INSTALL UPS UNIT IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS. UPS EQUIPMENT SHALL BE COMPATIBLE WITH MAINTAINING AGENCY EXISTING SYSTEM AND SHALL INCLUDE ETHERNET CONNECTION AND SNMP V3 SUPPORT.

15. 690-33-1:
COST OF REPLACING ANY DAMAGED SIDEWALK DUE TO POLE REMOVAL SHALL BE INCLUDED UNDER THIS PAY ITEM.

16. 690-100:
THIS PAY ITEM INCLUDES THE COST OF REMOVING EXISTING PULL BOXES.

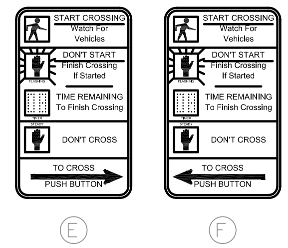
17. 699-1-1:
ALL INTERNALLY ILLUMINATED STREET NAME SIGNS SHALL BE EDGE LIT LED TYPE AND SHALL BE LISTED IN THE FDOT APPROVED PRODUCT LIST. THE SIGNS SHALL BE POWERED USING IMSA 50-2 CABLE. THE INSTALLATION OF THE PHOTOCELL ON THE SERVICE POLE SHALL BE PAID FOR UNDER 639-1-22.

CONDUIT LEGEND

LV = SIGNAL LOW VOLTAGE CONDUIT (INCLUDES VID CABLE)
HV = SIGNAL HIGH VOLTAGE CONDUIT
SP = SPARE CONDUIT

| | | | | | |
|---|---|---|---|---|---|
| 650-51-311 | 4 AS | 650-51-511 | 4 AS | 653-191 | 8 AS |
| 659-101 | 4 EA | 659-106 | 20 EA | | |
| 659-106 | 12 EA | 659-118 | 4 EA | | |

R10-3E
9" X 15"




* SIGNAL BACKPLATES SHALL BE PROVIDED WITH RETRO-REFLECTIVE BORDER MATERIAL

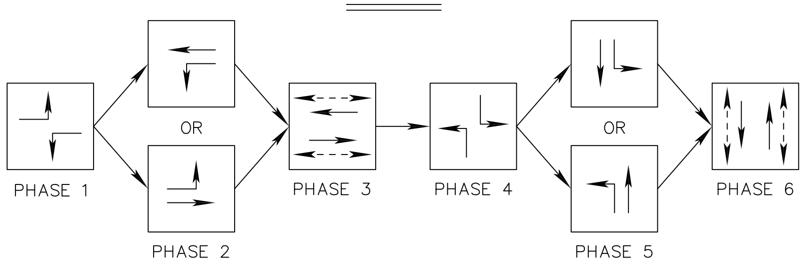
CONTROLLER NOTES:

1. MAJOR STREET IS CORTEZ RD. WEST (MOVEMENTS 1, 2, 5 & 6). MINOR STREET IS 43RD ST. WEST (MOVEMENTS 3, 4, 7 & 8).
2. THE CONTROLLER CABINET SHALL BE WIRED FOR SOP 10.
3. FLASHING OPERATION IS YELLOW FOR MOVEMENTS 2 & 6 AND RED FOR ALL OTHER MOVEMENTS.
4. EACH PHASE/ MOVEMENT SHALL BE WIRED FROM THE SIGNAL DISPLAY TO THE CONTROLLER AS A SEPARATE PHASE/ MOVEMENT. THIS INCLUDES LEFT TURN MOVEMENTS. EACH LEFT TURN MOVEMENT SHALL HAVE CONDUCTORS AVAILABLE FOR PROTECTED AND PERMISSIVE OPERATION.
5. THE SIGNAL SHALL BE INCORPORATED INTO THE MANATEE COUNTY ATMS SYSTEM.

SIGNAL HEAD LEGEND:

- F POSSIBLE FUTURE HEAD FOR MAST ARM CALCULATION
- PROPOSED SIGNAL HEAD

S.O.P. 10




REMOVAL NOTE:
REMOVE ENTIRE EXISTING SIGNAL SYSTEM

REMOVAL ITEMS:

| | |
|---|---|
| 690-10 | 8 EA |
| 690-33-1 | 40 LF |
| 690-50 | 1 EA |
| 690-60 | 10 EA |
| 690-80 | 1 EA |
| 690-90 | 1 PI |
| 690-100 | 1 PI |
| 700-48-60 | 3 EA |

CONTROLLER TIMINGS

| TIMING FUNCTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MOVEMENT NUMBER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| MINIMUM GREEN | 7 | 20 | 7 | 7 | 7 | 20 | 7 | 7 |
| EXTENSION | 3.0 | 3.0 | 3.0 | 4.0 | 3.0 | 3.0 | 3.0 | 4.0 |
| MAXIMUM GREEN 1 | 12 | 30 | 20 | 18 | 12 | 30 | 20 | 18 |
| MAXIMUM GREEN 2 | 25 | 50 | 35 | 60 | 25 | 50 | 35 | 60 |
| YELLOW CLEARANCE | 3.0 | 4.3 | 3.0 | 4.0 | 3.0 | 4.3 | 3.0 | 4.0 |
| ALL RED | 4.5 | 2.0 | 4.2 | 2.7 | 4.5 | 2.0 | 4.2 | 2.7 |
| PEDESTRIAN WALK | | 7 | | 7 | | 7 | | 7 |
| PED. CLEARANCE | | 25 | | 32 | | 25 | | 32 |
| RECALL | | MIN | | | | MIN | | |

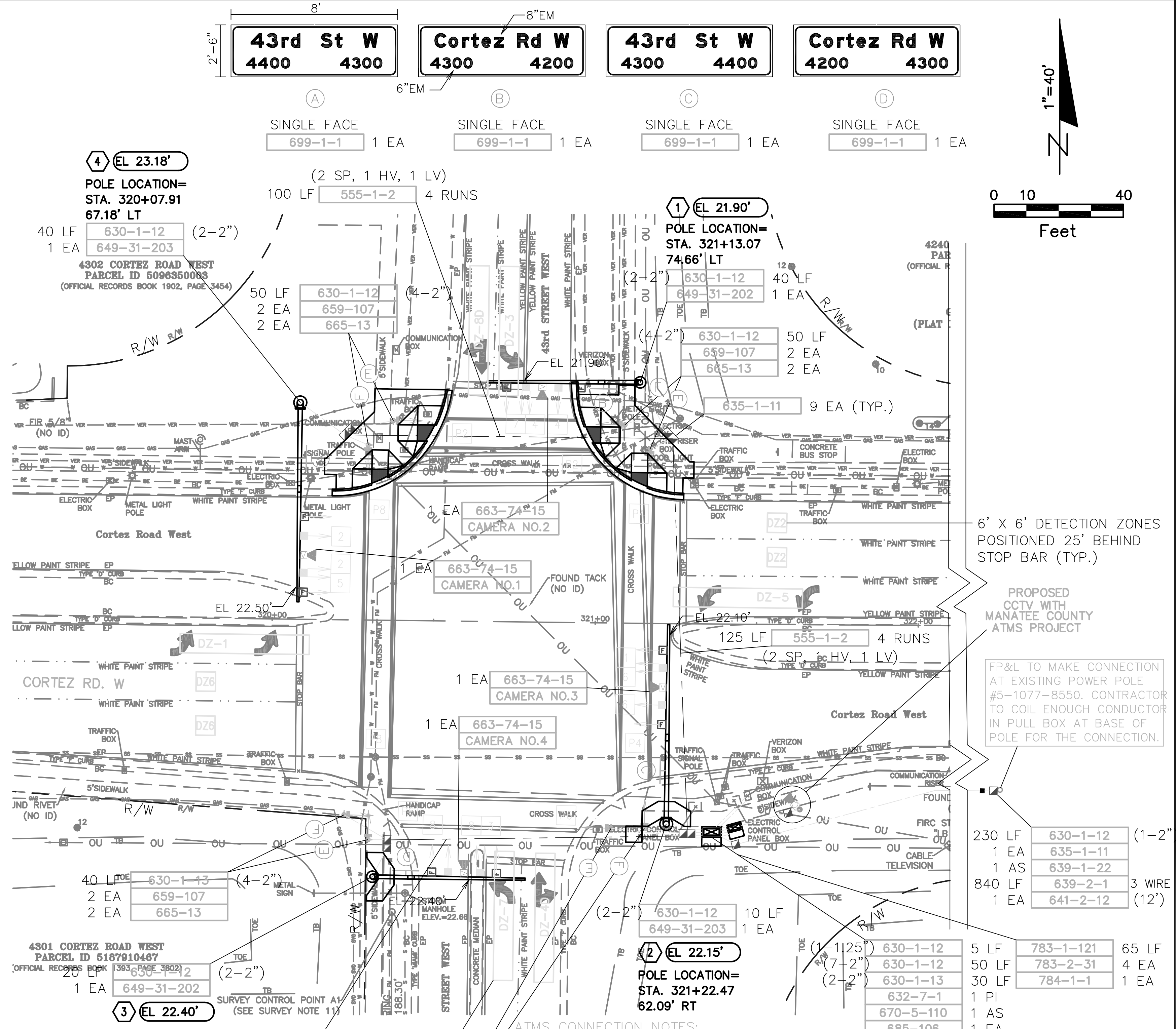
TIMING FUNCTION

TIMINGS ARE INITIAL AND MAY REQUIRE FIELD ADJUSTING AS DIRECTED BY PROJECT ENGINEER.

VIDEO DETECTOR ZONES

| ZONE LOCATION NO. | VIDEO CAMERA NO. | NO. OF DETECTION ZONES | DELAY TIME (SEC) |
|---|---|---|---|
| DZ-1 | 3 | 1 | 0 |
| DZ-2 | 1 | 2 | 0 |
| DZ-3 | 4 | 1 | 0 |
| DZ-4D | 2 | 1 | 5 |
| DZ-5 | 1 | 1 | 0 |
| DZ-6 | 3 | 2 | 0 |
| DZ-7 | 2 | 1 | 0 |
| DZ-8D | 4 | 1 | 5 |

DELAY TIME IS INITIAL AND MAY REQUIRE FIELD ADJUSTING AS DIRECTED BY PROJECT ENGINEER.




ATMS CONNECTION NOTES:

1. THE CONTRACTOR SHALL CONNECT TO THE EXISTING FIBER OPTIC PULL BOX TO SPLICE TO THE MANATEE ATMS TRUNK LINE. THE CONNECTION SHALL BE DONE WHEN THE SIGNAL IS OPERATIONAL AND IS READY TO BE TURNED ON.
2. THE CONTRACTOR SHALL COORDINATE WITH MANATEE COUNTY TRAFFIC OPERATIONS IF THE PROPOSED FIBER OPTIC TRUNK LINE IS NOT INSTALLED FOR TIME BASED CONTROLLER TIMINGS.
3. THE CONTRACTOR SHALL COORDINATE WITH MANATEE COUNTY TRAFFIC ENGINEERING ON THE FIBER OPTIC SPLICING PLAN.

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

MANATEE COUNTY

CORTEZ ROAD AND 43RD STREET WEST

Cardno TBE
12461 Telecom Drive, Tampa, Florida 33637
www.cardnotbe.com • 813.221.0048
Certificate of Authorization No. 3843

UPIK Y. SUWARNO

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

SIGNALIZATION PLAN

PROJECT NO. 00193-008-05
DATE 11-03-10
SHEET NO. T-5

SPECIAL NOTES:

A. EACH POLE AND MAST ARM SHALL BE IDENTIFIED WITH A PERMANENT ONE INCH (1") HIGH ENGRAVED OR IMPRESSED MARK WHICH BEARS THE POLE IDENTIFICATION NUMBER SHOWN ON THE PLANS.

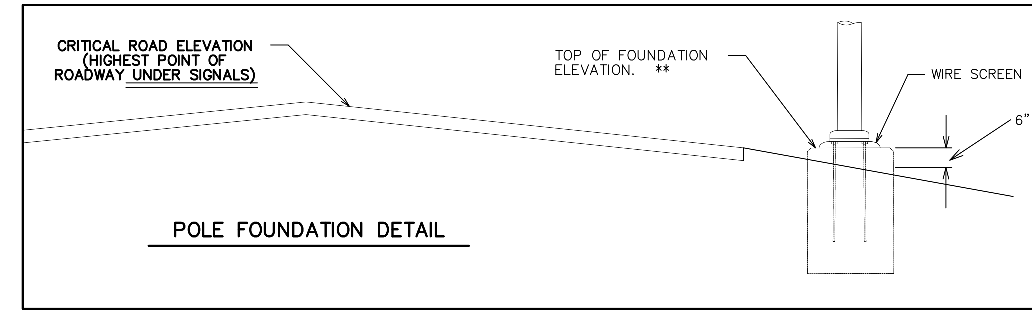
B. ANCHOR BOLT COVERS (ORNAMENTAL, NON-ORNAMENTAL, AND/OR PAINTED) SHALL BE GALVANIZED STEEL OR CAST ALUMINUM AND SHALL BE SECURED BY A MINIMUM OF TWO (2) THREADED FASTENERS. THE BOLT COVERS SHALL BE OF SUFFICIENT SIZE SO THAT THERE IS NO GAP BETWEEN ITSELF AND THE POLE SHAFT.

C. IT SHALL BE THE CONTRACTORS RESPONSIBILITY TO FIELD VERIFY ALL ELEVATIONS LISTED HEREIN.

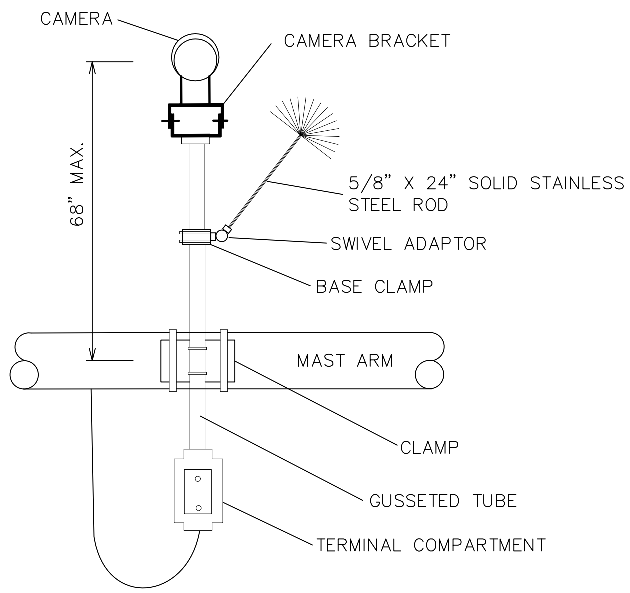
D. INFORMATION BELOW IS FOR DESIGN PURPOSES ONLY. FIELD ADJUSTMENTS MAY BE REQUIRED.

E. SEE APPROPRIATE PLAN SHEET FOR PROPOSED SIGNAL HEAD ALIGNMENTS AND SIGN CONFIGURATION/LOCATION.

F. BACKPLATES REQUIRED FOR ALL SIGNALS HEADS.

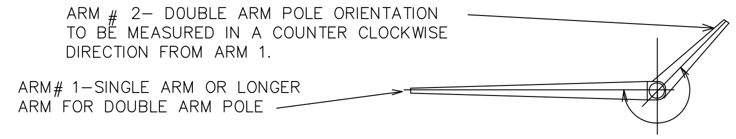


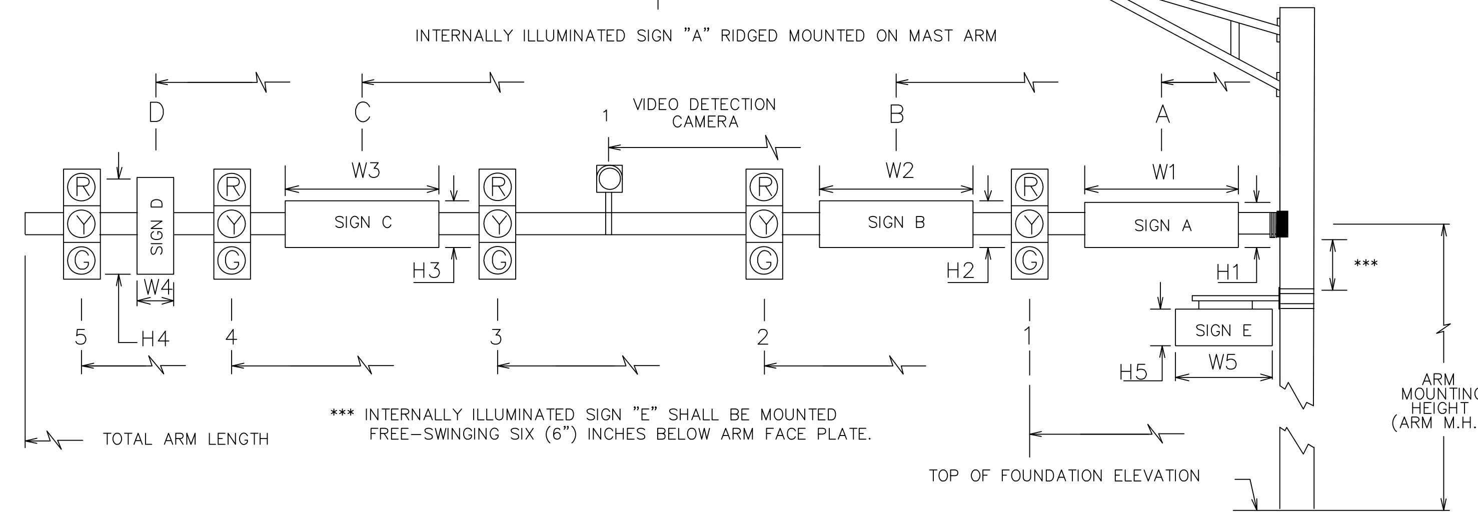

POLE FOUNDATION DETAIL




CAMERA MOUNTING DETAIL
(CONTACT MAINTAINING AGENCY
FOR MOUNTING PREFERENCES.)

| SPECIAL INSTRUCTIONS | | | | | |
|---|---|---|---|---|---|
| ID NO. | PED. BUTTON | | PED. SIGNALS | | HANDHOLE LOCATION |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |




* DENOTES NUMBER OF SECTIONS IN SIGNAL HEAD ASSEMBLY

| STRUCT. ID. NO. | POLE ID. NO. | SHEET NO. | LOCATION BY STA. | CRITICAL ROAD EL. | # FOUNDATION OUT OF GROUND | ** TOP OF FOUNDATION ELEVATION | RDWY ARM NO. | SIGNAL DATA: SIGNAL V/H | BACK PLATES Y/N | PED. SIGNAL Y/N | DISTANCE FROM POLE: 1 | * | 2 | * | 3 | * | 4 | * | 5 | * | 6 | * | 7 | * | 8 | * | TOTAL ARM LENGTH | ARM M.H. | ∠ BETWEEN DUAL ARMS 90/270 | SIGN DATA: DISTANCE FROM POLE / HEIGHT AND WIDTH OF SIGN: A | H1 | W1 | B | H2 | W2 | C | H3 | W3 | D | H4 | W4 | E | H5 | W5 | VIDEO DISTANCE FROM POLE: 1 | 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| – | 1 | T–5 | 321+13.07 | 21.90' | 0.5 | 21.90' | A | V | Y | N | 24.0 | 3 | 34.0 | 5 | | | | | | | | | | | | | 46 | 21.5 | | 12.0 | 2.5 | 8 | | | | | | | | | | | | | 29 | |
| | | | | | – | | B | V | Y | N | | | | | | | | | | | | | | | | | | – | – | | | | | | | | | | | | | | | | | |
| – | 2 | T–5 | 321+22.47 | 22.10' | 0.5 | 22.15' | B | V | Y | N | 35.0 | 3 | 46.5 | 5 | | | | | | | | | | | | | 60 | 21.5 | | 15.0 | 2.5 | 8 | | | | | | | | | | | | | 40.5 | |
| | | | | | – | – | A | V | Y | N | | | | | | | | | | | | | | | | | | – | – | | | | | | | | | | | | | | | | | |
| – | 3 | T–5 | 320+31.96 | 22.40' | 0.5 | 22.40' | A | V | Y | N | 22.0 | 3 | 32.0 | 5 | | | | | | | | | | | | | 46 | 21.5 | | 12.0 | 2.5 | 8 | | | | | | | | | | | | | 27 | |
| | | | | | – | – | B | V | Y | N | | | | | | | | | | | | | | | | | | – | – | | | | | | | | | | | | | | | | | |
| – | 4 | T–5 | 320+07.91 | 22.50' | 0.5 | 23.18' | – | V | Y | N | 39.5 | 3 | 51 | 5 | | | | | | | | | | | | | 60 | 21.5 | – | 15.5 | 2.5 | 8 | | | | | | | | | | | | | 45.5 | |
| | | | | | – | – | – | – | – | – | | | | | | | | | | | | | | | | | | – | – | | | | | | | | | | | | | | | | | |
| – | | | | | 0.5 | | A | V | Y | N | | | | | | | | | | | | | | | | | | – | | | | | | | | | | | | | | | | | | |
| | – | – | – | | – | – | B | V | Y | N | | | | | | | | | | | | | | | | | | – | – | | | | | | | | | | | | | | | | | |
| – | | | | | 0.5 | | – | V | Y | N | | | | | | | | | | | | | | | | | | – | – | | | | | | | | | | | | | | | | | |
| | | | | | | | – | – | – | – | | | | | | | | | | | | | | | | | | – | | | | | | | | | | | | | | | | | | |
| – | | | | | – | | A | V | Y | N | | | | | | | | | | | | | | | | | | – | | | | | | | | | | | | | | | | | | |
| | – | – | – | | – | – | B | V | Y | N | | | | | | | | | | | | | | | | | | – | – | | | | | | | | | | | | | | | | | |
| – | | | | | 0.5 | | A | V | Y | N | | | | | | | | | | | | | | | | | | – | | | | | | | | | | | | | | | | | | |
| | | | | | | | B | V | Y | N | | | | | | | | | | | | | | | | | | – | | | | | | | | | | | | | | | | | | |

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|
| | | | |

MANATEE COUNTY

CORTEZ ROAD AND 43RD STREET WEST

Cardno TBE
12481 Telecom Drive, Tampa, Florida 33637
www.cardnotbe.com - 813.221.0048
Certificate of Authorization No. 3843

UPIK Y. SUWARNO DATE

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

# MAST ARM TABULATION (DESIGN PLAN CONFIGURATION)

PROJECT NO. 00193-008-05
DATE: 11-03-10
SHEET NO. T-6

SPECIAL NOTES:

A. EACH POLE AND MAST ARM SHALL BE IDENTIFIED WITH A PERMANENT ONE INCH (1") HIGH ENGRAVED OR IMPRESSED MARK WHICH BEARS THE POLE IDENTIFICATION NUMBER SHOWN ON THE PLANS.

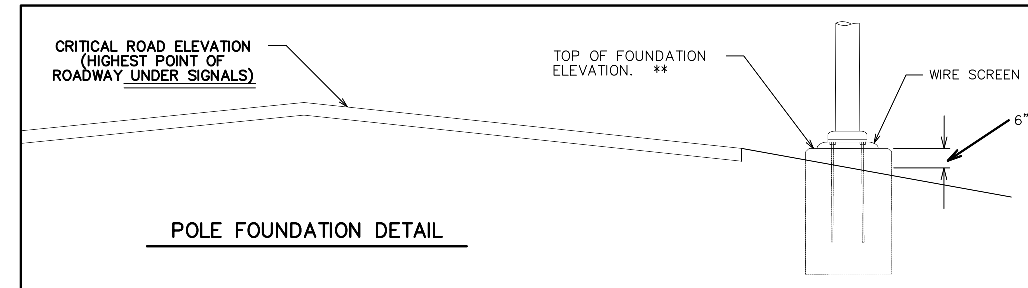
B. ANCHOR BOLT COVERS (ORNAMENTAL, NON-ORNAMENTAL, AND/OR PAINTED) SHALL BE GALVANIZED STEEL OR CAST ALUMINUM AND SHALL BE SECURED BY A MINIMUM OF TWO (2) THREADED FASTENERS. THE BOLT COVERS SHALL BE OF SUFFICIENT SIZE SO THAT THERE IS NO GAP BETWEEN ITSELF AND THE POLE SHAFT.

C. IT SHALL BE THE CONTRACTORS RESPONSIBILITY TO FIELD VERIFY ALL ELEVATIONS LISTED HEREIN.

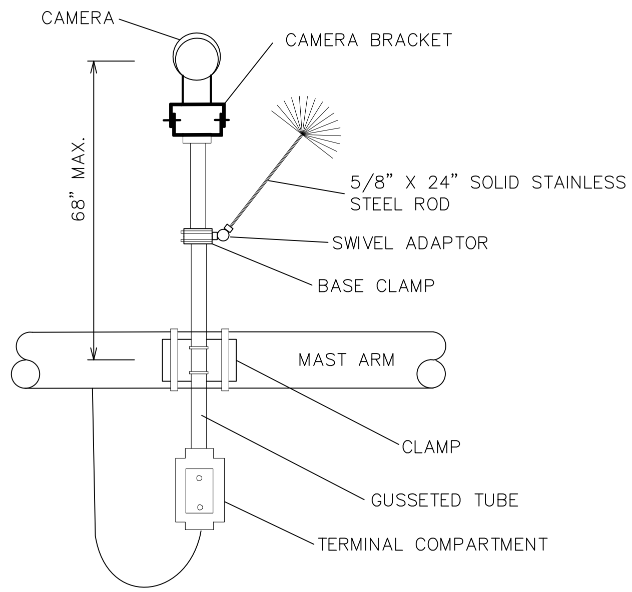
D. INFORMATION BELOW IS FOR DESIGN PURPOSES ONLY. FIELD ADJUSTMENTS MAY BE REQUIRED.

E. SEE APPROPRIATE PLAN SHEET FOR PROPOSED SIGNAL HEAD ALIGNMENTS AND SIGN CONFIGURATION/LOCATION.

F. BACKPLATES REQUIRED FOR ALL SIGNALS HEADS.

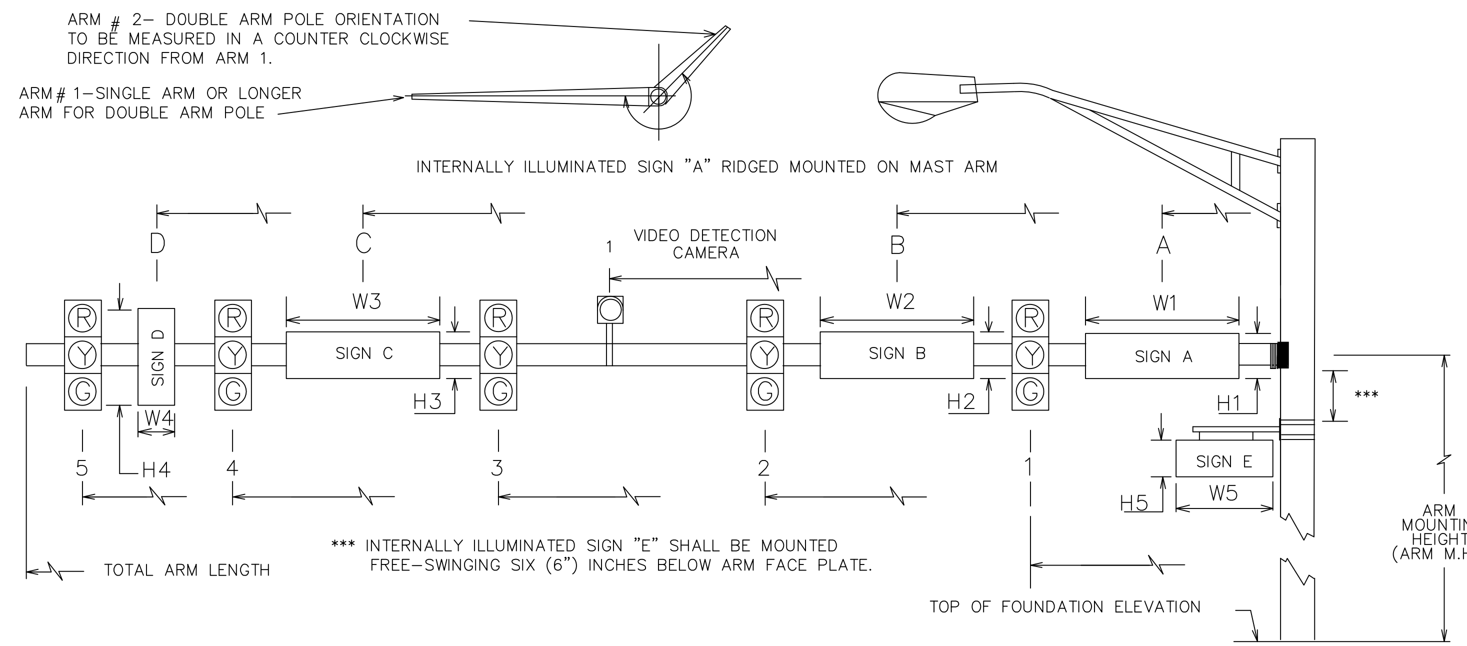



POLE FOUNDATION DETAIL




CAMERA MOUNTING DETAIL
(CONTACT MAINTAINING AGENCY FOR MOUNTING PREFERENCES.)

| SPECIAL INSTRUCTIONS | | | | | |
|---|---|---|---|---|---|
| ID NO. | PED. BUTTON | | PED. SIGNALS | | HANDHOLE LOCATION |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |
| ___ | ___ | ___ | ___ | ___ | |




* DENOTES NUMBER OF SECTIONS IN SIGNAL HEAD ASSEMBLY

| STRUCT. ID. NO. | POLE ID. NO. | SHEET NO. | LOCATION BY STA. | CRITICAL ROAD EL. | # FOUNDATION OUT OF GROUND | ** TOP OF FOUNDATION ELEVATION | RDWY ARM NO. | SIGNAL DATA: SIGNAL V/H | BACK PLATES Y/N | PED. SIGNAL Y/N | DISTANCE FROM POLE: 1 | * | 2 | * | 3 | * | 4 | * | 5 | * | 6 | * | 7 | * | 8 | * | TOTAL ARM LENGTH | ARM M.H. | ∠ BETWEEN DUAL ARMS 90/270 | SIGN DATA: DISTANCE FROM POLE / HEIGHT AND WIDTH OF SIGN: A | H1 | W1 | B | H2 | W2 | C | H3 | W3 | D | H4 | W4 | E | H5 | W5 | VIDEO DISTANCE FROM POLE: 1 | 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| – | 1 | T–5 | 321+13.07 | 21.90' | 0.5 | 21.90' | A | V | Y | N | 17.0 | 3 | 29.0 | 3 | 40.0 | 4 | | | | | | | | | | | 46 | 21.5 | | 10.0 | 2.5 | 8 | | | | | | | | | | 45 | 3 | 2.5 | 34 | |
| | | | | | – | | B | V | Y | N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| – | 2 | T–5 | 321+22.47 | 22.10' | 0.5 | 22.15' | B | V | Y | N | 29.0 | 3 | 40.5 | 3 | 52.0 | 4 | | | | | | | | | | | 60 | 21.5 | | 15.0 | 2.5 | 8 | | | | | | | | | | 59 | 3 | 2.5 | 46.5 | |
| | | | | | – | | A | V | Y | N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| – | 3 | T–5 | 320+31.96 | 22.40' | 0.5 | 22.40' | A | V | Y | N | 17.0 | 3 | 27.0 | 3 | 37.0 | 4 | | | | | | | | | | | 46 | 21.5 | | 9.0 | 2.5 | 8 | | | | | | | | | | 45 | 3 | 2.5 | 32 | |
| | | | | | – | | B | V | Y | N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| – | 4 | T–5 | 320+07.91 | 22.50' | 0.5 | 23.18' | – | V | Y | N | 33.5 | 3 | 45.5 | 3 | 57.0 | 4 | | | | | | | | | | | 60 | 21.5 | | 15.5 | 2.5 | 8 | | | | | | | | | | 59 | 3 | 2.5 | 51 | |
| | | | | | – | | – | – | – | – | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| – | | | | | 0.5 | | A | V | Y | N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | – | | B | V | Y | N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| – | | | | | 0.5 | | – | V | Y | N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | – | – | – | – | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| – | | | | | – | | A | V | Y | N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | – | | B | V | Y | N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| – | | | | | 0.5 | | A | V | Y | N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | B | V | Y | N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

MANATEE COUNTY

CORTEZ ROAD AND 43RD STREET WEST

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Certificate of Authorization No. 3843

UPIK Y. SUWARNO DATE

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APPROVED

# MAST ARM TABULATION (POSSIBLE FUTURE LOAD)

PROJECT NO. 00193-008-05
DATE: 11-03-10
SHEET NO. T-7

## SPECIAL MAST ARM ASSEMBLIES DATA TABLE

| NUMBER OF LOCATIONS | STRUCTURE NUMBER | FIRST ARM | | | | FIRST ARM EXTENSION | | | | SECOND ARM | | | | SECOND ARM EXTENSION | | | | POLE | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FA(ft) | FB(in) | FC(in) | FD(in) | FE(ft) | FF(in) | FG(in) | FH(in) | SA(ft) | SB(in) | SC(in) | SD(in) | SE(ft) | SF(in) | SG(in) | SH(in) | UA(ft) | UB(ft) | UC(in) | UD(in) | UE(in) | UF(deg) | UG(ft) |
| 2 | ID. No.1 & 3 | 36.3 | 7.06 | 12.14 | 0.25 | 11.7 | 11.4 | 13 | 0.375 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21.5 | 20 | 13 | 16 | 0.375 | 0 | 0 |
| 2 | ID. No.4 & 2 | 36 | 6.35 | 1.4 | 0.375 | 26 | 10.4 | 14 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21.5 | 20 | 16 | 19 | 0.375 | 0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |

## SPECIAL MAST ARM ASSEMBLIES DATA TABLE (CONT.)

| STRUCTURE NUMBER | FIRST ARM CONNECTION (in) First Arm Camber Angle = 2 Degrees | | | | | | | | | | | | | SECOND ARM CONNECTION (in) Second Arm Camber Angle = 2 Degrees | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | #Bolts | HT | FJ | FK | FL | FM | FN | FO | FP | FQ | FR | FS | FT | #Bolts | HT | SJ | SK | SL | SM | SN | SO | SP | SQ | SR | SS | ST |
| ID. No.1 & 3 | 6 | 22 | 23 | 2 | 0.5 | 0.313 | 0.375 | 14 | 1 | 0.438 | 2 | 9 | 0.375 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ID. No.4 & 2 | 6 | 30 | 32 | 2.75 | 0.75 | 0.438 | 0.375 | 19.5 | 1.25 | 0.563 | 2 | 12.5 | 0.375 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |

## SPECIAL MAST ARM ASSEMBLIES DATA TABLE (CONT.)

| STRUCTURE NUMBER | POLE BASE CONNECTION (in) | | | | | | | SHAFT AND REINF. | | | | LUMINAIRE AND LUMINAIRE CONNECTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | #Bolts | BA | BB | BC | BD | BE | BF | DA(ft) | DB(ft) | RA | RB | LA(ft) | LB(ft) | LC(in) | LD(in) | LE | LF(ft) | LG(in) | LH(in) | LJ(in) | LK(in) | LL(deg) |
| ID. No.1 & 3 | 6 | 28 | 1.75 | 1.5 | 0.375 | 0.313 | 36 | 14 | 3.5 | 11 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ID. No.2 & 4 | 6 | 35 | 1.75 | 2 | 0.375 | 0.313 | 40 | 15 | 4 | 11 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |

NOTES:
1. Work with Index 17745.
2. Design Wind Speed = 130 mph
3. Contractor shall coordinate anchor bolt requirements with fabricator.
4. Contractor shall identify Structures Numbers and submit detailed shop drawings.

FOUNDATION NOTES:

1. Design based on Borings taken and sealed by Martin E. Millburg, P.E. with Professional Service Industries, Inc.

2. Assumptions and Values used in design:
   Soil Type = Sand
   Soil Layer Thickness = 20 ft.
   Soil Friction Angle = 30 deg.
   Soil Weight = 42.6 pcf
   Design Water Table is 0.0 ft. below surface.

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

MANATEE COUNTY

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Certificate of Authorization No. 3843

MIGUEL A. VILLEGAS DATE

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

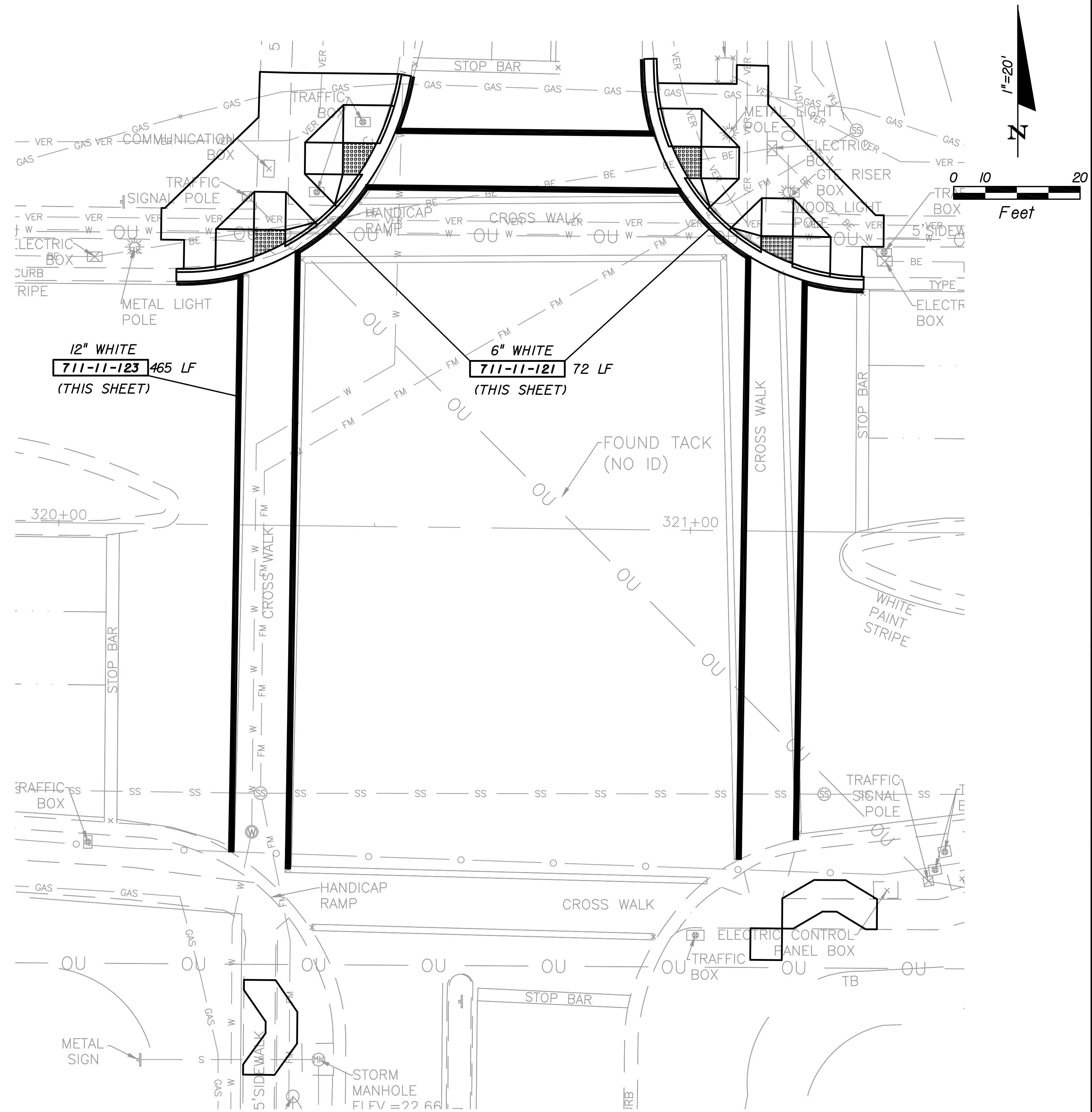
# TABLE OF VARIABLES FOR STANDARD MAST ARM ASSEMBLIES (INDEX S-1700)

PROJECT NO: 00193-008-05
DATE: 11-03-10
SHEET NO: T-8

**NOTES:**

1. THE CONTRACTOR SHALL REMOVE ALL THE EXISTING MARKINGS BEING REPLACED.

711-17 525 SF
(THIS SHEET)




| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|
| | | | |

MANATEE COUNTY

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Certificate of Authorization No. 3843

UPIK Y. SUWARNO DATE
LIC. NO.: 62995

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

PAVEMENT MARKING PLAN

PROJECT NO: 00193-008-05
DATE: 11-03-2010
SHEET NO: T-9

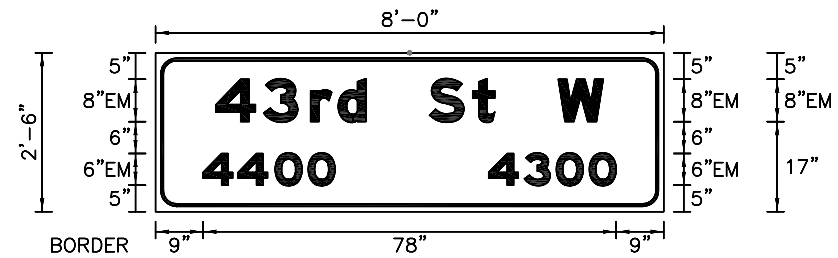
FILE: J:\JOB\0193\00193-008-05\ACAD\PLANSP01.dwg LAST SAVED: Wed, 11/03/10-1:03p PLOTTED: Wed, 11/03/10-3:58p BY: JTP

## SIGN A

| SIGN NAME | A | QTY | 1 | SIGN NUMBER | STATION(S) |
|---|---|---|---|---|---|
| PANEL | | BORDER | | | none |
| WIDTH | 8'-0" | WIDTH | 0.5" | | |
| HEIGHT | 2'-6" | RADII | 3" | | |
| LEGEND | White | COLOR | White | | |
| COLOR | Green | | | | |

| SYMBOL(S) | ANGLE | X | Y | WID | HT |
|---|---|---|---|---|---|

| SIGN NUMBER | NUMBER OF POSTS | CLEARANCE Edge Of Lane | COLUMN SIZE | | AVERAGE LENGTH |
|---|---|---|---|---|---|




BORDER
R=3"
TH=0.5"
IN=1"

| NO. OF LIGHT FIXTURES | | FIXTURE SPACING | | PHOTOMETRIC CURVE | | WATT | | VOLTAGE | |
|---|---|---|---|---|---|---|---|---|---|

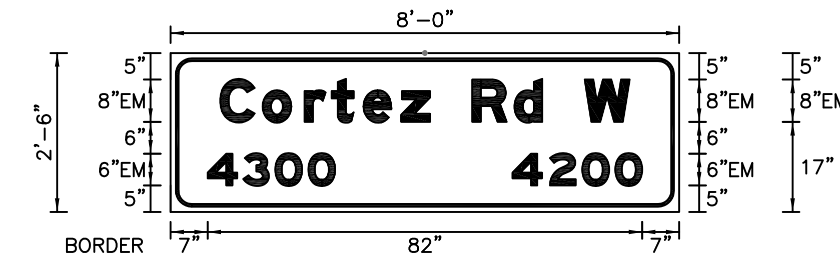
| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COPY | | 4 | 3 | r | d | | S | t | | W | | L |
| SPACE | 11.4 | 9 | 8.9 | 5.2 | 5.3 | 12 | 8.2 | 4.2 | 12 | 8.5 | 11.4 | 73.1 |
| COPY | | 4 | 4 | 0 | 0 | | 4 | 3 | 0 | 0 | | L |
| SPACE | 9 | 6.6 | 7 | 6.2 | 5 | 29 | 6.7 | 6.1 | 6.2 | 5 | 9 | 78 |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |

## SIGN B

| SIGN NAME | B | QTY | 1 | SIGN NUMBER | STATION(S) |
|---|---|---|---|---|---|
| PANEL | | BORDER | | | none |
| WIDTH | 8'-0" | WIDTH | 0.5" | | |
| HEIGHT | 2'-6" | RADII | 3" | | |
| LEGEND | White | COLOR | White | | |
| COLOR | Green | | | | |

| SYMBOL(S) | ANGLE | X | Y | WID | HT |
|---|---|---|---|---|---|

| SIGN NUMBER | NUMBER OF POSTS | CLEARANCE Edge Of Lane | COLUMN SIZE | | AVERAGE LENGTH |
|---|---|---|---|---|---|




BORDER
R=3"
TH=0.5"
IN=1"

| NO. OF LIGHT FIXTURES | | FIXTURE SPACING | | PHOTOMETRIC CURVE | | WATT | | VOLTAGE | |
|---|---|---|---|---|---|---|---|---|---|

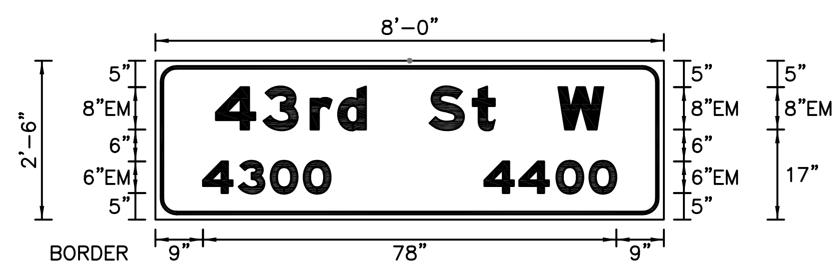
| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COPY | | C | o | r | t | e | z | | R | d | | W | | L |
| SPACE | 9.4 | 8 | 7.9 | 5.1 | 6 | 7.1 | 5.4 | 8 | 7.9 | 5.3 | 8 | 8.5 | 9.4 | 77.3 |
| COPY | | 4 | 3 | 0 | 0 | | 4 | 2 | 0 | 0 | | L | | |
| SPACE | 7 | 6.7 | 6.1 | 6.2 | 5 | 33.5 | 7.1 | 6.1 | 6.2 | 5 | 7 | 82 | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |

## SIGN C

| SIGN NAME | C | QTY | 1 | SIGN NUMBER | STATION(S) |
|---|---|---|---|---|---|
| PANEL | | BORDER | | | none |
| WIDTH | 8'-0" | WIDTH | 0.5" | | |
| HEIGHT | 2'-6" | RADII | 3" | | |
| LEGEND | White | COLOR | White | | |
| COLOR | Green | | | | |

| SYMBOL(S) | ANGLE | X | Y | WID | HT |
|---|---|---|---|---|---|

| SIGN NUMBER | NUMBER OF POSTS | CLEARANCE Edge Of Lane | COLUMN SIZE | | AVERAGE LENGTH |
|---|---|---|---|---|---|




BORDER
R=3"
TH=0.5"
IN=1"

| NO. OF LIGHT FIXTURES | | FIXTURE SPACING | | PHOTOMETRIC CURVE | | WATT | | VOLTAGE | |
|---|---|---|---|---|---|---|---|---|---|

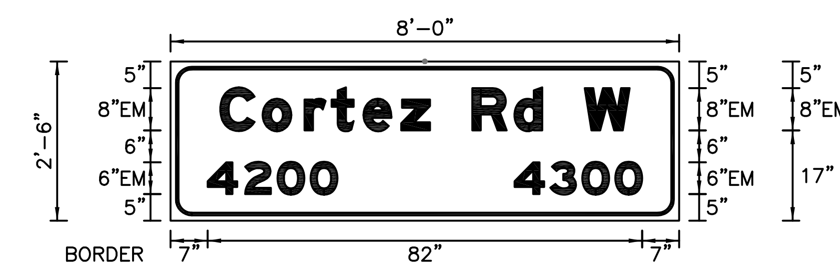
| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COPY | | 4 | 3 | r | d | | S | t | | W | | L |
| SPACE | 11.4 | 9 | 8.9 | 5.2 | 5.3 | 12 | 8.2 | 4.2 | 12 | 8.5 | 11.4 | 73.1 |
| COPY | | 4 | 3 | 0 | 0 | | 4 | 4 | 0 | 0 | | L |
| SPACE | 9 | 6.7 | 6.1 | 6.2 | 5 | 29 | 6.6 | 7 | 6.2 | 5 | 9 | 78 |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | |

## SIGN D

| SIGN NAME | D | QTY | 1 | SIGN NUMBER | STATION(S) |
|---|---|---|---|---|---|
| PANEL | | BORDER | | | none |
| WIDTH | 8'-0" | WIDTH | 0.5" | | |
| HEIGHT | 2'-6" | RADII | 3" | | |
| LEGEND | White | COLOR | White | | |
| COLOR | Green | | | | |

| SYMBOL(S) | ANGLE | X | Y | WID | HT |
|---|---|---|---|---|---|

| SIGN NUMBER | NUMBER OF POSTS | CLEARANCE Edge Of Lane | COLUMN SIZE | | AVERAGE LENGTH |
|---|---|---|---|---|---|




BORDER
R=3"
TH=0.5"
IN=1"

| NO. OF LIGHT FIXTURES | | FIXTURE SPACING | | PHOTOMETRIC CURVE | | WATT | | VOLTAGE | |
|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COPY | | C | o | r | t | e | z | | R | d | | W | | L |
| SPACE | 9.4 | 8 | 7.9 | 5.1 | 6 | 7.1 | 5.4 | 8 | 7.9 | 5.3 | 8 | 8.5 | 9.4 | 77.3 |
| COPY | | 4 | 2 | 0 | 0 | | 4 | 3 | 0 | 0 | | L | | |
| SPACE | 7 | 7.1 | 6.1 | 6.2 | 5 | 33.5 | 6.7 | 6.1 | 6.2 | 5 | 7 | 82 | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |
| COPY | | | | | | | | | | | | | | |
| SPACE | | | | | | | | | | | | | | |

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

**MANATEE COUNTY**

**CORTEZ ROAD AND 43RD STREET WEST**

Cardno TBE
12481 Telecom Drive, Tampa, Florida 33637
www.cardnotbe.com - 813.221.0048
Certificate of Authorization No. 3843

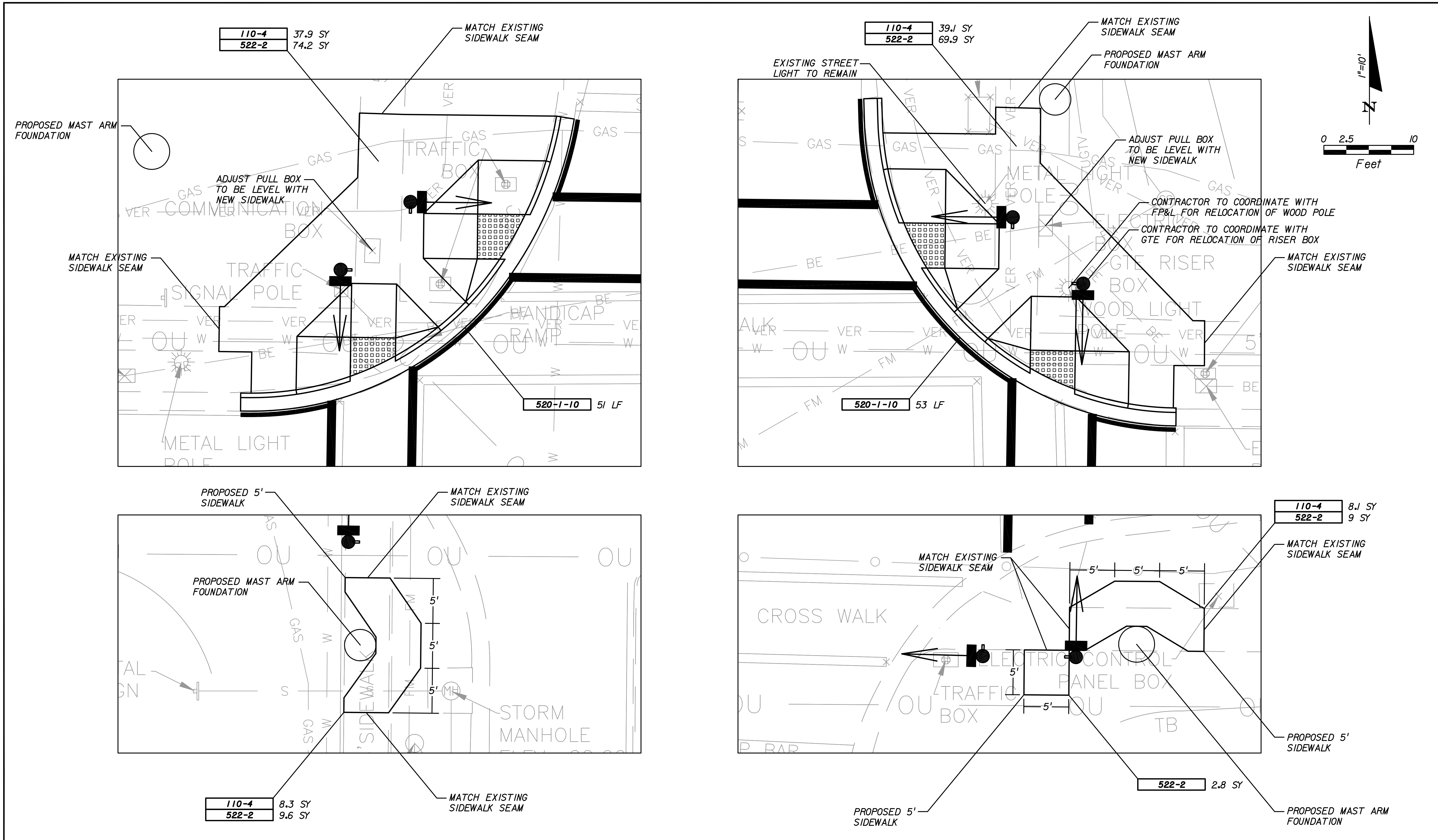
UPIK Y. SUWARNO DATE
LIC. NO.: 62995

| DESIGNED | JTP |
|---|---|
| DRAWN | JTP |
| Q.C. | |
| APPROVED | |

**GUIDESIGN WORKSHEET**

PROJECT NO: 00193-008-05
DATE: 11-03-10
SHEET NO: T-10

FILE: O:\JOB\0193\00193-008-05\ACAD\GSWKSG01.dwg LAST SAVED: Fri, 10/29/10-2:56a PLOTTED: Wed, 11/03/10-2:56p BY: uys




| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|
| | | | |

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UPIK Y. SUWARNO DATE
LIC. NO.: 62995

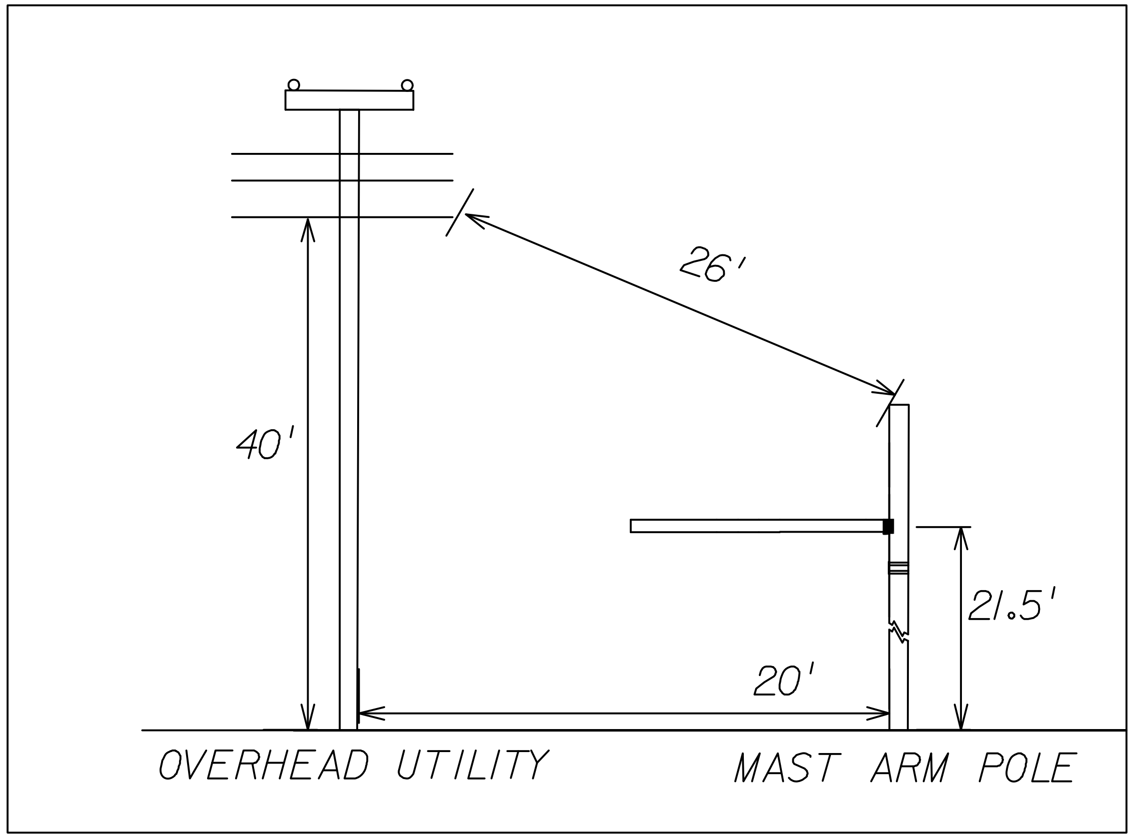
DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

**CONSTRUCTION DETAILS**

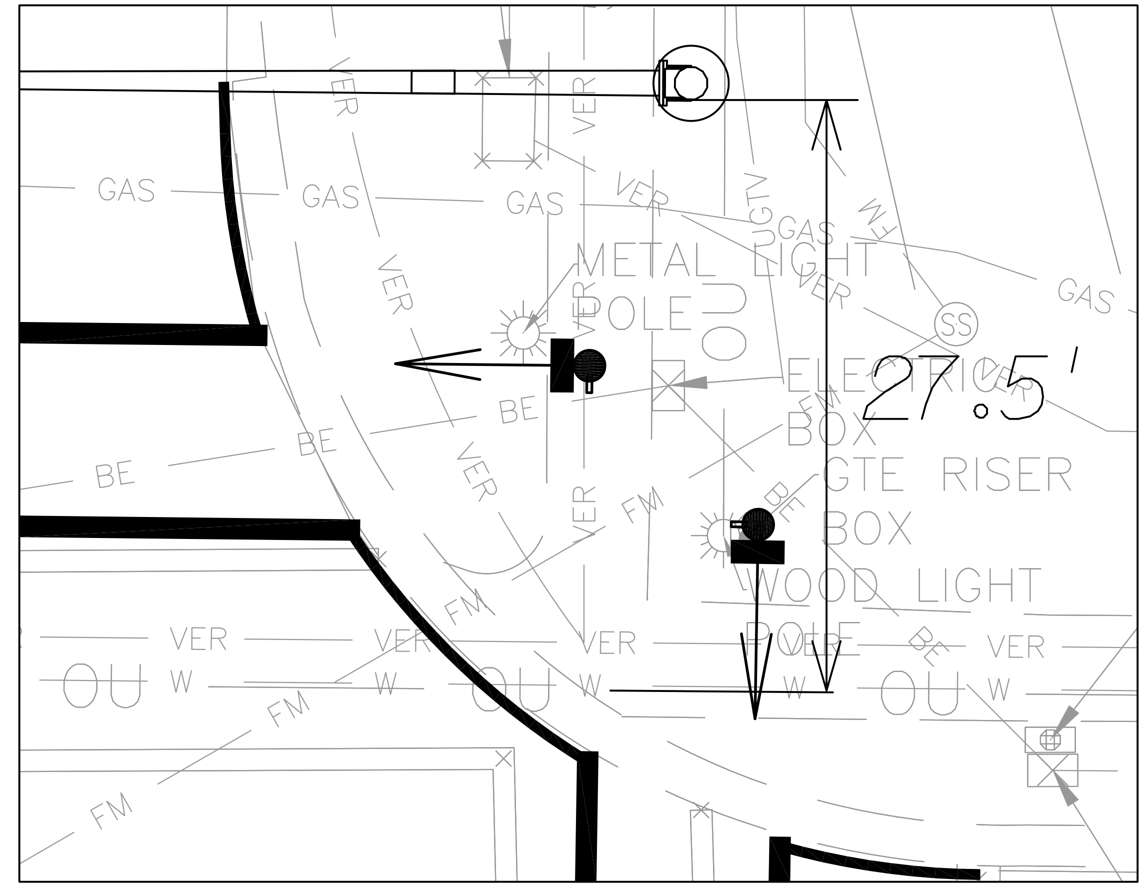
PROJECT NO: 00193-008-05
DATE: 11-03-10
SHEET NO: T-11

FILE: J:\JOB\0193\00193-008-05\ACAD\RAMP.dwg LAST SAVED: Wed, 11/03/10-3:55p PLOTTED: Wed, 11/03/10-3:55p BY: JTP

POLE NO. 1
NORTHWEST CORNER

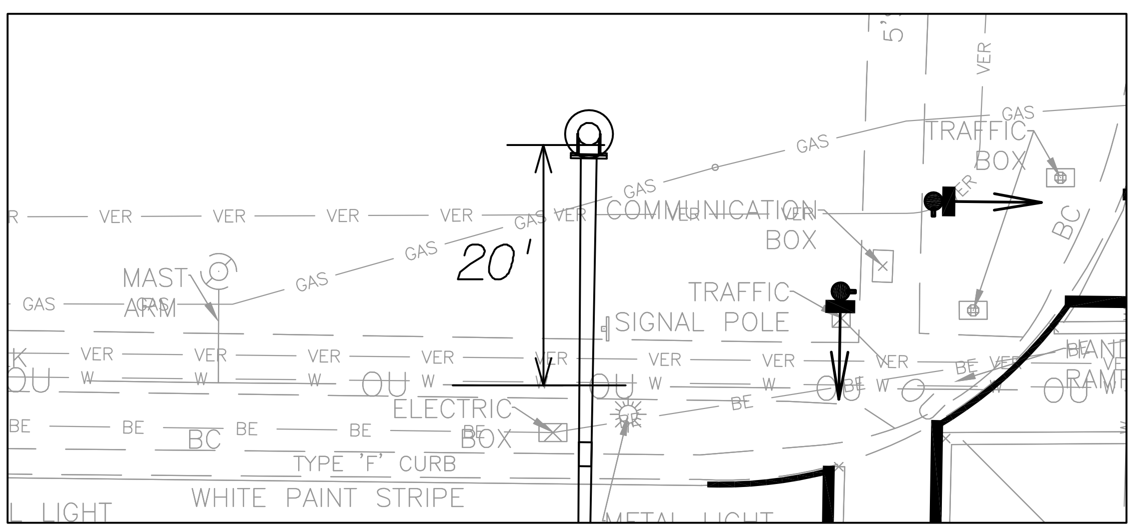



POLE NO. 2
NORTHEAST CORNER




N

N.T.S.




POLE NO. 1
NORTHWEST CORNER

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

MANATEE COUNTY

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UPIK Y. SUWARNO DATE
LIC. NO.: 62995

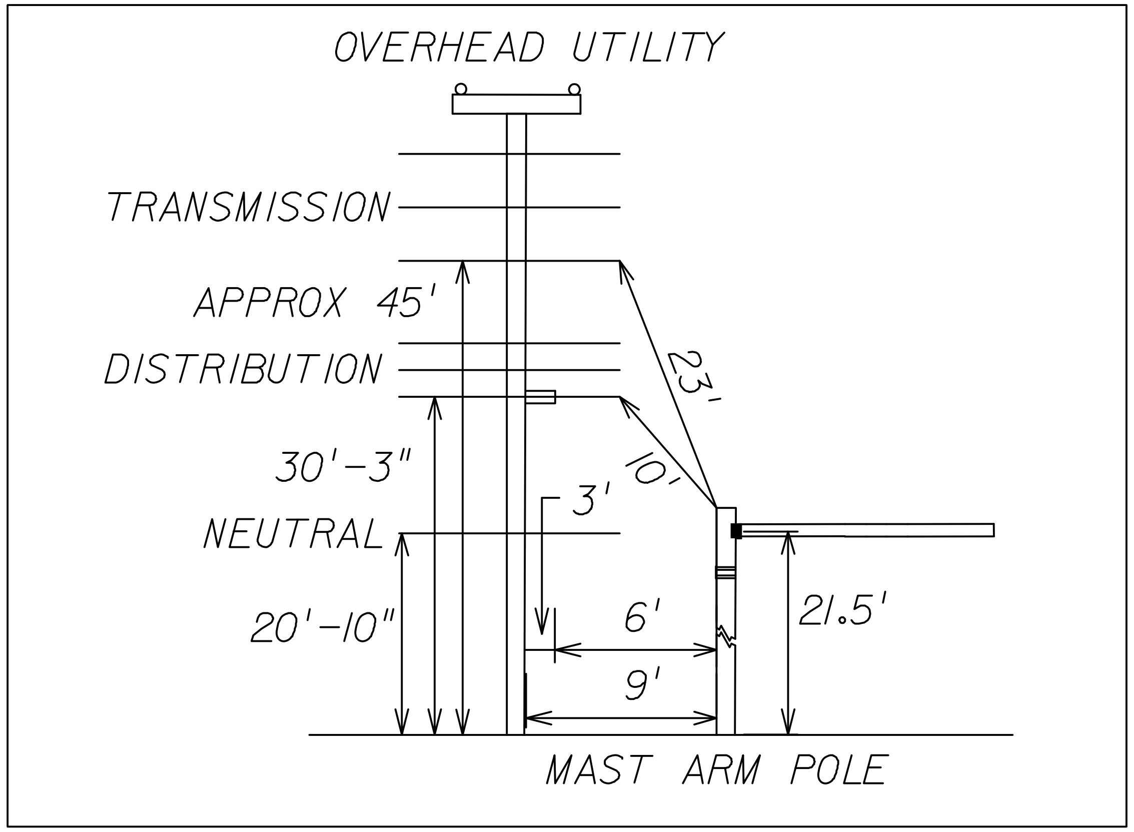
DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

OVERHEAD UTILITY
PROFILES (1)

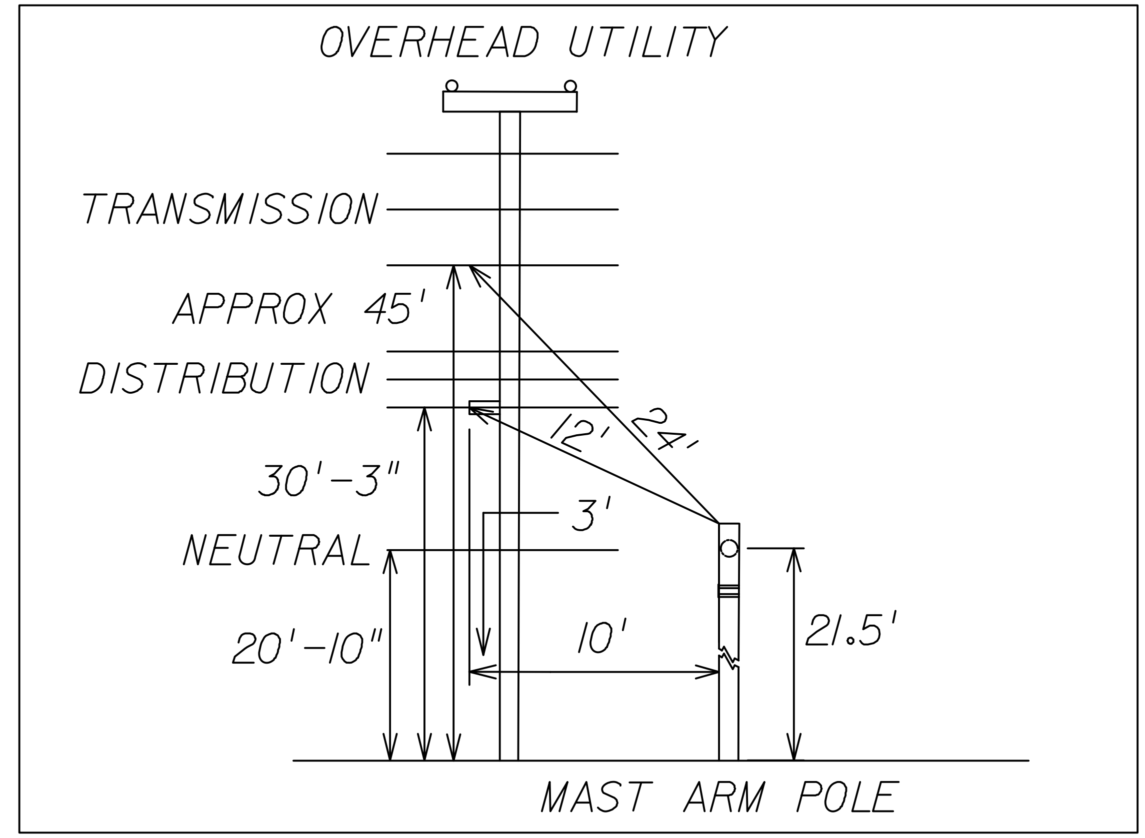
PROJECT NO: 00193-008-05
DATE: 11-03-10
SHEET NO: T-12

FILE: J:\JOB\0193\00193-008-05\ACAD\utility_profile.dwg LAST SAVED: Wed, 11/03/10-3:47p PLOTTED: Wed, 11/03/10-3:49p BY: JTP

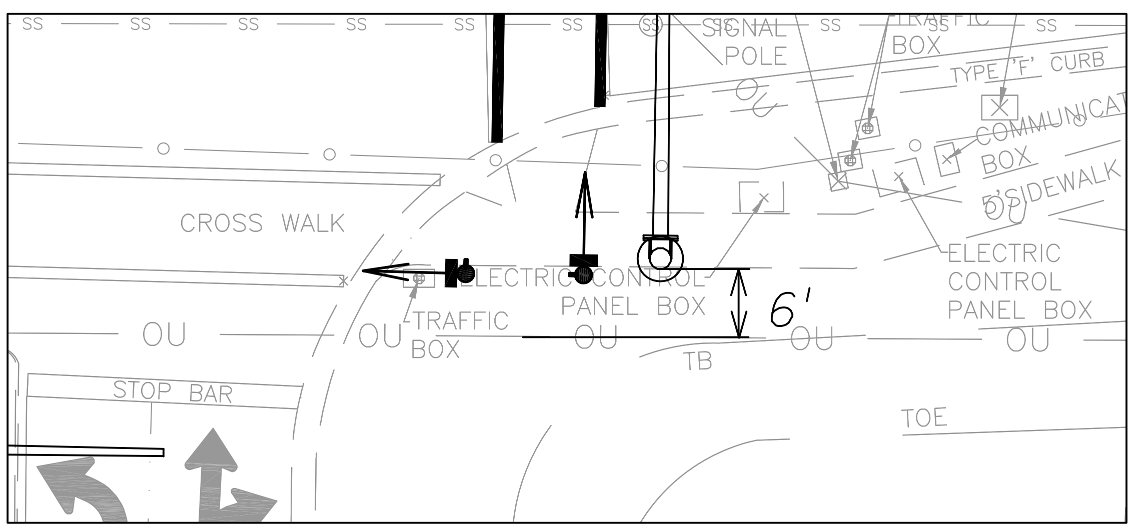
POLE NO. 3
SOUTHEAST CORNER



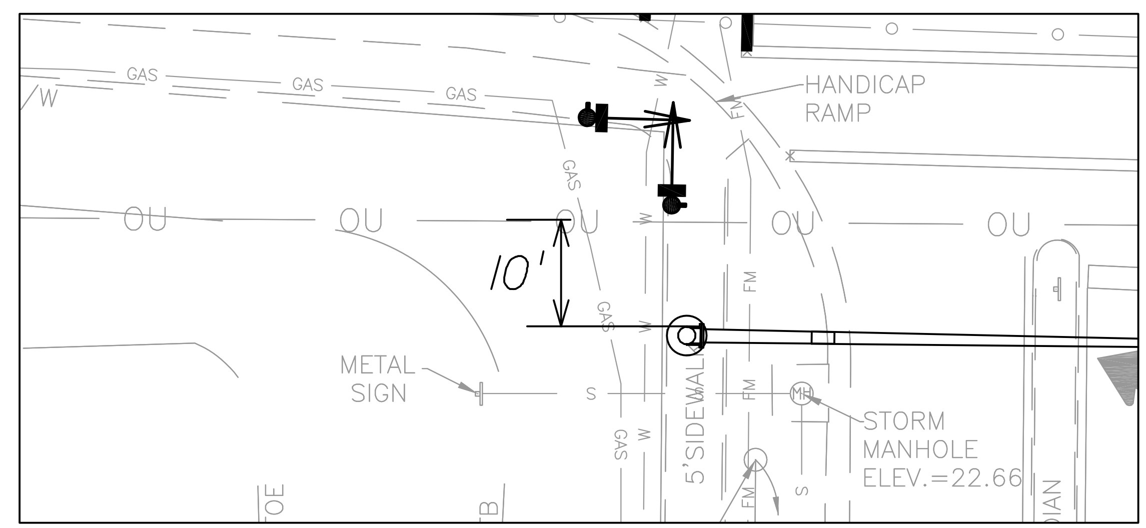

POLE NO. 4
SOUTHWEST CORNER




N.T.S.




POLE NO. 3
SOUTHEAST CORNER




POLE NO. 4
SOUTHWEST CORNER

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|

MANATEE COUNTY

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Certificate of Authorization No. 3843

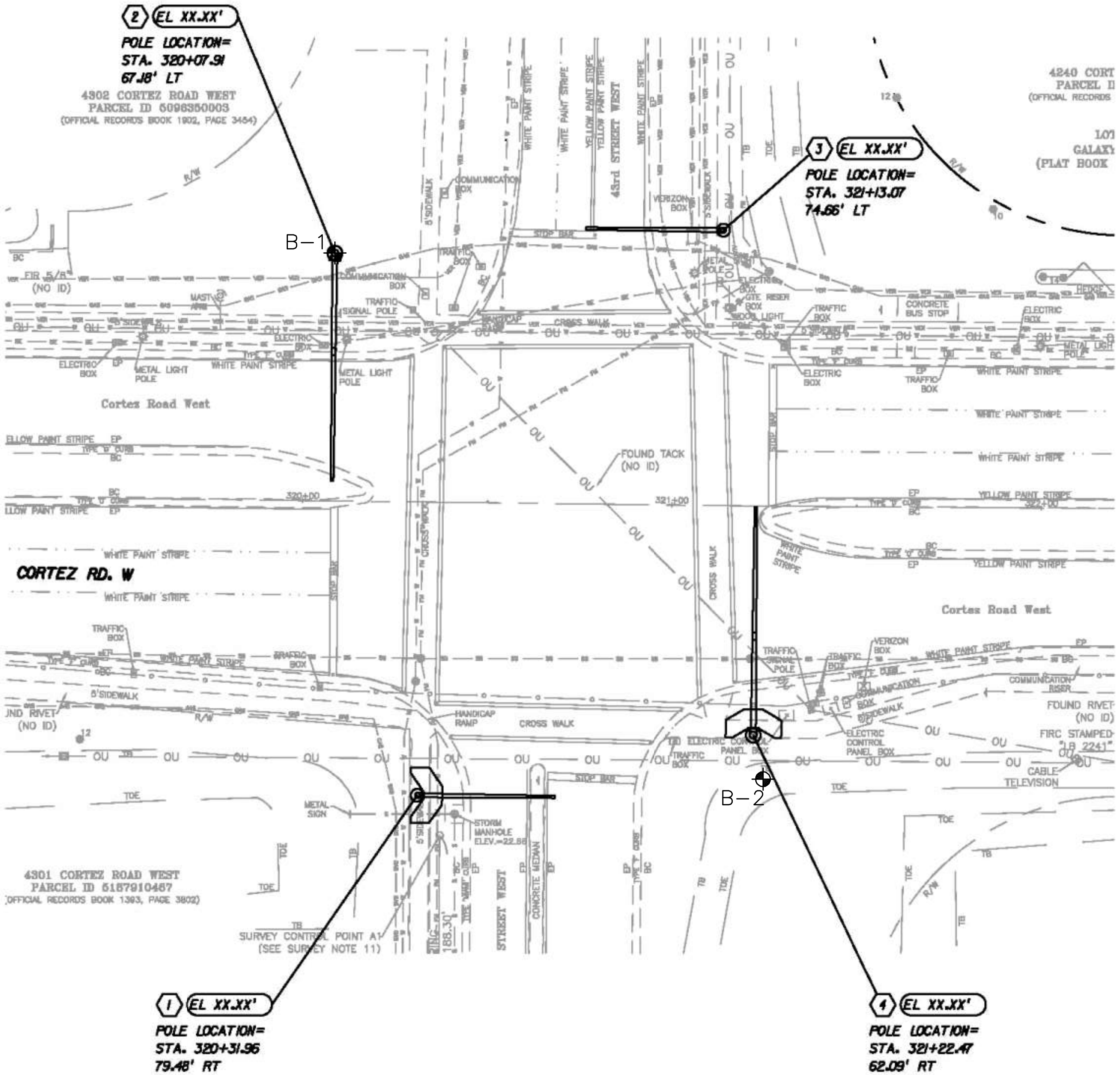
UPIK Y. SUWARNO DATE
LIC. NO.: 62995

DESIGNED JTP
DRAWN JTP
Q.C.
APPROVED

**OVERHEAD UTILITY PROFILES (2)**

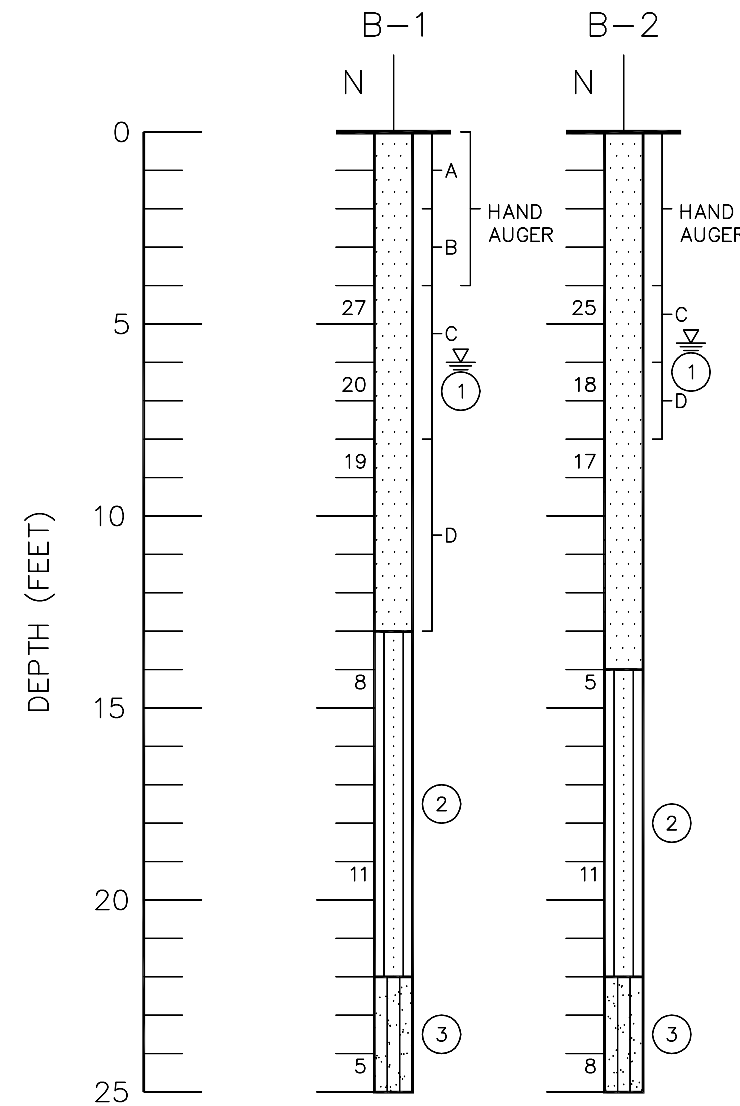
PROJECT NO: 00193-008-05
DATE: 11-03-10
SHEET NO: T-13

FILE: J:\JOB\0193\00193-008-05\ACAD\utility_profile.dwg LAST SAVED: Wed, 11/03/10-3:47p PLOTTED: Wed, 11/03/10-3:50p BY: JTP




# BORING LOCATION PLAN

0 40'
PLAN SCALE




# SOIL PROFILES

0 5'
VERTICAL SCALE

# LEGEND

1 — Light to dark brown, gray fine SAND to slightly silty fine SAND (SP/SP–SM)

2 — Silty to Sandy Shell fragments (SP–SM)

3 — Shell fragments with silty SAND (Bay Bottom) (SM)

SP — Unified Soil Classification System (ASTM D 2487) group symbol as determined by visual review

Groundwater level, August 2010

N — SPT N–value in blows/foot

A — With gravel fragments

B — With trace roots

C — Organic staining

D — With trace organics

Approximate SPT boring location

| | |
|---|---|
| DRAWN | DJG |
| CHECKED | JH |
| APPROVED | MEM |
| SCALE | NOTED |

GEOTECHNICAL SERVICES
MAST ARM SIGNAL POLES
CORTEZ ROAD WEST & 43RD STREET WEST
BRADENTON, FLORIDA

psi Information To Build On
Engineering • Consulting • Testing

| DATE | PROJ. NO. | |
|---|---|---|
| AUG 10 | 0775733 | SHEET T-14 |

# Appendix B

Mathcad Program Output – Existing Configuration

# FDOT Mast Arm Analysis Program

*Custom File Name (optional)* | Cortez 1 NE Exist

*The new custom file will be a copy of the last file called from the program. A ".dat" extension will be added to the file name.*

*Add file to file list* | Refresh File List

*Select Data File (required)*

F6F6W5
F6F5W4
F7W6
F6W4
F6W24
irunin
Cortez 1 NE Exist

*All data files are in the same directory as the MastArm.xmcd file.*

Path = "F:\Projects\University Pkwy at Legacy Blvd Mast Arms\04 Analys

DataFile = "Cortez 1 NE Exist.dat"

*Reference* *Changes*

*This program works in conjunction with Mastarm Design Standards 17743 and 17745.*

*References:*
*AASHTO Standard Specifications for Signs, Luminaires and Traffic Signals, 6th Edition (LTS).*
*FDOT Structures Manual Vol. 3 (SM V3).*

*For more information see Reference.xmcd and Changes.xmcd.*

Read In Data

## General Information

DataFile = "Cortez 1 NE Exist.dat"

| Current Values | New Values |
|---|---|
| **Subject** = "Cortez - 43rd St W NE Exist" | ortez - 43rd St W NE E |
| **ProjectNo** = "404-6002870" | 404-6002870 |
| **PoleLocation** = "Pole 1 - NE Corner" | Pole 1 - NE Corner |
| **Date** = "12/12/2017" | 12/12/2017 |
| **DesignedBy** = "SML" | SML |
| **CheckedBy** = " " | |

*Use Control+F9 to recalculate the worksheet, once to write out data, twice to read in data*

## Wind Speed

DataFile = "Cortez 1 NE Exist.dat"

| Current Value | New Value | | |
|---|---|---|---|
| WindSpeed = 130·mph | | *mph* | **SM V3 3.8.2** |

## Arm 1 Analysis

DataFile = "Cortez 1 NE Exist.dat"  WindSpeed = 130 mph

Arm 1 Loads

$$SignalData_{arm1} = \begin{pmatrix} \text{"SignalNumber"} & \text{"DistanceToSignal(ft)"} & \text{"NumberOfSignalHeads"} & \text{"BackPlate"} \\ 1 & 24 & 3 & \text{"yes"} \\ 2 & 34 & 5 & \text{"yes"} \\ 3 & 0 & 0 & \text{"yes"} \\ 4 & 0 & 0 & \text{"yes"} \\ 5 & 0 & 0 & \text{"yes"} \\ 6 & 0 & 0 & \text{"yes"} \\ 7 & 0 & 0 & \text{"yes"} \\ 8 & 0 & 0 & \text{"yes"} \\ 9 & 0 & 0 & \text{"yes"} \\ 10 & 0 & 0 & \text{"yes"} \end{pmatrix}$$

*use X to zero out data*
*use 0 to keep current values*  *"yes" or "no"*

**New Values**

| "SignalNumber" | "DistToSignal(ft)" | "#SignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 24 | 3 | "yes" |
| 2 | 34 | 5 | "yes" |
| 3 | "X" | "X" | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

$$SignData_{arm1} = \begin{pmatrix} \text{"PanelNumber"} & \text{"DistanceToPanelCentroid(ft)"} & \text{"PanelArea(sf)"} \\ 1 & 12 & 20 \\ 2 & 0 & 0 \\ 3 & 0 & 0 \\ 4 & 0 & 0 \\ 5 & 0 & 0 \end{pmatrix}$$

**New Values**

| "Panel#" | "DistToCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 12 | 20 |
| 2 | "X" | "X" |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

*use X to zero out data*
*use 0 to keep current values*

Arm 1 Properties

## Current Values

## New Values

$L_{total.arm1} = 46\,ft$ | *feet, 40 ft. max. for 1 piece arms*

$Diameter_{base.arm1} = 13\cdot in$ | *inches, measured flat to flat (FG)*

$Dist_{splice.from.base.arm1} = 12.9\,ft$ | *feet, splice distance, for 2 piece arms, length of piece closest to pole, use X to zero out (FE)*

*set* $Dist_{splice.from.base.arm1} = 0ft$ *for NO SPLICE*

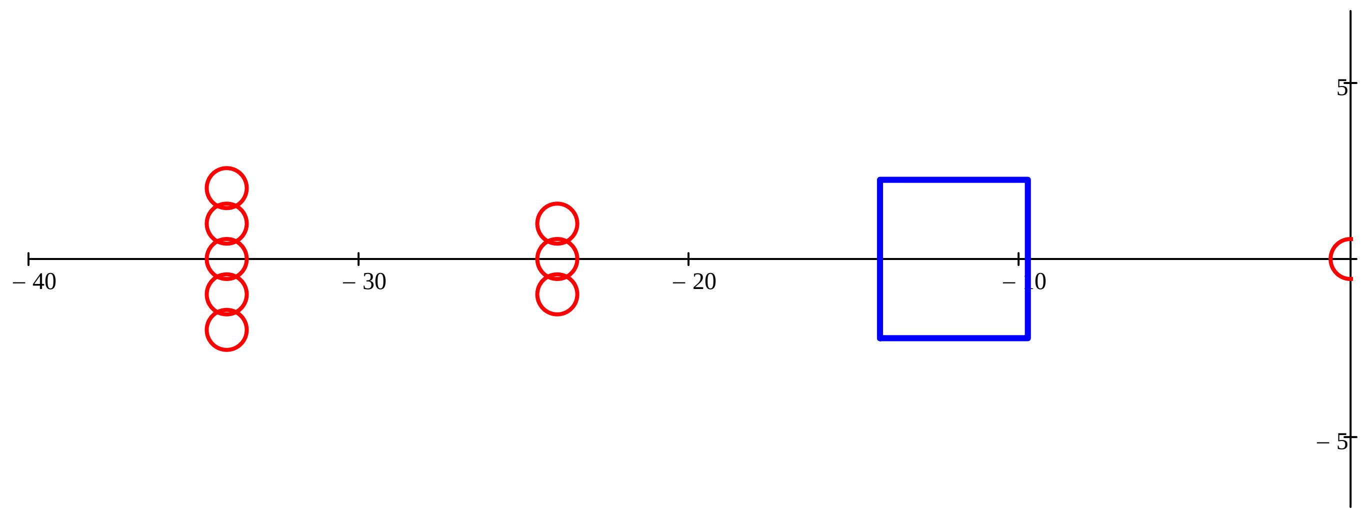
$t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix}\cdot in$ | *inches, this value is used for one piece arms (FD)*

0.375 | *inches, for 2 piece arms, wall thickness of piece closest to the pole, use X to zero out (FH)*

Arm 1 Properties

Analyze Arm 1

## Summary - Arm 1 Geometry and Loading




Location of Signs and Signals

$WindSpeed = 130\cdot mph$ $\quad L_{total.arm1} = 46\,ft$

$Diameter_{tip.arm1} = \begin{pmatrix} 7.08 \\ 11.22 \end{pmatrix}\cdot in$ $\quad Diameter_{base.arm1} = \begin{pmatrix} 12 \\ 13 \end{pmatrix}\cdot in$ $\quad L_{arm1} = \begin{pmatrix} 35.1 \\ 12.9 \end{pmatrix} ft$ $\quad t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix}\cdot in$

$X_{signal.arm1_{i1}} =$ $\begin{bmatrix} 24 \\ 34 \end{bmatrix} ft$ $\quad Sections_{signal.arm1_{i1}} =$ $\begin{bmatrix} 3 \\ 5 \end{bmatrix}$ $\quad X_{panel.arm1_{j1}} =$ $\begin{bmatrix} 12 \end{bmatrix} ft$ $\quad Area_{panel.arm1_{j1}} =$ $\begin{bmatrix} 20 \end{bmatrix} ft^2$

## Arm 1 Combined Stress Ratio and Deflection

$\max(CSR_{arm1}) = 0.571$ $\quad \max(\Delta_{arm1}) = 4.708\cdot in$ $\quad 2\cdot deg\cdot\sum(L_{arm1} - L_{splice.provided}) = 18.43\cdot in$

# Arm 2 Analysis

DataFile = "Cortez 1 NE Exist.dat"    WindSpeed = 130 mph

Arm 2 Loads

$$SignalData_{arm2} = \begin{pmatrix} \text{"SignalNumber"} & \text{"DistanceToSignal(ft)"} & \text{"NumberOfSignalHeads"} & \text{"BackPlate"} \\ 1 & 0 & 0 & \text{"yes"} \\ 2 & 0 & 0 & \text{"yes"} \\ 3 & 0 & 0 & \text{"yes"} \\ 4 & 0 & 0 & \text{"yes"} \\ 5 & 0 & 0 & \text{"yes"} \\ 6 & 0 & 0 & \text{"yes"} \\ 7 & 0 & 0 & \text{"yes"} \\ 8 & 0 & 0 & \text{"yes"} \\ 9 & 0 & 0 & \text{"yes"} \\ 10 & 0 & 0 & \text{"yes"} \end{pmatrix}$$

*use X to zero out data*
*use 0 to keep current values*    *"yes" or "no"*

## New Values

| "SignalNumber" | "DistToSignal(ft)" | "#SignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 0 | 0 | "yes" |
| 2 | 0 | 0 | "yes" |
| 3 | 0 | 0 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

$$SignData_{arm2} = \begin{pmatrix} \text{"PanelNumber"} & \text{"DistanceToPanelCentroid(ft)"} & \text{"PanelArea(sf)"} \\ 1 & 0 & 0 \\ 2 & 0 & 0 \\ 3 & 0 & 0 \\ 4 & 0 & 0 \\ 5 & 0 & 0 \end{pmatrix}$$

## New Values

| "Panel#" | "DistToCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 0 | 0 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

*use X to zero out*
*use 0 to keep current values*

Arm 2 Loads

Arm 2 Properties

## Current Values

## New Values

$L_{total.arm2} = 0\,ft$ — *feet, 40 ft. max. for 1 piece arms, use X to zero out* *set* $L_{total.arm2} = 0ft$ *for NO ARM2*

$Diameter_{base.arm2} = 0 \cdot in$ — *inches, measured flat to flat, use X to zero out (SG)*

$Dist_{splice.from.base.arm2} = 0 \cdot ft$ — *feet, splice distance, for 2 piece arms, length of piece closest to pole, use X to zero out (SE)* — *set* $Dist_{splice.from.base.arm2} = 0ft$ *for NO SPLICE*

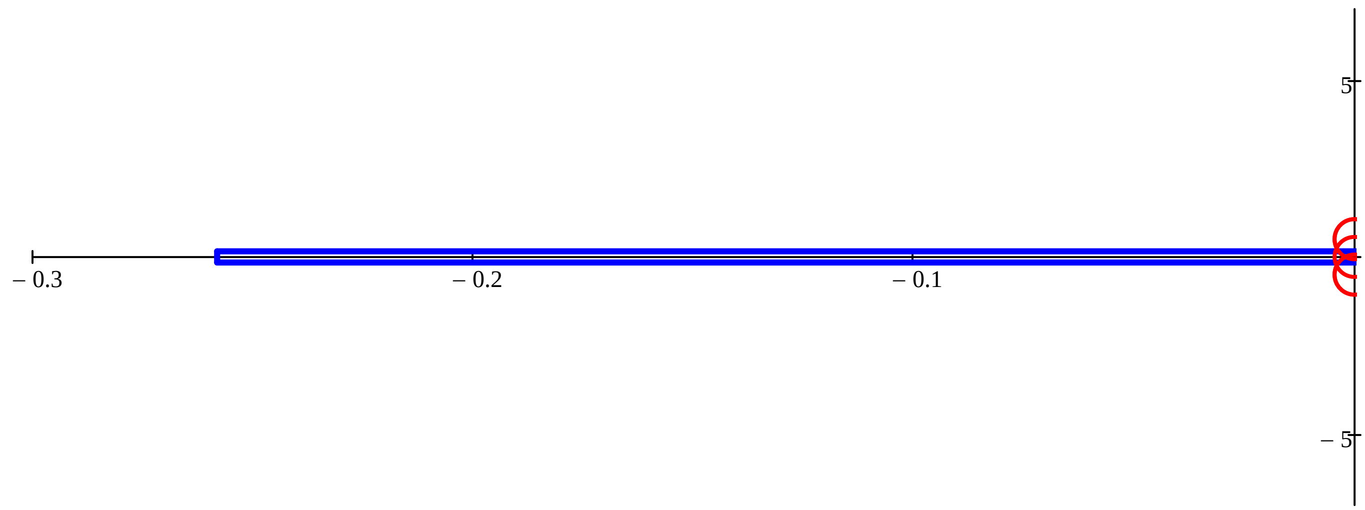
$t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ — *inches, use X to zero out (SD)*

*inches, for 2 piece arms, wall thickness of piece closest to the pole, use X to zero out (SH)*

Arm 2 Properties

## Summary - Arm 2 Geometry and Loading

Analyze Arm 2




Location of Signs and Signals

$WindSpeed = 130 \cdot mph$ $L_{total.arm2} = 0\,ft$

$Diameter_{tip.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ $Diameter_{base.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ $L_{arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} ft$ $t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$

| $X_{signal.arm2_{i2}} =$ (ft) | $Sections_{signal.arm2_{i2}} =$ | $X_{panel.arm2_{j2}} =$ (ft) | $Area_{panel.arm2_{j2}} =$ ($ft^2$) |
|---|---|---|---|
| 0 | 0 | 0.1 | 0.1 |
| 0 | 0 | | |

## Arm 2 Combined Stress Ratio and Deflection

$\max(CSR_{arm2}) = 0$ $\max(\Delta_{arm2}) = 0 \cdot in$ $2 \cdot deg \cdot \sum (L_{arm2} - L_{splice.provided}) = -1.68 \cdot in$

# Luminaire Arm Analysis

DataFile = "Cortez 1 NE Exist.dat"  WindSpeed = 130·mph

Luminaire Properties

*See Design Standards 17743 and 17745 for input values.*

## Current Values

## New Values

*set* $Y_{luminaire} = 0ft$ *for NO LUMINAIRE*

| Current Values | New Values | |
|---|---|---|
| $Y_{luminaire} = 0\,ft$ | | *feet, use X to zero out (Standard LA = 40 feet)* |
| $X_{luminaire} = 10 \cdot ft$ | | *feet, use X to zero out (Standard LB = 10 feet)* |
| $Diameter_{base.lumarm} = 3 \cdot in$ | | *inches, use X to zero out (Standard LC = 3 inches)* |
| $t_{wall.lumarm} = 0.125 \cdot in$ | | *inches, use X to zero out (Standard LD = 0.125 inches)* |
| $Slope_{lumarm} = 0.5$ | | *rise/run, use X to zero out (Standard LE = 0.5)* |
| $r_{lumarm} = 8 \cdot ft$ | | *feet, use X to zero out (Standard LF = 8 feet)* |
| $d_{bolt.lum} = 0.5 \cdot in$ | | *inches, use X to zero out (Standard LG = 0.5 inches)* |
| $t_{baseplate.lum} = 0.75 \cdot in$ | | *inches, use X to zero out (Standard LH = 0.75 inches)* |

Luminaire Properties

Analyze Luminaire

## Summary - Luminaire Arm Geometry

$Y_{luminaire} = 0\,ft$  $X_{luminaire} = 0 \cdot ft$  $Diameter_{base.lumarm} = 0 \cdot in$  $t_{wall.lumarm} = 0 \cdot in$

$Slope_{lumarm} = 0$  $r_{lumarm} = 0 \cdot ft$  $d_{bolt.lum} = 0 \cdot in$  $t_{baseplate.lum} = 0 \cdot in$

$w_{base.lum} = 0 \cdot in$  $w_{channel.lum} = 0 \cdot in$

## Luminaire Arm Ratios

$CSR_{base.lumarm} = 0$  $PR_{bolt.lum} = 0$  $PR_{baseplate.lum} = 0$  $PR_{conn.plate.lum} = 0$

# Upright Analysis

DataFile = "Cortez 1 NE Exist.dat"    WindSpeed = $130 \cdot mph$

Pole Properties

| Current Values | New Values | |
|---|---|---|
| $Y_{pole} = 21.5\,ft$ | 21.5 | *feet (UA)* |
| $Y_{arm.conn} = 20\,ft$ | 20.0 | *feet (UB)* |
| $Diameter_{base.pole} = 16 \cdot in$ | | *inches, measured flat to flat (UD)* |
| $t_{wall.pole} = 0.375 \cdot in$ | | *inches (UE)* |
| $Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$ | | *inches, clear distance between connection plate and upright* |
| | | *inches, use X to zero out* |

*Common wall thicknesses:*
*0.1793 in.*
*0.2391 in.*
*0.25 in.*
*0.313 in.*
*0.375 in.*
*0.5 in.*

Pole Properties

## Summary - Upright Geometry

$Y_{pole} = 21.5\,ft$    $Y_{arm.conn} = 20\,ft$    $\alpha = 0 \cdot deg$    $Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$

$Diameter_{base.pole} = 16 \cdot in$    $t_{wall.pole} = 0.375 \cdot in$

## Upright Combined Stress Ratio and Deflections

$\max(CSR_{pole}) = 0.531$    $\max(\Delta_{x.dl}) = 0.88 \cdot in$    $\max(\Delta_{z.dl}) = 0 \cdot in$

# Mast Arm Connection(s) Analysis

DataFile = "Cortez 1 NE Exist.dat"    WindSpeed = 130·mph

Connection Properties

## Current Values

$h_{conn.plate} = 22 \cdot in$

$t_{vertical.plate} = \begin{pmatrix} 0.5 \\ 0 \end{pmatrix} \cdot in$

$d_{bolt.conn} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \cdot in$

$t_{baseplate.arm} = \begin{pmatrix} 2 \\ 0 \end{pmatrix} \cdot in$

## New Values

*inches, for two arm Mast Arms both connection plate heights must be equal (HT)*

*inches (FL)*

*inches, use X to zero out (SL)*

*inches (FP)*

*inches, use X to zero out (SP)*

*inches (FK)*

*inches, use X to zero out (SK)*

Connection Properties

## Summary - Connection Geometry

$h_{conn.plate} = 22 \cdot in$    $Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$    $Offset_{conn} = \begin{pmatrix} 14.1146 \\ 0 \end{pmatrix} \cdot in$

$d_{bolt.conn} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \cdot in$    $\#ConnBolts = \begin{pmatrix} 6 \\ 0 \end{pmatrix}$    $Spacing_{bolts.conn} = \begin{pmatrix} 9 \\ 0 \end{pmatrix} \cdot in$

$t_{conn.plate} = \begin{pmatrix} 1.5 \\ 0 \end{pmatrix} \cdot in$    $b_{conn.plate} = \begin{pmatrix} 23 \\ 0 \end{pmatrix} \cdot in$    $t_{vertical.plate} = \begin{pmatrix} 0.5 \\ 0 \end{pmatrix} \cdot in$    $t_{baseplate.arm} = \begin{pmatrix} 2 \\ 0 \end{pmatrix} \cdot in$

$w_{conn.plate} = \begin{pmatrix} 0.3125 \\ 0 \end{pmatrix} \cdot in$    $w_{vertical.plate} = \begin{pmatrix} 0.3125 \\ 0 \end{pmatrix} \cdot in$

## Connection Ratios

$PR_{bolt} = \begin{pmatrix} 0.636 \\ 0 \end{pmatrix}$    $CSR_{t.vert.plate} = \begin{pmatrix} 0.627 \\ 0 \end{pmatrix}$    $PR_{t.baseplate.arm} = \begin{pmatrix} 0.839 \\ 0 \end{pmatrix}$    $PR_{t.connplate.arm} = \begin{pmatrix} 0.998 \\ 0 \end{pmatrix}$

## Base Plate Analysis

DataFile = "Cortez 1 NE Exist.dat"  WindSpeed = 130·mph

Base Plate Properties

### Current Values

### New Values

#AnchorRods = 6 | *use 6 bolts minimum*

$d_{bolt.pole} = 1.5 \cdot in$ | *inches (BC)*

Base Plate Properties

### Summary - Upright Base Plate Geometry & Anchors

#AnchorRods = 6  $d_{bolt.pole} = 1.5 \cdot in$  $t_{baseplate.pole} = 2.5 \cdot in$  $Diameter_{baseplate.pole} = 28 \cdot in$

### Upright Base Plate Performance Ratios

$PR_{rod} = 0.656$  $PR_{plate.pole} = 1$

## Foundation Analysis  Cohesionless or Cohesive Soil

DataFile = "Cortez 1 NE Exist.dat"

Soil Properties

### Current Values

### New Values

Clay
Sand

SoilType = 1  *0 - clay  1 - sand*

$\phi_{soil} = 30 \cdot deg$  *degrees, soil friction angle (sand)*

$c_{soil} = 2000 \cdot psf$  *psf, soil shear strength (clay)*

$\gamma_{soil} = 42.6 \cdot pcf$  42.6  *pcf, soil density (typical design value = 45-50 pcf)*

Offset = 0 ft  *vertical distance between top of foundation and groundline*

$N_{blows} = 15$  *Number of blows per foot. If N< 5, contact the district geotech Engineer*  **SM V3 13.6**

Soil Properties

### Summary - Soil Properties and Drilled Shaft Geometry

SoilType = 1 *0 - clay 1 - sand*  $\phi_{soil} = 30 \cdot deg$  $c_{soil} = 2000 \cdot psf$  $\gamma_{soil} = 42.6 \cdot pcf$  Offset = 0 ft

$Diameter_{shaft} = 4\ ft$  $L_{shaft} = 11\ ft$  $L_{embedment.rod} = 30 \cdot in$  $L_{anchor.rod} = 38 \cdot in$

#BarsProvided = 12  $d_{bar} = 1.41 \cdot in$

### Foundation Performance Ratios

$PR_{foundation} = 0.886$

## Fatigue Analysis   DataFile = "Cortez 1 NE Exist.dat"   $WindSpeed = 130 \cdot mph$

*Use the member cross section adjacent to the weld toe to compute the nominal stress range.*   ***LTS 11.9***

$FatigueCategory := 2$   ***SM V3 11.6***

Analyze Structure for Fatigue

*Arm and Pole Welds*

$f_{galloping.arm1} = 3.5 \cdot ksi$   $CAFT_{fullpengroove.weld.arm1} = 7 \cdot ksi$   $Check_{galloping.arm1} = \text{"OK"}$

$f_{galloping.arm2} = 0 \cdot ksi$   $CAFT_{fullpengroove.weld.arm2} = \text{"NA"} \cdot ksi$   $Check_{galloping.arm2} = \text{"NA"}$

$f_{galloping.pole} = 2.3 \cdot ksi$   $CAFT_{fullpengroove.weld.pole} = 4.5 \cdot ksi$   $Check_{galloping.pole} = \text{"OK"}$

$f_{nwg.arm1} = 2.4 \cdot ksi$   $Check_{nwg.arm1} = \text{"OK"}$

$f_{nwg.arm2} = 0 \cdot ksi$   $Check_{nwg.arm2} = \text{"NA"}$

$f_{nwg.pole} = 2.2 \cdot ksi$   $Check_{nwg.pole} = \text{"OK"}$

*A325 Connection Bolts*

$f_{t.g.bolt} = \begin{pmatrix} 4.9 \\ 0.0 \end{pmatrix} \cdot ksi$   $CAFT_{conn.bolt} = 16 \cdot ksi$   $Check_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$f_{t.nwg.bolt} = \begin{pmatrix} 3.3 \\ 0.0 \end{pmatrix} \cdot ksi$   $Check_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

*Anchor Bolts*

$f_{t.g.rod} = 3.5 \cdot ksi$   $CAFT_{anchor.rods} = 7 \cdot ksi$   $Check_{g.rod} = \text{"OK"}$

$f_{t.nwg.rod} = 3.4 \cdot ksi$   $Check_{nwg.rod} = \text{"OK"}$

Summary

## Mast Arm Design and Analysis Summary

DataFile = "Cortez 1 NE Exist.dat"   WindSpeed = 130·mph

**Subject** = "Cortez - 43rd St W NE Exist"   **DesignedBy** = "SML"   **PoleLocation** = "Pole 1 - NE Corner"

**ProjectNo** = "404-6002870"   **CheckedBy** = " "   **Date** = "12/12/2017"

### 1st Mast Arm

$\#Signals_{arm1} = 2$   $\#Panels_{arm1} = 1$

$X_{signal.arm1} = \begin{pmatrix} 24 \\ 34 \end{pmatrix} ft$   $Sections_{signal.arm1} = \begin{pmatrix} 3 \\ 5 \end{pmatrix}$   $Backplate_{signal.arm1} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$

$X_{panel.arm1} = (12)\,ft$   $Area_{panel.arm1} = (20)\,ft^2$

$L_{total.arm1} = 46\,ft$   $L_{splice.provided.arm1} = 24\cdot in$

'FA'= 'FE'= $L_{arm1} = \begin{pmatrix} 35.1 \\ 12.9 \end{pmatrix}\cdot ft$   'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 7.0833 \\ 11.2173 \end{pmatrix}\cdot in$   'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 11.9973 \\ 13 \end{pmatrix}\cdot in$

'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix}\cdot in$   $\max(\Delta_{arm1}) = 4.71\cdot in$   $\max(CSR_{arm1}) = 0.571$

### 2nd Mast Arm

$\#Signals_{arm2} = 0$   $\#Panels_{arm2} = 1$

$X_{signal.arm2} = (0)\,ft$   $Sections_{signal.arm2} = (0)$   $Backplate_{signal.arm2} = (0)$

$X_{panel.arm2} = (0.1)\,ft$   $Area_{panel.arm2} = (0.1)\,ft^2$

$L_{total.arm2} = 0\,ft$   $L_{splice.provided.arm2} = 24\cdot in$   'UF'= $\alpha = 0\cdot deg$ **(Angle Between Arms)**

'SA'= 'SE'= $L_{arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot ft$   'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot in$   'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot in$

'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot in$   $\max(\Delta_{arm2}) = 0\cdot in$   $\max(CSR_{arm2}) = 0$

## Luminaire Arm and Connection

DataFile = "Cortez 1 NE Exist.dat WindSpeed = 130·mph

*(use MC10x33.6 channel for connection)*

'LA'= $Y_{luminaire} = 0\,ft$ 'LB'= $X_{luminaire} = 0\,ft$ 'LC'= $Diameter_{base.lumarm} = 0\cdot in$

'LD'= $t_{wall.lumarm} = 0\cdot in$ 'LE'= $Slope_{lumarm} = 0$ 'LF'= $r_{lumarm} = 0\,ft$

'LG'= $d_{bolt.lum} = 0\cdot in$ 'LH'= $t_{baseplate.lum} = 0\cdot in$

'LJ'= $w_{base.lum} = 0\cdot in$ 'LK'= $w_{channel.lum} = 0\cdot in$

$CSR_{base.lumarm} = 0$ $PR_{bolt.lum} = 0$ $PR_{baseplate.lum} = 0$ $PR_{conn.plate.lum} = 0$

## Upright

'UA'= $Y_{pole} = 21.5\,ft$ 'UB'= $Y_{arm.conn} = 20\cdot ft$ 'UC'= $Diameter_{tip.pole} = 13.0192\,in$

'UD'= $Diameter_{base.pole} = 16\cdot in$ 'UE'= $t_{wall.pole} = 0.375\,in$ 'UF'= $\alpha = 0\cdot deg$

'UG'= $Y_{lum.conn} = 0\,ft$

$\Delta_{z.dl} = 0\cdot in$ $\Delta_{x.dl} = 0.88\cdot in$ $Slope_x = 0.46\cdot deg$

$Slope_z = 0\cdot deg$ $C_{a.pole} = 0.996$

$\max(CSR_{pole}) = 0.531$

## 1st Arm/Upright Connection

$\#ConnBolts_0 = 6$ 'HT'= $h_{conn.plate} = 22\cdot in$ 'FJ'= $b_{conn.plate_0} = 23\cdot in$

'FK'= $t_{baseplate.arm_0} = 2\cdot in$ 'FL'= $t_{vertical.plate_0} = 0.5\cdot in$

'FN'= $w_{vertical.plate_0} = 0.3125\,in$ 'FO'= $Offset_{conn_0} = 14.1146\,in$

'FP'= $d_{bolt.conn_0} = 1\cdot in$ 'FR'= $t_{conn.plate_0} = 1.5\cdot in$

'FS'= $Spacing_{bolts.conn_0} = 9\cdot in$ 'FT'= $w_{conn.plate_0} = 0.3125\,in$

$$\begin{pmatrix} PR_{bolt_0} \\ PR_{t.baseplate.arm_0} \\ PR_{t.connplate.arm_0} \\ CSR_{t.vert.plate_0} \end{pmatrix} = \begin{pmatrix} 0.636 \\ 0.839 \\ 0.998 \\ 0.627 \end{pmatrix}$$

## 2nd Arm/Upright Connection

$\#ConnBolts_1 = 0$ 'HT'= $h_{conn.plate} = 22\cdot in$ 'SJ'= $b_{conn.plate_1} = 0\cdot in$

'SK'= $t_{baseplate.arm_1} = 0\cdot in$ 'SL'= $t_{vertical.plate_1} = 0\cdot in$

'SN'= $w_{vertical.plate_1} = 0\cdot in$ 'SO'= $Offset_{conn_1} = 0\cdot in$

'SP'= $d_{bolt.conn_1} = 0\cdot in$ 'SR'= $t_{conn.plate_1} = 0\cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0\cdot in$ 'ST'= $w_{conn.plate_1} = 0\cdot in$

$$\begin{pmatrix} PR_{bolt_1} \\ PR_{t.baseplate.arm_1} \\ PR_{t.connplate.arm_1} \\ CSR_{t.vert.plate_1} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

## Pole Baseplate

DataFile = "Cortez 1 NE Exist.dat WindSpeed = 130·mph

$\#AnchorRods = 6$

'BA'= $Diameter_{baseplate.pole} = 28 \cdot in$

'BB'= $t_{baseplate.pole} = 2.5 \cdot in$

'BC'= $d_{bolt.pole} = 1.5 \cdot in$

'BF'= $L_{embedment.rod} = 30 \cdot in$

$Diameter_{boltcircle.pole} = 22 \cdot in$

$PR_{rod} = 0.656$

$PR_{plate.pole} = 1$

## Foundation

'DA'= $L_{shaft} = 11 \cdot ft$

'DB'= $Diameter_{shaft} = 4 \cdot ft$

$d_{bar} = 1.41 \cdot in$ Offset = 0 ft

'RA'= $round\left(\frac{d_{bar}}{0.125in}\right) = 11$

'RB'= $\#BarsProvided = 12$

$Diameter_{rebar.circle} = 2.7783\,ft$

'RC'= $NumSpaces_{v.bar} = 10$

'RD'= $s_{v2} = 12 \cdot in$

$PR_{foundation} = 0.886$

WRITEPRN to Line 1-2-3

## Mast Arm Tip Deflection

*Compare Mast Arm deflection of each arm to a proposed camber*

$Camber_{arm1} := \mathbf{2} \cdot deg$ $Camber_{arm2} := \mathbf{2} \cdot deg$

$L_{arm1} := \sum L_{arm1} - if\left[\left(L_{arm1_1} = 0 \cdot ft\right), 0 \cdot ft, 2 \cdot ft\right]$

$L_{arm2} := \sum L_{arm2} - if\left[\left(L_{arm2_1} = 0 \cdot ft\right), 0 \cdot ft, 2 \cdot ft\right]$

$Deflection_{arm1} := Slope_x \cdot L_{arm1} + max(\Delta_{arm1})$

$Deflection_{arm1} = 9.18 \cdot in$

$CamberArm1_{upward} := sin(Camber_{arm1}) \cdot L_{arm1}$

$CamberArm1_{upward} = 19.26 \cdot in$

$Deflection_{arm2} := \left[Slope_z \cdot L_{arm2} \cdot (sin(\alpha))\right] + Slope_x \cdot L_{arm2} \cdot cos(\alpha) + max(\Delta_{arm2})$

$Deflection_{arm2} = 0 \cdot in$

$CamberArm2_{upward} := sin(Camber_{arm2}) \cdot L_{arm2}$

$CamberArm2_{upward} = 0 \cdot in$

## Check Clearance Between Connection Plates

*(for Two Arm Structures only)*

$\alpha = 0 \cdot deg$ $\alpha := if[(\alpha > 180 \cdot deg), (360 \cdot deg - \alpha), \alpha]$

$Offset_{conn_0} = 14.1 \cdot in$ $b_{conn.plate_0} = 23 \cdot in$ $h_{conn.plate} = 22 \cdot in$ $\alpha = 0 \cdot deg$

$Offset_{conn_1} = 0 \cdot in$ $b_{conn.plate_1} = 0 \cdot in$

$x_1 := Offset_{conn_0} - t_{conn.plate_0} - h_{conn.plate} \cdot \frac{sin(Camber_{arm1})}{2}$ $y_1 := \frac{b_{conn.plate_0}}{2}$ $x_1 = 12.23 \cdot in$ $y_1 = 11.5 \cdot in$

$x_2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{sin(Camber_{arm2})}{2}\right) \cdot cos(\alpha) + \frac{b_{conn.plate_1}}{2} \cdot sin(\alpha)$

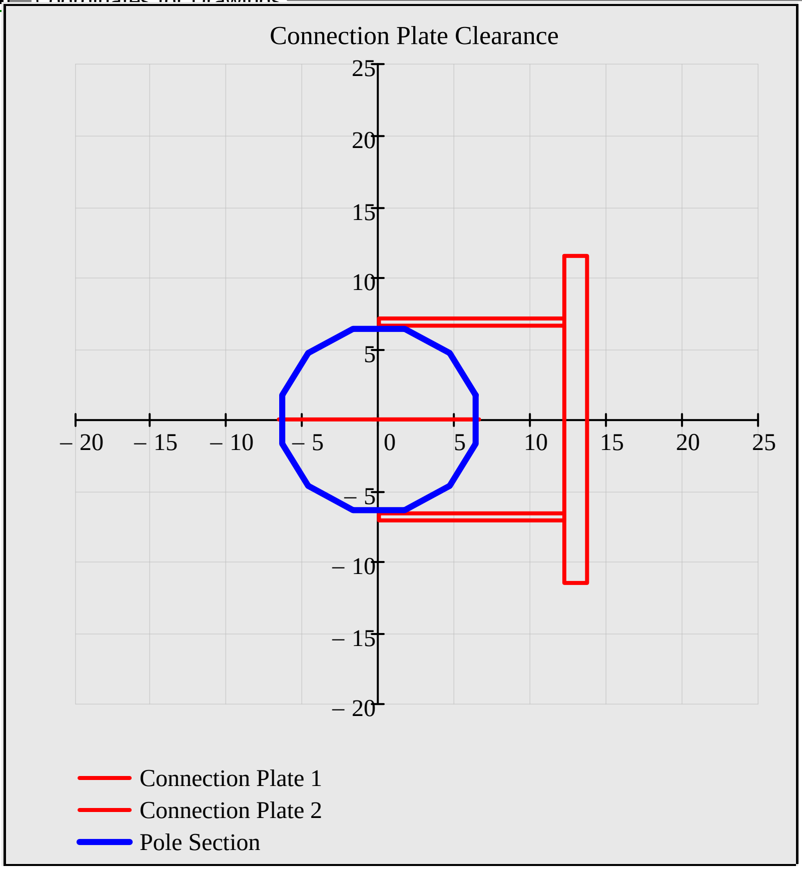
$y_2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{sin(Camber_{arm2})}{2}\right) \cdot sin(\alpha) - \frac{b_{conn.plate_1}}{2} \cdot cos(\alpha)$ $x_2 = -0.38 \cdot in$ $y_2 = 0 \cdot in$

$Clearance := \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$ $Clearance := if\left[(y_2 \le y_1), if\left[(x_1 > x_2), Clearance, 0 \cdot in\right], Clearance\right]$ $Clearance = 17.07 \cdot in$

***(if Clearance equals 0, then Connection Plates intersect and redesign is required.***

## Plan View - Connection Plate Clearance for Two Arm Connections

Coordinates for Drawings




$Clearance = 17.07 \cdot in$

$Diameter_{conn.pole} = 13.2292 \cdot in$

$t_{conn.plate_0} = 1.5 \cdot in$

$b_{conn.plate_0} = 23 \cdot in$

$t_{vertical.plate_0} = 0.5 \cdot in$

$Offset_{conn_0} = 14.1146 \cdot in$

$Gap_0 = 7.5 \cdot in$

$t_{conn.plate_1} = 0 \cdot in$

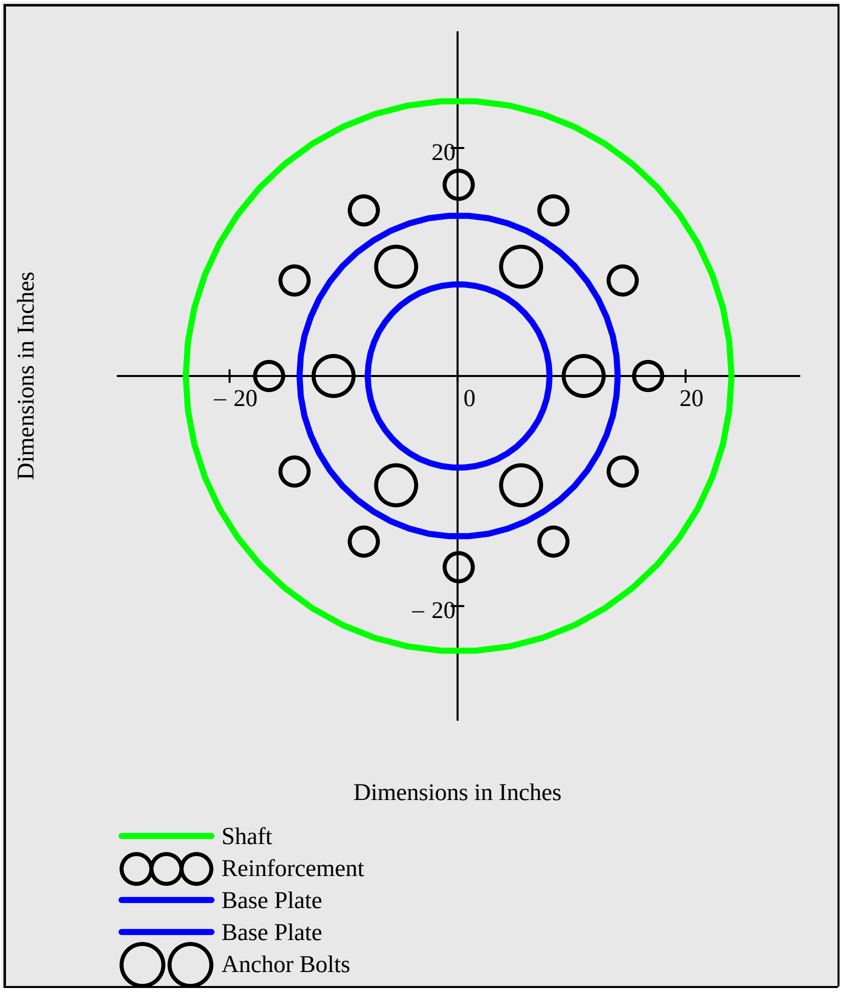
$b_{conn.plate_1} = 0 \cdot in$

$t_{vertical.plate_1} = 0 \cdot in$

$Offset_{conn_1} = 0 \cdot in$

$Gap_1 = 0 \cdot in$

## Plan View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$Diameter_{base.pole} = 16 \cdot in$

$Diameter_{baseplate.pole} = 28 \cdot in$

$Diameter_{shaft} = 48 \cdot in$

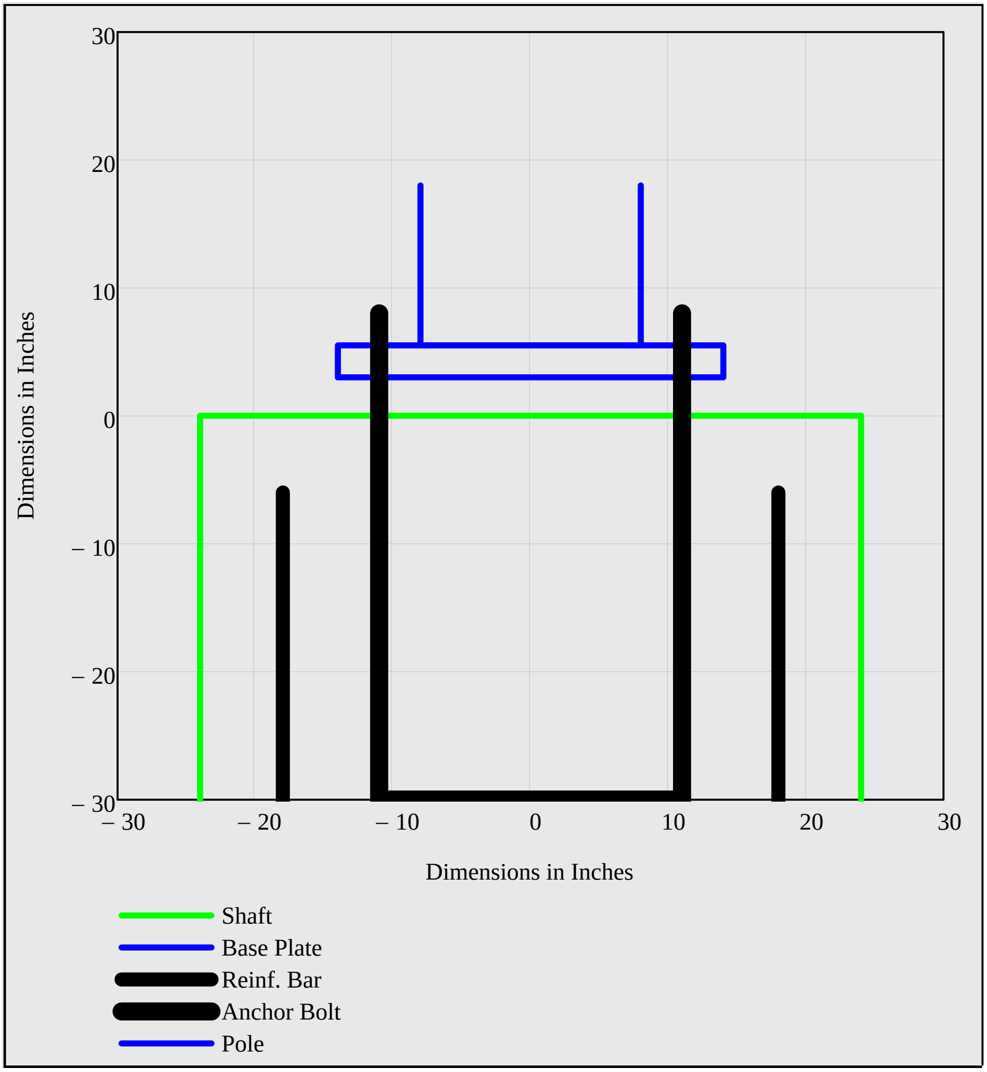
$Diameter_{boltcircle.pole} = 22 \cdot in$

$Diameter_{rebar.circle} = 33.34 \cdot in$

#AnchorRods = 6

#BarsProvided = 12

## Elevation View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$Diameter_{base.pole} = 16 \cdot in$

$Diameter_{baseplate.pole} = 28 \cdot in$

$t_{baseplate.pole} = 2.5 \cdot in$

$Diameter_{shaft} = 4 \cdot ft$

$Diameter_{boltcircle.pole} = 22 \cdot in$

$Diameter_{rebar.circle} = 33.3 \cdot in$

# Appendix C

Mathcad Program Output – Future Configuration

# FDOT Mast Arm Analysis Program

*Custom File Name (optional)* Cortez 1 NE Fut

*The new custom file will be a copy of the last file called from the program. A ".dat" extension will be added to the file name.*

*Add file to file list* Refresh File List

*Select Data File (required)*

E6E6T5
E6T24
E6T4
E7T6
Cortez 1 NE Exist
Cortez 1 NE Prop
Cortez 1 NE Fut

*All data files are in the same directory as the MastArm.xmcd file.*

Path = "F:\Projects\Cortez - 43rd Ave W Mast Arm Review - 13M126\04 .

DataFile = "Cortez 1 NE Fut.dat"

*Reference* *Changes*

*This program works in conjunction with Mastarm Design Standards 17743 and 17745.*

*References:*
*AASHTO Standard Specifications for Signs, Luminaires and Traffic Signals, 6th Edition (LTS).*
*FDOT Structures Manual Vol. 3 (SM V3).*

*For more information see Reference.xmcd and Changes.xmcd.*

Read In Data

## General Information

DataFile = "Cortez 1 NE Fut.dat"

| Current Values | New Values |
|---|---|
| **Subject** = "Cortez - 43rd St W NE Future" | 3rd St W NE Future |
| **ProjectNo** = "404-6002870" | |
| **PoleLocation** = "Pole 1 - NE Corner" | |
| **Date** = "12/21/2017" | 12/21/2017 |
| **DesignedBy** = "SML" | |
| **CheckedBy** = " " | |

*Use Control+F9 to recalculate the worksheet, once to write out data, twice to read in data*

## Wind Speed

DataFile = "Cortez 1 NE Fut.dat"

| Current Value | New Value | | |
|---|---|---|---|
| WindSpeed = 130·mph | | *mph* | ***SM V3 3.8.2*** |

## Arm 1 Analysis

DataFile = "Cortez 1 NE Fut.dat"    WindSpeed = 130 mph

Arm 1 Loads

$$SignalData_{arm1} = \begin{pmatrix} \text{"SignalNumber"} & \text{"DistanceToSignal(ft)"} & \text{"NumberOfSignalHeads"} & \text{"BackPlate"} \\ 1 & 17 & 3 & \text{"yes"} \\ 2 & 29 & 3 & \text{"yes"} \\ 3 & 40 & 4 & \text{"yes"} \\ 4 & 0 & 0 & \text{"yes"} \\ 5 & 0 & 0 & \text{"yes"} \\ 6 & 0 & 0 & \text{"yes"} \\ 7 & 0 & 0 & \text{"yes"} \\ 8 & 0 & 0 & \text{"yes"} \\ 9 & 0 & 0 & \text{"yes"} \\ 10 & 0 & 0 & \text{"yes"} \end{pmatrix}$$

*use X to zero out data*
*use 0 to keep current values*    *"yes" or "no"*

**New Values**

| "SignalNumber" | "DistToSignal(ft)" | "#SignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 17 | 3 | "yes" |
| 2 | 29 | 3 | "yes" |
| 3 | 40 | 4 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

$$SignData_{arm1} = \begin{pmatrix} \text{"PanelNumber"} & \text{"DistanceToPanelCentroid(ft)"} & \text{"PanelArea(sf)"} \\ 1 & 10 & 20 \\ 2 & 0 & 0 \\ 3 & 0 & 0 \\ 4 & 0 & 0 \\ 5 & 0 & 0 \end{pmatrix}$$

**New Values**

| "Panel#" | "DistToCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 10 | 20 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

*use X to zero out data*
*use 0 to keep current values*

Arm 1 Loads

Arm 1 Properties

## Current Values

## New Values

$L_{total.arm1} = 46\,ft$ — *feet, 40 ft. max. for 1 piece arms*

$Diameter_{base.arm1} = 13 \cdot in$ — *inches, measured flat to flat (FG)*

$Dist_{splice.from.base.arm1} = 12.9\,ft$ — *feet, splice distance, for 2 piece arms, length of piece closest to pole, use X to zero out (FE)*

*set* $Dist_{splice.from.base.arm1} = 0ft$ *for NO SPLICE*

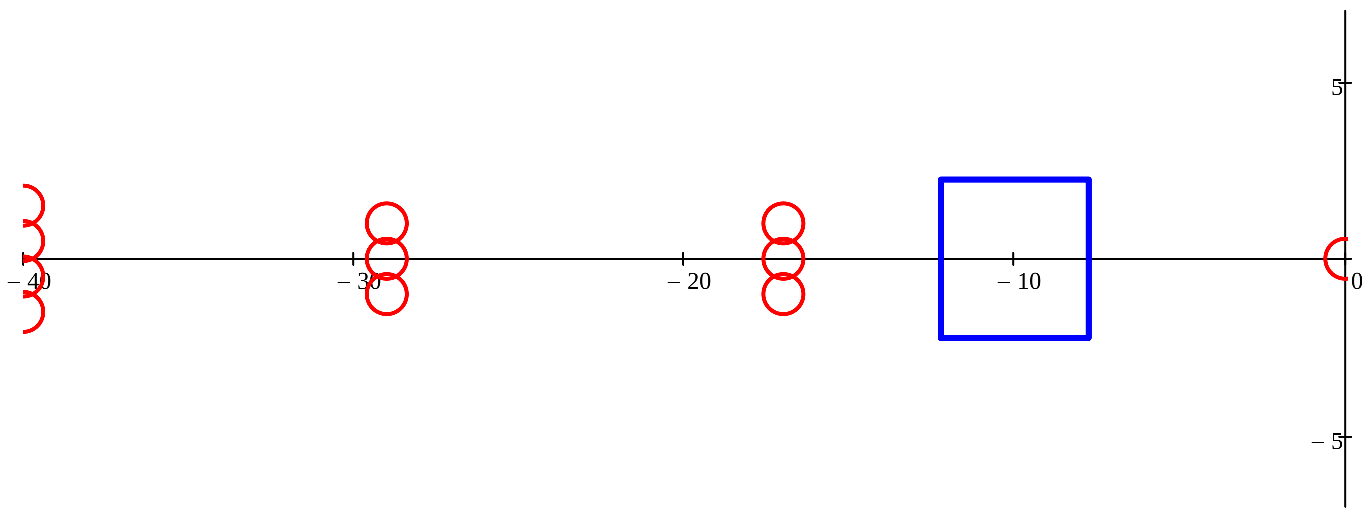
$t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$ — *inches, this value is used for one piece arms (FD)*

*inches, for 2 piece arms, wall thickness of piece closest to the pole, use X to zero out (FH)*

Arm 1 Properties

Analyze Arm 1

## Summary - Arm 1 Geometry and Loading




Location of Signs and Signals

$WindSpeed = 130 \cdot mph$ $L_{total.arm1} = 46\,ft$

$Diameter_{tip.arm1} = \begin{pmatrix} 7.08 \\ 11.22 \end{pmatrix} \cdot in$ $Diameter_{base.arm1} = \begin{pmatrix} 12 \\ 13 \end{pmatrix} \cdot in$ $L_{arm1} = \begin{pmatrix} 35.1 \\ 12.9 \end{pmatrix} ft$ $t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$

| $X_{signal.arm1_{i1}} =$ (ft) | $Sections_{signal.arm1_{i1}} =$ |
|---|---|
| 17 | 3 |
| 29 | 3 |
| 40 | 4 |

| $X_{panel.arm1_{j1}} =$ (ft) | $Area_{panel.arm1_{j1}} =$ ($ft^2$) |
|---|---|
| 10 | 20 |

## Arm 1 Combined Stress Ratio and Deflection

$max(CSR_{arm1}) = 0.628$ $max(\Delta_{arm1}) = 4.905 \cdot in$ $2 \cdot deg \cdot \sum (L_{arm1} - L_{splice.provided}) = 18.43 \cdot in$

## Arm 2 Analysis

DataFile = "Cortez 1 NE Fut.dat"    WindSpeed = 130 mph

Arm 2 Loads

$$SignalData_{arm2} = \begin{pmatrix} \text{"SignalNumber"} & \text{"DistanceToSignal(ft)"} & \text{"NumberOfSignalHeads"} & \text{"BackPlate"} \\ 1 & 0 & 0 & \text{"yes"} \\ 2 & 0 & 0 & \text{"yes"} \\ 3 & 0 & 0 & \text{"yes"} \\ 4 & 0 & 0 & \text{"yes"} \\ 5 & 0 & 0 & \text{"yes"} \\ 6 & 0 & 0 & \text{"yes"} \\ 7 & 0 & 0 & \text{"yes"} \\ 8 & 0 & 0 & \text{"yes"} \\ 9 & 0 & 0 & \text{"yes"} \\ 10 & 0 & 0 & \text{"yes"} \end{pmatrix}$$

*use X to zero out data*
*use 0 to keep current values*    *"yes" or "no"*

### New Values

| "SignalNumber" | "DistToSignal(ft)" | "#SignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 0 | 0 | "yes" |
| 2 | 0 | 0 | "yes" |
| 3 | 0 | 0 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

$$SignData_{arm2} = \begin{pmatrix} \text{"PanelNumber"} & \text{"DistanceToPanelCentroid(ft)"} & \text{"PanelArea(sf)"} \\ 1 & 0 & 0 \\ 2 & 0 & 0 \\ 3 & 0 & 0 \\ 4 & 0 & 0 \\ 5 & 0 & 0 \end{pmatrix}$$

### New Values

| "Panel#" | "DistToCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 0 | 0 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

*use X to zero out*
*use 0 to keep current values*

Arm 2 Properties

## Current Values

## New Values

$L_{total.arm2} = 0\,ft$ — [ ] *feet, 40 ft. max. for 1 piece arms, use X to zero out* *set* $L_{total.arm2} = 0ft$ *for NO ARM2*

$Diameter_{base.arm2} = 0 \cdot in$ — [ ] *inches, measured flat to flat, use X to zero out (SG)*

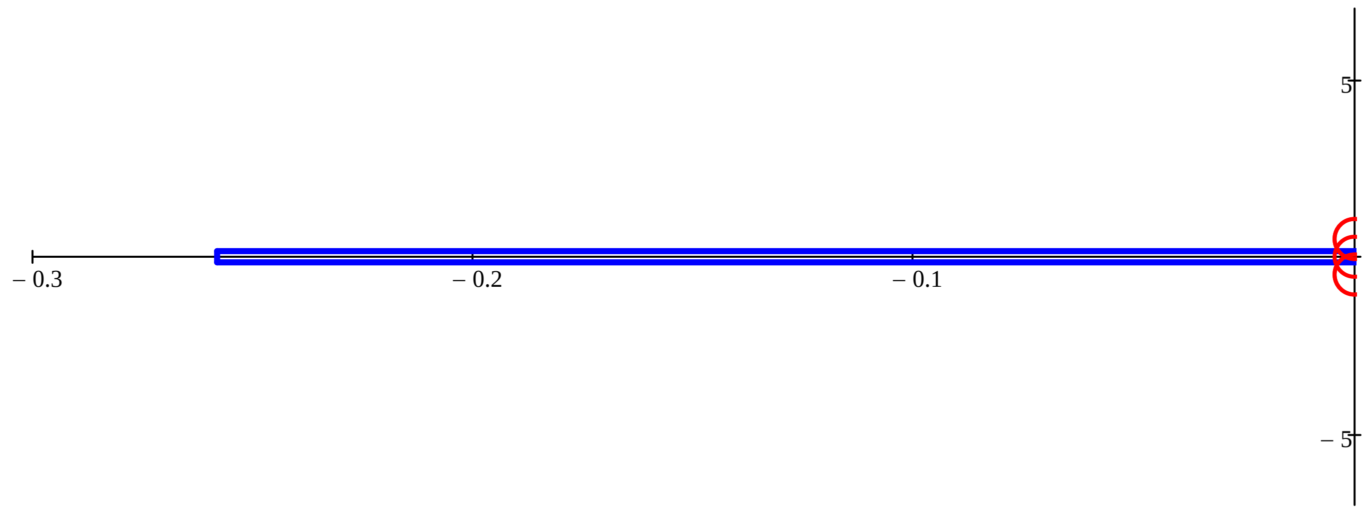
$Dist_{splice.from.base.arm2} = 0 \cdot ft$ — [ ] *feet, splice distance, for 2 piece arms, length of piece closest to pole, use X to zero out (SE)* *set* $Dist_{splice.from.base.arm2} = 0ft$ *for NO SPLICE*

$t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ — [ ] *inches, use X to zero out (SD)*; [ ] *inches, for 2 piece arms, wall thickness of piece closest to the pole, use X to zero out (SH)*

Arm 2 Properties

## Summary - Arm 2 Geometry and Loading

Analyze Arm 2




Location of Signs and Signals

$WindSpeed = 130 \cdot mph$ $L_{total.arm2} = 0\,ft$

$Diameter_{tip.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ $Diameter_{base.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ $L_{arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} ft$ $t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$

| $X_{signal.arm2_{i2}} =$ (ft) | $Sections_{signal.arm2_{i2}} =$ | $X_{panel.arm2_{j2}} =$ (ft) | $Area_{panel.arm2_{j2}} =$ ($ft^2$) |
|---|---|---|---|
| 0 | 0 | 0.1 | 0.1 |
| 0 | 0 | | |

## Arm 2 Combined Stress Ratio and Deflection

$max(CSR_{arm2}) = 0$ $max(\Delta_{arm2}) = 0 \cdot in$ $2 \cdot deg \cdot \sum (L_{arm2} - L_{splice.provided}) = -1.68 \cdot in$

# Luminaire Arm Analysis

DataFile = "Cortez 1 NE Fut.dat"    WindSpeed = 130·mph

Luminaire Properties

*See Design Standards 17743 and 17745 for input values.*

## Current Values

## New Values

*set* $Y_{luminaire} = 0ft$ *for NO LUMINAIRE*

| Current Values | New Values | |
|---|---|---|
| $Y_{luminaire} = 0\,ft$ | | *feet, use X to zero out (Standard LA = 40 feet)* |
| $X_{luminaire} = 10 \cdot ft$ | | *feet, use X to zero out (Standard LB = 10 feet)* |
| $Diameter_{base.lumarm} = 3 \cdot in$ | | *inches, use X to zero out (Standard LC = 3 inches)* |
| $t_{wall.lumarm} = 0.125 \cdot in$ | | *inches, use X to zero out (Standard LD = 0.125 inches)* |
| $Slope_{lumarm} = 0.5$ | | *rise/run, use X to zero out (Standard LE = 0.5)* |
| $r_{lumarm} = 8 \cdot ft$ | | *feet, use X to zero out (Standard LF = 8 feet)* |
| $d_{bolt.lum} = 0.5 \cdot in$ | | *inches, use X to zero out (Standard LG = 0.5 inches)* |
| $t_{baseplate.lum} = 0.75 \cdot in$ | | *inches, use X to zero out (Standard LH = 0.75 inches)* |

Luminaire Properties

Analyze Luminaire

## Summary - Luminaire Arm Geometry

| | | | |
|---|---|---|---|
| $Y_{luminaire} = 0\,ft$ | $X_{luminaire} = 0 \cdot ft$ | $Diameter_{base.lumarm} = 0 \cdot in$ | $t_{wall.lumarm} = 0 \cdot in$ |
| $Slope_{lumarm} = 0$ | $r_{lumarm} = 0 \cdot ft$ | $d_{bolt.lum} = 0 \cdot in$ | $t_{baseplate.lum} = 0 \cdot in$ |
| $w_{base.lum} = 0 \cdot in$ | $w_{channel.lum} = 0 \cdot in$ | | |

## Luminaire Arm Ratios

| | | | |
|---|---|---|---|
| $CSR_{base.lumarm} = 0$ | $PR_{bolt.lum} = 0$ | $PR_{baseplate.lum} = 0$ | $PR_{conn.plate.lum} = 0$ |

# Upright Analysis

DataFile = "Cortez 1 NE Fut.dat"    WindSpeed = 130·mph

Pole Properties

## Current Values

$Y_{pole} = 21.5\,ft$

$Y_{arm.conn} = 20\,ft$

$Diameter_{base.pole} = 16 \cdot in$

$t_{wall.pole} = 0.375 \cdot in$

$Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$

## New Values

*feet (UA)*

*feet (UB)*

*inches, measured flat to flat (UD)*

*inches (UE)*

*inches, clear distance between connection plate and upright*

*inches, use X to zero out*

*Common wall thicknesses:*
*0.1793 in.*
*0.2391 in.*
*0.25 in.*
*0.313 in.*
*0.375 in.*
*0.5 in.*

Pole Properties

## Summary - Upright Geometry

$Y_{pole} = 21.5\,ft$    $Y_{arm.conn} = 20\,ft$    $\alpha = 0 \cdot deg$    $Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$

$Diameter_{base.pole} = 16 \cdot in$    $t_{wall.pole} = 0.375 \cdot in$

## Upright Combined Stress Ratio and Deflections

$\max(CSR_{pole}) = 0.597$    $\max(\Delta_{x.dl}) = 0.9 \cdot in$    $\max(\Delta_{z.dl}) = 0 \cdot in$

# Mast Arm Connection(s) Analysis

DataFile = "Cortez 1 NE Fut.dat"  WindSpeed = 130·mph

Connection Properties

## Current Values

$h_{conn.plate} = 22 \cdot in$

$t_{vertical.plate} = \begin{pmatrix} 0.5 \\ 0 \end{pmatrix} \cdot in$

$d_{bolt.conn} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \cdot in$

$t_{baseplate.arm} = \begin{pmatrix} 2 \\ 0 \end{pmatrix} \cdot in$

## New Values

*inches, for two arm Mast Arms both connection plate heights must be equal (HT)*

*inches (FL)*

*inches, use X to zero out (SL)*

*inches (FP)*

*inches, use X to zero out (SP)*

*inches (FK)*

*inches, use X to zero out (SK)*

Connection Properties

## Summary - Connection Geometry

$h_{conn.plate} = 22 \cdot in$  $Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$  $Offset_{conn} = \begin{pmatrix} 14.1146 \\ 0 \end{pmatrix} \cdot in$

$d_{bolt.conn} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \cdot in$  $\#ConnBolts = \begin{pmatrix} 6 \\ 0 \end{pmatrix}$  $Spacing_{bolts.conn} = \begin{pmatrix} 9 \\ 0 \end{pmatrix} \cdot in$

$t_{conn.plate} = \begin{pmatrix} 1.5 \\ 0 \end{pmatrix} \cdot in$  $b_{conn.plate} = \begin{pmatrix} 23 \\ 0 \end{pmatrix} \cdot in$  $t_{vertical.plate} = \begin{pmatrix} 0.5 \\ 0 \end{pmatrix} \cdot in$  $t_{baseplate.arm} = \begin{pmatrix} 2 \\ 0 \end{pmatrix} \cdot in$

$w_{conn.plate} = \begin{pmatrix} 0.3125 \\ 0 \end{pmatrix} \cdot in$  $w_{vertical.plate} = \begin{pmatrix} 0.3125 \\ 0 \end{pmatrix} \cdot in$

## Connection Ratios

$PR_{bolt} = \begin{pmatrix} 0.684 \\ 0 \end{pmatrix}$  $CSR_{t.vert.plate} = \begin{pmatrix} 0.682 \\ 0 \end{pmatrix}$  $PR_{t.baseplate.arm} = \begin{pmatrix} 0.839 \\ 0 \end{pmatrix}$  $PR_{t.connplate.arm} = \begin{pmatrix} 0.998 \\ 0 \end{pmatrix}$

## Base Plate Analysis

DataFile = "Cortez 1 NE Fut.dat"   WindSpeed = 130·mph

Base Plate Properties

### Current Values / New Values

$\#AnchorRods = 6$ — *use 6 bolts minimum*

$d_{bolt.pole} = 1.5 \cdot in$ — *inches (BC)*

Base Plate Properties

### Summary - Upright Base Plate Geometry & Anchors

$\#AnchorRods = 6$   $d_{bolt.pole} = 1.5 \cdot in$   $t_{baseplate.pole} = 2.5 \cdot in$   $Diameter_{baseplate.pole} = 28 \cdot in$

### Upright Base Plate Performance Ratios

$PR_{rod} = 0.722$   $PR_{plate.pole} = 1$

## Foundation Analysis   Cohesionless or Cohesive Soil

DataFile = "Cortez 1 NE Fut.dat"

Soil Properties

### Current Values / New Values

$SoilType = 1$ — ○ Clay ● Sand — *0 - clay 1 - sand*

$\phi_{soil} = 30 \cdot deg$ — *degrees, soil friction angle (sand)*

$c_{soil} = 2000 \cdot psf$ — *psf, soil shear strength (clay)*

$\gamma_{soil} = 42.6 \cdot pcf$ — *pcf, soil density (typical design value = 45-50 pcf)*

$Offset = 0\ ft$ — *vertical distance between top of foundation and groundline*

$N_{blows} = 15$ — *Number of blows per foot. If N< 5, contact the district geotech Engineer*   **SM V3 13.6**

Soil Properties

### Summary - Soil Properties and Drilled Shaft Geometry

$SoilType = 1$ *0 - clay 1 - sand*   $\phi_{soil} = 30 \cdot deg$   $c_{soil} = 2000 \cdot psf$   $\gamma_{soil} = 42.6 \cdot pcf$   $Offset = 0\ ft$

$Diameter_{shaft} = 4\ ft$   $L_{shaft} = 11\ ft$   $L_{embedment.rod} = 30 \cdot in$   $L_{anchor.rod} = 38 \cdot in$

$\#BarsProvided = 12$   $d_{bar} = 1.41 \cdot in$

### Foundation Performance Ratios

$PR_{foundation} = 0.96$

## Fatigue Analysis

DataFile = "Cortez 1 NE Fut.dat"    WindSpeed = 130·mph

*Use the member cross section adjacent to the weld toe to compute the nominal stress range.*    **LTS 11.9**

FatigueCategory := 2    **SM V3 11.6**

Analyze Structure for Fatigue

*Arm and Pole Welds*

$f_{galloping.arm1} = 4.1 \cdot ksi$    $CAFT_{fullpengroove.weld.arm1} = 7 \cdot ksi$    $Check_{galloping.arm1} = $ "OK"

$f_{galloping.arm2} = 0 \cdot ksi$    $CAFT_{fullpengroove.weld.arm2} = $ "NA" $\cdot ksi$    $Check_{galloping.arm2} = $ "NA"

$f_{galloping.pole} = 2.7 \cdot ksi$    $CAFT_{fullpengroove.weld.pole} = 4.5 \cdot ksi$    $Check_{galloping.pole} = $ "OK"

$f_{nwg.arm1} = 2.6 \cdot ksi$    $Check_{nwg.arm1} = $ "OK"

$f_{nwg.arm2} = 0 \cdot ksi$    $Check_{nwg.arm2} = $ "NA"

$f_{nwg.pole} = 2.4 \cdot ksi$    $Check_{nwg.pole} = $ "OK"

*A325 Connection Bolts*

$f_{t.g.bolt} = \begin{pmatrix} 5.6 \\ 0.0 \end{pmatrix} \cdot ksi$    $CAFT_{conn.bolt} = 16 \cdot ksi$    $Check_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$f_{t.nwg.bolt} = \begin{pmatrix} 3.5 \\ 0.0 \end{pmatrix} \cdot ksi$    $Check_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

*Anchor Bolts*

$f_{t.g.rod} = 4.1 \cdot ksi$    $CAFT_{anchor.rods} = 7 \cdot ksi$    $Check_{g.rod} = $ "OK"

$f_{t.nwg.rod} = 3.7 \cdot ksi$    $Check_{nwg.rod} = $ "OK"

Summary

# Mast Arm Design and Analysis Summary

DataFile = "Cortez 1 NE Fut.dat"    WindSpeed = $130 \cdot mph$

**Subject** = "Cortez - 43rd St W NE Future"    **DesignedBy** = "SML"    **PoleLocation** = "Pole 1 - NE Corner"

**ProjectNo** = "404-6002870"    **CheckedBy** = " "    **Date** = "12/21/2017"

## 1st Mast Arm

$\#Signals_{arm1} = 3$    $\#Panels_{arm1} = 1$

$X_{signal.arm1} = \begin{pmatrix} 17 \\ 29 \\ 40 \end{pmatrix} ft$    $Sections_{signal.arm1} = \begin{pmatrix} 3 \\ 3 \\ 4 \end{pmatrix}$    $Backplate_{signal.arm1} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$

$X_{panel.arm1} = (10)\, ft$    $Area_{panel.arm1} = (20)\, ft^2$

$L_{total.arm1} = 46\, ft$    $L_{splice.provided.arm1} = 24 \cdot in$

'FA'= 'FE'= $L_{arm1} = \begin{pmatrix} 35.1 \\ 12.9 \end{pmatrix} \cdot ft$    'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 7.0833 \\ 11.2173 \end{pmatrix} \cdot in$    'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 11.9973 \\ 13 \end{pmatrix} \cdot in$

'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$    $max(\Delta_{arm1}) = 4.9 \cdot in$    $max(CSR_{arm1}) = 0.628$

## 2nd Mast Arm

$\#Signals_{arm2} = 0$    $\#Panels_{arm2} = 1$

$X_{signal.arm2} = (0)\, ft$    $Sections_{signal.arm2} = (0)$    $Backplate_{signal.arm2} = (0)$

$X_{panel.arm2} = (0.1)\, ft$    $Area_{panel.arm2} = (0.1)\, ft^2$

$L_{total.arm2} = 0\, ft$    $L_{splice.provided.arm2} = 24 \cdot in$    'UF'= $\alpha = 0 \cdot deg$ **(Angle Between Arms)**

'SA'= 'SE'= $L_{arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot ft$    'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$    'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$

'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$    $max(\Delta_{arm2}) = 0 \cdot in$    $max(CSR_{arm2}) = 0$

## Luminaire Arm and Connection

DataFile = "Cortez 1 NE Fut.dat"   WindSpeed = 130·mph

*(use MC10x33.6 channel for connection)*

'LA'= $Y_{luminaire} = 0\ ft$    'LB'= $X_{luminaire} = 0\ ft$    'LC'= $Diameter_{base.lumarm} = 0 \cdot in$

'LD'= $t_{wall.lumarm} = 0 \cdot in$    'LE'= $Slope_{lumarm} = 0$    'LF'= $r_{lumarm} = 0\ ft$

'LG'= $d_{bolt.lum} = 0 \cdot in$    'LH'= $t_{baseplate.lum} = 0 \cdot in$

'LJ'= $w_{base.lum} = 0 \cdot in$    'LK'= $w_{channel.lum} = 0 \cdot in$

$CSR_{base.lumarm} = 0$    $PR_{bolt.lum} = 0$    $PR_{baseplate.lum} = 0$    $PR_{conn.plate.lum} = 0$

## Upright

'UA'= $Y_{pole} = 21.5 \cdot ft$    'UB'= $Y_{arm.conn} = 20 \cdot ft$    'UC'= $Diameter_{tip.pole} = 13.0192 \cdot in$

'UD'= $Diameter_{base.pole} = 16 \cdot in$    'UE'= $t_{wall.pole} = 0.375 \cdot in$    'UF'= $\alpha = 0 \cdot deg$

'UG'= $Y_{lum.conn} = 0\ ft$    $\Delta_{x.dl} = 0.9 \cdot in$    $Slope_x = 0.48 \cdot deg$

$\Delta_{z.dl} = 0 \cdot in$    $Slope_z = 0 \cdot deg$    $C_{a.pole} = 0.996$

$\max(CSR_{pole}) = 0.597$

## 1st Arm/Upright Connection

$\#ConnBolts_0 = 6$    'HT'= $h_{conn.plate} = 22 \cdot in$    'FJ'= $b_{conn.plate_0} = 23 \cdot in$

'FK'= $t_{baseplate.arm_0} = 2 \cdot in$    'FL'= $t_{vertical.plate_0} = 0.5 \cdot in$

'FN'= $w_{vertical.plate_0} = 0.3125 \cdot in$    'FO'= $Offset_{conn_0} = 14.1146 \cdot in$

'FP'= $d_{bolt.conn_0} = 1 \cdot in$    'FR'= $t_{conn.plate_0} = 1.5 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 9 \cdot in$    'FT'= $w_{conn.plate_0} = 0.3125 \cdot in$

$$\begin{pmatrix} PR_{bolt_0} \\ PR_{t.baseplate.arm_0} \\ PR_{t.connplate.arm_0} \\ CSR_{t.vert.plate_0} \end{pmatrix} = \begin{pmatrix} 0.684 \\ 0.839 \\ 0.998 \\ 0.682 \end{pmatrix}$$

## 2nd Arm/Upright Connection

$\#ConnBolts_1 = 0$    'HT'= $h_{conn.plate} = 22 \cdot in$    'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SK'= $t_{baseplate.arm_1} = 0 \cdot in$    'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$    'SO'= $Offset_{conn_1} = 0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$    'SR'= $t_{conn.plate_1} = 0 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0 \cdot in$    'ST'= $w_{conn.plate_1} = 0 \cdot in$

$$\begin{pmatrix} PR_{bolt_1} \\ PR_{t.baseplate.arm_1} \\ PR_{t.connplate.arm_1} \\ CSR_{t.vert.plate_1} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

## Pole Baseplate

DataFile = "Cortez 1 NE Fut.dat" $WindSpeed = 130 \cdot mph$

#AnchorRods = 6

'BA'= $Diameter_{baseplate.pole} = 28 \cdot in$

'BB'= $t_{baseplate.pole} = 2.5 \cdot in$

'BC'= $d_{bolt.pole} = 1.5 \cdot in$

'BF'= $L_{embedment.rod} = 30 \cdot in$

$Diameter_{boltcircle.pole} = 22 \cdot in$

$PR_{rod} = 0.722$

$PR_{plate.pole} = 1$

## Foundation

'DA'= $L_{shaft} = 11 \cdot ft$

'DB'= $Diameter_{shaft} = 4 \cdot ft$

$d_{bar} = 1.41 \cdot in$ $Offset = 0\, ft$

'RA'= $round\left(\frac{d_{bar}}{0.125in}\right) = 11$

'RB'= #BarsProvided = 12

$Diameter_{rebar.circle} = 2.7783\, ft$

'RC'= $NumSpaces_{v.bar} = 10$

'RD'= $s_{v2} = 12 \cdot in$

$PR_{foundation} = 0.96$

WRITEPRN to Line 1-2-3

## Mast Arm Tip Deflection

*Compare Mast Arm deflection of each arm to a proposed camber*

$Camber_{arm1} := \mathbf{2} \cdot deg$ $Camber_{arm2} := \mathbf{2} \cdot deg$

$L_{arm1} := \sum L_{arm1} - if\left[\left(L_{arm1_1} = 0 \cdot ft\right), 0 \cdot ft, 2 \cdot ft\right]$

$L_{arm2} := \sum L_{arm2} - if\left[\left(L_{arm2_1} = 0 \cdot ft\right), 0 \cdot ft, 2 \cdot ft\right]$

$Deflection_{arm1} := Slope_x \cdot L_{arm1} + max\left(\Delta_{arm1}\right)$

$Deflection_{arm1} = 9.49 \cdot in$

$CamberArm1_{upward} := sin\left(Camber_{arm1}\right) \cdot L_{arm1}$

$CamberArm1_{upward} = 19.26 \cdot in$

$Deflection_{arm2} := \left[Slope_z \cdot L_{arm2} \cdot (sin(\alpha))\right] + Slope_x \cdot L_{arm2} \cdot cos(\alpha) + max\left(\Delta_{arm2}\right)$

$Deflection_{arm2} = 0 \cdot in$

$CamberArm2_{upward} := sin\left(Camber_{arm2}\right) \cdot L_{arm2}$

$CamberArm2_{upward} = 0 \cdot in$

## Check Clearance Between Connection Plates

*(for Two Arm Structures only)*

$\alpha = 0 \cdot deg$ $\alpha := if[(\alpha > 180 \cdot deg), (360 \cdot deg - \alpha), \alpha]$

$Offset_{conn_0} = 14.1 \cdot in$ $b_{conn.plate_0} = 23 \cdot in$ $h_{conn.plate} = 22 \cdot in$ $\alpha = 0 \cdot deg$

$Offset_{conn_1} = 0 \cdot in$ $b_{conn.plate_1} = 0 \cdot in$

$x_1 := Offset_{conn_0} - t_{conn.plate_0} - h_{conn.plate} \cdot \frac{sin\left(Camber_{arm1}\right)}{2}$ $y_1 := \frac{b_{conn.plate_0}}{2}$ $x_1 = 12.23 \cdot in$ $y_1 = 11.5 \cdot in$

$x_2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{sin\left(Camber_{arm2}\right)}{2}\right) \cdot cos(\alpha) + \frac{b_{conn.plate_1}}{2} \cdot sin(\alpha)$

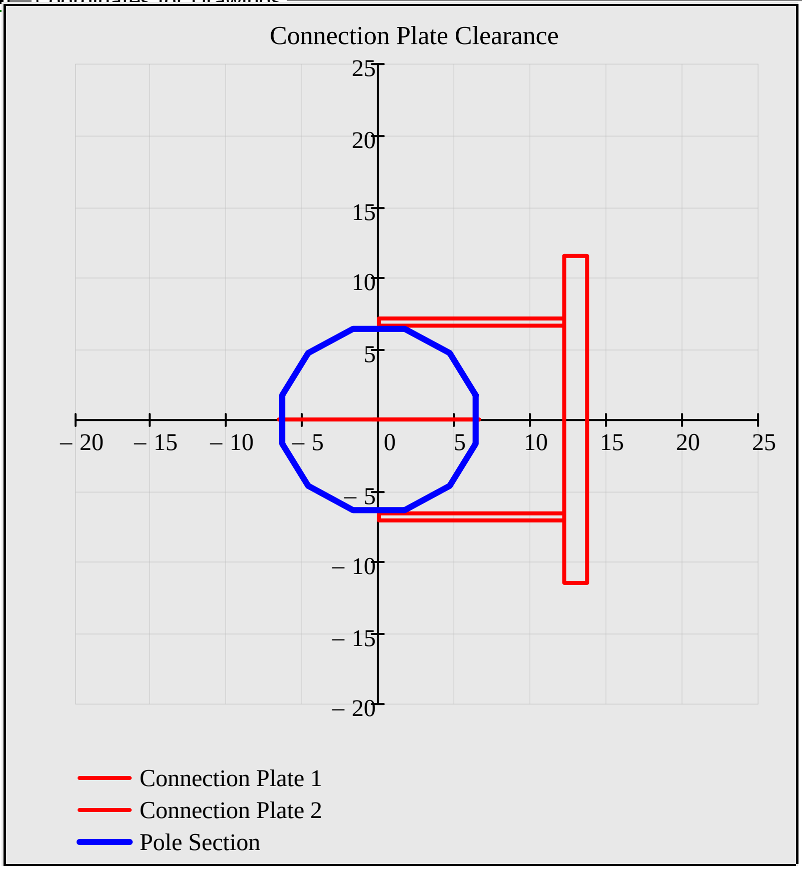
$y_2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{sin\left(Camber_{arm2}\right)}{2}\right) \cdot sin(\alpha) - \frac{b_{conn.plate_1}}{2} \cdot cos(\alpha)$ $x_2 = -0.38 \cdot in$ $y_2 = 0 \cdot in$

$Clearance := \sqrt{\left(x_1 - x_2\right)^2 + \left(y_1 - y_2\right)^2}$ $Clearance := if\left[\left(y_2 \le y_1\right), if\left[\left(x_1 > x_2\right), Clearance, 0 \cdot in\right], Clearance\right]$ $Clearance = 17.07 \cdot in$

***(if Clearance equals 0, then Connection Plates intersect and redesign is required.***

## Plan View - Connection Plate Clearance for Two Arm Connections

Coordinates for Drawings




$Clearance = 17.07 \cdot in$

$Diameter_{conn.pole} = 13.2292 \cdot in$

$t_{conn.plate_0} = 1.5 \cdot in$

$b_{conn.plate_0} = 23 \cdot in$

$t_{vertical.plate_0} = 0.5 \cdot in$

$Offset_{conn_0} = 14.1146 \cdot in$

$Gap_0 = 7.5 \cdot in$

$t_{conn.plate_1} = 0 \cdot in$

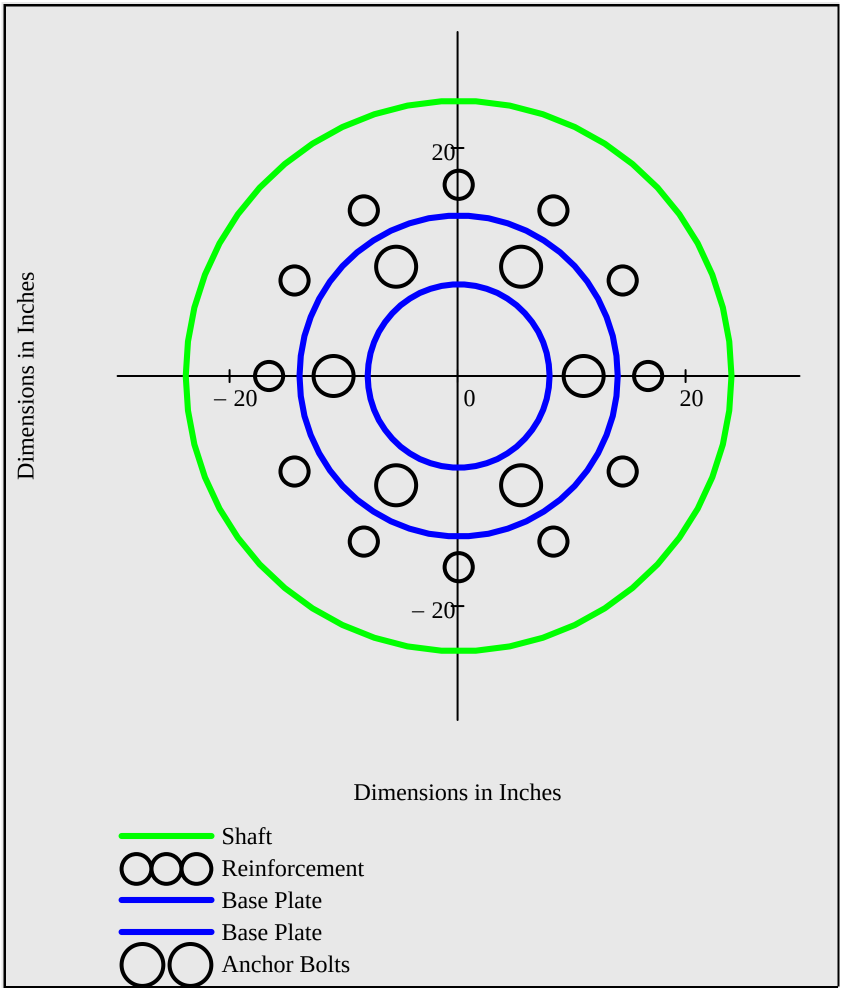
$b_{conn.plate_1} = 0 \cdot in$

$t_{vertical.plate_1} = 0 \cdot in$

$Offset_{conn_1} = 0 \cdot in$

$Gap_1 = 0 \cdot in$

## Plan View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$\text{Diameter}_{base.pole} = 16 \cdot in$

$\text{Diameter}_{baseplate.pole} = 28 \cdot in$

$\text{Diameter}_{shaft} = 48 \cdot in$

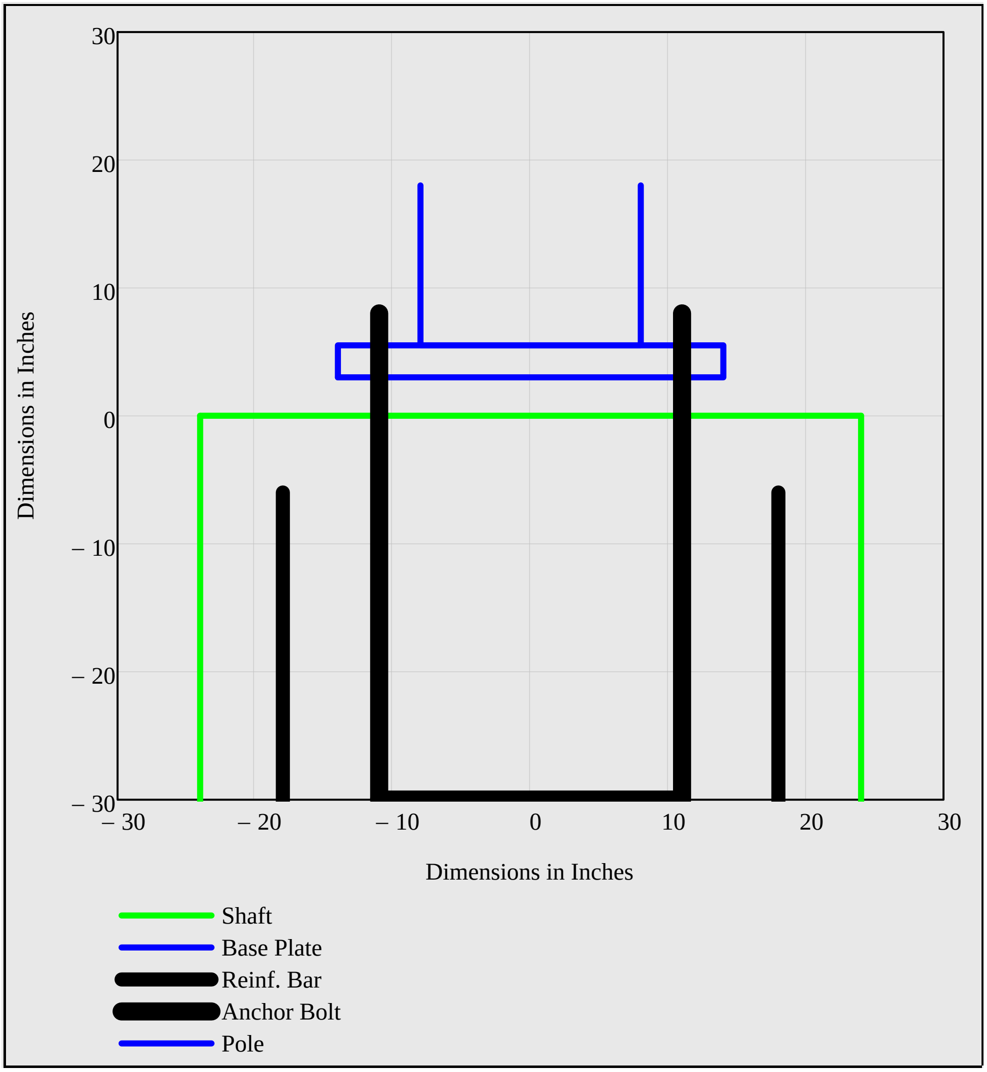
$\text{Diameter}_{boltcircle.pole} = 22 \cdot in$

$\text{Diameter}_{rebar.circle} = 33.34 \cdot in$

#AnchorRods = 6

#BarsProvided = 12

## Elevation View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$\text{Diameter}_{base.pole} = 16 \cdot in$

$\text{Diameter}_{baseplate.pole} = 28 \cdot in$

$t_{baseplate.pole} = 2.5 \cdot in$

$\text{Diameter}_{shaft} = 4 \cdot ft$

$\text{Diameter}_{boltcircle.pole} = 22 \cdot in$

$\text{Diameter}_{rebar.circle} = 33.3 \cdot in$

# Appendix D

Mathcad Program Output – Proposed Configuration

# FDOT Mast Arm Analysis Program

*Custom File Name (optional)* Cortez 1 NE Prop

*The new custom file will be a copy of the last file called from the program. A ".dat" extension will be added to the file name.*

*Add file to file list* Refresh File List

*Select Data File (required)*

F6F5W4
F7W6
F6W4
F6W24
irunin
Cortez 1 NE Exist
Cortez 1 NE Prop

*All data files are in the same directory as the MastArm.xmcd file.*

Path = "F:\Projects\University Pkwy at Legacy Blvd Mast Arms\04 Analys

DataFile = "Cortez 1 NE Prop.dat"

*Reference* *Changes*

*This program works in conjunction with Mastarm Design Standards 17743 and 17745.*

*References:*
*AASHTO Standard Specifications for Signs, Luminaires and Traffic Signals, 6th Edition (LTS).*
*FDOT Structures Manual Vol. 3 (SM V3).*

*For more information see Reference.xmcd and Changes.xmcd.*

Read In Data

## General Information

DataFile = "Cortez 1 NE Prop.dat"

| Current Values | New Values |
|---|---|
| **Subject** = "Cortez - 43rd St W NE Prop" | : - 43rd St W NE Prop |
| **ProjectNo** = "404-6002870" | 404-6002870 |
| **PoleLocation** = "Pole 1 - NE Corner" | Pole 1 - NE Corner |
| **Date** = "12/12/2017" | 12/12/2017 |
| **DesignedBy** = "SML" | SML |
| **CheckedBy** = " " | |

*Use Control+F9 to recalculate the worksheet, once to write out data, twice to read in data*

## Wind Speed

DataFile = "Cortez 1 NE Prop.dat"

| Current Value | New Value | | |
|---|---|---|---|
| WindSpeed = 130·mph | | *mph* | ***SM V3 3.8.2*** |

## Arm 1 Analysis

DataFile = "Cortez 1 NE Prop.dat"    WindSpeed = 130 mph

Arm 1 Loads

SignalData$_{arm1}$ =

| "SignalNumber" | "DistanceToSignal(ft)" | "NumberOfSignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 14 | 5 | "yes" |
| 2 | 24 | 3 | "yes" |
| 3 | 34 | 5 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

*use X to zero out data*
*use 0 to keep current values*    *"yes" or "no"*

**New Values**

| "SignalNumber" | "DistToSignal(ft)" | "#SignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 14 | 5 | "yes" |
| 2 | 24 | 3 | "yes" |
| 3 | 34 | 5 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

SignData$_{arm1}$ =

| "PanelNumber" | "DistanceToPanelCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 6 | 20 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

**New Values**

| "Panel#" | "DistToCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 6 | 20 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

*use X to zero out data*
*use 0 to keep current values*

Arm 1 Properties

## Current Values

## New Values

$L_{total.arm1} = 46\,ft$ | | *feet, 40 ft. max. for 1 piece arms*

$Diameter_{base.arm1} = 13 \cdot in$ | | *inches, measured flat to flat (FG)*

$Dist_{splice.from.base.arm1} = 12.9\,ft$ | | *feet, splice distance, for 2 piece arms, length of piece closest to pole, use X to zero out (FE)*

*set* $Dist_{splice.from.base.arm1} = 0ft$ *for NO SPLICE*

$t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$

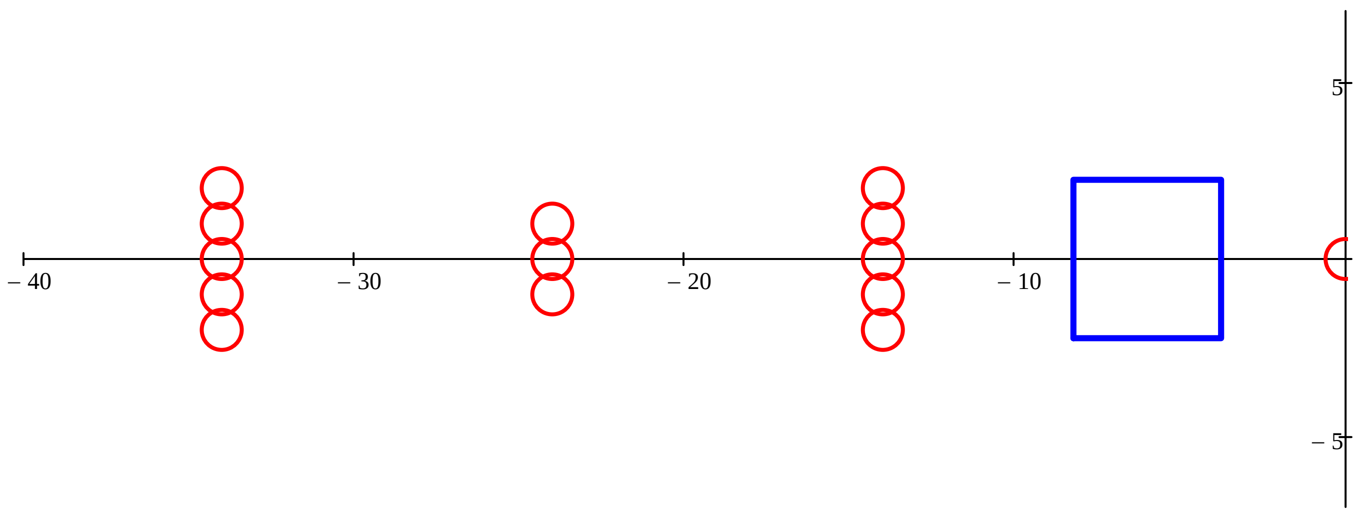
| | *inches, this value is used for one piece arms (FD)*

0.375 | *inches, for 2 piece arms, wall thickness of piece closest to the pole, use X to zero out (FH)*

Arm 1 Properties

Analyze Arm 1

## Summary - Arm 1 Geometry and Loading




Location of Signs and Signals

$WindSpeed = 130 \cdot mph$ $L_{total.arm1} = 46\,ft$

$Diameter_{tip.arm1} = \begin{pmatrix} 7.08 \\ 11.22 \end{pmatrix} \cdot in$ $Diameter_{base.arm1} = \begin{pmatrix} 12 \\ 13 \end{pmatrix} \cdot in$ $L_{arm1} = \begin{pmatrix} 35.1 \\ 12.9 \end{pmatrix} ft$ $t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$

$X_{signal.arm1_{i1}} =$

| | |
|---|---|
| 14 | ft |
| 24 | |
| 34 | |

$Sections_{signal.arm1_{i1}} =$

| |
|---|
| 5 |
| 3 |
| 5 |

$X_{panel.arm1_{j1}} =$ 6 ft

$Area_{panel.arm1_{j1}} =$ 20 $ft^2$

## Arm 1 Combined Stress Ratio and Deflection

$\max(CSR_{arm1}) = 0.602$ $\max(\Delta_{arm1}) = 4.738 \cdot in$ $2 \cdot deg \cdot \sum (L_{arm1} - L_{splice.provided}) = 18.43 \cdot in$

## Arm 2 Analysis

DataFile = "Cortez 1 NE Prop.dat" WindSpeed = 130 mph

Arm 2 Loads

$$SignalData_{arm2} = \begin{pmatrix} \text{"SignalNumber"} & \text{"DistanceToSignal(ft)"} & \text{"NumberOfSignalHeads"} & \text{"BackPlate"} \\ 1 & 0 & 0 & \text{"yes"} \\ 2 & 0 & 0 & \text{"yes"} \\ 3 & 0 & 0 & \text{"yes"} \\ 4 & 0 & 0 & \text{"yes"} \\ 5 & 0 & 0 & \text{"yes"} \\ 6 & 0 & 0 & \text{"yes"} \\ 7 & 0 & 0 & \text{"yes"} \\ 8 & 0 & 0 & \text{"yes"} \\ 9 & 0 & 0 & \text{"yes"} \\ 10 & 0 & 0 & \text{"yes"} \end{pmatrix}$$

*use X to zero out data*
*use 0 to keep current values* *"yes" or "no"*

**New Values**

| "SignalNumber" | "DistToSignal(ft)" | "#SignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 0 | 0 | "yes" |
| 2 | 0 | 0 | "yes" |
| 3 | 0 | 0 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

$$SignData_{arm2} = \begin{pmatrix} \text{"PanelNumber"} & \text{"DistanceToPanelCentroid(ft)"} & \text{"PanelArea(sf)"} \\ 1 & 0 & 0 \\ 2 & 0 & 0 \\ 3 & 0 & 0 \\ 4 & 0 & 0 \\ 5 & 0 & 0 \end{pmatrix}$$

**New Values**

| "Panel#" | "DistToCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 0 | 0 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

*use X to zero out*
*use 0 to keep current values*

Arm 2 Loads

Arm 2 Properties

## Current Values

## New Values

$L_{total.arm2} = 0\,ft$ — *feet, 40 ft. max. for 1 piece arms, use X to zero out* *set* $L_{total.arm2} = 0ft$ *for NO ARM2*

$Diameter_{base.arm2} = 0 \cdot in$ — *inches, measured flat to flat, use X to zero out (SG)*

$Dist_{splice.from.base.arm2} = 0 \cdot ft$ — *feet, splice distance, for 2 piece arms, length of piece closest to pole, use X to zero out (SE)* *set* $Dist_{splice.from.base.arm2} = 0ft$ *for NO SPLICE*

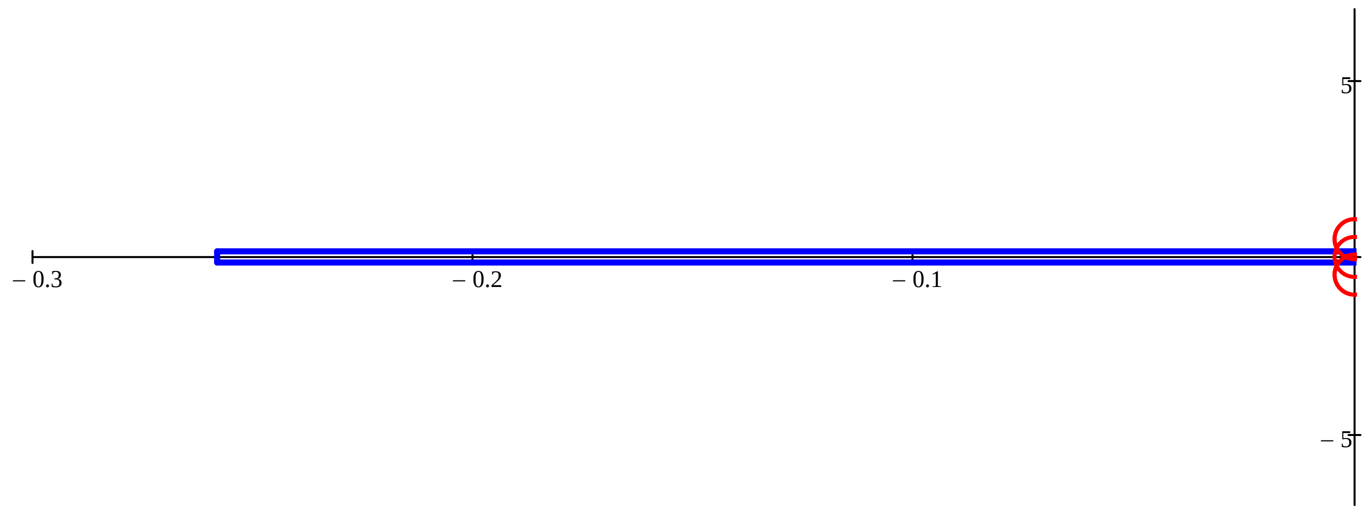
$t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ — *inches, use X to zero out (SD)*

*inches, for 2 piece arms, wall thickness of piece closest to the pole, use X to zero out (SH)*

Arm 2 Properties

## Summary - Arm 2 Geometry and Loading

Analyze Arm 2



Location of Signs and Signals

$WindSpeed = 130 \cdot mph$ $L_{total.arm2} = 0\,ft$

$Diameter_{tip.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ $Diameter_{base.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ $L_{arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} ft$ $t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$

$X_{signal.arm2_{i2}} = \begin{array}{|c|}\hline 0 \\ \hline 0 \\ \hline\end{array}\ ft$ $Sections_{signal.arm2_{i2}} = \begin{array}{|c|}\hline 0 \\ \hline 0 \\ \hline\end{array}$ $X_{panel.arm2_{j2}} = \boxed{0.1}\ ft$ $Area_{panel.arm2_{j2}} = \boxed{0.1}\ ft^2$

## Arm 2 Combined Stress Ratio and Deflection

$\max(CSR_{arm2}) = 0$ $\max(\Delta_{arm2}) = 0 \cdot in$ $2 \cdot deg \cdot \sum (L_{arm2} - L_{splice.provided}) = -1.68 \cdot in$

# Luminaire Arm Analysis

DataFile = "Cortez 1 NE Prop.dat"    WindSpeed = 130·mph

Luminaire Properties

*See Design Standards 17743 and 17745 for input values.*

## Current Values

## New Values

*set* $Y_{luminaire} = 0ft$ *for NO LUMINAIRE*

| Current Values | New Values | |
|---|---|---|
| $Y_{luminaire} = 0\ ft$ | | *feet, use X to zero out (Standard LA = 40 feet)* |
| $X_{luminaire} = 10 \cdot ft$ | | *feet, use X to zero out (Standard LB = 10 feet)* |
| $Diameter_{base.lumarm} = 3 \cdot in$ | | *inches, use X to zero out (Standard LC = 3 inches)* |
| $t_{wall.lumarm} = 0.125 \cdot in$ | | *inches, use X to zero out (Standard LD = 0.125 inches)* |
| $Slope_{lumarm} = 0.5$ | | *rise/run, use X to zero out (Standard LE = 0.5)* |
| $r_{lumarm} = 8 \cdot ft$ | | *feet, use X to zero out (Standard LF = 8 feet)* |
| $d_{bolt.lum} = 0.5 \cdot in$ | | *inches, use X to zero out (Standard LG = 0.5 inches)* |
| $t_{baseplate.lum} = 0.75 \cdot in$ | | *inches, use X to zero out (Standard LH = 0.75 inches)* |

Luminaire Properties

Analyze Luminaire

## Summary - Luminaire Arm Geometry

$Y_{luminaire} = 0\ ft$    $X_{luminaire} = 0 \cdot ft$    $Diameter_{base.lumarm} = 0 \cdot in$    $t_{wall.lumarm} = 0 \cdot in$

$Slope_{lumarm} = 0$    $r_{lumarm} = 0 \cdot ft$    $d_{bolt.lum} = 0 \cdot in$    $t_{baseplate.lum} = 0 \cdot in$

$w_{base.lum} = 0 \cdot in$    $w_{channel.lum} = 0 \cdot in$

## Luminaire Arm Ratios

$CSR_{base.lumarm} = 0$    $PR_{bolt.lum} = 0$    $PR_{baseplate.lum} = 0$    $PR_{conn.plate.lum} = 0$

# Upright Analysis

DataFile = "Cortez 1 NE Prop.dat"     WindSpeed = 130·mph

Pole Properties

## Current Values

## New Values

$Y_{pole} = 21.5\,ft$ | 21.5 | *feet (UA)*

$Y_{arm.conn} = 20\,ft$ | 20.0 | *feet (UB)*

$Diameter_{base.pole} = 16 \cdot in$ | | *inches, measured flat to flat (UD)*

$t_{wall.pole} = 0.375 \cdot in$ | | *inches (UE)*

$Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$ | | *inches, clear distance between connection plate and upright*

| | *inches, use X to zero out*

*Common wall thicknesses:*
*0.1793 in.*
*0.2391 in.*
*0.25 in.*
*0.313 in.*
*0.375 in.*
*0.5 in.*

Pole Properties

## Summary - Upright Geometry

$Y_{pole} = 21.5\,ft$     $Y_{arm.conn} = 20\,ft$     $\alpha = 0 \cdot deg$     $Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$

$Diameter_{base.pole} = 16 \cdot in$     $t_{wall.pole} = 0.375 \cdot in$

## Upright Combined Stress Ratio and Deflections

$\max(CSR_{pole}) = 0.619$     $\max(\Delta_{x.dl}) = 0.89 \cdot in$     $\max(\Delta_{z.dl}) = 0 \cdot in$

Connection Properties

## Current Values

## New Values

$h_{conn.plate} = 22 \cdot in$

*inches, for two arm Mast Arms both connection plate heights must be equal (HT)*

$t_{vertical.plate} = \begin{pmatrix} 0.5 \\ 0 \end{pmatrix} \cdot in$

*inches (FL)*

*inches, use X to zero out (SL)*

$d_{bolt.conn} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \cdot in$

*inches (FP)*

*inches, use X to zero out (SP)*

$t_{baseplate.arm} = \begin{pmatrix} 2 \\ 0 \end{pmatrix} \cdot in$

*inches (FK)*

*inches, use X to zero out (SK)*

Connection Properties

## Summary - Connection Geometry

$h_{conn.plate} = 22 \cdot in$  $Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$  $Offset_{conn} = \begin{pmatrix} 14.1146 \\ 0 \end{pmatrix} \cdot in$

$d_{bolt.conn} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \cdot in$  $\#ConnBolts = \begin{pmatrix} 6 \\ 0 \end{pmatrix}$  $Spacing_{bolts.conn} = \begin{pmatrix} 9 \\ 0 \end{pmatrix} \cdot in$

$t_{conn.plate} = \begin{pmatrix} 1.5 \\ 0 \end{pmatrix} \cdot in$  $b_{conn.plate} = \begin{pmatrix} 23 \\ 0 \end{pmatrix} \cdot in$  $t_{vertical.plate} = \begin{pmatrix} 0.5 \\ 0 \end{pmatrix} \cdot in$  $t_{baseplate.arm} = \begin{pmatrix} 2 \\ 0 \end{pmatrix} \cdot in$

$w_{conn.plate} = \begin{pmatrix} 0.3125 \\ 0 \end{pmatrix} \cdot in$  $w_{vertical.plate} = \begin{pmatrix} 0.3125 \\ 0 \end{pmatrix} \cdot in$

## Connection Ratios

$PR_{bolt} = \begin{pmatrix} 0.663 \\ 0 \end{pmatrix}$  $CSR_{t.vert.plate} = \begin{pmatrix} 0.661 \\ 0 \end{pmatrix}$  $PR_{t.baseplate.arm} = \begin{pmatrix} 0.839 \\ 0 \end{pmatrix}$  $PR_{t.connplate.arm} = \begin{pmatrix} 0.998 \\ 0 \end{pmatrix}$

# Base Plate Analysis

DataFile = "Cortez 1 NE Prop.dat"    WindSpeed = 130·mph

Base Plate Properties

## Current Values

## New Values

#AnchorRods = 6    *use 6 bolts minimum*

$d_{bolt.pole} = 1.5 \cdot in$    *inches (BC)*

Base Plate Properties

## Summary - Upright Base Plate Geometry & Anchors

#AnchorRods = 6    $d_{bolt.pole} = 1.5 \cdot in$    $t_{baseplate.pole} = 2.5 \cdot in$    $Diameter_{baseplate.pole} = 28 \cdot in$

## Upright Base Plate Performance Ratios

$PR_{rod} = 0.772$    $PR_{plate.pole} = 1$

# Foundation Analysis    Cohesionless or Cohesive Soil

DataFile = "Cortez 1 NE Prop.dat"

Soil Properties

## Current Values

## New Values

SoilType = 1    ○ Clay ◉ Sand    *0 - clay  1 - sand*

$\phi_{soil} = 30 \cdot deg$    *degrees, soil friction angle (sand)*

$c_{soil} = 2000 \cdot psf$    *psf, soil shear strength (clay)*

$\gamma_{soil} = 42.6 \cdot pcf$    42.6    *pcf, soil density (typical design value = 45-50 pcf)*

Offset = 0 ft    *vertical distance between top of foundation and groundline*

$N_{blows} = 15$    *Number of blows per foot. If N< 5, contact the district geotech Engineer*    **SM V3 13.6**

Soil Properties

## Summary - Soil Properties and Drilled Shaft Geometry

SoilType = 1 *0 - clay 1 - sand*    $\phi_{soil} = 30 \cdot deg$    $c_{soil} = 2000 \cdot psf$    $\gamma_{soil} = 42.6 \cdot pcf$    Offset = 0 ft

$Diameter_{shaft} = 4\ ft$    $L_{shaft} = 12\ ft$    $L_{embedment.rod} = 30 \cdot in$    $L_{anchor.rod} = 38 \cdot in$

#BarsProvided = 12    $d_{bar} = 1.41 \cdot in$

## Foundation Performance Ratios

$PR_{foundation} = 0.822$

## Fatigue Analysis

DataFile = "Cortez 1 NE Prop.dat"    WindSpeed = 130·mph

*Use the member cross section adjacent to the weld toe to compute the nominal stress range.*    ***LTS 11.9***

FatigueCategory := 2    ***SM V3 11.6***

Analyze Structure for Fatigue

*Arm and Pole Welds*

$f_{galloping.arm1} = 3.8 \cdot ksi$    $CAFT_{fullpengroove.weld.arm1} = 7 \cdot ksi$    $Check_{galloping.arm1} = \text{"OK"}$

$f_{galloping.arm2} = 0 \cdot ksi$    $CAFT_{fullpengroove.weld.arm2} = \text{"NA"} \cdot ksi$    $Check_{galloping.arm2} = \text{"NA"}$

$f_{galloping.pole} = 2.5 \cdot ksi$    $CAFT_{fullpengroove.weld.pole} = 4.5 \cdot ksi$    $Check_{galloping.pole} = \text{"OK"}$

$f_{nwg.arm1} = 2.5 \cdot ksi$    $Check_{nwg.arm1} = \text{"OK"}$

$f_{nwg.arm2} = 0 \cdot ksi$    $Check_{nwg.arm2} = \text{"NA"}$

$f_{nwg.pole} = 2.6 \cdot ksi$    $Check_{nwg.pole} = \text{"OK"}$

*A325 Connection Bolts*

$f_{t.g.bolt} = \begin{pmatrix} 5.3 \\ 0.0 \end{pmatrix} \cdot ksi$    $CAFT_{conn.bolt} = 16 \cdot ksi$    $Check_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$f_{t.nwg.bolt} = \begin{pmatrix} 3.4 \\ 0.0 \end{pmatrix} \cdot ksi$    $Check_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

*Anchor Bolts*

$f_{t.g.rod} = 3.8 \cdot ksi$    $CAFT_{anchor.rods} = 7 \cdot ksi$    $Check_{g.rod} = \text{"OK"}$

$f_{t.nwg.rod} = 4 \cdot ksi$    $Check_{nwg.rod} = \text{"OK"}$

# Mast Arm Design and Analysis Summary

DataFile = "Cortez 1 NE Prop.dat" WindSpeed = 130·mph

**Subject** = "Cortez - 43rd St W NE Prop" **DesignedBy** = "SML" **PoleLocation** = "Pole 1 - NE Corner"

**ProjectNo** = "404-6002870" **CheckedBy** = " " **Date** = "12/12/2017"

## 1st Mast Arm

$\#Signals_{arm1} = 3$ $\#Panels_{arm1} = 1$

$X_{signal.arm1} = \begin{pmatrix} 14 \\ 24 \\ 34 \end{pmatrix} ft$ $Sections_{signal.arm1} = \begin{pmatrix} 5 \\ 3 \\ 5 \end{pmatrix}$ $Backplate_{signal.arm1} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$

$X_{panel.arm1} = (6)\ ft$ $Area_{panel.arm1} = (20)\ ft^2$

$L_{total.arm1} = 46\ ft$ $L_{splice.provided.arm1} = 24 \cdot in$

'FA'= 'FE'= $L_{arm1} = \begin{pmatrix} 35.1 \\ 12.9 \end{pmatrix} \cdot ft$ 'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 7.0833 \\ 11.2173 \end{pmatrix} \cdot in$ 'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 11.9973 \\ 13 \end{pmatrix} \cdot in$

'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$ $\max(\Delta_{arm1}) = 4.74 \cdot in$ $\max(CSR_{arm1}) = 0.602$

## 2nd Mast Arm

$\#Signals_{arm2} = 0$ $\#Panels_{arm2} = 1$

$X_{signal.arm2} = (0)\ ft$ $Sections_{signal.arm2} = (0)$ $Backplate_{signal.arm2} = (0)$

$X_{panel.arm2} = (0.1)\ ft$ $Area_{panel.arm2} = (0.1)\ ft^2$

$L_{total.arm2} = 0\ ft$ $L_{splice.provided.arm2} = 24 \cdot in$ 'UF'= $\alpha = 0 \cdot deg$ **(Angle Between Arms)**

'SA'= 'SE'= $L_{arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot ft$ 'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ 'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$

'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ $\max(\Delta_{arm2}) = 0 \cdot in$ $\max(CSR_{arm2}) = 0$

## Luminaire Arm and Connection

DataFile = "Cortez 1 NE Prop.dat' WindSpeed = $130 \cdot mph$

*(use MC10x33.6 channel for connection)*

'LA'= $Y_{luminaire} = 0\,ft$

'LB'= $X_{luminaire} = 0\,ft$

'LC'= $Diameter_{base.lumarm} = 0 \cdot in$

'LD'= $t_{wall.lumarm} = 0 \cdot in$

'LE'= $Slope_{lumarm} = 0$

'LF'= $r_{lumarm} = 0\,ft$

'LG'= $d_{bolt.lum} = 0 \cdot in$

'LH'= $t_{baseplate.lum} = 0 \cdot in$

'LJ'= $w_{base.lum} = 0 \cdot in$

'LK'= $w_{channel.lum} = 0 \cdot in$

$CSR_{base.lumarm} = 0$ $PR_{bolt.lum} = 0$ $PR_{baseplate.lum} = 0$ $PR_{conn.plate.lum} = 0$

## Upright

'UA'= $Y_{pole} = 21.5\,ft$

'UB'= $Y_{arm.conn} = 20\,ft$

'UC'= $Diameter_{tip.pole} = 13.0192\,in$

'UD'= $Diameter_{base.pole} = 16\,in$

'UE'= $t_{wall.pole} = 0.375\,in$

'UF'= $\alpha = 0 \cdot deg$

'UG'= $Y_{lum.conn} = 0\,ft$

$\Delta_{x.dl} = 0.89 \cdot in$

$Slope_x = 0.47 \cdot deg$

$\Delta_{z.dl} = 0 \cdot in$

$Slope_z = 0 \cdot deg$

$C_{a.pole} = 0.996$

$\max(CSR_{pole}) = 0.619$

## 1st Arm/Upright Connection

$\#ConnBolts_0 = 6$

'HT'= $h_{conn.plate} = 22 \cdot in$

'FJ'= $b_{conn.plate_0} = 23 \cdot in$

'FK'= $t_{baseplate.arm_0} = 2 \cdot in$

'FL'= $t_{vertical.plate_0} = 0.5 \cdot in$

'FN'= $w_{vertical.plate_0} = 0.3125\,in$

'FO'= $Offset_{conn_0} = 14.1146\,in$

'FP'= $d_{bolt.conn_0} = 1 \cdot in$

'FR'= $t_{conn.plate_0} = 1.5 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 9 \cdot in$

'FT'= $w_{conn.plate_0} = 0.3125\,in$

$$\begin{pmatrix} PR_{bolt_0} \\ PR_{t.baseplate.arm_0} \\ PR_{t.connplate.arm_0} \\ CSR_{t.vert.plate_0} \end{pmatrix} = \begin{pmatrix} 0.663 \\ 0.839 \\ 0.998 \\ 0.661 \end{pmatrix}$$

## 2nd Arm/Upright Connection

$\#ConnBolts_1 = 0$

'HT'= $h_{conn.plate} = 22 \cdot in$

'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SK'= $t_{baseplate.arm_1} = 0 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

$$\begin{pmatrix} PR_{bolt_1} \\ PR_{t.baseplate.arm_1} \\ PR_{t.connplate.arm_1} \\ CSR_{t.vert.plate_1} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

## Pole Baseplate

DataFile = "Cortez 1 NE Prop.dat' WindSpeed = 130·mph

#AnchorRods = 6 'BA'= $Diameter_{baseplate.pole} = 28 \cdot in$ 'BB'= $t_{baseplate.pole} = 2.5 \cdot in$

'BC'= $d_{bolt.pole} = 1.5 \cdot in$ 'BF'= $L_{embedment.rod} = 30 \cdot in$

$Diameter_{boltcircle.pole} = 22 \cdot in$

$PR_{rod} = 0.772$

$PR_{plate.pole} = 1$

## Foundation

'DA'= $L_{shaft} = 12 \cdot ft$ 'DB'= $Diameter_{shaft} = 4 \cdot ft$ $d_{bar} = 1.41 \cdot in$ Offset = 0 ft

'RA'= $round\left(\frac{d_{bar}}{0.125in}\right) = 11$ 'RB'= #BarsProvided = 12 $Diameter_{rebar.circle} = 2.7783\,ft$

'RC'= $NumSpaces_{v.bar} = 10$ 'RD'= $s_{v2} = 12 \cdot in$ $PR_{foundation} = 0.822$

WRITEPRN to Line 1-2-3

## Mast Arm Tip Deflection

*Compare Mast Arm deflection of each arm to a proposed camber*

$Camber_{arm1} := \mathbf{2} \cdot deg$ $Camber_{arm2} := \mathbf{2} \cdot deg$

$L_{arm1} := \sum L_{arm1} - if\left[\left(L_{arm1_1} = 0 \cdot ft\right), 0 \cdot ft, 2 \cdot ft\right]$ $L_{arm2} := \sum L_{arm2} - if\left[\left(L_{arm2_1} = 0 \cdot ft\right), 0 \cdot ft, 2 \cdot ft\right]$

$Deflection_{arm1} := Slope_x \cdot L_{arm1} + max\left(\Delta_{arm1}\right)$ $Deflection_{arm1} = 9.3 \cdot in$

$CamberArm1_{upward} := sin\left(Camber_{arm1}\right) \cdot L_{arm1}$ $CamberArm1_{upward} = 19.26 \cdot in$

$Deflection_{arm2} := \left[Slope_z \cdot L_{arm2} \cdot (sin(\alpha))\right] + Slope_x \cdot L_{arm2} \cdot cos(\alpha) + max\left(\Delta_{arm2}\right)$ $Deflection_{arm2} = 0 \cdot in$

$CamberArm2_{upward} := sin\left(Camber_{arm2}\right) \cdot L_{arm2}$ $CamberArm2_{upward} = 0 \cdot in$

## Check Clearance Between Connection Plates *(for Two Arm Structures only)*

$\alpha = 0 \cdot deg$ $\alpha := if[(\alpha > 180 \cdot deg), (360 \cdot deg - \alpha), \alpha]$

$Offset_{conn_0} = 14.1 \cdot in$ $b_{conn.plate_0} = 23 \cdot in$ $h_{conn.plate} = 22 \cdot in$ $\alpha = 0 \cdot deg$

$Offset_{conn_1} = 0 \cdot in$ $b_{conn.plate_1} = 0 \cdot in$

$x_1 := Offset_{conn_0} - t_{conn.plate_0} - h_{conn.plate} \cdot \frac{sin\left(Camber_{arm1}\right)}{2}$ $y_1 := \frac{b_{conn.plate_0}}{2}$ $x_1 = 12.23 \cdot in$ $y_1 = 11.5 \cdot in$

$x_2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{sin\left(Camber_{arm2}\right)}{2}\right) \cdot cos(\alpha) + \frac{b_{conn.plate_1}}{2} \cdot sin(\alpha)$

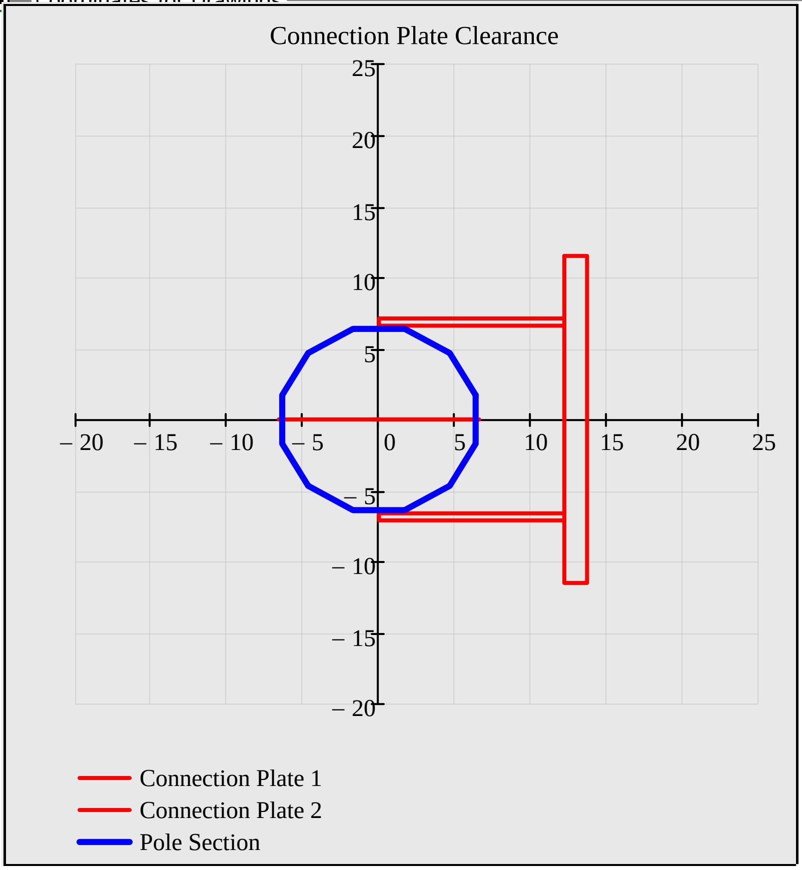
$y_2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{sin\left(Camber_{arm2}\right)}{2}\right) \cdot sin(\alpha) - \frac{b_{conn.plate_1}}{2} \cdot cos(\alpha)$ $x_2 = -0.38 \cdot in$ $y_2 = 0 \cdot in$

$Clearance := \sqrt{\left(x_1 - x_2\right)^2 + \left(y_1 - y_2\right)^2}$ $Clearance := if\left[\left(y_2 \le y_1\right), if\left[\left(x_1 > x_2\right), Clearance, 0 \cdot in\right], Clearance\right]$ $Clearance = 17.07 \cdot in$

***(if Clearance equals 0, then Connection Plates intersect and redesign is required.***

## Plan View - Connection Plate Clearance for Two Arm Connections

Coordinates for Drawings




$\text{Clearance} = 17.07 \cdot in$

$\text{Diameter}_{conn.pole} = 13.2292 \cdot in$

$t_{conn.plate_0} = 1.5 \cdot in$

$b_{conn.plate_0} = 23 \cdot in$

$t_{vertical.plate_0} = 0.5 \cdot in$

$\text{Offset}_{conn_0} = 14.1146 \cdot in$

$\text{Gap}_0 = 7.5 \cdot in$

$t_{conn.plate_1} = 0 \cdot in$

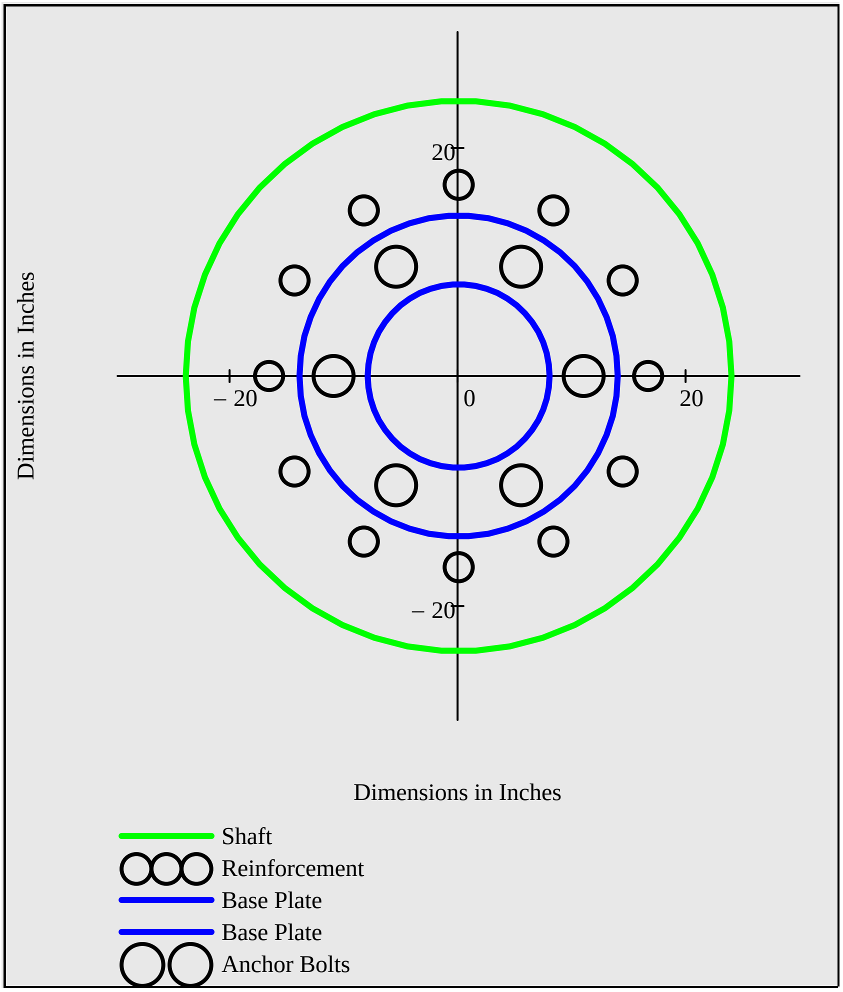
$b_{conn.plate_1} = 0 \cdot in$

$t_{vertical.plate_1} = 0 \cdot in$

$\text{Offset}_{conn_1} = 0 \cdot in$

$\text{Gap}_1 = 0 \cdot in$

## Plan View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$Diameter_{base.pole} = 16 \cdot in$

$Diameter_{baseplate.pole} = 28 \cdot in$

$Diameter_{shaft} = 48 \cdot in$

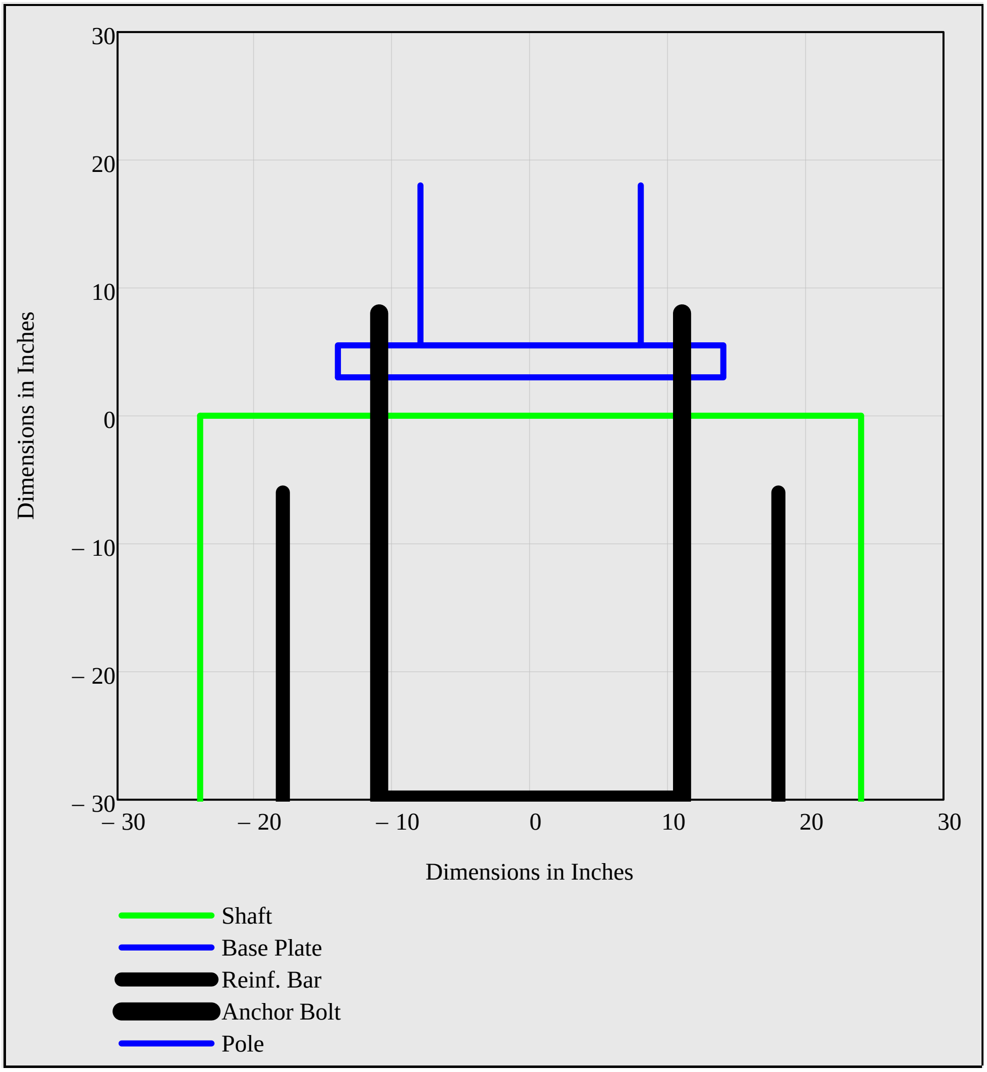
$Diameter_{boltcircle.pole} = 22 \cdot in$

$Diameter_{rebar.circle} = 33.34 \cdot in$

$\#AnchorRods = 6$

$\#BarsProvided = 12$

## Elevation View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$Diameter_{base.pole} = 16 \cdot in$

$Diameter_{baseplate.pole} = 28 \cdot in$

$t_{baseplate.pole} = 2.5 \cdot in$

$Diameter_{shaft} = 4 \cdot ft$

$Diameter_{boltcircle.pole} = 22 \cdot in$

$Diameter_{rebar.circle} = 33.3 \cdot in$

# Addendum 1

Concrete Torsion Calculation Summary

Manatee County
FLORIDA

# Cortez Rd (SR 684 - 44$^{th}$ Ave W) at 43$^{rd}$ St W

## (TSMA No. 13M126)

## NE Mast Arm Structural Evaluation
## Comment Response Review

**Date: 06/21/2018**

STEVEN M. LANEY
LICENSE
No 46449
STATE OF
FLORIDA
PROFESSIONAL ENGINEER
6/21/18

**Steven M. Laney, PE. 46449**
**Date: 06/21/2018**

***Cortez Rd (SR 684 - 44th Ave W) at 43rd St W***
***Mast Arm Structural Evaluation (TSMA 13M126)***
***Comment Response Review***

**Summary:**

- Regarding the Phase 3 Submittal comment responses provided on 4/25/2018, an additional request for concrete torsion calculations was made. As discussed, the design of the existing mast arm was provided using an FDOT Mathcad program version prior to the inclusion of the concrete torsion calculation routine. The intent of the evaluation provided was to show that the Performance Ratios (PRs) were not negatively impacted for the signal and sign modification versus the current configuration or the future configuration as part of the original design.

- Concrete torsion calculations are included in the FDOT Mathcad program but are hidden under collapsed areas in order to save the amount of output provide for a paper submittal. Additionally, the programs are to be rerun for the current configuration and the proposed configuration using the actual drilled shaft details as provided in the original design plans. Thus, the main reinforcing and the stirrup reinforcing will be set to include the actual bar sizes and spacing. Note that in both cases of the existing drilled shaft reinforcing for the stirrup spacing, using the latest program version will show that the results exceed the torsion ratio limit. However, as noted before, this does not mean that the structure is inadequate and that replacement of the structure is necessary.

- Refer to the following table for the comparison results and to the appendices for the program output.

| Configuration | Foundation PR | Shear/Torsion Ratio | Torsion (kip-ft) | Torsion ($T_u$) (kip-ft) | Torsion at $S_{v2}$ (Tor2) (kip-ft) | Torsion Capacity at $S_{v2}$ (Tn2) (kip-ft) |
|---|---|---|---|---|---|---|
| Existing | 0.805 | 1.30 | 90.9 | 118.2 | 115.7 | 99.2 |
| Proposed | 0.871 | 1.38 | 96.9 | 126.0 | 123.5 | 99.2 |
| Proposed “New” | 0.871 | 0.92 | 96.9 | 126.0 | 123.5 | 148.8 |

Notes:
1. Foundation PR is for soil torsion analysis only
2. Shear/Torsion Ratio is to be ≤ 1.0
3. Proposed “New” analysis is for current drilled shaft stirrup spacing
4. $S_{v2}$ is the location along the drilled shaft for the stirrup below the top 2 ft.

- The Shear/Torsion ratio is calculated from the following formula with $\phi_{tor} = 0.9$

$$\text{TorsionRatio}_{n2} := \frac{\text{Tor2}}{\phi_{tor} \cdot T_{n2}}$$

# Appendix A

Mathcad Program Output

NE Mast Arm Existing Configuration with Concrete Torsion Calculations

# FDOT Mast Arm Analysis Program

*Custom File Name (optional)*

*The new custom file will be a copy of the last file called from the program. A ".dat" extension will be added to the file name.*

*Add file to file list*

Refresh File List

*Select Data File (required)*

E6T4
E7T6
Cortez 1 NE Exist
Cortez 1 NE Prop
Cortez 1 NE Fut
Cortez 1 NE Review_P
Cortez 1 NE Review

*All data files are in the same directory as the MastArm.xmcd file.*

Path = "F:\Projects\Cortez - 43rd Ave W Mast Arm Review - 13M126\04 .

DataFile = "Cortez 1 NE Review_E.dat"

*Reference* *Changes*

*This program works in conjunction with Mastarm Design Standards 17743 and 17745.*

*References:*
*AASHTO Standard Specifications for Signs, Luminaires and Traffic Signals, 6th Edition (LTS).*
*FDOT Structures Manual Vol. 3 (SM V3).*

*For more information see Reference.xmcd and Changes.xmcd.*

Read In Data

## General Information

DataFile = "Cortez 1 NE Review_E.dat"

**Current Values** **New Values**

**Subject** = "Cortez - 43rd St W E Rev"

**ProjectNo** = "404-6002870"

**PoleLocation** = "Pole 1 - NE Corner"

**Date** = "06/21/2018"

**DesignedBy** = "SML"

**CheckedBy** = " "

*Use Control+F9 to recalculate the worksheet, once to write out data, twice to read in data*

## Wind Speed

DataFile = "Cortez 1 NE Review_E.dat"

**Current Value** **New Value**

WindSpeed = 130·mph *mph* **SM V3 3.8.2**

## Arm 1 Analysis

DataFile = "Cortez 1 NE Review_E.dat"   WindSpeed = 130·mph

Arm 1 Loads

$SignalData_{arm1}$ =

| "SignalNumber" | "DistanceToSignal(ft)" | "NumberOfSignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 24 | 3 | "yes" |
| 2 | 34 | 5 | "yes" |
| 3 | 0 | 0 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

*use X to zero out data*
*use 0 to keep current values*   *"yes" or "no"*

**New Values**

| "SignalNumber" | "DistToSignal(ft)" | "#SignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 0 | 0 | "yes" |
| 2 | 0 | 0 | "yes" |
| 3 | 0 | 0 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

$SignData_{arm1}$ =

| "PanelNumber" | "DistanceToPanelCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 12 | 20 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

**New Values**

| "Panel#" | "DistToCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 0 | 0 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

*use X to zero out data*
*use 0 to keep current values*

Arm 1 Loads

Arm 1 Properties

## Current Values

## New Values

$L_{total.arm1} = 46\,ft$ — *feet, 40 ft. max. for 1 piece arms*

$Diameter_{base.arm1} = 13 \cdot in$ — *inches, measured flat to flat (FG)*

$Dist_{splice.from.base.arm1} = 12.9\,ft$ — *feet, splice distance, for 2 piece arms, length of piece closest to pole, use X to zero out (FE)*

*set* $Dist_{splice.from.base.arm1} = 0ft$ *for NO SPLICE*

$t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$

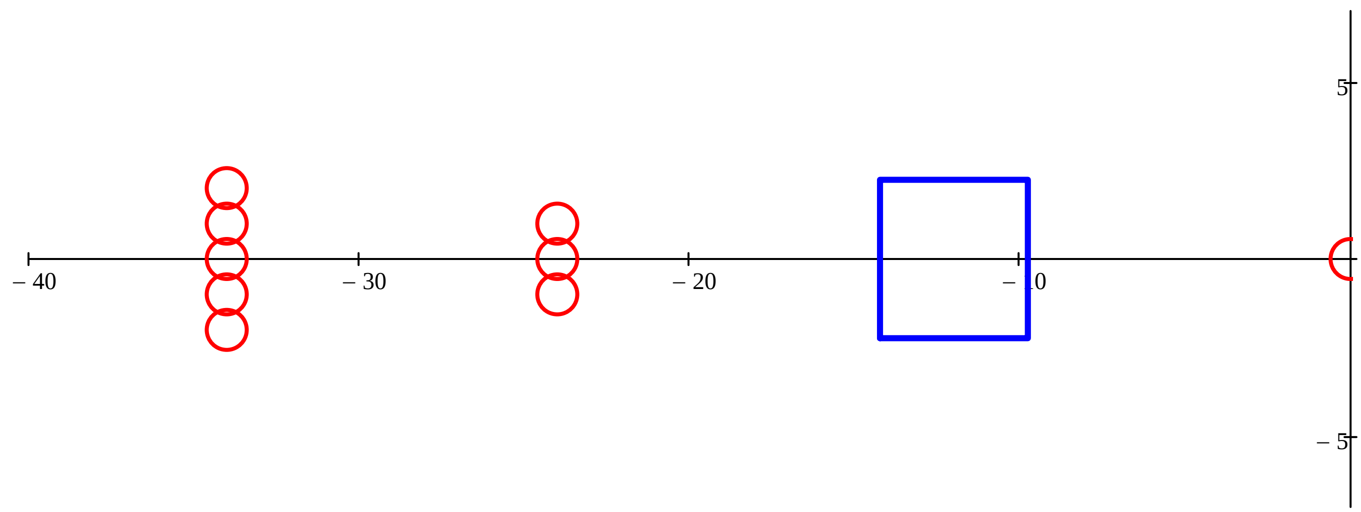
*inches, this value is used for one piece arms (FD)*

*inches, for 2 piece arms, wall thickness of piece closest to the pole, use X to zero out (FH)*

Arm 1 Properties

Analyze Arm 1

## Summary - Arm 1 Geometry and Loading




Location of Signs and Signals

$WindSpeed = 130 \cdot mph$  $L_{total.arm1} = 46\,ft$

$Diameter_{tip.arm1} = \begin{pmatrix} 7.08 \\ 11.22 \end{pmatrix} \cdot in$  $Diameter_{base.arm1} = \begin{pmatrix} 12 \\ 13 \end{pmatrix} \cdot in$  $L_{arm1} = \begin{pmatrix} 35.1 \\ 12.9 \end{pmatrix} ft$  $t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$

$X_{signal.arm1_{i1}} =$

| | |
|---|---|
| 24 | ft |
| 34 | |

$Sections_{signal.arm1_{i1}} =$

| |
|---|
| 3 |
| 5 |

$X_{panel.arm1_{j1}} =$ 12 ft

$Area_{panel.arm1_{j1}} =$ 20 $ft^2$

## Arm 1 Combined Stress Ratio and Deflection

$\max(CSR_{arm1}) = 0.571$  $\max(\Delta_{arm1}) = 4.708 \cdot in$  $2 \cdot deg \cdot \sum (L_{arm1} - L_{splice.provided}) = 18.43 \cdot in$

# Arm 2 Analysis

DataFile = "Cortez 1 NE Review_E.dat"   WindSpeed = 130 mph

Arm 2 Loads

$$SignalData_{arm2} = \begin{pmatrix} \text{"SignalNumber"} & \text{"DistanceToSignal(ft)"} & \text{"NumberOfSignalHeads"} & \text{"BackPlate"} \\ 1 & 0 & 0 & \text{"yes"} \\ 2 & 0 & 0 & \text{"yes"} \\ 3 & 0 & 0 & \text{"yes"} \\ 4 & 0 & 0 & \text{"yes"} \\ 5 & 0 & 0 & \text{"yes"} \\ 6 & 0 & 0 & \text{"yes"} \\ 7 & 0 & 0 & \text{"yes"} \\ 8 & 0 & 0 & \text{"yes"} \\ 9 & 0 & 0 & \text{"yes"} \\ 10 & 0 & 0 & \text{"yes"} \end{pmatrix}$$

*use X to zero out data*
*use 0 to keep current values*   *"yes" or "no"*

## New Values

| "SignalNumber" | "DistToSignal(ft)" | "#SignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 0 | 0 | "yes" |
| 2 | 0 | 0 | "yes" |
| 3 | 0 | 0 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

$$SignData_{arm2} = \begin{pmatrix} \text{"PanelNumber"} & \text{"DistanceToPanelCentroid(ft)"} & \text{"PanelArea(sf)"} \\ 1 & 0 & 0 \\ 2 & 0 & 0 \\ 3 & 0 & 0 \\ 4 & 0 & 0 \\ 5 & 0 & 0 \end{pmatrix}$$

## New Values

| "Panel#" | "DistToCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 0 | 0 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

*use X to zero out*
*use 0 to keep current values*

Arm 2 Properties

## Current Values

## New Values

$L_{total.arm2} = 0\,ft$ | [ ] | *feet, 40 ft. max. for 1 piece arms, use X to zero out* *set* $L_{total.arm2} = 0ft$ *for NO ARM2*

$Diameter_{base.arm2} = 0 \cdot in$ | [ ] | *inches, measured flat to flat, use X to zero out (SG)*

$Dist_{splice.from.base.arm2} = 0 \cdot ft$ | [ ] | *feet, splice distance, for 2 piece arms, length of piece closest to pole, use X to zero out (SE)*

*set* $Dist_{splice.from.base.arm2} = 0ft$ *for NO SPLICE*

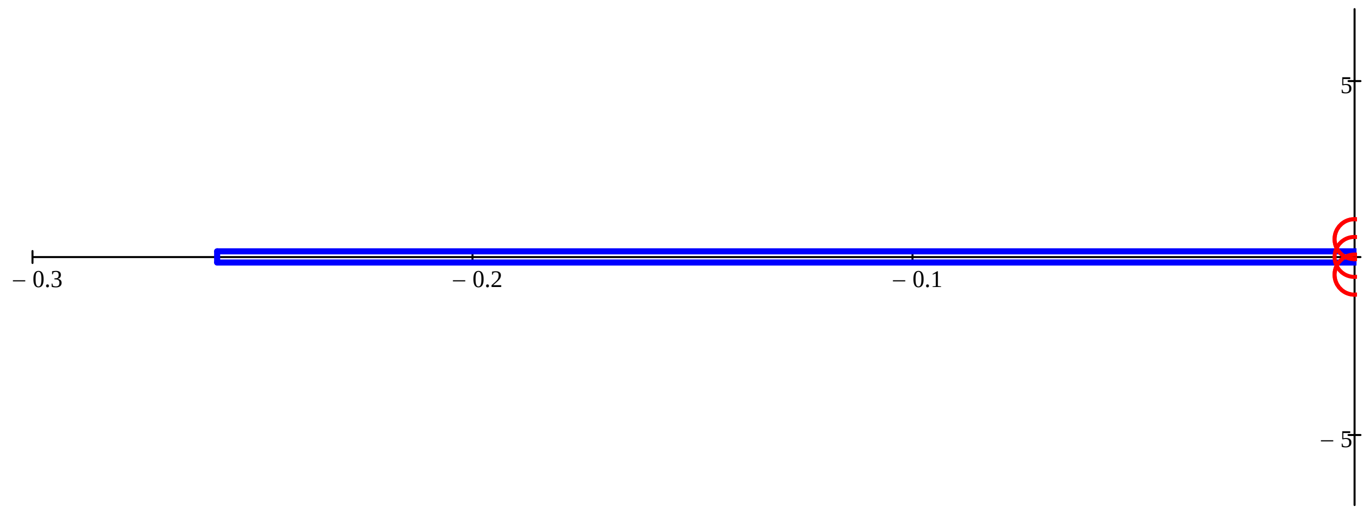
$t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ | [ ] | *inches, use X to zero out (SD)*

[ ] | *inches, for 2 piece arms, wall thickness of piece closest to the pole, use X to zero out (SH)*

Arm 2 Properties

## Summary - Arm 2 Geometry and Loading

Analyze Arm 2




Location of Signs and Signals

$WindSpeed = 130 \cdot mph$ $\quad L_{total.arm2} = 0\,ft$

$Diameter_{tip.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ $\quad Diameter_{base.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ $\quad L_{arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} ft$ $\quad t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$

| $X_{signal.arm2_{i2}} =$ (ft) | $Sections_{signal.arm2_{i2}} =$ | $X_{panel.arm2_{j2}} =$ (ft) | $Area_{panel.arm2_{j2}} =$ ($ft^2$) |
|---|---|---|---|
| 0 | 0 | 0.1 | 0.1 |
| 0 | 0 | | |

## Arm 2 Combined Stress Ratio and Deflection

$max(CSR_{arm2}) = 0$ $\quad max(\Delta_{arm2}) = 0 \cdot in$ $\quad 2 \cdot deg \cdot \sum (L_{arm2} - L_{splice.provided}) = -1.68 \cdot in$

# Luminaire Arm Analysis

DataFile = "Cortez 1 NE Review_E.dat"  WindSpeed = 130·mph

Luminaire Properties

*See Design Standards 17743 and 17745 for input values.*

## Current Values

## New Values

*set* $Y_{luminaire} = 0ft$ *for NO LUMINAIRE*

| Current Values | New Values | |
|---|---|---|
| $Y_{luminaire} = 0\ ft$ | | *feet, use X to zero out (Standard LA = 40 feet)* |
| $X_{luminaire} = 10 \cdot ft$ | | *feet, use X to zero out (Standard LB = 10 feet)* |
| $Diameter_{base.lumarm} = 3 \cdot in$ | | *inches, use X to zero out (Standard LC = 3 inches)* |
| $t_{wall.lumarm} = 0.125 \cdot in$ | | *inches, use X to zero out (Standard LD = 0.125 inches)* |
| $Slope_{lumarm} = 0.5$ | | *rise/run, use X to zero out (Standard LE = 0.5)* |
| $r_{lumarm} = 8 \cdot ft$ | | *feet, use X to zero out (Standard LF = 8 feet)* |
| $d_{bolt.lum} = 0.5 \cdot in$ | | *inches, use X to zero out (Standard LG = 0.5 inches)* |
| $t_{baseplate.lum} = 0.75 \cdot in$ | | *inches, use X to zero out (Standard LH = 0.75 inches)* |

Luminaire Properties

Analyze Luminaire

## Summary - Luminaire Arm Geometry

$Y_{luminaire} = 0\ ft$  $X_{luminaire} = 0 \cdot ft$  $Diameter_{base.lumarm} = 0 \cdot in$  $t_{wall.lumarm} = 0 \cdot in$

$Slope_{lumarm} = 0$  $r_{lumarm} = 0 \cdot ft$  $d_{bolt.lum} = 0 \cdot in$  $t_{baseplate.lum} = 0 \cdot in$

$w_{base.lum} = 0 \cdot in$  $w_{channel.lum} = 0 \cdot in$

## Luminaire Arm Ratios

$CSR_{base.lumarm} = 0$  $PR_{bolt.lum} = 0$  $PR_{baseplate.lum} = 0$  $PR_{conn.plate.lum} = 0$

# Upright Analysis

DataFile = "Cortez 1 NE Review_E.dat"  WindSpeed = 130·mph

Pole Properties

## Current Values

$Y_{pole} = 21.5\,ft$

$Y_{arm.conn} = 20\,ft$

$Diameter_{base.pole} = 16 \cdot in$

$t_{wall.pole} = 0.375 \cdot in$

$Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$

## New Values

*feet (UA)*

*feet (UB)*

*inches, measured flat to flat (UD)*

*inches (UE)*

*inches, clear distance between connection plate and upright*

*inches, use X to zero out*

*Common wall thicknesses:*
*0.1793 in.*
*0.2391 in.*
*0.25 in.*
*0.313 in.*
*0.375 in.*
*0.5 in.*

Pole Properties

## Summary - Upright Geometry

$Y_{pole} = 21.5\,ft$  $Y_{arm.conn} = 20\,ft$  $\alpha = 0 \cdot deg$  $Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$

$Diameter_{base.pole} = 16 \cdot in$  $t_{wall.pole} = 0.375 \cdot in$

## Upright Combined Stress Ratio and Deflections

$\max(CSR_{pole}) = 0.531$  $\max(\Delta_{x.dl}) = 0.88 \cdot in$  $\max(\Delta_{z.dl}) = 0 \cdot in$

## Mast Arm Connection(s) Analysis

DataFile = "Cortez 1 NE Review_E.dat"   WindSpeed = 130·mph

Connection Properties

### Current Values

### New Values

$h_{conn.plate} = 22 \cdot in$

*inches, for two arm Mast Arms both connection plate heights must be equal (HT)*

$t_{vertical.plate} = \begin{pmatrix} 0.5 \\ 0 \end{pmatrix} \cdot in$

*inches (FL)*

*inches, use X to zero out (SL)*

$d_{bolt.conn} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \cdot in$

*inches (FP)*

*inches, use X to zero out (SP)*

$t_{baseplate.arm} = \begin{pmatrix} 2 \\ 0 \end{pmatrix} \cdot in$

*inches (FK)*

*inches, use X to zero out (SK)*

Connection Properties

## Summary - Connection Geometry

$h_{conn.plate} = 22 \cdot in$   $Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$   $Offset_{conn} = \begin{pmatrix} 14.1146 \\ 0 \end{pmatrix} \cdot in$

$d_{bolt.conn} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \cdot in$   $\#ConnBolts = \begin{pmatrix} 6 \\ 0 \end{pmatrix}$   $Spacing_{bolts.conn} = \begin{pmatrix} 9 \\ 0 \end{pmatrix} \cdot in$

$t_{conn.plate} = \begin{pmatrix} 1.5 \\ 0 \end{pmatrix} \cdot in$   $b_{conn.plate} = \begin{pmatrix} 23 \\ 0 \end{pmatrix} \cdot in$   $t_{vertical.plate} = \begin{pmatrix} 0.5 \\ 0 \end{pmatrix} \cdot in$   $t_{baseplate.arm} = \begin{pmatrix} 2 \\ 0 \end{pmatrix} \cdot in$

$w_{conn.plate} = \begin{pmatrix} 0.3125 \\ 0 \end{pmatrix} \cdot in$   $w_{vertical.plate} = \begin{pmatrix} 0.3125 \\ 0 \end{pmatrix} \cdot in$

## Connection Ratios

$PR_{bolt} = \begin{pmatrix} 0.636 \\ 0 \end{pmatrix}$   $CSR_{t.vert.plate} = \begin{pmatrix} 0.627 \\ 0 \end{pmatrix}$   $PR_{t.baseplate.arm} = \begin{pmatrix} 0.839 \\ 0 \end{pmatrix}$   $PR_{t.connplate.arm} = \begin{pmatrix} 0.998 \\ 0 \end{pmatrix}$

## Base Plate Analysis

DataFile = "Cortez 1 NE Review_E.dat"    WindSpeed = 130·mph

Base Plate Properties

### Current Values | New Values

#AnchorRods = 6    *use 6 bolts minimum*

$d_{bolt.pole} = 1.5\cdot in$    *inches (BC)*

Base Plate Properties

### Summary - Upright Base Plate Geometry

#AnchorRods = 6 & Anchors — $d_{bolt.pole} = 1.5\cdot in$ — $t_{baseplate.pole} = 2.5\cdot in$ — $Diameter_{baseplate.pole} = 28\cdot in$

### Upright Base Plate Performance Ratios

$PR_{rod} = 0.656$    $PR_{plate.pole} = 1$

## Foundation Analysis    Cohesionless or Cohesive Soil

DataFile = "Cortez 1 NE Review_E.dat"

Soil Properties

### Current Values | New Values

SoilType = 1    ○ Clay ◉ Sand    *0 - clay 1 - sand*

$\phi_{soil} = 30\cdot deg$    *degrees, soil friction angle (sand)*

$c_{soil} = 2000\cdot psf$    *psf, soil shear strength (clay)*

$\gamma_{soil} = 42.6\cdot pcf$    *pcf, soil density (typical design value = 45-50 pcf)*

Offset = 0 ft    *vertical distance between top of foundation and groundline*

$N_{blows} = 15$    *Number of blows per foot.*
*If N< 5, contact the district geotech Engineer*    ***SM V3 13.6***

Soil Properties

Analyze Foundation

### Switch values, set values for DataOut, and Write Out Data to DataFile and Temp.dat

out := out + 1    out = 35

SoilType := if (newSoilType = 0, 0, 1)    $data_{out} :=$ SoilType    $data_{out} = 1$

out := out + 1    out = 36

$\phi_{soil} := fSwitchData(\phi_{soil}, new\phi_{soil}, deg)$    $data_{out} := \frac{\phi_{soil}}{deg}$    $data_{out} = 30$

$out := out + 1 \quad out = 37$

$c_{soil} := fSwitchData(c_{soil}, newc_{soil}, psf)$ $\qquad data_{out} := \frac{c_{soil}}{psf}$ $\qquad data_{out} = 2000$

$out := out + 1 \quad out = 38$

$\gamma_{soil} := fSwitchData(\gamma_{soil}, new\gamma_{soil}, pcf)$ $\qquad data_{out} := \frac{\gamma_{soil}}{pcf}$ $\qquad data_{out} = 42.6$

$out := out + 1 \quad out = 39$

$\gamma_{water} := 62.4 \cdot pcf$ *(not used)* $\qquad data_{out} := \frac{\gamma_{water}}{pcf}$ $\qquad data_{out} = 62.4$

$out := out + 1 \quad out = 40$

$Offset := fSwitchData(Offset, newOffset, ft)$ $\qquad data_{out} := \frac{Offset}{ft}$ $\qquad data_{out} = 0$

$out := out + 1 \quad out = 41$

$N_{blows} := fSwitchData(N_{blows}, newN_{blows}, 1)$ $\qquad data_{out} := \frac{N_{blows}}{1}$ $\qquad data_{out} = 15$

$out := out + 1 \quad out = 42$

Subject := if (newSubject = 0, Subject, newSubject) $\qquad data_{out}$ := Subject

$data_{out}$ = "Cortez - 43rd St W E Rev"

$out := out + 1 \quad out = 43$

ProjectNo := if (newProjectNumber = 0, ProjectNo, newProjectNumber) $\qquad data_{out}$ := ProjectNo

$data_{out}$ = "404-6002870"

$out := out + 1 \quad out = 44$

PoleLocation := if (newPoleLocation = 0, PoleLocation, newPoleLocation) $\qquad data_{out}$ := PoleLocation

$data_{out}$ = "Pole 1 - NE Corner"

$out := out + 1 \quad out = 45$

Date := if (newDate = 0, Date, newDate) $\qquad data_{out}$ := Date

$data_{out}$ = "06/21/2018"

$out := out + 1 \quad out = 46$

DesignedBy := if (newDesignedBy = 0, DesignedBy, newDesignedBy) $\qquad data_{out}$ := DesignedBy

$data_{out}$ = "SML"

$out := out + 1 \quad out = 47$

CheckedBy := if (newCheckedBy = 0, CheckedBy, newCheckedBy) $\qquad data_{out}$ := CheckedBy

$data_{out}$ = " "

WRITEPRN(DataFile) := data $\qquad$ WRITEPRN("temp.dat") := data

## Foundation Design References

*LRFD = AASHTO LRFD Bridge Design Specifications*

*SM V3 = FDOT Structures Manual Volume 3*

*SDG = FDOT Structures Design Guidelines*

*Spec = FDOT Standard Specifications*

*ACI = ACI 318 Structural Concrete Building Code*

*UF Report = FDOT/University of Florida Report BD545 RPWO #54*

## Applied Loads

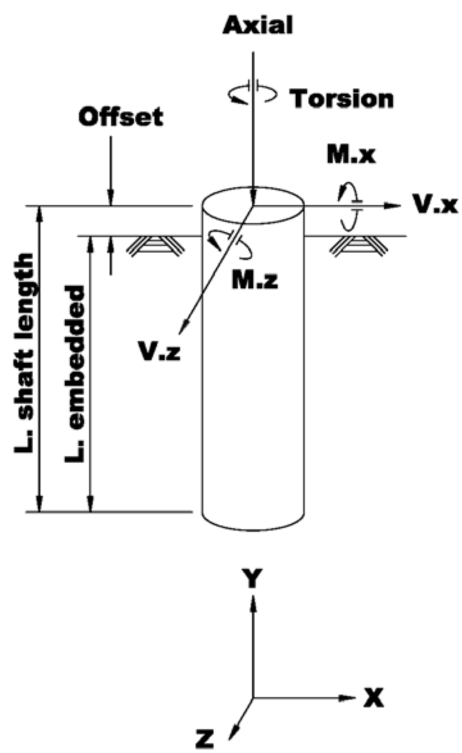
*(From Arm1 Design)*

$\text{WindSpeed} = 130 \cdot \text{mph}$

*(from Base Plate Design)*

$\#\text{AnchorRods} = 6$ $\quad d_{bolt.pole} = 1.5 \cdot \text{in}$ $\quad \text{Diameter}_{boltcircle.pole} = 22 \cdot \text{in}$ $\quad T_{u.rod} = 35.2 \cdot \text{kip}$

*(from Upright Design)*




$M_{x.polebase} = \begin{pmatrix} 0 \\ 89.3 \\ 89.3 \end{pmatrix} \cdot \text{kip} \cdot \text{ft}$ $\quad M_{y.polebase} = \begin{pmatrix} 90.9 \\ 0 \\ 90.9 \end{pmatrix} \cdot \text{kip} \cdot \text{ft}$ $\quad M_{z.polebase} = \begin{pmatrix} 0 \\ 36.8 \\ 36.8 \end{pmatrix} \cdot \text{kip} \cdot \text{ft}$

$\text{LoadCaseT} = 0$

$\text{LoadCaseOT} = 1$

$\text{LoadCaseCSR} = 2$

$V_{x.polebase} = \begin{pmatrix} 0 \\ 0.2 \\ 0.2 \end{pmatrix} \cdot \text{kip}$ $\quad \text{AxialForce}_{polebase} = \begin{pmatrix} 3 \\ 3 \\ 3 \end{pmatrix} \cdot \text{kip}$ $\quad V_{z.polebase} = \begin{pmatrix} 0 \\ 4.9 \\ 4.9 \end{pmatrix} \cdot \text{kip}$

## Foundation Diameter

$Diameter_{shaft} := Diameter_{boltcircle.pole} + 12 \cdot in + 12 \cdot in$ $\quad$ $Diameter_{shaft} = 3.83 \cdot ft$

*round shaft diameter up to the nearest half foot dimension to accommodate available coring equipment*

$Diameter_{shaft} := Ceil\left(Diameter_{shaft}, \frac{1}{2} \cdot ft\right)$ $\quad$ $Diameter_{shaft} = 4\,ft$

$Diameter_{shaft.custom} := 3.5 \cdot ft$

*SML change from 0.0 ft to 3.5 ft for actual drilled shaft diamter*

$Diameter_{shaft} := if\left(Diameter_{shaft.custom} > 0 \cdot ft, Diameter_{shaft.custom}, Diameter_{shaft}\right) = 1.1$

$Diameter_{shaft} = 3.5\,ft$

$b := Diameter_{shaft}$

## Shaft Depth Required to Resist Overturning

$SF_{ot} := 2$ *Safety Factor against Overturning* ***SM V3 13.6***

$Offset = 0 \cdot ft$ *vertical distance between top of foundation and groundline*

$$M_{total} := SF_{ot} \cdot \frac{\sqrt{\left(M_{x.polebase_{LoadCaseOT}}\right)^2 + \left(M_{z.polebase_{LoadCaseOT}}\right)^2}}{C_{a.pole}}$$

$M_{total} = 193.8 \cdot kip \cdot ft$

$$P_{total} := SF_{ot} \cdot \sqrt{\left(V_{x.polebase_{LoadCaseOT}}\right)^2 + \left(V_{z.polebase_{LoadCaseOT}}\right)^2}$$

$P_{total} = 9.8 \cdot kip$

*short free-head pile in cohesionless soil using Broms method*

$$K_p := \tan\left(45 \cdot deg + \frac{\phi_{soil}}{2}\right)^2$$

$e_{sand} := Offset$

*Guess value* $\quad L_{otSand} := 8 \cdot ft$

Given $\quad \dfrac{\gamma_{soil} \cdot b \cdot L_{otSand}^{\,3} \cdot K_p}{2} - P_{total} \cdot \left(e_{sand} + L_{otSand}\right) - M_{total} = 0 \cdot kip \cdot ft$

$Temp := Find\left(L_{otSand}\right)$ $\quad$ $L_{otSand} := Temp$ $\quad$ $L_{otSand} = 11.1 \cdot ft$

*(round up to next foot)* $\quad L_{otSand} := ceil\left(\frac{L_{otSand}}{ft}\right) \cdot ft$ $\quad$ $L_{otSand} = 12\,ft$

$$PR_{otSand} := \frac{M_{total} + P_{total} \cdot \left(e_{sand} + L_{otSand}\right)}{\dfrac{\gamma_{soil} \cdot b \cdot L_{otSand}^{\,3} \cdot K_p}{2}}$$

$PR_{otSand} = 0.8$

*short free-head pile in* *<u>cohesive soil</u>* *using Modified Broms method for L < 3b (see reference file for derivation)*

$c_{soil} := \text{if}\left(c_{soil} = 0\cdot ksf, 0.1\cdot ksf, c_{soil}\right)$  $Slope := 8\cdot\frac{c_{soil}}{3\cdot b}$  $e_{clay} := \frac{M_{total}}{P_{total}} + Offset$

$nforce(M,N) := \left[Slope\cdot(2\cdot M + N) + 2\cdot c_{soil}\right]\cdot N\cdot\frac{b}{2}$  $mforce(M) := \left(2\cdot c_{soil} + M\cdot Slope\right)\cdot M\cdot\frac{b}{2}$

$$m\_arm(M) := e_{clay} + \frac{M}{3}\cdot\frac{2\cdot\left(M\cdot Slope + c_{soil}\right) + c_{soil}}{M\cdot Slope + 2\cdot c_{soil}}$$

$$n\_arm(M,N) := e_{clay} + M + \frac{N}{3}\cdot\frac{2\cdot\left(N\cdot Slope + M\cdot Slope + c_{soil}\right) + \left(M\cdot Slope + c_{soil}\right)}{Slope\cdot(2\cdot M + N) + 2\cdot c_{soil}}$$

*Guess value*  $M := 4.0\cdot ft$  $N := 4.0\cdot ft$

Given  $P_{total} + nforce(M,N) = mforce(M)$  $mforce(M)\cdot m\_arm(M) = nforce(M,N)\cdot n\_arm(M,N)$

$\begin{pmatrix} M \\ N \end{pmatrix} := Find(M,N)$  $L_{ot1Clay.temp} := M + N$  $L_{ot1Clay.temp} = 6.6\cdot ft$

*(round up to next foot)*  $L_{ot1Clay} := ceil\left(\frac{L_{ot1Clay.temp}}{ft}\right)\cdot ft$  $L_{ot1Clay} = 7\cdot ft$

*short free-head pile in* *<u>cohesive soil</u>* *using Regular Broms method for L > 3b*

$f_{clay} := \frac{P_{total}}{9\cdot c_{soil}\cdot b}$  $M_{maxtemp} := P_{total}\cdot\left(e_{clay} + 1.5\cdot b + 0.5\cdot f_{clay}\right)$  $g := \sqrt{\frac{M_{maxtemp}}{2.25\cdot c_{soil}\cdot b}}$

$L_{ot2Clay} := \left(1.5\cdot b + f_{clay} + g\right)$  $L_{ot2Clay} = 9.4\,ft$

*(round up to next foot)*  $L_{ot2Clay} := ceil\left(\frac{L_{ot2Clay}}{ft}\right)\cdot ft$  $L_{ot2Clay} = 10\cdot ft$

$L_{otClay} := \text{if}\left(L_{ot1Clay} < 3\cdot b, L_{ot1Clay}, L_{ot2Clay}\right)$  $L_{otClay} = 7\cdot ft$

*(If $L_{ot} < 3b$, use Modified Broms method)*

$$PR_{otClay} := \text{if}\left(L_{otClay} < 3\cdot b, \frac{L_{ot1Clay.temp}}{L_{ot1Clay}}, \frac{\sqrt{\frac{M_{maxtemp}}{2.25\cdot c_{soil}\cdot b}} + \frac{P_{total}}{9\cdot c_{soil}\cdot b}}{L_{ot2Clay} - 1.5\cdot b}\right)$$  $PR_{otClay} = 0.9$

$L_{reqdOT} := \text{if}(\text{SoilType} = 1, L_{otSand}, L_{otClay})$ $\qquad L_{reqdOT} = 12\,\text{ft}$

$PR_{ot} := \text{if}(\text{SoilType} = 1, PR_{otSand}, PR_{otClay})$ $\qquad PR_{ot} = 0.8$

## Shaft Depth Required to Resist Torsion

$SF_{tor} := \mathbf{1.0}$ *Safety Factor against Torsion*
*1.0 for Mast Arm signal structures*

***SM V3 13.6***

*NOTE: $\omega_{fdot}$ and $\mu$ are based upon CONCRETE and soil interaction.* ***This torsion methodology is not to be used with permanent casing.***

$N_{blows} = 15$ *Number of blows per foot. If N< 5, contact the district geotech Engineer*

$\omega_{fdot} := \text{if}\left(N_{blows} < 5, 0, \text{if}\left(N_{blows} \geq 15, 1.5, 1.5 \cdot \frac{N_{blows}}{15}\right)\right) = 1.5$ *load transfer ratio*

$\mu := \tan(\phi_{soil}) = 0.6$ *coefficient of friction between concrete shaft and soil*

$\gamma_{concrete} := 150 \cdot \text{pcf}$ $\qquad \gamma_{concrete} := \gamma_{concrete} - \gamma_{water}$ $\qquad \gamma_{concrete} = 87.6 \cdot \text{pcf}$

$\text{CohesionFactor} := 0.55$ $\qquad f_{se} := \text{CohesionFactor} \cdot c_{soil}$

$\text{Torsion} := M_{y.polebase_{LoadCaseT}}$ $\qquad \text{Torsion} = 90.9 \cdot \text{kip} \cdot \text{ft}$

*short free-head pile in cohesionless soil*

*Guess value* $\qquad L_{torSand} := L_{reqdOT}$

Given

$$\text{Torsion} \cdot SF_{tor} = \left[\pi \cdot b \cdot (L_{torSand}) \cdot \gamma_{soil} \cdot \left(\frac{L_{torSand}}{2}\right) \cdot (\omega_{fdot}) \cdot \frac{b}{2} + \pi \cdot \left(\frac{b}{2}\right)^2 \cdot L_{torSand} \cdot (\gamma_{concrete}) \cdot \frac{b}{3} \cdot \mu\right]$$

$\text{Temp} := \text{Find}(L_{torSand})$ $\qquad L_{torSand} := \text{Temp}$ $\qquad L_{torSand} = 11.7\,\text{ft}$

*(round up to next foot)* $\qquad L_{torSand} := \text{ceil}\left(\frac{L_{torSand}}{\text{ft}}\right) \cdot \text{ft}$ $\qquad L_{torSand} = 12\,\text{ft}$

$$PR_{torSand} := \frac{\text{Torsion} \cdot SF_{tor}}{\pi \cdot b \cdot (L_{torSand}) \cdot \gamma_{soil} \cdot \left(\frac{L_{torSand}}{2}\right) \cdot (\omega_{fdot}) \cdot \frac{b}{2} + \pi \cdot \left(\frac{b}{2}\right)^2 \cdot L_{torSand} \cdot (\gamma_{concrete}) \cdot \frac{b}{3} \cdot \mu} \qquad PR_{torSand} = 1$$

*short free-head pile in cohesive soil*

*Guess value* $\qquad L_{torClay} := L_{reqdOT}$

Given $\quad Torsion \cdot SF_{tor} = \left[f_{se} \cdot (\pi \cdot b) \cdot (L_{torClay} - 1.5 \cdot ft) \cdot \frac{b}{2}\right] + \left[f_{se} \cdot \pi \cdot \left(\frac{b}{2}\right)^2 \cdot \left(\frac{b}{3}\right)\right]$

$Temp := Find(L_{torClay})$ $\qquad L_{torClay} := Temp$ $\qquad L_{torClay} = 5.21\,ft$

*(round up to next foot)* $\qquad L_{torClay} := ceil\left(\frac{L_{torClay}}{ft}\right) \cdot ft$ $\qquad L_{torClay} = 6\,ft$

$$PR_{torClay} := \frac{Torsion \cdot SF_{tor}}{\left[f_{se} \cdot (\pi \cdot b) \cdot (L_{torClay} - 1.5 \cdot ft) \cdot \frac{b}{2}\right] + \left[f_{se} \cdot \pi \cdot \left(\frac{b}{2}\right)^2 \cdot \left(\frac{b}{3}\right)\right]}$$ $\qquad PR_{torClay} = 0.8$

$L_{reqdTor} := if(SoilType = 1, L_{torSand}, L_{torClay})$ $\qquad L_{reqdTor} = 12\,ft$

$PR_{tor} := if(SoilType = 1, PR_{torSand}, PR_{torClay})$ $\qquad PR_{tor} = 1$

$L_{embedded} := if(L_{reqdTor} > L_{reqdOT}, L_{reqdTor}, L_{reqdOT})$ $\qquad L_{embedded} = 12\,ft$

$L_{shaft} := L_{embedded} + Offset$ $\qquad L_{shaft} = 12\,ft$

$L_{shaft} := 14 \cdot ft$ $\qquad$ *Actual Drilled Shaft L = 14'* $\qquad L_{shaft} = 14\,ft$

$PR_{foundation} := if(L_{reqdTor} > L_{reqdOT}, PR_{tor}, PR_{ot})$ $\qquad PR_{foundation} = 0.805$

## Unfactored Maximum Moment in Shaft

*short free-head pile in cohesionless soil using Broms method*

$$f_{sand} := \sqrt{\frac{2 \cdot \frac{P_{total}}{SF_{ot}}}{3 \cdot \gamma_{soil} \cdot b \cdot K_p}}$$ $\qquad f_{sand} = 2.7\,ft$

$$M_{maxSand} := \frac{P_{total}}{SF_{ot}} \cdot (e_{sand} + f_{sand}) - \frac{\frac{P_{total}}{SF_{ot}} \cdot f_{sand}}{3} + \frac{M_{total}}{SF_{ot}}$$ $\qquad M_{maxSand} = 105.7 \cdot kip \cdot ft$

*short free-head pile in cohesive soil using Modified Broms method for L < 3b (see reference file for derivation)*

*Guess value* $\quad f_{mod} := 4.0 \cdot ft$

Given $\quad \frac{P_{total}}{SF_{ot}} = \frac{f_{mod} \cdot b}{2} \cdot (2 \cdot c_{soil} + f_{mod} \cdot Slope)$

$f_{mod} := Find(f_{mod})$ $\qquad f_{mod} = 0.6\,ft$

$$M_{modBroms} := \frac{P_{total}}{SF_{ot}} \cdot (e_{clay} + f_{mod}) - \frac{c_{soil} \cdot b \cdot f_{mod}^2}{2} - \frac{b \cdot f_{mod}^3 \cdot Slope}{6}$$ $\qquad M_{modBroms} = 98.4 \cdot kip \cdot ft$

*short free-head pile in cohesive soil using Regular Broms method for L > 3b*

$$M_{Broms} := \frac{P_{total}}{SF_{ot}} \cdot \left(e_{clay} + 1.5 \cdot b + 0.5 \cdot f_{clay}\right)$$ $M_{Broms} = 122.9 \cdot kip \cdot ft$

$$M_{maxClay} := if\left(L_{ot1Clay} < 3 \cdot b, M_{modBroms}, M_{Broms}\right)$$ $M_{maxClay} = 98.4 \cdot kip \cdot ft$

*(If $L_{ot} < 3b$, use Modified Broms method)*

$$M_{max} := if\left(SoilType = 1, M_{maxSand}, M_{maxClay}\right)$$

*(this is a Service moment)* $M_{max} = 105.7 \cdot kip \cdot ft$

## Minimum Reinforcing and Spacing

| | | | |
|---|---|---|---|
| $F_{y.rebar} := 60 \cdot ksi$ | *reinforcing yield strength* | | |
| $f_c := 4.0 \cdot ksi$ | *concrete strength* | ***Spec 346-3*** | |
| $cover := 6 \cdot in$ | *cover* | ***SDG Table 1.4.2-1*** | *Cover okay at 6"* |
| $A_{bar} := 1.56 \cdot in^2$ | *longitudinal bar area* | | *Main bar size okay, using #11s* |
| $d_{bar} := 1.41 \cdot in$ | *longitudinal bar diameter* | | |
| | | | *Stirrup bar size okay, using #5s* |
| $A_{v.bar} := 0.31 \cdot in^2$ | *stirrup area* | | ***SM V3 13.6.2*** |
| $d_{v.bar} := 0.625 \cdot in$ | *stirrup diameter* | | *Stirrup $s_{v1}$ spacing okay, using 4"* |
| $s_{v1} := 4 \cdot in$ | *stirrup spacing, depth = 0 ft-2 ft* | | ***SM V3 13.6.2*** |
| $s_{v2} := 18 \cdot in$ | *stirrup spacing, depth = 2 ft-depth.stir* | | *Stirrup $s_{v2}$ spacing adjusted from 12'to 18"* |
| $s_{v3} := 18 \cdot in$ | *stirrup spacing, depth > depth.stir* | | *Stirrup $s_{v3}$ spacing adjusted from 12'to 18"* |
| $depth_{stir} := 12 \cdot ft$ | *stirrup depth, see s.v2 and s.v3 above* | | |
| $b = 3.5\,ft$ | *shaft diameter* | | |

$$BarsProv_1 := \frac{0.01}{A_{bar}} \cdot \frac{\pi \cdot b^2}{4}$$ $BarsProv_1 = 8.9$ ***LRFD 5.7.4.2***

$$BarsProv_2 := \frac{0.135}{A_{bar} \cdot F_{y.rebar}} \cdot \left(\frac{\pi \cdot b^2}{4} \cdot f_c\right)$$ $BarsProv_2 = 8$

$$BarsProv := ceil\left(max\left(BarsProv_1, BarsProv_2\right)\right)$$ $BarsProv = 9$ *number of longitudinal bars*

$BarsProv := 10$ $BarsProv = 10$ *Main bar No. adjusted to 10*

$$NumSpaces_{v.bar} := round\left(\frac{depth_{stir} - 2\cdot ft}{s_{v2}}\right) \qquad NumSpaces_{v.bar} = 7$$

$$ReinfClearSpacing := \left[b - 2\cdot\left(cover + d_{v.bar} + \frac{d_{bar}}{2}\right)\right]\cdot\frac{\pi}{BarsProv} - d_{bar} \qquad ReinfClearSpacing = 7.18\cdot in$$

$CheckReinfClearSpacing := if(ReinfClearSpacing \geq 6in, "OK", "No Good")$ $CheckReinfClearSpacing = "OK"$

SDG 3.6.10

## Check Shear and Torsion

| | | |
|---|---|---|
| $LF_{shr} := \mathbf{1.3}$ | *Shear Load Factor* | *1.3 is a reasonable Load Factor for combined WL + DL on sign and signal structures* |
| $LF_{tor} := \mathbf{1.3}$ | *Torsion Load Factor* | |
| $\phi_{shr} := \mathbf{0.90}$ | *Shear Resistance Factor* | LRFD 5.5.4.2.1 |
| $\phi_{tor} := \mathbf{0.90}$ | *Torsion Resistance Factor* | LRFD 5.5.4.2.1 |

$$V_u := LF_{shr}\cdot\sqrt{\left(V_{x.polebase_{LoadCaseOT}}\right)^2 + \left(V_{z.polebase_{LoadCaseOT}}\right)^2} \qquad V_u = 6.4\cdot kip$$

$$T_u := LF_{tor}\cdot Torsion \qquad T_u = 118.2\cdot kip\cdot ft$$

$Torsion = 90.9\cdot kip\cdot ft$

*Area and perimeter of concrete cross-section*

$$A_{cp} := \pi\cdot\left(\frac{b}{2}\right)^2 \qquad A_{cp} = 1385.4\cdot in^2$$

$$p_{cp} := 2\cdot\pi\cdot\left(\frac{b}{2}\right) \qquad p_{cp} = 131.9\cdot in$$

*Diameter, perimeter and area enclosed by the centerline of the outermost closed transverse torsion reinforcement*

$$d_{oh} := b - 2\cdot\left(cover + \frac{d_{v.bar}}{2}\right) \qquad d_{oh} = 29.4\cdot in$$

$$p_h := \pi\cdot d_{oh} \qquad p_h = 92.3\cdot in$$

$$A_{oh} := \pi\left(\frac{d_{oh}}{2}\right)^2 \qquad A_{oh} = 677.7\cdot in^2$$

$$A_o := 0.85\cdot A_{oh} \qquad A_o = 576.1\cdot in^2$$

LRFD C5.8.2.1

*Effective shear depth*

$$D_r := b - 2\cdot\left(cover + d_{v.bar} + \frac{d_{bar}}{2}\right) \qquad d_e := \frac{b}{2} + \frac{D_r}{\pi} = 2.5\,ft$$

LRFD C5.8.2.1

$$d_v := max\left(0.9\cdot d_e, 0.72\cdot b\right) = 2.5\,ft$$

*Check Shear Strength*

$$V_c := 0.0316\cdot(2.0)\cdot\sqrt{\frac{f_c}{ksi}}\cdot\left(\frac{d_v}{in}\right)\cdot\left(\frac{b}{in}\right)\cdot kip \qquad V_c = 160.5\cdot kip$$

LRFD Eqn 5.8.3.3-3
LRFD 5.8.3.4.1

ACI 11.3.3

$$V_s := \frac{A_{v.bar}\cdot F_{y.rebar}\cdot(d_v)}{\max(s_{v1}, s_{v2}, s_{v3})} \qquad V_s = 31.2\cdot kip$$

LRFD Eqn 5.8.3.3-4

$$\phi_{shr} = 0.9 \qquad V_u = 6.4\cdot kip$$

$$ShearRatio := \frac{V_u - \phi_{shr}\cdot V_c}{\phi_{shr}\cdot V_s} \qquad ShearRatio = -4.9$$

$$ShearRatio := if(ShearRatio \le 0, 0, ShearRatio) \quad ShearRatio = 0$$

*Check Torsion Strength*

$$T_{n1} := \frac{2\cdot A_o\cdot A_{v.bar}\cdot F_{y.rebar}}{s_{v1}} \qquad T_{n1} = 446.4\cdot kip\cdot ft$$

LRFD Eqn 5.8.3.6.2-1

LRFD 5.8.3.4.1

$$T_{n2} := \frac{2\cdot A_o\cdot A_{v.bar}\cdot F_{y.rebar}}{s_{v2}} \qquad T_{n2} = 99.2\cdot kip\cdot ft$$

$$T_{n3} := \frac{2\cdot A_o\cdot A_{v.bar}\cdot F_{y.rebar}}{s_{v3}} \qquad T_{n3} = 99.2\cdot kip\cdot ft$$

$$\phi_{tor} = 0.9 \qquad T_u = 118.2\cdot kip\cdot ft \qquad L_{reqdTor} = 12\,ft$$

$$Tor2_{sand} := T_u - if\left[2\cdot ft > Offset, \left[\pi\cdot b\cdot(2\cdot ft - Offset)\cdot\gamma_{soil}\cdot\left(\frac{2\cdot ft - Offset}{2}\right)\cdot(\omega_{fdot})\cdot\frac{b}{2}\right], 0\cdot kip\cdot ft\right] = 115.7\cdot kip\cdot ft$$

$$Tor3_{sand} := T_u - if\left[depth_{stir} > Offset, \left[\pi\cdot b\cdot(depth_{stir} - Offset)\cdot\gamma_{soil}\cdot\left(\frac{depth_{stir} - Offset}{2}\right)\cdot(\omega_{fdot})\cdot\frac{b}{2}\right], 0\cdot kip\cdot ft\right] = 29.6\cdot kip\cdot ft$$

$$Tor2_{clay} := T_u - if\left[2\cdot ft - 1.5\cdot ft > Offset, \left[f_{se}\cdot(\pi\cdot b)\cdot(2.0\cdot ft - Offset - 1.5\cdot ft)\cdot\frac{b}{2}\right], 0\cdot kip\cdot ft\right] = 107.6\cdot kip\cdot ft$$

$$Tor3_{clay} := T_u - if\left[depth_{stir} - 1.5\cdot ft > Offset, \left[f_{se}\cdot(\pi\cdot b)\cdot(depth_{stir} - Offset - 1.5\cdot ft)\cdot\frac{b}{2}\right], 0\cdot kip\cdot ft\right] = -104.1\cdot kip\cdot ft$$

$$Tor2 := if(SoilType = 1, Tor2_{sand}, Tor2_{clay}) \qquad Tor2 = 115.7\cdot kip\cdot ft$$

$$Tor3 := if(SoilType = 1, Tor3_{sand}, Tor3_{clay}) \qquad Tor3 = 29.6\cdot kip\cdot ft$$

$TorsionRatio_{n1} := \frac{T_u}{\phi_{tor} \cdot T_{n1}}$ $TorsionRatio_{n1} = 0.29$

$TorsionRatio_{n2} := \frac{Tor2}{\phi_{tor} \cdot T_{n2}}$ $TorsionRatio_{n2} = 1.3$

$TorsionRatio_{n3} := \frac{Tor3}{\phi_{tor} \cdot T_{n3}}$ $TorsionRatio_{n3} = 0.33$

$TorsionRatio := \max\left(TorsionRatio_{n1}, TorsionRatio_{n2}, TorsionRatio_{n3}\right)$ $TorsionRatio = 1.3$

$T_{cr} := 0.125\sqrt{\frac{f_c}{ksi}} \cdot \left(\frac{A_{cp}^{\,2}}{p_{cp} \cdot in^3}\right) \cdot kip \cdot in$ $T_{cr} = 303.1 \cdot kip \cdot ft$ ***LRFD Eqn 5.8.2.1-4***

$TorsionRatio := if\left(T_u \le 0.25 \cdot \phi_{tor} \cdot T_{cr}, 0, TorsionRatio\right)$ $TorsionRatio = 1.3$ ***LRFD Eqn 5.8.2.1-3***

$ShearRatio = 0$

$CheckShearTorsion := if(ShearRatio + TorsionRatio \le 1, \text{"OK"}, \text{"No Good"})$ $CheckShearTorsion = \text{"No Good"}$

$\boxed{ShearRatio + TorsionRatio = 1.3}$ *Should be 1.0 or less*

*Check Maximum Spacing Transverse Reinforcement*

$vu := \frac{V_u}{\phi_{shr} \cdot b \cdot (0.8 \cdot b)}$ $vu = 0.005005 \cdot ksi$ ***LRFD Eqn 5.8.2.9-1***

$0.125 \cdot f_c = 0.5 \cdot ksi$

$s_{max1} := if\left(0.8 \cdot d_v < 24 \cdot in, 0.8 \cdot d_v, 24 \cdot in\right)$ $s_{max1} = 24 \cdot in$ ***LRFD Eqn 5.8.2.7-1***

$s_{max2} := if\left(0.4 \cdot d_v < 12 \cdot in, 0.4 \cdot d_v, 12 \cdot in\right)$ $s_{max2} = 12 \cdot in$ ***LRFD Eqn 5.8.2.7-2***

$s_{max} := if\left(vu < 0.125 \cdot f_c, s_{max1}, s_{max2}\right)$ $s_{max} = 24 \cdot in$

$\max\left(s_{v1}, s_{v2}, s_{v3}\right) = 18 \cdot in$

$CheckMaxSpacingTransvReinf := if\left(\max\left(s_{v1}, s_{v2}, s_{v3}\right) \le s_{max}, \text{"OK"}, \text{"No Good"}\right)$ $CheckMaxSpacingTransvReinf = \text{"OK"}$

*Check Longitudinal Reinforcement for Combined Shear and Torsion* ***LRFD Eqn 5.8.3.6.3-1***

***LRFD 5.8.3.4.1***

$M_u := LF_{tor} \cdot \sqrt{\left(M_{x.polebase_{LoadCaseOT}}\right)^2 + \left(M_{z.polebase_{LoadCaseOT}}\right)^2}$ $M_u = 125.5 \cdot kip \cdot ft$

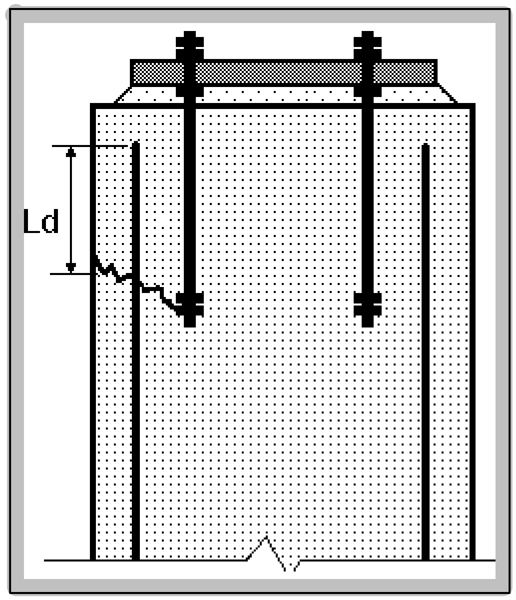
$V_{temp} := if\left(\frac{V_u}{\phi_{shr}} - 0.5 \cdot V_s > 0 \cdot kip, \frac{V_u}{\phi_{shr}} - 0.5 \cdot V_s, 0 \cdot kip\right)$ $V_{temp} = 0 \cdot kip$

$$LongReinf_{shr.tor} := \frac{\dfrac{M_u}{\phi_{tor}\cdot(0.8\cdot b)} + \sqrt{\left(\dfrac{V_{temp}}{kip}\right)^2 + \left(\dfrac{0.45\cdot p_h\cdot T_u}{2\cdot A_o\cdot\phi_{tor}\cdot kip}\right)^2}\cdot kip}{F_{y.rebar}} \qquad LongReinf_{shr.tor} = 1.8\cdot in^2$$

$$BarsProv\cdot A_{bar} = 15.6\cdot in^2$$

$$CheckLongReinf_{shr.tor} := if\left(BarsProv\cdot A_{bar} \ge LongReinf_{shr.tor}, \text{"OK"}, \text{"No Good"}\right) \qquad CheckLongReinf_{shr.tor} = \text{"OK"}$$

## Anchor Bolt Embedment




$$Gap_{shaft} := \frac{b - 2\cdot cover - 2\cdot d_{v.bar} - Diameter_{boltcircle.pole} - d_{bar}}{2}$$

$$Gap_{shaft} = 2.67\cdot in$$

$$Diameter_{rebar.circle} := b - 2\cdot cover - d_{bar} - 2\cdot d_{v.bar}$$

$$Diameter_{rebar.circle} = 27.3\cdot in$$

$$\#BarsProvided := BarsProv \qquad \#BarsProvided = 10$$

$$\#BarsProvidedPerRod := \min\left(\begin{pmatrix}\dfrac{\#BarsProvided}{\#AnchorRods}\\ 3\end{pmatrix}\right)$$

*Use a maximum of three rebar per anchor bolt (conservative)*

$$\#BarsProvidedPerRod = 1.7$$

$$\phi := 0.9 \qquad \#BarsReqdPerRod := \frac{T_{u.rod}}{A_{bar}\cdot(\phi\cdot F_{y.rebar})}\cdot\frac{Diameter_{boltcircle.pole}}{Diameter_{rebar.circle}} \qquad \#BarsReqdPerRod = 0.34$$

$$AreaRatio := \frac{\#BarsReqdPerRod}{\#BarsProvidedPerRod} \qquad AreaRatio = 0.2$$

$$AreaRatio := if(AreaRatio < 1, AreaRatio, 1) \qquad AreaRatio = 0.2$$

*2015 AASHTO Development Length of Deformed Bars in Tension* ***5.11.2.1***

$\text{cover} = 6 \cdot \text{in}$

$c_b$ = *the smaller of the distance from center of bar or wire being developed to the nearest concrete surface and one half the center-to-center spacing of the bars or wires being developed*

$$c_b := \min\left(\text{cover} + d_{v.bar} + \frac{d_{bar}}{2}, \frac{\text{ReinfClearSpacing} + d_{bar}}{2}\right) = 4.3 \cdot \text{in}$$

$k_{tr} := 0 \cdot \text{in}$ *assume no transverse bars:*

$$\lambda_{rc} := \min\left(1, \max\left(0.4, \frac{d_{bar}}{c_b + k_{tr}}\right)\right)$$ ***LRFD Eqn 5.11.2.1.3-1***

$\lambda_{rc} = 0.4$

$$L_{d.bar} := \max\left(12\text{in}, \lambda_{rc} \cdot 2.4 \cdot d_{bar} \cdot \frac{F_{y.rebar}}{\sqrt{f_c \cdot \text{ksi}}}\right)$$ *tension development length* ***LRFD Eqn 5.11.2.1.1-2***

$$\text{SpacingFactor} := \max\left(\begin{pmatrix} \#\text{BarsProvidedPerRod} \cdot 0.5 - 0.5 \\ 0.5 \end{pmatrix}\right)$$ $\text{SpacingFactor} = 0.5$

$$L_{embedment.added} := \sqrt{(\text{ReinfClearSpacing} \cdot \text{SpacingFactor})^2 + \text{Gap}_{shaft}^{\;2}}$$ $L_{embedment.added} = 4.5 \cdot \text{in}$

$$L_{embedment.rod} := \max\left[\begin{bmatrix} L_{d.bar} \cdot (\text{AreaRatio}) + 12 \cdot \text{in} + L_{embedment.added} \\ 20 \cdot d_{bolt.pole} \end{bmatrix}\right]$$

*Note:* $20d_{anchor}$ *minimum embedment was in old AASHTO LTS, 2nd Ed. 1985 and 3rd Ed. 1994 in Section 3 - 1.3.4. It was removed in the 4th Ed., but is still a good rule of thumb.*

$L_{embedment.rod} := \text{Ceil}(L_{embedment.rod}, \text{in})$ $L_{embedment.rod} = 30 \cdot \text{in}$

$L_{anchor.rod} := \text{Ceil}[(L_{embedment.rod} + 8 \cdot \text{in}), \text{in}]$ $L_{anchor.rod} = 38 \cdot \text{in}$

## Anchor Bolt Shear Break-Out Strength

***References:***
***ACI 318-05 Appendix D.***
***FDOT/University of Florida Report BD545 RPWO #54,***
***Anchor Embedment Requirements for Signal/Sign Structures, July 2007.***

$\#AnchorRods = 6$ *number of anchor bolts*

$d_{bolt.pole} = 1.5 \cdot in$ *anchor bolt diameter*

$Diameter_{boltcircle.pole} = 22 \cdot in$ *anchor bolt circle diameter*

$L_{embedment.rod} = 30 \cdot in$ *anchor bolt embedment*

$b = 42 \cdot in$ *shaft diameter*

$r_b := \dfrac{Diameter_{boltcircle.pole}}{2}$ $\quad r_b = 11 \cdot in$

$r := \dfrac{b}{2}$ $\quad r = 21 \cdot in$

$c_{a1} := \dfrac{\sqrt{r_b^{\,2} + 3.25 \cdot \left(r^2 - r_b^{\,2}\right)} - r_b}{3.25}$ $\quad c_{a1} = 7.1 \cdot in$ *adjusted cover*

***UF Report Eqn 3-2***

$L_e := \min\left(8 \cdot d_{bolt.pole}, L_{embedment.rod}\right)$ $\quad L_e = 12 \cdot in$ *load bearing length of anchor for shear*

***ACI D.6.2.2***

$V_b := 13 \cdot \left(\dfrac{L_e}{d_{bolt.pole}}\right)^{0.2} \cdot \sqrt{\dfrac{d_{bolt.pole}}{in}} \cdot \sqrt{\dfrac{f_c}{psi}} \left(\dfrac{c_{a1}}{in}\right)^{1.5} \cdot lbf$ *shear break-out strength (single anchor)*

***UF Report Eqn 2-11***

$V_b = 28.9 \cdot kip$

$A_{bolt.sector} := \dfrac{(360 \cdot deg)}{\#AnchorRods} = 60 \cdot deg$ ***UF Report Fig 3-7***

$alpha := 2\,\mathrm{asin}\left[\dfrac{\left(1.5 \cdot c_{a1}\right)}{r}\right] = 60.9 \cdot deg$

OverlapTest := if( $A_{bolt.sector} \le alpha$, "Overlap of Failure Cones" , "No Overlap of Failure Cones" )

OverlapTest = "Overlap of Failure Cones"

$chord := 2 \cdot r \cdot \sin\left(\dfrac{A_{bolt.sector}}{2}\right)$ $\quad chord = 21 \cdot in$ ***UF Report Fig 3-7***

$A_{Vco} := 4.5 \cdot c_{a1}^{\,2}$ $\quad A_{Vco} = 226.8 \cdot in^2$ *projected concrete failure area (single anchor)*

***ACI Eqn D-23***

$A_{Vc} := chord \cdot 1.5 \cdot c_{a1}$ $\quad A_{Vc} = 223.6 \cdot in^2$ *projected concrete failure area (group)*

***ACI D.6.2.1***

$A_{Vc} := \text{if}\left(A_{Vc} > A_{Vco}, A_{Vco}, A_{Vc}\right)$ $\qquad A_{Vc} = 223.6 \cdot in^2$

$\psi_{ecV} := \mathbf{1.0}$ *eccentric load modifier* ***ACI D.6.2.5***

$\psi_{edV} := \mathbf{1.0}$ *edge effect modifier* ***ACI D.6.2.6***

$\psi_{cV} := \mathbf{1.4}$ *cracked section modifier* ***ACI D.6.2.7*** *(stirrup spacing <= 4")*

$\psi_{hV} := \mathbf{1.0}$ *member thickness modifier* ***ACI D.6.2.8***

$\phi_{breakout} := \mathbf{0.75}$ *strength reduction factor* ***ACI D.4.4.c.i*** *( shear breakout, condition A)*

$V_{cbg} := \#AnchorRods \cdot \left(\frac{A_{Vc}}{A_{Vco}}\right) \cdot \left(\psi_{ecV} \cdot \psi_{edV} \cdot \psi_{cV} \cdot \psi_{hV}\right) \cdot V_b$ $\qquad V_{cbg} = 239.1 \cdot kip$ *concrete breakout strength - shear*

***ACI Eqn D-22*** *Shear force ⊥ to edge*

$V_{cbg\_parallel} := 2 \cdot V_{cbg}$ $\qquad V_{cbg\_parallel} = 478.3 \cdot kip$ ***ACI D.6.2.1.c*** *Shear force || to edge*

$T_{n.breakout} := V_{cbg\_parallel} \cdot r_b$ $\qquad T_{n.breakout} = 438.4 \cdot kip \cdot ft$ *concrete breakout strength - torsion*

$\phi_{breakout} \cdot T_{n.breakout} = 328.8 \cdot kip \cdot ft$

$T_u = 118.2 \cdot kip \cdot ft$

$BreakoutTest := \text{if}\left(\phi_{breakout} \cdot T_{n.breakout} \geq T_u, \text{"OK"}, \text{"No Good"}\right)$ $\qquad BreakoutTest = \text{"OK"}$

$OverlapDesign := \text{if}\left(A_{bolt.sector} \leq alpha, \text{"Based on Overlap of Failure Cones"}, \text{"Based on No Overlap of Failure Cones"}\right)$

$OverlapDesign = \text{"Based on Overlap of Failure Cones"}$

$M_{x.polebase} = \begin{pmatrix} 0.0 \\ 89.3 \\ 89.3 \end{pmatrix} \cdot kip \quad M_{y.polebase} = \begin{pmatrix} 90.9 \\ 0.0 \\ 90.9 \end{pmatrix} \cdot kip \cdot ft \quad M_{z.polebase} = \begin{pmatrix} 0.0 \\ 36.8 \\ 36.8 \end{pmatrix} \cdot kip \cdot ft$

*maximum torsion (Mx & Mz not used)*
*maximum overturning (My not used)*
*maximum CSR*

Analyze Foundation

## Summary - Soil Properties and Drilled Shaft Geometry

$\mathrm{SoilType} = 1$ *0 - clay* *1 - sand* $\phi_{soil} = 30 \cdot deg$ $c_{soil} = 2000 \cdot psf$ $\gamma_{soil} = 42.6 \cdot pcf$ $\mathrm{Offset} = 0\ ft$

$\mathrm{Diameter}_{shaft} = 3.5\ ft$ $L_{shaft} = 14\ ft$ $L_{embedment.rod} = 30 \cdot in$ $L_{anchor.rod} = 38 \cdot in$

$\#\mathrm{BarsProvided} = 10$ $d_{bar} = 1.41 \cdot in$

## Foundation Performance Ratios

$PR_{foundation} = 0.805$

## Fatigue Analysis

DataFile = "Cortez 1 NE Review_E.dat" WindSpeed = 130·mph

*Use the member cross section adjacent to the weld toe to compute the nominal stress range.* ***LTS 11.9***

$\mathrm{FatigueCategory} := 2$ ***SM V3 11.6***

Analyze Structure for Fatigue

*Arm and Pole Welds*

$f_{galloping.arm1} = 3.5 \cdot ksi$ $CAFT_{fullpengroove.weld.arm1} = 7 \cdot ksi$ $\mathrm{Check}_{galloping.arm1} = \text{"OK"}$

$f_{galloping.arm2} = 0 \cdot ksi$ $CAFT_{fullpengroove.weld.arm2} = \text{"NA"} \cdot ksi$ $\mathrm{Check}_{galloping.arm2} = \text{"NA"}$

$f_{galloping.pole} = 2.3 \cdot ksi$ $CAFT_{fullpengroove.weld.pole} = 4.5 \cdot ksi$ $\mathrm{Check}_{galloping.pole} = \text{"OK"}$

$f_{nwg.arm1} = 2.4 \cdot ksi$ $\mathrm{Check}_{nwg.arm1} = \text{"OK"}$

$f_{nwg.arm2} = 0 \cdot ksi$ $\mathrm{Check}_{nwg.arm2} = \text{"NA"}$

$f_{nwg.pole} = 2.2 \cdot ksi$ $\mathrm{Check}_{nwg.pole} = \text{"OK"}$

*A325 Connection Bolts*

$f_{t.g.bolt} = \begin{pmatrix} 4.9 \\ 0.0 \end{pmatrix} \cdot ksi$ $CAFT_{conn.bolt} = 16 \cdot ksi$ $\mathrm{Check}_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$f_{t.nwg.bolt} = \begin{pmatrix} 3.3 \\ 0.0 \end{pmatrix} \cdot ksi$ $\mathrm{Check}_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

*Anchor Bolts*

$f_{t.g.rod} = 3.5 \cdot ksi$ $CAFT_{anchor.rods} = 7 \cdot ksi$ $\mathrm{Check}_{g.rod} = \text{"OK"}$

$f_{t.nwg.rod} = 3.4 \cdot ksi$ $\mathrm{Check}_{nwg.rod} = \text{"OK"}$

Summary

# Mast Arm Design and Analysis Summary

DataFile = "Cortez 1 NE Review_E.dat"

WindSpeed = 130·mph

**Subject** = "Cortez - 43rd St W E Rev"   **DesignedBy** = "SML"   **PoleLocation** = "Pole 1 - NE Corner"

**ProjectNo** = "404-6002870"   **CheckedBy** = " "   **Date** = "06/21/2018"

## 1st Mast Arm

$\#Signals_{arm1} = 2$   $\#Panels_{arm1} = 1$

$X_{signal.arm1} = \begin{pmatrix} 24 \\ 34 \end{pmatrix} ft$   $Sections_{signal.arm1} = \begin{pmatrix} 3 \\ 5 \end{pmatrix}$   $Backplate_{signal.arm1} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$

$X_{panel.arm1} = (12)\,ft$   $Area_{panel.arm1} = (20)\,ft^2$

$L_{total.arm1} = 46\,ft$   $L_{splice.provided.arm1} = 24 \cdot in$

'FA'= 'FE'= $L_{arm1} = \begin{pmatrix} 35.1 \\ 12.9 \end{pmatrix} \cdot ft$   'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 7.0833 \\ 11.2173 \end{pmatrix} \cdot in$   'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 11.9973 \\ 13 \end{pmatrix} \cdot in$

'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$   $\max(\Delta_{arm1}) = 4.71 \cdot in$   $\max(CSR_{arm1}) = 0.571$

## 2nd Mast Arm

$\#Signals_{arm2} = 0$   $\#Panels_{arm2} = 1$

$X_{signal.arm2} = (0)\,ft$   $Sections_{signal.arm2} = (0)$   $Backplate_{signal.arm2} = (0)$

$X_{panel.arm2} = (0.1)\,ft$   $Area_{panel.arm2} = (0.1)\,ft^2$

$L_{total.arm2} = 0\,ft$   $L_{splice.provided.arm2} = 24 \cdot in$   'UF'= $\alpha = 0 \cdot deg$ **(Angle Between Arms)**

'SA'= 'SE'= $L_{arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot ft$   'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$   'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$

'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$

$max(\Delta_{arm2}) = 0 \cdot in$

$max(CSR_{arm2}) = 0$

## Luminaire Arm and Connection

DataFile = "Cortez 1 NE Review_ WindSpeed = 130·mph

*(use MC10x33.6 channel for connection)*

'LA'= $Y_{luminaire} = 0\,ft$

'LB'= $X_{luminaire} = 0\,ft$

'LC'= $Diameter_{base.lumarm} = 0 \cdot in$

'LD'= $t_{wall.lumarm} = 0 \cdot in$

'LE'= $Slope_{lumarm} = 0$

'LF'= $r_{lumarm} = 0\,ft$

'LG'= $d_{bolt.lum} = 0 \cdot in$

'LH'= $t_{baseplate.lum} = 0 \cdot in$

'LJ'= $w_{base.lum} = 0 \cdot in$

'LK'= $w_{channel.lum} = 0 \cdot in$

$CSR_{base.lumarm} = 0$

$PR_{bolt.lum} = 0$

$PR_{baseplate.lum} = 0$

$PR_{conn.plate.lum} = 0$

## Upright

'UA'= $Y_{pole} = 21.5\,ft$

'UB'= $Y_{arm.conn} = 20\,ft$

'UC'= $Diameter_{tip.pole} = 13.0192\,in$

'UD'= $Diameter_{base.pole} = 16\,in$

'UE'= $t_{wall.pole} = 0.375\,in$

'UF'= $\alpha = 0 \cdot deg$

'UG'= $Y_{lum.conn} = 0\,ft$

$\Delta_{x.dl} = 0.88 \cdot in$

$Slope_x = 0.46 \cdot deg$

$\Delta_{z.dl} = 0 \cdot in$

$Slope_z = 0 \cdot deg$

$C_{a.pole} = 0.996$

$max(CSR_{pole}) = 0.531$

## 1st Arm/Upright Connection

$\#ConnBolts_0 = 6$

'HT'= $h_{conn.plate} = 22 \cdot in$

'FJ'= $b_{conn.plate_0} = 23 \cdot in$

'FK'= $t_{baseplate.arm_0} = 2 \cdot in$

'FL'= $t_{vertical.plate_0} = 0.5 \cdot in$

'FN'= $w_{vertical.plate_0} = 0.3125\,in$

'FO'= $Offset_{conn_0} = 14.1146\,in$

'FP'= $d_{bolt.conn_0} = 1 \cdot in$

'FR'= $t_{conn.plate_0} = 1.5 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 9 \cdot in$

'FT'= $w_{conn.plate_0} = 0.3125\,in$

$$\begin{pmatrix} PR_{bolt_0} \\ PR_{t.baseplate.arm_0} \\ PR_{t.connplate.arm_0} \\ CSR_{t.vert.plate_0} \end{pmatrix} = \begin{pmatrix} 0.636 \\ 0.839 \\ 0.998 \\ 0.627 \end{pmatrix}$$

## 2nd Arm/Upright Connection

$\#ConnBolts_1 = 0$

'HT'= $h_{conn.plate} = 22 \cdot in$

'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SK'= $t_{baseplate.arm_1} = 0 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

$$\begin{pmatrix} PR_{bolt_1} \\ PR_{t.baseplate.arm_1} \\ PR_{t.connplate.arm_1} \\ CSR_{t.vert.plate_1} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

## Pole Baseplate

DataFile = "Cortez 1 NE Review_ WindSpeed = 130·mph

$\#AnchorRods = 6$

'BA'= $Diameter_{baseplate.pole} = 28 \cdot in$

'BB'= $t_{baseplate.pole} = 2.5 \cdot in$

'BC'= $d_{bolt.pole} = 1.5 \cdot in$

'BF'= $L_{embedment.rod} = 30 \cdot in$

$Diameter_{boltcircle.pole} = 22 \cdot in$

$PR_{rod} = 0.656$

$PR_{plate.pole} = 1$

## Foundation

'DA'= $L_{shaft} = 14 \cdot ft$

'DB'= $Diameter_{shaft} = 3.5 \cdot ft$

$d_{bar} = 1.41 \cdot in$ $Offset = 0\ ft$

'RA'= $round\left(\frac{d_{bar}}{0.125in}\right) = 11$

'RB'= $\#BarsProvided = 10$

$Diameter_{rebar.circle} = 2.2783\ ft$

'RC'= $NumSpaces_{v.bar} = 7$

'RD'= $s_{v2} = 18 \cdot in$

$PR_{foundation} = 0.805$

WRITEPRN to Line 1-2-3

## Mast Arm Tip Deflection

*Compare Mast Arm deflection of each arm to a proposed camber*

$Camber_{arm1} := \mathbf{2} \cdot deg$ $Camber_{arm2} := \mathbf{2} \cdot deg$

$L_{arm1} := \sum L_{arm1} - if\left[\left(L_{arm1_1} = 0 \cdot ft\right), 0 \cdot ft, 2 \cdot ft\right]$

$L_{arm2} := \sum L_{arm2} - if\left[\left(L_{arm2_1} = 0 \cdot ft\right), 0 \cdot ft, 2 \cdot ft\right]$

$Deflection_{arm1} := Slope_x \cdot L_{arm1} + max\left(\Delta_{arm1}\right)$

$Deflection_{arm1} = 9.18 \cdot in$

$CamberArm1_{upward} := sin\left(Camber_{arm1}\right) \cdot L_{arm1}$

$CamberArm1_{upward} = 19.26 \cdot in$

$Deflection_{arm2} := \left[Slope_z \cdot L_{arm2} \cdot (sin(\alpha))\right] + Slope_x \cdot L_{arm2} \cdot cos(\alpha) + max\left(\Delta_{arm2}\right)$

$Deflection_{arm2} = 0 \cdot in$

$CamberArm2_{upward} := sin\left(Camber_{arm2}\right) \cdot L_{arm2}$

$CamberArm2_{upward} = 0 \cdot in$

## Check Clearance Between Connection Plates *(for Two Arm Structures only)*

$\alpha = 0 \cdot deg$ $\alpha := if[(\alpha > 180 \cdot deg), (360 \cdot deg - \alpha), \alpha]$

$Offset_{conn_0} = 14.1 \cdot in$ $b_{conn.plate_0} = 23 \cdot in$ $h_{conn.plate} = 22 \cdot in$ $\alpha = 0 \cdot deg$

$Offset_{conn_1} = 0 \cdot in$ $b_{conn.plate_1} = 0 \cdot in$

$$x_1 := Offset_{conn_0} - t_{conn.plate_0} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm1})}{2} \qquad y_1 := \frac{b_{conn.plate_0}}{2} \qquad x_1 = 12.23 \cdot in \quad y_1 = 11.5 \cdot in$$

$$x_2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \cos(\alpha) + \frac{b_{conn.plate_1}}{2} \cdot \sin(\alpha)$$

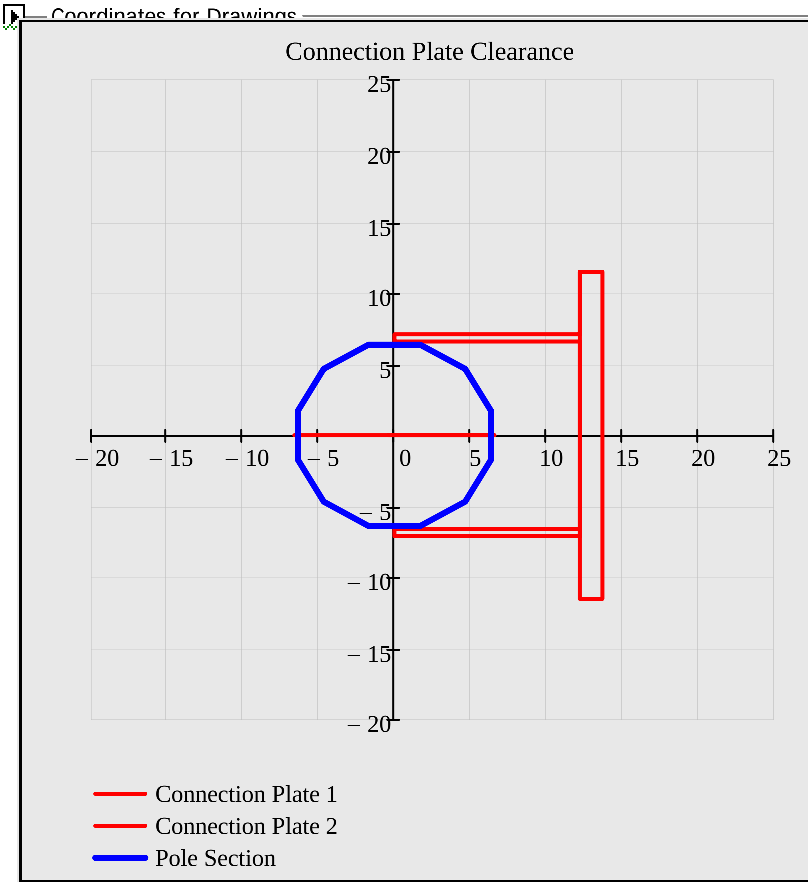
$$y_2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \sin(\alpha) - \frac{b_{conn.plate_1}}{2} \cdot \cos(\alpha) \qquad x_2 = -0.38 \cdot in \; y_2 = 0 \cdot in$$

$$Clearance := \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \quad Clearance := if\left[(y_2 \le y_1), if\left[(x_1 > x_2), Clearance, 0 \cdot in\right], Clearance\right] \; Clearance = 17.07 \cdot in$$

***(if Clearance equals 0, then Connection Plates intersect and redesign is required.***

## Plan View - Connection Plate Clearance for Two Arm Connections

Coordinates for Drawings




$Clearance = 17.07 \cdot in$

$Diameter_{conn.pole} = 13.2292 \cdot in$

$t_{conn.plate_0} = 1.5 \cdot in$

$b_{conn.plate_0} = 23 \cdot in$

$t_{vertical.plate_0} = 0.5 \cdot in$

$Offset_{conn_0} = 14.1146 \cdot in$

$Gap_0 = 7.5 \cdot in$

$t_{conn.plate_1} = 0 \cdot in$

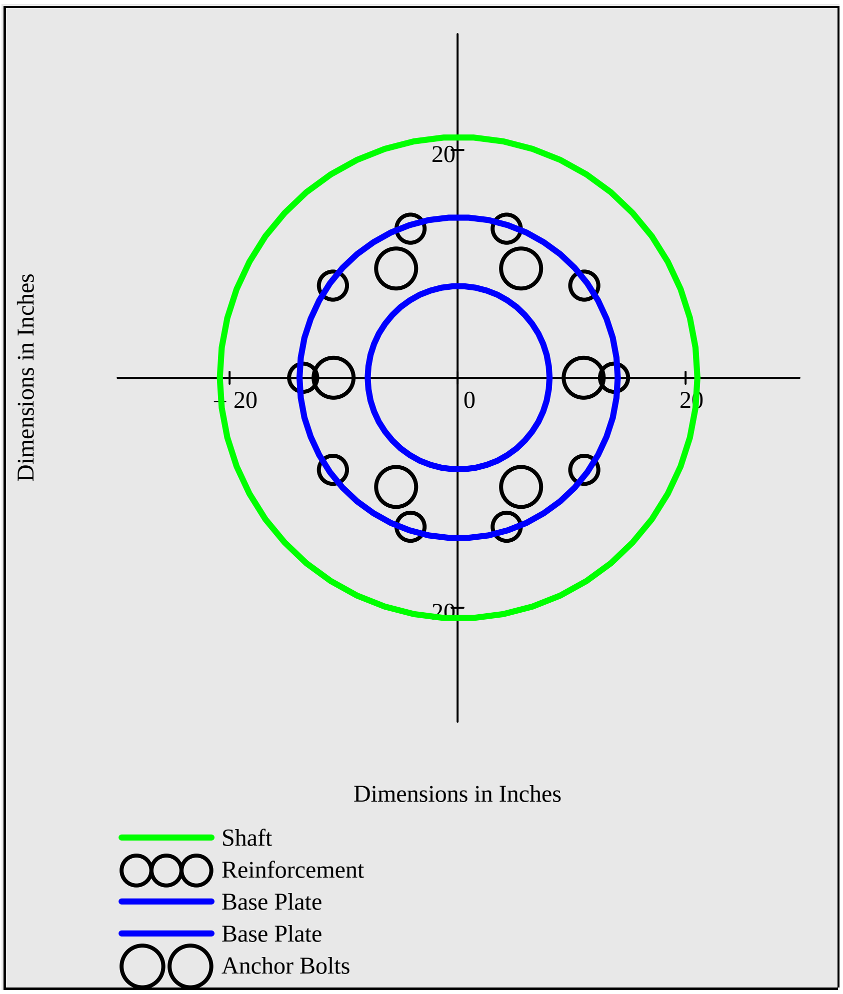
$b_{conn.plate_1} = 0 \cdot in$

$t_{vertical.plate_1} = 0 \cdot in$

$Offset_{conn_1} = 0 \cdot in$

$Gap_1 = 0 \cdot in$

## Plan View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$\text{Diameter}_{base.pole} = 16 \cdot in$

$\text{Diameter}_{baseplate.pole} = 28 \cdot in$

$\text{Diameter}_{shaft} = 42 \cdot in$

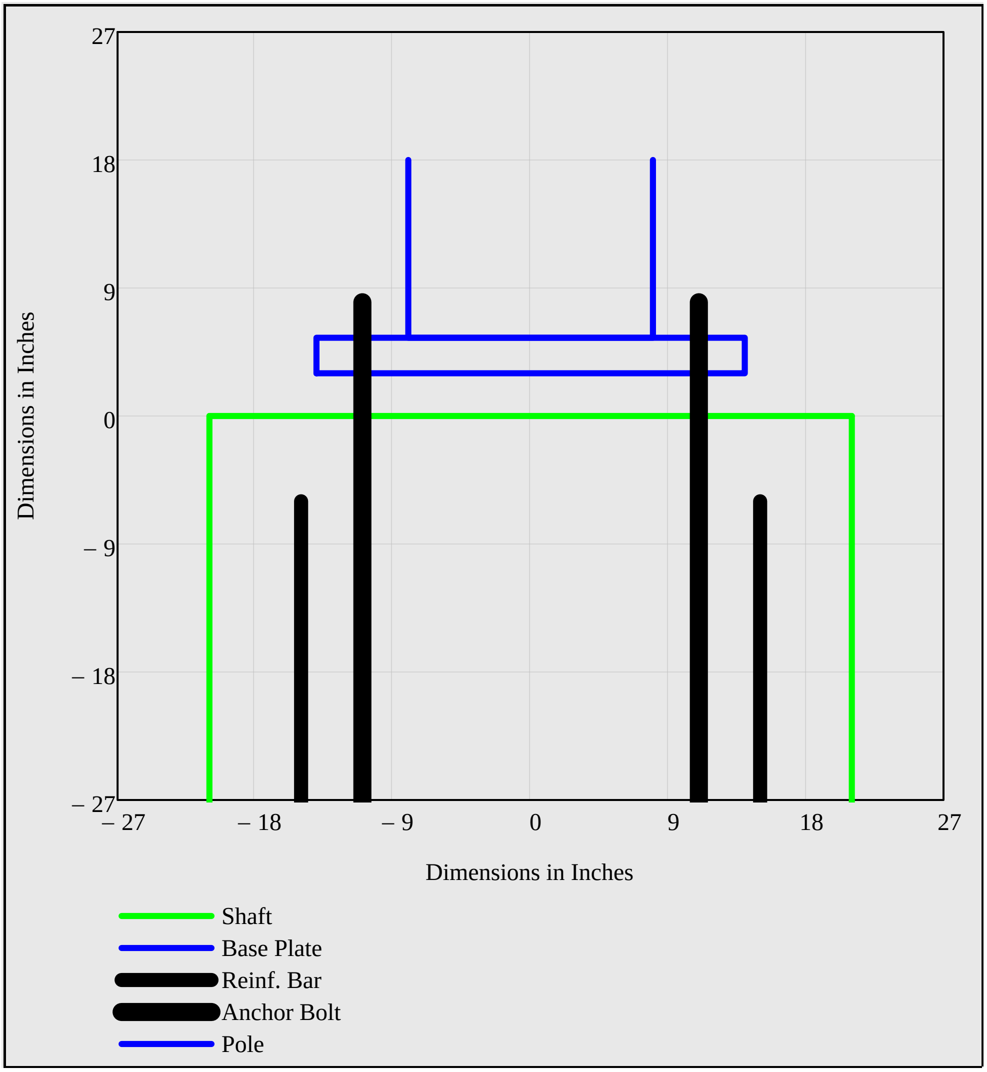
$\text{Diameter}_{boltcircle.pole} = 22 \cdot in$

$\text{Diameter}_{rebar.circle} = 27.34 \cdot in$

#AnchorRods = 6

#BarsProvided = 10

## Elevation View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$\text{Diameter}_{\text{base.pole}} = 16 \cdot \text{in}$

$\text{Diameter}_{\text{baseplate.pole}} = 28 \cdot \text{in}$

$t_{\text{baseplate.pole}} = 2.5 \cdot \text{in}$

$\text{Diameter}_{\text{shaft}} = 3.5 \cdot \text{ft}$

$\text{Diameter}_{\text{boltcircle.pole}} = 22 \cdot \text{in}$

$\text{Diameter}_{\text{rebar.circle}} = 27.3 \cdot \text{in}$

# Appendix B

Mathcad Program Output

NE Mast Arm Proposed Configuration with Concrete Torsion Calculations

# FDOT Mast Arm Analysis Program

*Custom File Name (optional)* | Cortez 1 NE Review  P

*The new custom file will be a copy of the last file called from the program. A ".dat" extension will be added to the file name.*

*Add file to file list* | Refresh File List

*Select Data File (required)*

E6T24
E6T4
E7T6
Cortez 1 NE Exist
Cortez 1 NE Prop
Cortez 1 NE Fut
Cortez 1 NE Review

*All data files are in the same directory as the MastArm.xmcd file.*

Path = "F:\Projects\Cortez - 43rd Ave W Mast Arm Review - 13M126\04 .

DataFile = "Cortez 1 NE Review_P.dat"

*Reference* *Changes*

*This program works in conjunction with Mastarm Design Standards 17743 and 17745.*

*References:*
*AASHTO Standard Specifications for Signs, Luminaires and Traffic Signals, 6th Edition (LTS).*
*FDOT Structures Manual Vol. 3 (SM V3).*

*For more information see Reference.xmcd and Changes.xmcd.*

Read In Data

## General Information

DataFile = "Cortez 1 NE Review_P.dat"

| Current Values | New Values |
|---|---|
| **Subject** = "Cortez - 43rd St W P Rev" | ortez - 43rd St W P Rev |
| **ProjectNo** = "404-6002870" | |
| **PoleLocation** = "Pole 1 - NE Corner" | |
| **Date** = "06/21/2018" | 06/21/2018 |
| **DesignedBy** = "SML" | |
| **CheckedBy** = " " | |

*Use Control+F9 to recalculate the worksheet, once to write out data, twice to read in data*

## Wind Speed

DataFile = "Cortez 1 NE Review_P.dat"

| Current Value | New Value | | |
|---|---|---|---|
| WindSpeed = 130·mph | | *mph* | **SM V3 3.8.2** |

# Arm 1 Analysis

DataFile = "Cortez 1 NE Review_P.dat"   WindSpeed = 130·mph

Arm 1 Loads

$SignalData_{arm1}$ =

| "SignalNumber" | "DistanceToSignal(ft)" | "NumberOfSignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 14 | 5 | "yes" |
| 2 | 24 | 3 | "yes" |
| 3 | 34 | 5 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

*use X to zero out data*
*use 0 to keep current values*   *"yes" or "no"*

## New Values

| "SignalNumber" | "DistToSignal(ft)" | "#SignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 0 | 0 | "yes" |
| 2 | 0 | 0 | "yes" |
| 3 | 0 | 0 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

$SignData_{arm1}$ =

| "PanelNumber" | "DistanceToPanelCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 6 | 20 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

## New Values

| "Panel#" | "DistToCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 0 | 0 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

*use X to zero out data*
*use 0 to keep current values*

Arm 1 Loads

Arm 1 Properties

## Current Values

## New Values

$L_{total.arm1} = 46\,ft$ — *feet, 40 ft. max. for 1 piece arms*

$Diameter_{base.arm1} = 13 \cdot in$ — *inches, measured flat to flat (FG)*

$Dist_{splice.from.base.arm1} = 12.9\,ft$ — *feet, splice distance, for 2 piece arms, length of piece closest to pole, use X to zero out (FE)*

*set* $Dist_{splice.from.base.arm1} = 0ft$ *for NO SPLICE*

$t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$

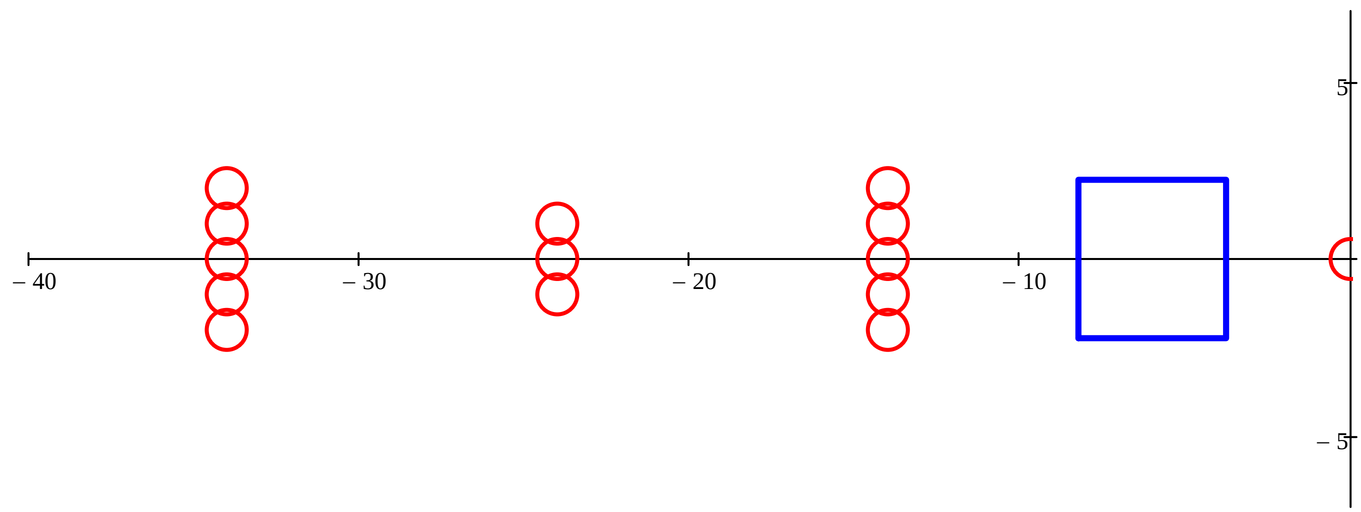
*inches, this value is used for one piece arms (FD)*

*inches, for 2 piece arms, wall thickness of piece closest to the pole, use X to zero out (FH)*

Arm 1 Properties

Analyze Arm 1

## Summary - Arm 1 Geometry and Loading




Location of Signs and Signals

$WindSpeed = 130 \cdot mph$ $\quad L_{total.arm1} = 46\,ft$

$Diameter_{tip.arm1} = \begin{pmatrix} 7.08 \\ 11.22 \end{pmatrix} \cdot in$ $\quad Diameter_{base.arm1} = \begin{pmatrix} 12 \\ 13 \end{pmatrix} \cdot in$ $\quad L_{arm1} = \begin{pmatrix} 35.1 \\ 12.9 \end{pmatrix} ft$ $\quad t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$

| $X_{signal.arm1_{i1}}$ = (ft) | $Sections_{signal.arm1_{i1}}$ = |
|---|---|
| 14 | 5 |
| 24 | 3 |
| 34 | 5 |

| $X_{panel.arm1_{j1}}$ = (ft) | $Area_{panel.arm1_{j1}}$ = ($ft^2$) |
|---|---|
| 6 | 20 |

## Arm 1 Combined Stress Ratio and Deflection

$\max(CSR_{arm1}) = 0.602$ $\quad \max(\Delta_{arm1}) = 4.738 \cdot in$ $\quad 2 \cdot deg \cdot \sum (L_{arm1} - L_{splice.provided}) = 18.43 \cdot in$

## Arm 2 Analysis

DataFile = "Cortez 1 NE Review_P.dat"    WindSpeed = 130 mph

Arm 2 Loads

$$SignalData_{arm2} = \begin{pmatrix} \text{"SignalNumber"} & \text{"DistanceToSignal(ft)"} & \text{"NumberOfSignalHeads"} & \text{"BackPlate"} \\ 1 & 0 & 0 & \text{"yes"} \\ 2 & 0 & 0 & \text{"yes"} \\ 3 & 0 & 0 & \text{"yes"} \\ 4 & 0 & 0 & \text{"yes"} \\ 5 & 0 & 0 & \text{"yes"} \\ 6 & 0 & 0 & \text{"yes"} \\ 7 & 0 & 0 & \text{"yes"} \\ 8 & 0 & 0 & \text{"yes"} \\ 9 & 0 & 0 & \text{"yes"} \\ 10 & 0 & 0 & \text{"yes"} \end{pmatrix}$$

*use X to zero out data*
*use 0 to keep current values*    *"yes" or "no"*

**New Values**

| "SignalNumber" | "DistToSignal(ft)" | "#SignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 0 | 0 | "yes" |
| 2 | 0 | 0 | "yes" |
| 3 | 0 | 0 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

$$SignData_{arm2} = \begin{pmatrix} \text{"PanelNumber"} & \text{"DistanceToPanelCentroid(ft)"} & \text{"PanelArea(sf)"} \\ 1 & 0 & 0 \\ 2 & 0 & 0 \\ 3 & 0 & 0 \\ 4 & 0 & 0 \\ 5 & 0 & 0 \end{pmatrix}$$

**New Values**

| "Panel#" | "DistToCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 0 | 0 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

*use X to zero out*
*use 0 to keep current values*

Arm 2 Properties

## Current Values | New Values

$L_{total.arm2} = 0\,ft$ — feet, 40 ft. max. for 1 piece arms, use X to zero out *set* $L_{total.arm2} = 0ft$ *for NO ARM2*

$Diameter_{base.arm2} = 0\cdot in$ — inches, measured flat to flat, use X to zero out (SG)

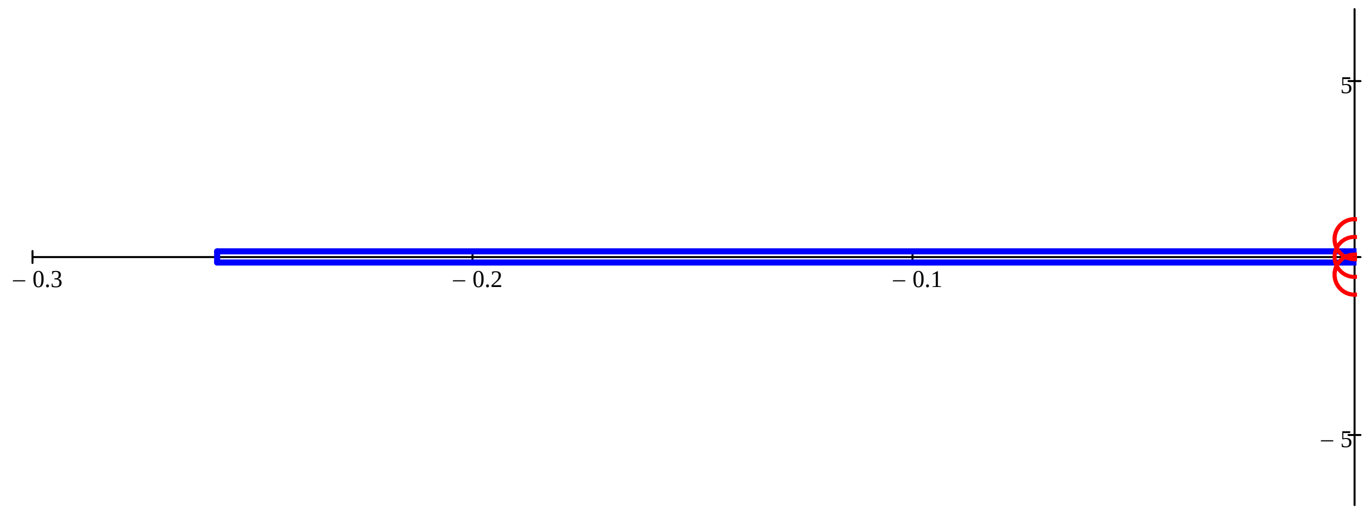
$Dist_{splice.from.base.arm2} = 0\cdot ft$ — feet, splice distance, for 2 piece arms, length of piece closest to pole, use X to zero out (SE) — *set* $Dist_{splice.from.base.arm2} = 0ft$ *for NO SPLICE*

$t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot in$ — inches, use X to zero out (SD); inches, for 2 piece arms, wall thickness of piece closest to the pole, use X to zero out (SH)

Arm 2 Properties

## Summary - Arm 2 Geometry and Loading

Analyze Arm 2




Location of Signs and Signals

$WindSpeed = 130\cdot mph$ $\quad L_{total.arm2} = 0\,ft$

$Diameter_{tip.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot in$ $\quad Diameter_{base.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot in$ $\quad L_{arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\,ft$ $\quad t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot in$

$X_{signal.arm2_{i2}} =$ 

| | |
|---|---|
| 0 | ft |
| 0 | |

$Sections_{signal.arm2_{i2}} =$

| |
|---|
| 0 |
| 0 |

$X_{panel.arm2_{j2}} =$ 0.1 ft

$Area_{panel.arm2_{j2}} =$ 0.1 $ft^2$

## Arm 2 Combined Stress Ratio and Deflection

$max(CSR_{arm2}) = 0$ $\quad max(\Delta_{arm2}) = 0\cdot in$ $\quad 2\cdot deg\cdot\sum\left(L_{arm2} - L_{splice.provided}\right) = -1.68\cdot in$

# Luminaire Arm Analysis

DataFile = "Cortez 1 NE Review_P.dat"  WindSpeed = 130·mph

Luminaire Properties

*See Design Standards 17743 and 17745 for input values.*

## Current Values

## New Values

*set* $Y_{luminaire} = 0ft$ *for NO LUMINAIRE*

| Current Values | New Values | |
|---|---|---|
| $Y_{luminaire} = 0\ ft$ | | *feet, use X to zero out (Standard LA = 40 feet)* |
| $X_{luminaire} = 10 \cdot ft$ | | *feet, use X to zero out (Standard LB = 10 feet)* |
| $Diameter_{base.lumarm} = 3 \cdot in$ | | *inches, use X to zero out (Standard LC = 3 inches)* |
| $t_{wall.lumarm} = 0.125 \cdot in$ | | *inches, use X to zero out (Standard LD = 0.125 inches)* |
| $Slope_{lumarm} = 0.5$ | | *rise/run, use X to zero out (Standard LE = 0.5)* |
| $r_{lumarm} = 8 \cdot ft$ | | *feet, use X to zero out (Standard LF = 8 feet)* |
| $d_{bolt.lum} = 0.5 \cdot in$ | | *inches, use X to zero out (Standard LG = 0.5 inches)* |
| $t_{baseplate.lum} = 0.75 \cdot in$ | | *inches, use X to zero out (Standard LH = 0.75 inches)* |

Luminaire Properties

Analyze Luminaire

## Summary - Luminaire Arm Geometry

$Y_{luminaire} = 0\ ft$  $X_{luminaire} = 0 \cdot ft$  $Diameter_{base.lumarm} = 0 \cdot in$  $t_{wall.lumarm} = 0 \cdot in$

$Slope_{lumarm} = 0$  $r_{lumarm} = 0 \cdot ft$  $d_{bolt.lum} = 0 \cdot in$  $t_{baseplate.lum} = 0 \cdot in$

$w_{base.lum} = 0 \cdot in$  $w_{channel.lum} = 0 \cdot in$

## Luminaire Arm Ratios

$CSR_{base.lumarm} = 0$  $PR_{bolt.lum} = 0$  $PR_{baseplate.lum} = 0$  $PR_{conn.plate.lum} = 0$

# Upright Analysis

DataFile = "Cortez 1 NE Review_P.dat" WindSpeed = 130·mph

Pole Properties

## Current Values

$Y_{pole} = 21.5\,ft$

$Y_{arm.conn} = 20\,ft$

$Diameter_{base.pole} = 16 \cdot in$

$t_{wall.pole} = 0.375 \cdot in$

$Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$

## New Values

*feet (UA)*

*feet (UB)*

*inches, measured flat to flat (UD)*

*inches (UE)*

*inches, clear distance between connection plate and upright*

*inches, use X to zero out*

*Common wall thicknesses:*
*0.1793 in.*
*0.2391 in.*
*0.25 in.*
*0.313 in.*
*0.375 in.*
*0.5 in.*

Pole Properties

## Summary - Upright Geometry

$Y_{pole} = 21.5\,ft$ $Y_{arm.conn} = 20\,ft$ $\alpha = 0 \cdot deg$ $Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$

$Diameter_{base.pole} = 16 \cdot in$ $t_{wall.pole} = 0.375 \cdot in$

## Upright Combined Stress Ratio and Deflections

$\max(CSR_{pole}) = 0.619$ $\max(\Delta_{x.dl}) = 0.89 \cdot in$ $\max(\Delta_{z.dl}) = 0 \cdot in$

# Mast Arm Connection(s) Analysis

DataFile = "Cortez 1 NE Review_P.dat"    WindSpeed = 130·mph

Connection Properties

## Current Values

## New Values

$h_{conn.plate} = 22 \cdot in$

*inches, for two arm Mast Arms both connection plate heights must be equal (HT)*

$t_{vertical.plate} = \begin{pmatrix} 0.5 \\ 0 \end{pmatrix} \cdot in$

*inches (FL)*

*inches, use X to zero out (SL)*

$d_{bolt.conn} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \cdot in$

*inches (FP)*

*inches, use X to zero out (SP)*

$t_{baseplate.arm} = \begin{pmatrix} 2 \\ 0 \end{pmatrix} \cdot in$

*inches (FK)*

*inches, use X to zero out (SK)*

Connection Properties

## Summary - Connection Geometry

$h_{conn.plate} = 22 \cdot in$    $Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$    $Offset_{conn} = \begin{pmatrix} 14.1146 \\ 0 \end{pmatrix} \cdot in$

$d_{bolt.conn} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \cdot in$    $\#ConnBolts = \begin{pmatrix} 6 \\ 0 \end{pmatrix}$    $Spacing_{bolts.conn} = \begin{pmatrix} 9 \\ 0 \end{pmatrix} \cdot in$

$t_{conn.plate} = \begin{pmatrix} 1.5 \\ 0 \end{pmatrix} \cdot in$    $b_{conn.plate} = \begin{pmatrix} 23 \\ 0 \end{pmatrix} \cdot in$    $t_{vertical.plate} = \begin{pmatrix} 0.5 \\ 0 \end{pmatrix} \cdot in$    $t_{baseplate.arm} = \begin{pmatrix} 2 \\ 0 \end{pmatrix} \cdot in$

$w_{conn.plate} = \begin{pmatrix} 0.3125 \\ 0 \end{pmatrix} \cdot in$    $w_{vertical.plate} = \begin{pmatrix} 0.3125 \\ 0 \end{pmatrix} \cdot in$

## Connection Ratios

$PR_{bolt} = \begin{pmatrix} 0.663 \\ 0 \end{pmatrix}$    $CSR_{t.vert.plate} = \begin{pmatrix} 0.661 \\ 0 \end{pmatrix}$    $PR_{t.baseplate.arm} = \begin{pmatrix} 0.839 \\ 0 \end{pmatrix}$    $PR_{t.connplate.arm} = \begin{pmatrix} 0.998 \\ 0 \end{pmatrix}$

## Base Plate Analysis

DataFile = "Cortez 1 NE Review_P.dat"    WindSpeed = 130·mph

Base Plate Properties

### Current Values / New Values

$\#AnchorRods = 6$    *use 6 bolts minimum*

$d_{bolt.pole} = 1.5 \cdot in$    *inches (BC)*

Base Plate Properties

### Summary - Upright Base Plate Geometry

$\#AnchorRods = 6$ & Anchors — $d_{bolt.pole} = 1.5 \cdot in$ — $t_{baseplate.pole} = 2.5 \cdot in$ — $Diameter_{baseplate.pole} = 28 \cdot in$

### Upright Base Plate Performance Ratios

$PR_{rod} = 0.772$    $PR_{plate.pole} = 1$

## Foundation Analysis    Cohesionless or Cohesive Soil

DataFile = "Cortez 1 NE Review_P.dat"

Soil Properties

### Current Values / New Values

○ Clay
◉ Sand

$SoilType = 1$    *0 - clay  1 - sand*

$\phi_{soil} = 30 \cdot deg$    *degrees, soil friction angle (sand)*

$c_{soil} = 2000 \cdot psf$    *psf, soil shear strength (clay)*

$\gamma_{soil} = 42.6 \cdot pcf$    *pcf, soil density (typical design value = 45-50 pcf)*

$Offset = 0\,ft$    *vertical distance between top of foundation and groundline*

$N_{blows} = 15$    *Number of blows per foot. If N< 5, contact the district geotech Engineer*    ***SM V3 13.6***

Soil Properties

Analyze Foundation

## Switch values, set values for DataOut, and Write Out Data to DataFile and Temp.dat

$out := out + 1 \quad out = 35$

$SoilType := if(newSoilType = 0, 0, 1)$    $data_{out} := SoilType$    $data_{out} = 1$

$out := out + 1 \quad out = 36$

$\phi_{soil} := fSwitchData(\phi_{soil}, new\phi_{soil}, deg)$    $data_{out} := \frac{\phi_{soil}}{deg}$    $data_{out} = 30$

$out := out + 1 \quad out = 37$

$c_{soil} := fSwitchData(c_{soil}, newc_{soil}, psf)$ $\quad data_{out} := \frac{c_{soil}}{psf}$ $\quad data_{out} = 2000$

$out := out + 1 \quad out = 38$

$\gamma_{soil} := fSwitchData(\gamma_{soil}, new\gamma_{soil}, pcf)$ $\quad data_{out} := \frac{\gamma_{soil}}{pcf}$ $\quad data_{out} = 42.6$

$out := out + 1 \quad out = 39$

$\gamma_{water} := 62.4 \cdot pcf$ *(not used)* $\quad data_{out} := \frac{\gamma_{water}}{pcf}$ $\quad data_{out} = 62.4$

$out := out + 1 \quad out = 40$

$Offset := fSwitchData(Offset, newOffset, ft)$ $\quad data_{out} := \frac{Offset}{ft}$ $\quad data_{out} = 0$

$out := out + 1 \quad out = 41$

$N_{blows} := fSwitchData(N_{blows}, newN_{blows}, 1)$ $\quad data_{out} := \frac{N_{blows}}{1}$ $\quad data_{out} = 15$

$out := out + 1 \quad out = 42$

**Subject** := if (**newSubject** = 0, **Subject**, **newSubject**) $\quad$ $data_{out}$ := **Subject**

$data_{out}$ = "Cortez - 43rd St W P Rev"

$out := out + 1 \quad out = 43$

**ProjectNo** := if (**newProjectNumber** = 0, **ProjectNo**, **newProjectNumber**) $\quad$ $data_{out}$ := **ProjectNo**

$data_{out}$ = "404-6002870"

$out := out + 1 \quad out = 44$

**PoleLocation** := if (**newPoleLocation** = 0, **PoleLocation**, **newPoleLocation**) $\quad$ $data_{out}$ := **PoleLocation**

$data_{out}$ = "Pole 1 - NE Corner"

$out := out + 1 \quad out = 45$

**Date** := if (**newDate** = 0, **Date**, **newDate**) $\quad$ $data_{out}$ := **Date**

$data_{out}$ = "06/21/2018"

$out := out + 1 \quad out = 46$

**DesignedBy** := if (**newDesignedBy** = 0, **DesignedBy**, **newDesignedBy**) $\quad$ $data_{out}$ := **DesignedBy**

$data_{out}$ = "SML"

$out := out + 1 \quad out = 47$

**CheckedBy** := if (**newCheckedBy** = 0, **CheckedBy**, **newCheckedBy**) $\quad$ $data_{out}$ := **CheckedBy**

$data_{out}$ = " "

WRITEPRN(DataFile) := data $\qquad$ WRITEPRN("temp.dat") := data

## Foundation Design References

***LRFD = AASHTO LRFD Bridge Design Specifications***

*SM V3 = FDOT Structures Manual Volume 3*

*SDG = FDOT Structures Design Guidelines*

*Spec = FDOT Standard Specifications*

*ACI = ACI 318 Structural Concrete Building Code*

*UF Report = FDOT/University of Florida Report BD545 RPWO #54*

## Applied Loads

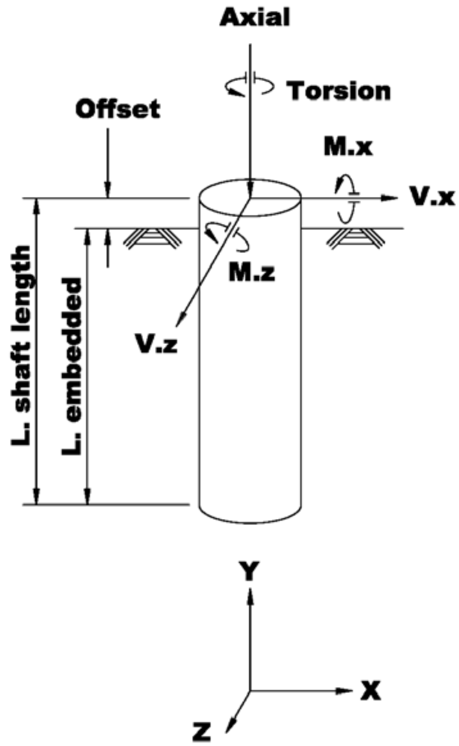
*(From Arm1 Design)*

$WindSpeed = 130 \cdot mph$

*(from Base Plate Design)*

$\#AnchorRods = 6$ $\quad d_{bolt.pole} = 1.5 \cdot in$ $\quad Diameter_{boltcircle.pole} = 22 \cdot in$ $\quad T_{u.rod} = 41 \cdot kip$

*(from Upright Design)*




$$M_{x.polebase} = \begin{pmatrix} 0 \\ 106 \\ 106 \end{pmatrix} \cdot kip \cdot ft \quad M_{y.polebase} = \begin{pmatrix} 96.9 \\ 0 \\ 96.9 \end{pmatrix} \cdot kip \cdot ft \quad M_{z.polebase} = \begin{pmatrix} 0 \\ 37.5 \\ 37.5 \end{pmatrix} \cdot kip \cdot ft$$

$LoadCaseT = 0$

$LoadCaseOT = 1$

$LoadCaseCSR = 2$

$$V_{x.polebase} = \begin{pmatrix} 0 \\ 0.2 \\ 0.2 \end{pmatrix} \cdot kip \quad AxialForce_{polebase} = \begin{pmatrix} 3.1 \\ 3.1 \\ 3.1 \end{pmatrix} \cdot kip \quad V_{z.polebase} = \begin{pmatrix} 0 \\ 5.7 \\ 5.7 \end{pmatrix} \cdot kip$$

## Foundation Diameter

$Diameter_{shaft} := Diameter_{boltcircle.pole} + 12\cdot in + 12\cdot in$ $\quad Diameter_{shaft} = 3.83\cdot ft$

*round shaft diameter up to the nearest half foot dimension to accommodate available coring equipment*

$Diameter_{shaft} := Ceil\left(Diameter_{shaft}, \frac{1}{2}\cdot ft\right)$ $\quad Diameter_{shaft} = 4\ ft$

$Diameter_{shaft.custom} := 3.5\cdot ft$ $\quad$ *SML change from 0.0 ft to 3.5 ft for actual drilled shaft diamter*

$Diameter_{shaft} := if\left(Diameter_{shaft.custom} > 0\cdot ft, Diameter_{shaft.custom}, Diameter_{shaft}\right) = 1.1$

$Diameter_{shaft} = 3.5\ ft$

$b := Diameter_{shaft}$

## Shaft Depth Required to Resist Overturning

$SF_{ot} := 2$ *Safety Factor against Overturning* ***SM V3 13.6*** $\quad Offset = 0\cdot ft$ *vertical distance between top of foundation and groundline*

$$M_{total} := SF_{ot}\cdot\frac{\sqrt{\left(M_{x.polebase_{LoadCaseOT}}\right)^2 + \left(M_{z.polebase_{LoadCaseOT}}\right)^2}}{C_{a.pole}} \qquad M_{total} = 225.7\cdot kip\cdot ft$$

$$P_{total} := SF_{ot}\cdot\sqrt{\left(V_{x.polebase_{LoadCaseOT}}\right)^2 + \left(V_{z.polebase_{LoadCaseOT}}\right)^2} \qquad P_{total} = 11.5\cdot kip$$

*short free-head pile in cohesionless soil using Broms method*

$$K_p := \tan\left(45\cdot deg + \frac{\phi_{soil}}{2}\right)^2 \qquad e_{sand} := Offset$$

*Guess value* $\quad L_{otSand} := 8\cdot ft$

Given $\quad \dfrac{\gamma_{soil}\cdot b\cdot L_{otSand}^{\ 3}\cdot K_p}{2} - P_{total}\cdot\left(e_{sand} + L_{otSand}\right) - M_{total} = 0\cdot kip\cdot ft$

$Temp := Find\left(L_{otSand}\right)$ $\quad L_{otSand} := Temp$ $\quad L_{otSand} = 11.7\cdot ft$

*(round up to next foot)* $\quad L_{otSand} := ceil\left(\frac{L_{otSand}}{ft}\right)\cdot ft$ $\quad L_{otSand} = 12\ ft$

$$PR_{otSand} := \frac{M_{total} + P_{total}\cdot\left(e_{sand} + L_{otSand}\right)}{\dfrac{\gamma_{soil}\cdot b\cdot L_{otSand}^{\ 3}\cdot K_p}{2}} \qquad PR_{otSand} = 0.9$$

*short free-head pile in cohesive soil using Modified Broms method for L < 3b (see reference file for derivation)*

$c_{soil} := \text{if}\left(c_{soil} = 0\cdot ksf, 0.1\cdot ksf, c_{soil}\right)$ $\quad$ $Slope := 8\cdot\dfrac{c_{soil}}{3\cdot b}$ $\quad$ $e_{clay} := \dfrac{M_{total}}{P_{total}} + Offset$

$nforce(M,N) := \left[Slope\cdot(2\cdot M + N) + 2\cdot c_{soil}\right]\cdot N\cdot\dfrac{b}{2}$ $\quad$ $mforce(M) := \left(2\cdot c_{soil} + M\cdot Slope\right)\cdot M\cdot\dfrac{b}{2}$

$$m\_arm(M) := e_{clay} + \frac{M}{3}\cdot\frac{2\cdot\left(M\cdot Slope + c_{soil}\right) + c_{soil}}{M\cdot Slope + 2\cdot c_{soil}}$$

$$n\_arm(M,N) := e_{clay} + M + \frac{N}{3}\cdot\frac{2\cdot\left(N\cdot Slope + M\cdot Slope + c_{soil}\right) + \left(M\cdot Slope + c_{soil}\right)}{Slope\cdot(2\cdot M + N) + 2\cdot c_{soil}}$$

*Guess value* $\quad M := 4.0\cdot ft \quad N := 4.0\cdot ft$

Given $\quad P_{total} + nforce(M,N) = mforce(M) \quad mforce(M)\cdot m\_arm(M) = nforce(M,N)\cdot n\_arm(M,N)$

$\begin{pmatrix} M \\ N \end{pmatrix} := Find(M,N)$ $\quad$ $L_{ot1Clay.temp} := M + N$ $\quad$ $L_{ot1Clay.temp} = 7\cdot ft$

*(round up to next foot)* $\quad$ $L_{ot1Clay} := ceil\left(\dfrac{L_{ot1Clay.temp}}{ft}\right)\cdot ft$ $\quad$ $L_{ot1Clay} = 8\cdot ft$

*short free-head pile in cohesive soil using Regular Broms method for L > 3b*

$f_{clay} := \dfrac{P_{total}}{9\cdot c_{soil}\cdot b}$ $\quad$ $M_{maxtemp} := P_{total}\cdot\left(e_{clay} + 1.5\cdot b + 0.5\cdot f_{clay}\right)$ $\quad$ $g := \sqrt{\dfrac{M_{maxtemp}}{2.25\cdot c_{soil}\cdot b}}$

$L_{ot2Clay} := \left(1.5\cdot b + f_{clay} + g\right)$ $\quad$ $L_{ot2Clay} = 9.7\,ft$

*(round up to next foot)* $\quad$ $L_{ot2Clay} := ceil\left(\dfrac{L_{ot2Clay}}{ft}\right)\cdot ft$ $\quad$ $L_{ot2Clay} = 10\cdot ft$

$L_{otClay} := \text{if}\left(L_{ot1Clay} < 3\cdot b, L_{ot1Clay}, L_{ot2Clay}\right)$ $\quad$ $L_{otClay} = 8\cdot ft$

*(If $L_{ot} < 3b$, use Modified Broms method)*

$$PR_{otClay} := \text{if}\left(L_{otClay} < 3\cdot b, \frac{L_{ot1Clay.temp}}{L_{ot1Clay}}, \frac{\sqrt{\dfrac{M_{maxtemp}}{2.25\cdot c_{soil}\cdot b}} + \dfrac{P_{total}}{9\cdot c_{soil}\cdot b}}{L_{ot2Clay} - 1.5\cdot b}\right) \quad PR_{otClay} = 0.9$$

$L_{reqdOT} := \text{if}(\text{SoilType} = 1, L_{otSand}, L_{otClay})$ $L_{reqdOT} = 12\,\text{ft}$

$PR_{ot} := \text{if}(\text{SoilType} = 1, PR_{otSand}, PR_{otClay})$ $PR_{ot} = 0.9$

## Shaft Depth Required to Resist Torsion

$SF_{tor} := \mathbf{1.0}$

*Safety Factor against Torsion*
*1.0 for Mast Arm signal structures*

*SM V3 13.6*

*NOTE: $\omega_{fdot}$ and $\mu$ are based upon CONCRETE and soil interaction.* ***This torsion methodology is not to be used with permanent casing****.*

$N_{blows} = 15$ *Number of blows per foot. If N< 5, contact the district geotech Engineer*

$\omega_{fdot} := \text{if}\left(N_{blows} < 5, 0, \text{if}\left(N_{blows} \ge 15, 1.5, 1.5 \cdot \frac{N_{blows}}{15}\right)\right) = 1.5$ *load transfer ratio*

$\mu := \tan(\phi_{soil}) = 0.6$ *coefficient of friction between concrete shaft and soil*

$\gamma_{concrete} := 150 \cdot pcf$ $\gamma_{concrete} := \gamma_{concrete} - \gamma_{water}$ $\gamma_{concrete} = 87.6 \cdot pcf$

$\text{CohesionFactor} := 0.55$ $f_{se} := \text{CohesionFactor} \cdot c_{soil}$

$\text{Torsion} := M_{y.polebase_{LoadCaseT}}$ $\text{Torsion} = 96.9 \cdot kip \cdot ft$

*short free-head pile in cohesionless soil*

*Guess value* $L_{torSand} := L_{reqdOT}$

Given

$$\text{Torsion} \cdot SF_{tor} = \left[\pi \cdot b \cdot (L_{torSand}) \cdot \gamma_{soil} \cdot \left(\frac{L_{torSand}}{2}\right) \cdot (\omega_{fdot}) \cdot \frac{b}{2} + \pi \cdot \left(\frac{b}{2}\right)^2 \cdot L_{torSand} \cdot (\gamma_{concrete}) \cdot \frac{b}{3} \cdot \mu\right]$$

$\text{Temp} := \text{Find}(L_{torSand})$ $L_{torSand} := \text{Temp}$ $L_{torSand} = 12.1\,\text{ft}$

*(round up to next foot)* $L_{torSand} := \text{ceil}\left(\frac{L_{torSand}}{ft}\right) \cdot ft$ $L_{torSand} = 13\,\text{ft}$

$$PR_{torSand} := \frac{\text{Torsion} \cdot SF_{tor}}{\pi \cdot b \cdot (L_{torSand}) \cdot \gamma_{soil} \cdot \left(\frac{L_{torSand}}{2}\right) \cdot (\omega_{fdot}) \cdot \frac{b}{2} + \pi \cdot \left(\frac{b}{2}\right)^2 \cdot L_{torSand} \cdot (\gamma_{concrete}) \cdot \frac{b}{3} \cdot \mu}$$ $PR_{torSand} = 0.9$

*short free-head pile in cohesive soil*

*Guess value* $L_{torClay} := L_{reqdOT}$

Given $\quad \text{Torsion}\cdot SF_{tor} = \left[f_{se}\cdot(\pi\cdot b)\cdot(L_{torClay} - 1.5\cdot ft)\cdot\frac{b}{2}\right] + \left[f_{se}\cdot\pi\cdot\left(\frac{b}{2}\right)^2\cdot\left(\frac{b}{3}\right)\right]$

$\text{Temp} := \text{Find}(L_{torClay})$ $\quad L_{torClay} := \text{Temp}$ $\quad L_{torClay} = 5.5\,ft$

*(round up to next foot)* $\quad L_{torClay} := \text{ceil}\left(\frac{L_{torClay}}{ft}\right)\cdot ft$ $\quad L_{torClay} = 6\,ft$

$$PR_{torClay} := \frac{\text{Torsion}\cdot SF_{tor}}{\left[f_{se}\cdot(\pi\cdot b)\cdot(L_{torClay} - 1.5\cdot ft)\cdot\frac{b}{2}\right] + \left[f_{se}\cdot\pi\cdot\left(\frac{b}{2}\right)^2\cdot\left(\frac{b}{3}\right)\right]} \qquad PR_{torClay} = 0.9$$

$L_{reqdTor} := \text{if}(\text{SoilType} = 1, L_{torSand}, L_{torClay})$ $\quad L_{reqdTor} = 13\,ft$

$PR_{tor} := \text{if}(\text{SoilType} = 1, PR_{torSand}, PR_{torClay})$ $\quad PR_{tor} = 0.9$

$L_{embedded} := \text{if}(L_{reqdTor} > L_{reqdOT}, L_{reqdTor}, L_{reqdOT})$ $\quad L_{embedded} = 13\,ft$

$L_{shaft} := L_{embedded} + \text{Offset}$ $\quad L_{shaft} = 13\,ft$

$L_{shaft} := 14\cdot ft$ $\quad$ *Actual Drilled Shaft L = 14'* $\quad L_{shaft} = 14\,ft$

$PR_{foundation} := \text{if}(L_{reqdTor} > L_{reqdOT}, PR_{tor}, PR_{ot})$ $\quad PR_{foundation} = 0.871$

## Unfactored Maximum Moment in Shaft

*short free-head pile in cohesionless soil using Broms method*

$$f_{sand} := \sqrt{\frac{2\cdot\frac{P_{total}}{SF_{ot}}}{3\cdot\gamma_{soil}\cdot b\cdot K_p}} \qquad f_{sand} = 2.9\,ft$$

$$M_{maxSand} := \frac{P_{total}}{SF_{ot}}\cdot(e_{sand} + f_{sand}) - \frac{\frac{P_{total}}{SF_{ot}}\cdot f_{sand}}{3} + \frac{M_{total}}{SF_{ot}} \qquad M_{maxSand} = 124\cdot kip\cdot ft$$

*short free-head pile in cohesive soil using Modified Broms method for L < 3b (see reference file for derivation)*

*Guess value* $\quad f_{mod} := 4.0\cdot ft$

Given $\quad \frac{P_{total}}{SF_{ot}} = \frac{f_{mod}\cdot b}{2}\cdot(2\cdot c_{soil} + f_{mod}\cdot \text{Slope})$

$f_{mod} := \text{Find}(f_{mod})$ $\quad f_{mod} = 0.7\,ft$

$$M_{modBroms} := \frac{P_{total}}{SF_{ot}}\cdot(e_{clay} + f_{mod}) - \frac{c_{soil}\cdot b\cdot f_{mod}^{\,2}}{2} - \frac{b\cdot f_{mod}^{\,3}\cdot \text{Slope}}{6} \qquad M_{modBroms} = 114.9\cdot kip\cdot ft$$

*short free-head pile in cohesive soil using Regular Broms method for L > 3b*

$$M_{Broms} := \frac{P_{total}}{SF_{ot}} \cdot \left(e_{clay} + 1.5 \cdot b + 0.5 \cdot f_{clay}\right)$$ $M_{Broms} = 143.4 \cdot kip \cdot ft$

$$M_{maxClay} := if\left(L_{ot1Clay} < 3 \cdot b, M_{modBroms}, M_{Broms}\right)$$ $M_{maxClay} = 114.9 \cdot kip \cdot ft$

*(If $L_{ot} < 3b$, use Modified Broms method)*

$$M_{max} := if\left(SoilType = 1, M_{maxSand}, M_{maxClay}\right)$$ *(this is a Service moment)* $M_{max} = 124 \cdot kip \cdot ft$

## Minimum Reinforcing and Spacing

$F_{y.rebar} := \mathbf{60} \cdot ksi$ *reinforcing yield strength*

$f_c := \mathbf{4.0} \cdot ksi$ *concrete strength* ***Spec 346-3***

$cover := \mathbf{6} \cdot in$ *cover* ***SDG Table 1.4.2-1*** *Cover okay at 6"*

$A_{bar} := \mathbf{1.56} \cdot in^2$ *longitudinal bar area* *Main bar size okay, using #11s*

$d_{bar} := \mathbf{1.41} \cdot in$ *longitudinal bar diameter*

*Stirrup bar size okay, using #5s*

$A_{v.bar} := \mathbf{0.31} \cdot in^2$ *stirrup area* ***SM V3 13.6.2***

$d_{v.bar} := \mathbf{0.625} \cdot in$ *stirrup diameter* *Stirrup $s_{v1}$ spacing okay, using 4"*

$s_{v1} := \mathbf{4} \cdot in$ *stirrup spacing, depth = 0 ft-2 ft* ***SM V3 13.6.2***

$s_{v2} := \mathbf{18} \cdot in$ *stirrup spacing, depth = 2 ft-depth.stir* *Stirrup $s_{v2}$ spacing adjusted from 12' to 18"*

$s_{v3} := \mathbf{18} \cdot in$ *stirrup spacing, depth > depth.stir* *Stirrup $s_{v3}$ spacing adjusted from 12' to 18"*

$depth_{stir} := \mathbf{12} \cdot ft$ *stirrup depth, see s.v2 and s.v3 above*

$b = 3.5\,ft$ *shaft diameter*

$$BarsProv_1 := \frac{0.01}{A_{bar}} \cdot \frac{\pi \cdot b^2}{4}$$ $BarsProv_1 = 8.9$ ***LRFD 5.7.4.2***

$$BarsProv_2 := \frac{0.135}{A_{bar} \cdot F_{y.rebar}} \cdot \left(\frac{\pi \cdot b^2}{4} \cdot f_c\right)$$ $BarsProv_2 = 8$

$$BarsProv := ceil\left(max\left(BarsProv_1, BarsProv_2\right)\right)$$ $BarsProv = 9$ *number of longitudinal bars*

$BarsProv := 10$ $BarsProv = 10$ *Main bar No. adjusted to 10*

$$NumSpaces_{v.bar} := round\left(\frac{depth_{stir} - 2 \cdot ft}{s_{v2}}\right) \qquad NumSpaces_{v.bar} = 7$$

$$ReinfClearSpacing := \left[b - 2 \cdot \left(cover + d_{v.bar} + \frac{d_{bar}}{2}\right)\right] \cdot \frac{\pi}{BarsProv} - d_{bar} \qquad ReinfClearSpacing = 7.18 \cdot in$$

CheckReinfClearSpacing := if (ReinfClearSpacing ≥ 6in, "OK" , "No Good" ) CheckReinfClearSpacing = "OK"

SDG 3.6.10

## Check Shear and Torsion

| | | |
|---|---|---|
| $LF_{shr} := \mathbf{1.3}$ | *Shear Load Factor* | *1.3 is a reasonable Load Factor for combined WL + DL on sign and signal structures* |
| $LF_{tor} := \mathbf{1.3}$ | *Torsion Load Factor* | |
| $\phi_{shr} := \mathbf{0.90}$ | *Shear Resistance Factor* | LRFD 5.5.4.2.1 |
| $\phi_{tor} := \mathbf{0.90}$ | *Torsion Resistance Factor* | LRFD 5.5.4.2.1 |

$$V_u := LF_{shr} \cdot \sqrt{\left(V_{x.polebase_{LoadCaseOT}}\right)^2 + \left(V_{z.polebase_{LoadCaseOT}}\right)^2} \qquad V_u = 7.4 \cdot kip$$

$$T_u := LF_{tor} \cdot Torsion \qquad T_u = 126 \cdot kip \cdot ft$$

$$Torsion = 96.9\,kip \cdot ft$$

*Area and perimeter of concrete cross-section*

$$A_{cp} := \pi \cdot \left(\frac{b}{2}\right)^2 \qquad A_{cp} = 1385.4 \cdot in^2$$

$$p_{cp} := 2 \cdot \pi \cdot \left(\frac{b}{2}\right) \qquad p_{cp} = 131.9 \cdot in$$

*Diameter, perimeter and area enclosed by the centerline of the outermost closed transverse torsion reinforcement*

$$d_{oh} := b - 2 \cdot \left(cover + \frac{d_{v.bar}}{2}\right) \qquad d_{oh} = 29.4 \cdot in$$

$$p_h := \pi \cdot d_{oh} \qquad p_h = 92.3 \cdot in$$

$$A_{oh} := \pi \left(\frac{d_{oh}}{2}\right)^2 \qquad A_{oh} = 677.7 \cdot in^2$$

$$A_o := 0.85 \cdot A_{oh} \qquad A_o = 576.1 \cdot in^2$$

LRFD C5.8.2.1

*Effective shear depth*

$$D_r := b - 2 \cdot \left(cover + d_{v.bar} + \frac{d_{bar}}{2}\right) \qquad d_e := \frac{b}{2} + \frac{D_r}{\pi} = 2.5\,ft$$

LRFD C5.8.2.1

$$d_v := \max\left(0.9 \cdot d_e, 0.72 \cdot b\right) = 2.5\,ft$$

*Check Shear Strength*

$V_c := 0.0316 \cdot (2.0) \cdot \sqrt{\frac{f_c}{ksi}} \cdot \left(\frac{d_v}{in}\right) \cdot \left(\frac{b}{in}\right) \cdot kip$ $\quad V_c = 160.5 \cdot kip$ $\quad$ ***LRFD Eqn 5.8.3.3-3*** ***LRFD 5.8.3.4.1*** ***ACI 11.3.3***

$V_s := \frac{A_{v.bar} \cdot F_{y.rebar} \cdot (d_v)}{\max(s_{v1}, s_{v2}, s_{v3})}$ $\quad V_s = 31.2 \cdot kip$ $\quad$ ***LRFD Eqn 5.8.3.3-4***

$\phi_{shr} = 0.9$ $\quad V_u = 7.4 \cdot kip$

$ShearRatio := \frac{V_u - \phi_{shr} \cdot V_c}{\phi_{shr} \cdot V_s}$ $\quad ShearRatio = -4.9$

$ShearRatio := \text{if}(ShearRatio \le 0, 0, ShearRatio)$ $\quad ShearRatio = 0$

*Check Torsion Strength*

$T_{n1} := \frac{2 \cdot A_o \cdot A_{v.bar} \cdot F_{y.rebar}}{s_{v1}}$ $\quad T_{n1} = 446.4 \cdot kip \cdot ft$ $\quad$ ***LRFD Eqn 5.8.3.6.2-1*** ***LRFD 5.8.3.4.1***

$T_{n2} := \frac{2 \cdot A_o \cdot A_{v.bar} \cdot F_{y.rebar}}{s_{v2}}$ $\quad T_{n2} = 99.2 \cdot kip \cdot ft$

$T_{n3} := \frac{2 \cdot A_o \cdot A_{v.bar} \cdot F_{y.rebar}}{s_{v3}}$ $\quad T_{n3} = 99.2 \cdot kip \cdot ft$

$\phi_{tor} = 0.9$ $\quad T_u = 126 \cdot kip \cdot ft$ $\quad L_{reqdTor} = 13\,ft$

$$Tor2_{sand} := T_u - \text{if}\left[2 \cdot ft > Offset, \left[\pi \cdot b \cdot (2 \cdot ft - Offset) \cdot \gamma_{soil} \cdot \left(\frac{2 \cdot ft - Offset}{2}\right) \cdot (\omega_{fdot}) \cdot \frac{b}{2}\right], 0 \cdot kip \cdot ft\right] = 123.5 \cdot kip \cdot ft$$

$$Tor3_{sand} := T_u - \text{if}\left[depth_{stir} > Offset, \left[\pi \cdot b \cdot (depth_{stir} - Offset) \cdot \gamma_{soil} \cdot \left(\frac{depth_{stir} - Offset}{2}\right) \cdot (\omega_{fdot}) \cdot \frac{b}{2}\right], 0 \cdot kip \cdot ft\right] = 37.5 \cdot kip \cdot ft$$

$$Tor2_{clay} := T_u - \text{if}\left[2 \cdot ft - 1.5 \cdot ft > Offset, \left[f_{se} \cdot (\pi \cdot b) \cdot (2.0 \cdot ft - Offset - 1.5 \cdot ft) \cdot \frac{b}{2}\right], 0 \cdot kip \cdot ft\right] = 115.4 \cdot kip \cdot ft$$

$$Tor3_{clay} := T_u - \text{if}\left[depth_{stir} - 1.5 \cdot ft > Offset, \left[f_{se} \cdot (\pi \cdot b) \cdot (depth_{stir} - Offset - 1.5 \cdot ft) \cdot \frac{b}{2}\right], 0 \cdot kip \cdot ft\right] = -96.2 \cdot kip \cdot ft$$

$Tor2 := \text{if}(SoilType = 1, Tor2_{sand}, Tor2_{clay})$ $\quad Tor2 = 123.5 \cdot kip \cdot ft$

$Tor3 := \text{if}(SoilType = 1, Tor3_{sand}, Tor3_{clay})$ $\quad Tor3 = 37.5 \cdot kip \cdot ft$

$$TorsionRatio_{n1} := \frac{T_u}{\phi_{tor} \cdot T_{n1}} \qquad TorsionRatio_{n1} = 0.31$$

$$TorsionRatio_{n2} := \frac{Tor2}{\phi_{tor} \cdot T_{n2}} \qquad TorsionRatio_{n2} = 1.38$$

$$TorsionRatio_{n3} := \frac{Tor3}{\phi_{tor} \cdot T_{n3}} \qquad TorsionRatio_{n3} = 0.42$$

$$TorsionRatio := \max\left(TorsionRatio_{n1}, TorsionRatio_{n2}, TorsionRatio_{n3}\right) \qquad TorsionRatio = 1.38$$

$$T_{cr} := 0.125\sqrt{\frac{f_c}{ksi}} \cdot \left(\frac{A_{cp}{}^2}{p_{cp} \cdot in^3}\right) \cdot kip \cdot in \qquad T_{cr} = 303.1 \cdot kip \cdot ft$$ ***LRFD Eqn 5.8.2.1-4***

$$TorsionRatio := if\left(T_u \le 0.25 \cdot \phi_{tor} \cdot T_{cr}, 0, TorsionRatio\right) \qquad TorsionRatio = 1.4$$ ***LRFD Eqn 5.8.2.1-3***

$$ShearRatio = 0$$

$$CheckShearTorsion := if(ShearRatio + TorsionRatio \le 1, \text{"OK"}, \text{"No Good"}) \qquad CheckShearTorsion = \text{"No Good"}$$

$$ShearRatio + TorsionRatio = 1.4$$ *Should be 1.0 or less*

*Check Maximum Spacing Transverse Reinforcement*

$$vu := \frac{V_u}{\phi_{shr} \cdot b \cdot (0.8 \cdot b)} \qquad vu = 0.005862 \cdot ksi$$ ***LRFD Eqn 5.8.2.9-1***

$$0.125 \cdot f_c = 0.5 \cdot ksi$$

$$s_{max1} := if\left(0.8 \cdot d_v < 24 \cdot in, 0.8 \cdot d_v, 24 \cdot in\right) \qquad s_{max1} = 24 \cdot in$$ ***LRFD Eqn 5.8.2.7-1***

$$s_{max2} := if\left(0.4 \cdot d_v < 12 \cdot in, 0.4 \cdot d_v, 12 \cdot in\right) \qquad s_{max2} = 12 \cdot in$$ ***LRFD Eqn 5.8.2.7-2***

$$s_{max} := if\left(vu < 0.125 \cdot f_c, s_{max1}, s_{max2}\right) \qquad s_{max} = 24 \cdot in$$

$$\max\left(s_{v1}, s_{v2}, s_{v3}\right) = 18 \cdot in$$

$$CheckMaxSpacingTransvReinf := if\left(\max\left(s_{v1}, s_{v2}, s_{v3}\right) \le s_{max}, \text{"OK"}, \text{"No Good"}\right) \qquad CheckMaxSpacingTransvReinf = \text{"OK"}$$

*Check Longitudinal Reinforcement for Combined Shear and Torsion* ***LRFD Eqn 5.8.3.6.3-1***

***LRFD 5.8.3.4.1***

$$M_u := LF_{tor} \cdot \sqrt{\left(M_{x.polebase_{LoadCaseOT}}\right)^2 + \left(M_{z.polebase_{LoadCaseOT}}\right)^2} \qquad M_u = 146.2 \cdot kip \cdot ft$$

$$V_{temp} := if\left(\frac{V_u}{\phi_{shr}} - 0.5 \cdot V_s > 0 \cdot kip, \frac{V_u}{\phi_{shr}} - 0.5 \cdot V_s, 0 \cdot kip\right) \qquad V_{temp} = 0 \cdot kip$$

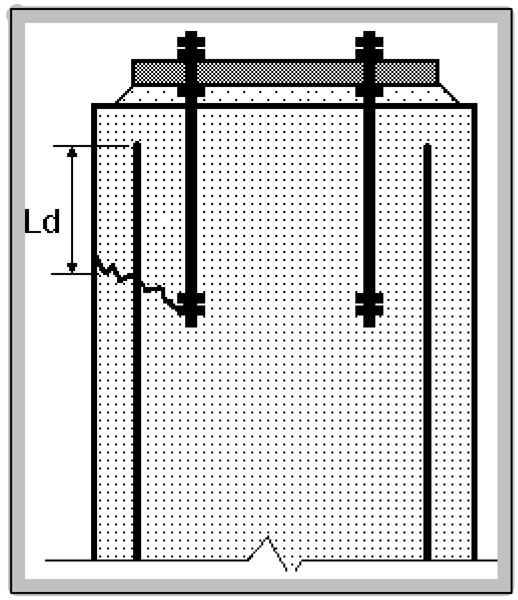
$$LongReinf_{shr.tor} := \frac{\dfrac{M_u}{\phi_{tor}\cdot(0.8\cdot b)} + \sqrt{\left(\dfrac{V_{temp}}{kip}\right)^2 + \left(\dfrac{0.45\cdot p_h\cdot T_u}{2\cdot A_o\cdot\phi_{tor}\cdot kip}\right)^2}\cdot kip}{F_{y.rebar}} \qquad LongReinf_{shr.tor} = 2\cdot in^2$$

$$BarsProv\cdot A_{bar} = 15.6\cdot in^2$$

$$CheckLongReinf_{shr.tor} := if\left(BarsProv\cdot A_{bar} \geq LongReinf_{shr.tor}, \text{"OK"}, \text{"No Good"}\right) \qquad CheckLongReinf_{shr.tor} = \text{"OK"}$$

## Anchor Bolt Embedment

$$Gap_{shaft} := \frac{b - 2\cdot cover - 2\cdot d_{v.bar} - Diameter_{boltcircle.pole} - d_{bar}}{2}$$




$$Gap_{shaft} = 2.67\cdot in$$

$$Diameter_{rebar.circle} := b - 2\cdot cover - d_{bar} - 2\cdot d_{v.bar}$$

$$Diameter_{rebar.circle} = 27.3\cdot in$$

$$\#BarsProvided := BarsProv \qquad \#BarsProvided = 10$$

$$\#BarsProvidedPerRod := min\left(\left(\begin{matrix}\dfrac{\#BarsProvided}{\#AnchorRods} \\ 3\end{matrix}\right)\right) \qquad \#BarsProvidedPerRod = 1.7$$

*Use a maximum of three rebar per anchor bolt (conservative)*

$$\phi := 0.9 \qquad \#BarsReqdPerRod := \frac{T_{u.rod}}{A_{bar}\cdot\left(\phi\cdot F_{y.rebar}\right)}\cdot\frac{Diameter_{boltcircle.pole}}{Diameter_{rebar.circle}} \qquad \#BarsReqdPerRod = 0.39$$

$$AreaRatio := \frac{\#BarsReqdPerRod}{\#BarsProvidedPerRod} \qquad AreaRatio = 0.24$$

$$AreaRatio := if(AreaRatio < 1, AreaRatio, 1) \qquad AreaRatio = 0.24$$

*2015 AASHTO Development Length of Deformed Bars in Tension* ***5.11.2.1***

$cover = 6 \cdot in$

$c_b$ = *the smaller of the distance from center of bar or wire being developed to the nearest concrete surface and one half the center-to-center spacing of the bars or wires being developed*

$$c_b := \min\left(cover + d_{v.bar} + \frac{d_{bar}}{2}, \frac{ReinfClearSpacing + d_{bar}}{2}\right) = 4.3 \cdot in$$

$k_{tr} := 0 \cdot in$ *assume no transverse bars:*

$$\lambda_{rc} := \min\left(1, \max\left(0.4, \frac{d_{bar}}{c_b + k_{tr}}\right)\right)$$ ***LRFD Eqn 5.11.2.1.3-1***

$\lambda_{rc} = 0.4$

$$L_{d.bar} := \max\left(12in, \lambda_{rc} \cdot 2.4 \cdot d_{bar} \cdot \frac{F_{y.rebar}}{\sqrt{f_c \cdot ksi}}\right)$$ *tension development length* ***LRFD Eqn 5.11.2.1.1-2***

$$SpacingFactor := \max\left(\begin{pmatrix} \#BarsProvidedPerRod \cdot 0.5 - 0.5 \\ 0.5 \end{pmatrix}\right)$$ $SpacingFactor = 0.5$

$$L_{embedment.added} := \sqrt{(ReinfClearSpacing \cdot SpacingFactor)^2 + Gap_{shaft}^{\ 2}}$$ $L_{embedment.added} = 4.5 \cdot in$

$$L_{embedment.rod} := \max\left[\begin{bmatrix} L_{d.bar} \cdot (AreaRatio) + 12 \cdot in + L_{embedment.added} \\ 20 \cdot d_{bolt.pole} \end{bmatrix}\right]$$

*Note:* $20d_{anchor}$ *minimum embedment was in old AASHTO LTS, 2nd Ed. 1985 and 3rd Ed. 1994 in Section 3 - 1.3.4. It was removed in the 4th Ed., but is still a good rule of thumb.*

$$L_{embedment.rod} := Ceil(L_{embedment.rod}, in)$$ $L_{embedment.rod} = 30 \cdot in$

$$L_{anchor.rod} := Ceil[(L_{embedment.rod} + 8 \cdot in), in]$$ $L_{anchor.rod} = 38 \cdot in$

## Anchor Bolt Shear Break-Out Strength

***References:***
***ACI 318-05 Appendix D.***
***FDOT/University of Florida Report BD545 RPWO #54,***
***Anchor Embedment Requirements for Signal/Sign Structures, July 2007.***

$\#AnchorRods = 6$ *number of anchor bolts*

$d_{bolt.pole} = 1.5 \cdot in$ *anchor bolt diameter*

$Diameter_{boltcircle.pole} = 22 \cdot in$ *anchor bolt circle diameter*

$L_{embedment.rod} = 30 \cdot in$ *anchor bolt embedment*

$b = 42 \cdot in$ *shaft diameter*

$r_b := \frac{Diameter_{boltcircle.pole}}{2}$ $r_b = 11 \cdot in$

$r := \frac{b}{2}$ $r = 21 \cdot in$

$c_{a1} := \frac{\sqrt{r_b^2 + 3.25 \cdot (r^2 - r_b^2)} - r_b}{3.25}$ $c_{a1} = 7.1 \cdot in$ *adjusted cover*

***UF Report Eqn 3-2***

$L_e := \min(8 \cdot d_{bolt.pole}, L_{embedment.rod})$ $L_e = 12 \cdot in$ *load bearing length of anchor for shear*

***ACI D.6.2.2***

$V_b := 13 \cdot \left(\frac{L_e}{d_{bolt.pole}}\right)^{0.2} \cdot \sqrt{\frac{d_{bolt.pole}}{in}} \cdot \sqrt{\frac{f_c}{psi}} \left(\frac{c_{a1}}{in}\right)^{1.5} \cdot lbf$ *shear break-out strength (single anchor)*

***UF Report Eqn 2-11***

$V_b = 28.9 \cdot kip$

$A_{bolt.sector} := \frac{(360 \cdot deg)}{\#AnchorRods} = 60 \cdot deg$ ***UF Report Fig 3-7***

$alpha := 2 \operatorname{asin}\left[\frac{(1.5 \cdot c_{a1})}{r}\right] = 60.9 \cdot deg$

OverlapTest := if$(A_{bolt.sector} \le alpha$, "Overlap of Failure Cones" , "No Overlap of Failure Cones" $)$

OverlapTest = "Overlap of Failure Cones"

$chord := 2 \cdot r \cdot \sin\left(\frac{A_{bolt.sector}}{2}\right)$ $chord = 21 \cdot in$ ***UF Report Fig 3-7***

$A_{Vco} := 4.5 \cdot c_{a1}^2$ $A_{Vco} = 226.8 \cdot in^2$ *projected concrete failure area (single anchor)*

***ACI Eqn D-23***

$A_{Vc} := chord \cdot 1.5 \cdot c_{a1}$ $A_{Vc} = 223.6 \cdot in^2$ *projected concrete failure area (group)*

***ACI D.6.2.1***

$A_{Vc} := \text{if}(A_{Vc} > A_{Vco}, A_{Vco}, A_{Vc})$ $A_{Vc} = 223.6 \cdot in^2$

$\psi_{ecV} := \mathbf{1.0}$ *eccentric load modifier* ***ACI D.6.2.5***

$\psi_{edV} := \mathbf{1.0}$ *edge effect modifier* ***ACI D.6.2.6***

$\psi_{cV} := \mathbf{1.4}$ *cracked section modifier* ***ACI D.6.2.7*** *(stirrup spacing <= 4")*

$\psi_{hV} := \mathbf{1.0}$ *member thickness modifier* ***ACI D.6.2.8***

$\phi_{breakout} := \mathbf{0.75}$ *strength reduction factor* ***ACI D.4.4.c.i*** *( shear breakout, condition A)*

$$V_{cbg} := \#AnchorRods \cdot \left(\frac{A_{Vc}}{A_{Vco}}\right) \cdot \left(\psi_{ecV} \cdot \psi_{edV} \cdot \psi_{cV} \cdot \psi_{hV}\right) \cdot V_b \qquad V_{cbg} = 239.1 \cdot kip$$

*concrete breakout strength - shear*

***ACI Eqn D-22*** *Shear force ⊥ to edge*

$$V_{cbg\_parallel} := 2 \cdot V_{cbg} \qquad V_{cbg\_parallel} = 478.3 \cdot kip$$

***ACI D.6.2.1.c*** *Shear force || to edge*

$$T_{n.breakout} := V_{cbg\_parallel} \cdot r_b \qquad T_{n.breakout} = 438.4 \cdot kip \cdot ft$$

*concrete breakout strength - torsion*

$$\phi_{breakout} \cdot T_{n.breakout} = 328.8 \cdot kip \cdot ft$$

$$T_u = 126 \cdot kip \cdot ft$$

$$BreakoutTest := if\left(\phi_{breakout} \cdot T_{n.breakout} \ge T_u, \text{"OK"}, \text{"No Good"}\right) \qquad BreakoutTest = \text{"OK"}$$

$$OverlapDesign := if\left(A_{bolt.sector} \le alpha, \text{"Based on Overlap of Failure Cones"}, \text{"Based on No Overlap of Failure Cones"}\right)$$

$$OverlapDesign = \text{"Based on Overlap of Failure Cones"}$$

$$M_{x.polebase} = \begin{pmatrix} 0.0 \\ 106.0 \\ 106.0 \end{pmatrix} \cdot ki \quad M_{y.polebase} = \begin{pmatrix} 96.9 \\ 0.0 \\ 96.9 \end{pmatrix} \cdot kip \cdot ft \quad M_{z.polebase} = \begin{pmatrix} 0.0 \\ 37.5 \\ 37.5 \end{pmatrix} \cdot kip \cdot ft$$

*maximum torsion (Mx & Mz not used)*
*maximum overturning (My not used)*
*maximum CSR*

Analyze Foundation

## Summary - Soil Properties and Drilled Shaft Geometry

$SoilType = 1$ *0 - clay* *1 - sand* $\phi_{soil} = 30 \cdot deg$ $c_{soil} = 2000 \cdot psf$ $\gamma_{soil} = 42.6 \cdot pcf$ $Offset = 0\,ft$

$Diameter_{shaft} = 3.5\,ft$ $L_{shaft} = 14\,ft$ $L_{embedment.rod} = 30 \cdot in$ $L_{anchor.rod} = 38 \cdot in$

$\#BarsProvided = 10$ $d_{bar} = 1.41 \cdot in$

## Foundation Performance Ratios

$PR_{foundation} = 0.871$

## Fatigue Analysis

DataFile = "Cortez 1 NE Review_P.dat" WindSpeed = 130·mph

*Use the member cross section adjacent to the weld toe to compute the nominal stress range.* **LTS 11.9**

$FatigueCategory := 2$ **SM V3 11.6**

Analyze Structure for Fatigue

*Arm and Pole Welds*

$f_{galloping.arm1} = 3.8 \cdot ksi$ $CAFT_{fullpengroove.weld.arm1} = 7 \cdot ksi$ $Check_{galloping.arm1} = "OK"$

$f_{galloping.arm2} = 0 \cdot ksi$ $CAFT_{fullpengroove.weld.arm2} = "NA" \cdot ksi$ $Check_{galloping.arm2} = "NA"$

$f_{galloping.pole} = 2.5 \cdot ksi$ $CAFT_{fullpengroove.weld.pole} = 4.5 \cdot ksi$ $Check_{galloping.pole} = "OK"$

$f_{nwg.arm1} = 2.5 \cdot ksi$ $Check_{nwg.arm1} = "OK"$

$f_{nwg.arm2} = 0 \cdot ksi$ $Check_{nwg.arm2} = "NA"$

$f_{nwg.pole} = 2.6 \cdot ksi$ $Check_{nwg.pole} = "OK"$

*A325 Connection Bolts*

$f_{t.g.bolt} = \begin{pmatrix} 5.3 \\ 0.0 \end{pmatrix} \cdot ksi$ $CAFT_{conn.bolt} = 16 \cdot ksi$ $Check_{g.conn.bolt} = \begin{pmatrix} "OK" \\ "OK" \end{pmatrix}$

$f_{t.nwg.bolt} = \begin{pmatrix} 3.4 \\ 0.0 \end{pmatrix} \cdot ksi$ $Check_{nwg.conn.bolt} = \begin{pmatrix} "OK" \\ "OK" \end{pmatrix}$

*Anchor Bolts*

$f_{t.g.rod} = 3.8 \cdot ksi$ $CAFT_{anchor.rods} = 7 \cdot ksi$ $Check_{g.rod} = "OK"$

$f_{t.nwg.rod} = 4 \cdot ksi$ $Check_{nwg.rod} = "OK"$

Summary

## Mast Arm Design and Analysis Summary

DataFile = "Cortez 1 NE Review_P.dat"

WindSpeed = 130·mph

**Subject** = "Cortez - 43rd St W P Rev" **DesignedBy** = "SML" **PoleLocation** = "Pole 1 - NE Corner"

**ProjectNo** = "404-6002870" **CheckedBy** = " " **Date** = "06/21/2018"

### 1st Mast Arm

$\#Signals_{arm1} = 3$ $\#Panels_{arm1} = 1$

$X_{signal.arm1} = \begin{pmatrix} 14 \\ 24 \\ 34 \end{pmatrix} ft$ $Sections_{signal.arm1} = \begin{pmatrix} 5 \\ 3 \\ 5 \end{pmatrix}$ $Backplate_{signal.arm1} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$

$X_{panel.arm1} = (6)\,ft$ $Area_{panel.arm1} = (20)\,ft^2$

$L_{total.arm1} = 46\,ft$ $L_{splice.provided.arm1} = 24 \cdot in$

'FA'= 'FE'= $L_{arm1} = \begin{pmatrix} 35.1 \\ 12.9 \end{pmatrix} \cdot ft$ 'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 7.0833 \\ 11.2173 \end{pmatrix} \cdot in$ 'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 11.9973 \\ 13 \end{pmatrix} \cdot in$

'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$ $\max(\Delta_{arm1}) = 4.74 \cdot in$ $\max(CSR_{arm1}) = 0.602$

### 2nd Mast Arm

$\#Signals_{arm2} = 0$ $\#Panels_{arm2} = 1$

$X_{signal.arm2} = (0)\,ft$ $Sections_{signal.arm2} = (0)$ $Backplate_{signal.arm2} = (0)$

$X_{panel.arm2} = (0.1)\,ft$ $Area_{panel.arm2} = (0.1)\,ft^2$

$L_{total.arm2} = 0\,ft$ $L_{splice.provided.arm2} = 24\cdot in$ 'UF'= $\alpha = 0\cdot deg$ **(Angle Between Arms)**

'SA'= 'SE'= $L_{arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot ft$ 'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot in$ 'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot in$

'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot in$ $\max(\Delta_{arm2}) = 0\cdot in$ $\max(CSR_{arm2}) = 0$

## Luminaire Arm and Connection

DataFile = "Cortez 1 NE Review_ WindSpeed = 130·mph

*(use MC10x33.6 channel for connection)*

'LA'= $Y_{luminaire} = 0\,ft$ 'LB'= $X_{luminaire} = 0\,ft$ 'LC'= $Diameter_{base.lumarm} = 0\cdot in$

'LD'= $t_{wall.lumarm} = 0\cdot in$ 'LE'= $Slope_{lumarm} = 0$ 'LF'= $r_{lumarm} = 0\,ft$

'LG'= $d_{bolt.lum} = 0\cdot in$ 'LH'= $t_{baseplate.lum} = 0\cdot in$

'LJ'= $w_{base.lum} = 0\cdot in$ 'LK'= $w_{channel.lum} = 0\cdot in$

$CSR_{base.lumarm} = 0$ $PR_{bolt.lum} = 0$ $PR_{baseplate.lum} = 0$ $PR_{conn.plate.lum} = 0$

## Upright

'UA'= $Y_{pole} = 21.5\,ft$ 'UB'= $Y_{arm.conn} = 20\cdot ft$ 'UC'= $Diameter_{tip.pole} = 13.0192\,in$

'UD'= $Diameter_{base.pole} = 16\,in$ 'UE'= $t_{wall.pole} = 0.375\,in$ 'UF'= $\alpha = 0\cdot deg$

'UG'= $Y_{lum.conn} = 0\,ft$ $\Delta_{x.dl} = 0.89\cdot in$ $Slope_x = 0.47\cdot deg$

$\Delta_{z.dl} = 0\cdot in$ $Slope_z = 0\cdot deg$ $C_{a.pole} = 0.996$

$\max(CSR_{pole}) = 0.619$

## 1st Arm/Upright Connection

$\#ConnBolts_0 = 6$ 'HT'= $h_{conn.plate} = 22\cdot in$ 'FJ'= $b_{conn.plate_0} = 23\cdot in$

'FK'= $t_{baseplate.arm_0} = 2\cdot in$ 'FL'= $t_{vertical.plate_0} = 0.5\cdot in$

'FN'= $w_{vertical.plate_0} = 0.3125\,in$ 'FO'= $Offset_{conn_0} = 14.1146\,in$

'FP'= $d_{bolt.conn_0} = 1\cdot in$ 'FR'= $t_{conn.plate_0} = 1.5\cdot in$

'FS'= $Spacing_{bolts.conn_0} = 9\cdot in$ 'FT'= $w_{conn.plate_0} = 0.3125\,in$

$$\begin{pmatrix} PR_{bolt_0} \\ PR_{t.baseplate.arm_0} \\ PR_{t.connplate.arm_0} \\ CSR_{t.vert.plate_0} \end{pmatrix} = \begin{pmatrix} 0.663 \\ 0.839 \\ 0.998 \\ 0.661 \end{pmatrix}$$

## 2nd Arm/Upright Connection

$\#ConnBolts_1 = 0$ 'HT'= $h_{conn.plate} = 22\cdot in$ 'SJ'= $b_{conn.plate_1} = 0\cdot in$

'SK'= $t_{baseplate.arm_1} = 0\cdot in$ 'SL'= $t_{vertical.plate_1} = 0\cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

$$\begin{pmatrix} PR_{bolt_1} \\ PR_{t.baseplate.arm_1} \\ PR_{t.connplate.arm_1} \\ CSR_{t.vert.plate_1} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

## Pole Baseplate

DataFile = "Cortez 1 NE Review_ WindSpeed = 130·mph

$\#AnchorRods = 6$

'BA'= $Diameter_{baseplate.pole} = 28 \cdot in$

'BB'= $t_{baseplate.pole} = 2.5 \cdot in$

'BC'= $d_{bolt.pole} = 1.5 \cdot in$

'BF'= $L_{embedment.rod} = 30 \cdot in$

$Diameter_{boltcircle.pole} = 22 \cdot in$

$PR_{rod} = 0.772$

$PR_{plate.pole} = 1$

## Foundation

'DA'= $L_{shaft} = 14 \cdot ft$

'DB'= $Diameter_{shaft} = 3.5 \cdot ft$

$d_{bar} = 1.41 \cdot in$ $\quad Offset = 0\ ft$

'RA'= $round\left(\frac{d_{bar}}{0.125 in}\right) = 11$

'RB'= $\#BarsProvided = 10$

$Diameter_{rebar.circle} = 2.2783\ ft$

'RC'= $NumSpaces_{v.bar} = 7$

'RD'= $s_{v2} = 18 \cdot in$

$PR_{foundation} = 0.871$

WRITEPRN to Line 1-2-3

## Mast Arm Tip Deflection

*Compare Mast Arm deflection of each arm to a proposed camber*

$Camber_{arm1} := \mathbf{2} \cdot deg$ $\qquad Camber_{arm2} := \mathbf{2} \cdot deg$

$$L_{arm1} := \sum L_{arm1} - if\left[\left(L_{arm1_1} = 0 \cdot ft\right), 0 \cdot ft, 2 \cdot ft\right]$$

$$L_{arm2} := \sum L_{arm2} - if\left[\left(L_{arm2_1} = 0 \cdot ft\right), 0 \cdot ft, 2 \cdot ft\right]$$

$Deflection_{arm1} := Slope_x \cdot L_{arm1} + max(\Delta_{arm1})$

$Deflection_{arm1} = 9.3 \cdot in$

$CamberArm1_{upward} := sin(Camber_{arm1}) \cdot L_{arm1}$

$CamberArm1_{upward} = 19.26 \cdot in$

$Deflection_{arm2} := \left[Slope_z \cdot L_{arm2} \cdot (sin(\alpha))\right] + Slope_x \cdot L_{arm2} \cdot cos(\alpha) + max(\Delta_{arm2})$

$Deflection_{arm2} = 0 \cdot in$

$CamberArm2_{upward} := sin(Camber_{arm2}) \cdot L_{arm2}$

$CamberArm2_{upward} = 0 \cdot in$

## Check Clearance Between Connection Plates *(for Two Arm Structures only)*

$\alpha = 0 \cdot deg$ $\qquad \alpha := if[(\alpha > 180 \cdot deg), (360 \cdot deg - \alpha), \alpha]$

$Offset_{conn_0} = 14.1 \cdot in$ $\qquad b_{conn.plate_0} = 23 \cdot in$ $\qquad h_{conn.plate} = 22 \cdot in$ $\qquad \alpha = 0 \cdot deg$

$Offset_{conn_1} = 0 \cdot in$ $\qquad b_{conn.plate_1} = 0 \cdot in$

$x_1 := Offset_{conn_0} - t_{conn.plate_0} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm1})}{2}$ $y_1 := \frac{b_{conn.plate_0}}{2}$ $x_1 = 12.23 \cdot in$ $y_1 = 11.5 \cdot in$

$$x_2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \cos(\alpha) + \frac{b_{conn.plate_1}}{2} \cdot \sin(\alpha)$$

$$y_2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \sin(\alpha) - \frac{b_{conn.plate_1}}{2} \cdot \cos(\alpha)$$

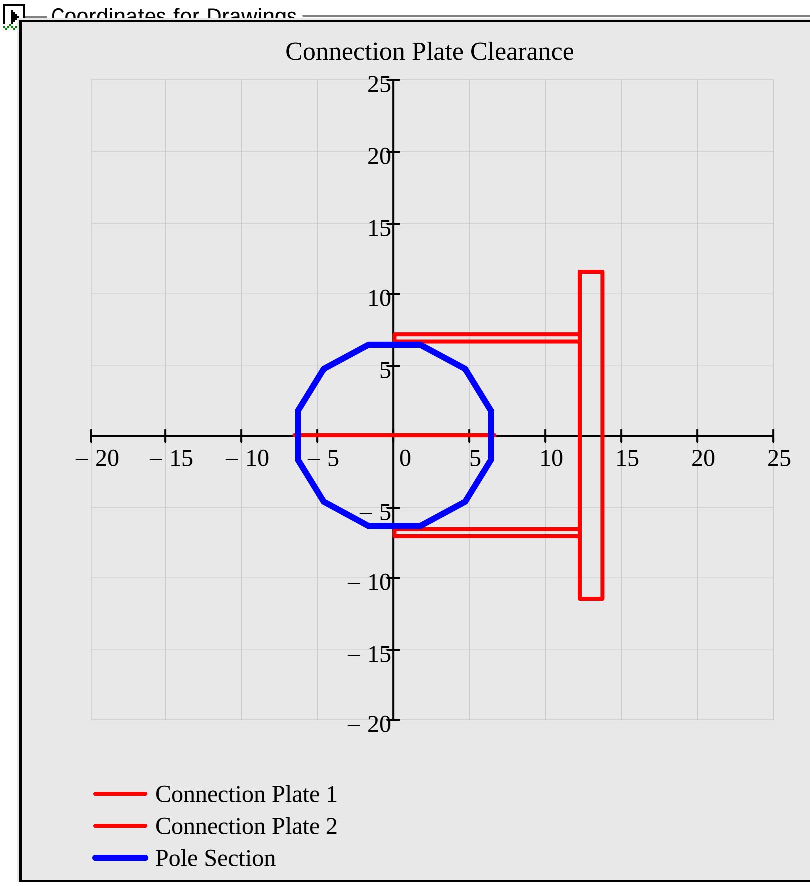
$x_2 = -0.38 \cdot in$ $y_2 = 0 \cdot in$

$Clearance := \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$ $Clearance := if\left[(y_2 \le y_1), if\left[(x_1 > x_2), Clearance, 0 \cdot in\right], Clearance\right]$ $Clearance = 17.07 \cdot in$

***(if Clearance equals 0, then Connection Plates intersect and redesign is required.***

## Plan View - Connection Plate Clearance for Two Arm Connections

Coordinates for Drawings




$Clearance = 17.07 \cdot in$

$Diameter_{conn.pole} = 13.2292 \cdot in$

$t_{conn.plate_0} = 1.5 \cdot in$

$b_{conn.plate_0} = 23 \cdot in$

$t_{vertical.plate_0} = 0.5 \cdot in$

$Offset_{conn_0} = 14.1146 \cdot in$

$Gap_0 = 7.5 \cdot in$

$t_{conn.plate_1} = 0 \cdot in$

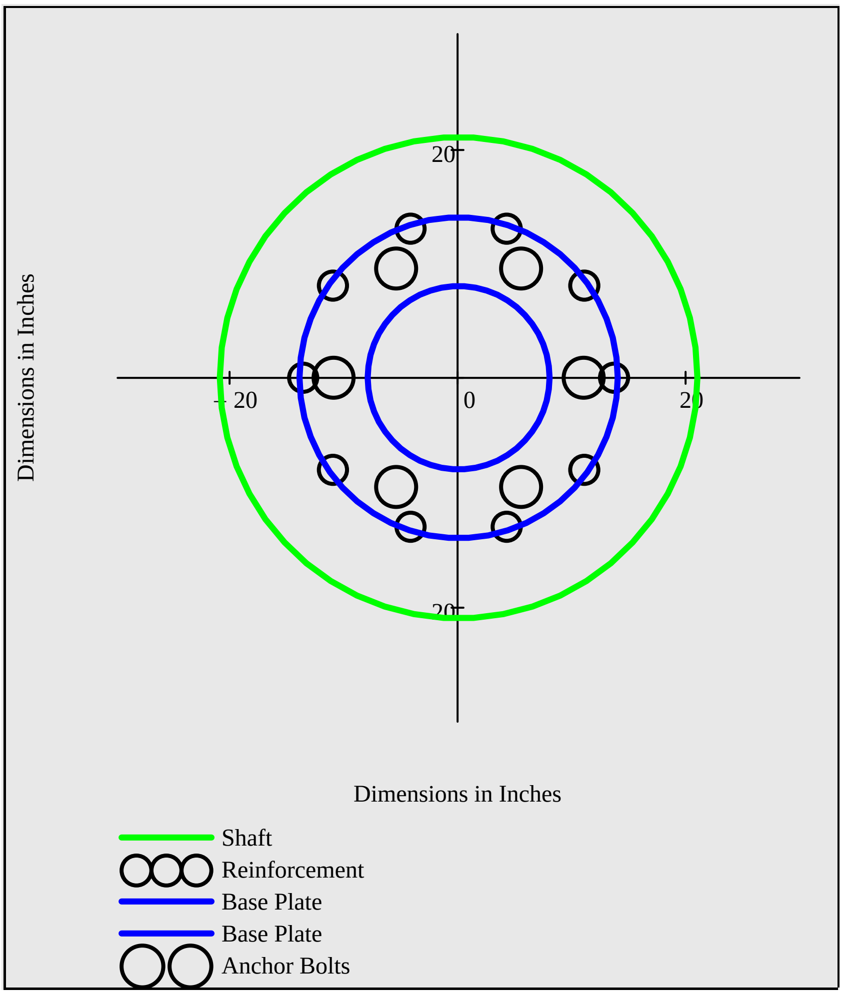
$b_{conn.plate_1} = 0 \cdot in$

$t_{vertical.plate_1} = 0 \cdot in$

$Offset_{conn_1} = 0 \cdot in$

$Gap_1 = 0 \cdot in$

## Plan View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$\text{Diameter}_{base.pole} = 16 \cdot in$

$\text{Diameter}_{baseplate.pole} = 28 \cdot in$

$\text{Diameter}_{shaft} = 42 \cdot in$

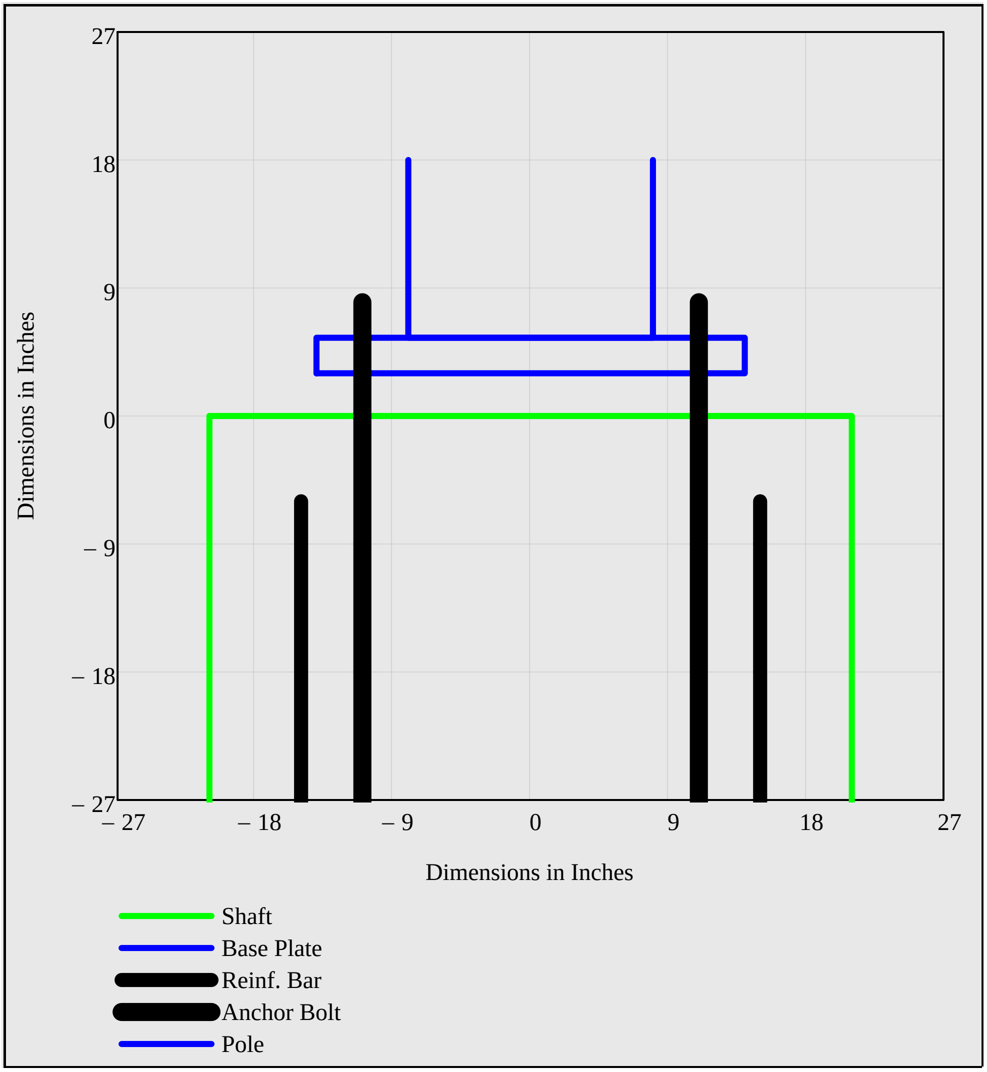
$\text{Diameter}_{boltcircle.pole} = 22 \cdot in$

$\text{Diameter}_{rebar.circle} = 27.34 \cdot in$

#AnchorRods = 6

#BarsProvided = 10

## Elevation View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$Diameter_{base.pole} = 16 \cdot in$

$Diameter_{baseplate.pole} = 28 \cdot in$

$t_{baseplate.pole} = 2.5 \cdot in$

$Diameter_{shaft} = 3.5 \cdot ft$

$Diameter_{boltcircle.pole} = 22 \cdot in$

$Diameter_{rebar.circle} = 27.3 \cdot in$

# Appendix C

Mathcad Program Output

NE Mast Arm Proposed-New Configuration with Concrete Torsion Calculations

(Evaluation of Mast Arm using the current Stirrup Spacing recommendations)

# FDOT Mast Arm Analysis Program

*Custom File Name (optional)*

*The new custom file will be a copy of the last file called from the program. A ".dat" extension will be added to the file name.*

*Add file to file list*

Refresh File List

*Select Data File (required)*

E6T4
E7T6
Cortez 1 NE Exist
Cortez 1 NE Prop
Cortez 1 NE Fut
Cortez 1 NE Review_P
Cortez 1 NE Review_E

*All data files are in the same directory as the MastArm.xmcd file.*

Path = "F:\Projects\Cortez - 43rd Ave W Mast Arm Review - 13M126\04 .

DataFile = "Cortez 1 NE Prop.dat"

*Reference* *Changes*

*This program works in conjunction with Mastarm Design Standards 17743 and 17745.*

*References:*
*AASHTO Standard Specifications for Signs, Luminaires and Traffic Signals, 6th Edition (LTS).*
*FDOT Structures Manual Vol. 3 (SM V3).*

*For more information see Reference.xmcd and Changes.xmcd.*

Read In Data

## General Information

DataFile = "Cortez 1 NE Prop.dat"

### Current Values / New Values

**Subject** = "Cortez - 43rd St W NE Prop"

**ProjectNo** = "404-6002870"

**PoleLocation** = "Pole 1 - NE Corner"

**Date** = "12/12/2017"

**DesignedBy** = "SML"

**CheckedBy** = " "

*Use Control+F9 to recalculate the worksheet, once to write out data, twice to read in data*

## Wind Speed

DataFile = "Cortez 1 NE Prop.dat"

### Current Value / New Value

WindSpeed = 130·mph

*mph*

***SM V3 3.8.2***

# Arm 1 Analysis

DataFile = "Cortez 1 NE Prop.dat"   WindSpeed = 130 mph

Arm 1 Loads

SignalData$_{arm1}$ =

| "SignalNumber" | "DistanceToSignal(ft)" | "NumberOfSignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 14 | 5 | "yes" |
| 2 | 24 | 3 | "yes" |
| 3 | 34 | 5 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

*use X to zero out data*
*use 0 to keep current values*   *"yes" or "no"*

## New Values

| "SignalNumber" | "DistToSignal(ft)" | "#SignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 0 | 0 | "yes" |
| 2 | 0 | 0 | "yes" |
| 3 | 0 | 0 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

SignData$_{arm1}$ =

| "PanelNumber" | "DistanceToPanelCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 6 | 20 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

## New Values

| "Panel#" | "DistToCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 0 | 0 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

*use X to zero out data*
*use 0 to keep current values*

Arm 1 Loads

Arm 1 Properties

## Current Values

## New Values

$L_{total.arm1} = 46\,ft$ — *feet, 40 ft. max. for 1 piece arms*

$Diameter_{base.arm1} = 13 \cdot in$ — *inches, measured flat to flat (FG)*

$Dist_{splice.from.base.arm1} = 12.9\,ft$ — *feet, splice distance, for 2 piece arms, length of piece closest to pole, use X to zero out (FE)*

*set* $Dist_{splice.from.base.arm1} = 0ft$ *for NO SPLICE*

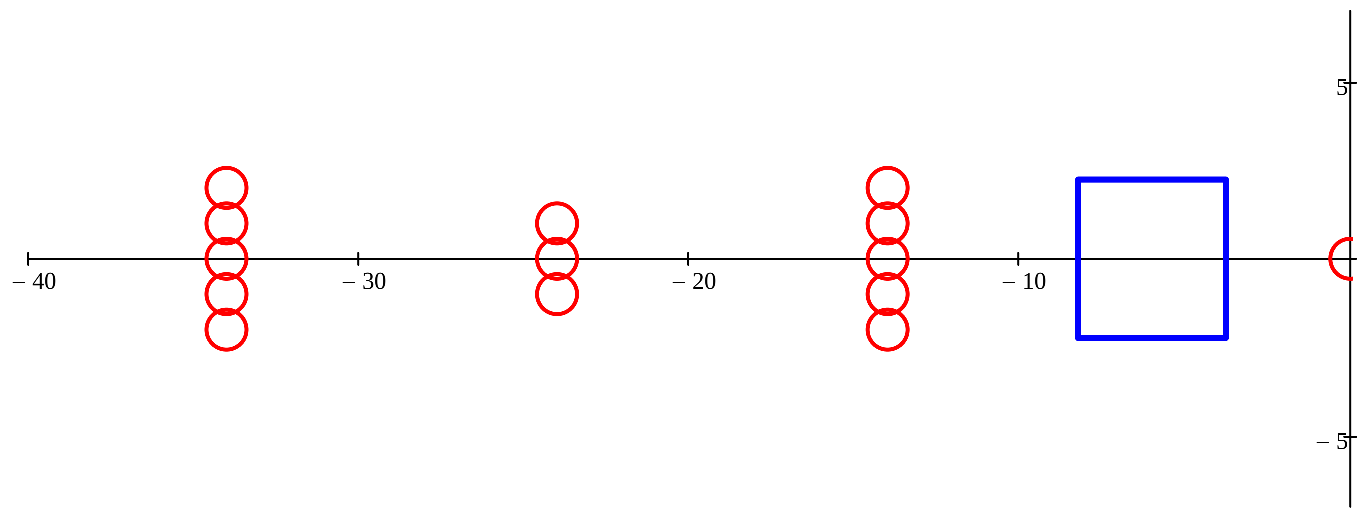
$t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$ — *inches, this value is used for one piece arms (FD)*

*inches, for 2 piece arms, wall thickness of piece closest to the pole, use X to zero out (FH)*

Arm 1 Properties

Analyze Arm 1

## Summary - Arm 1 Geometry and Loading




Location of Signs and Signals

$WindSpeed = 130 \cdot mph$ $L_{total.arm1} = 46\,ft$

$Diameter_{tip.arm1} = \begin{pmatrix} 7.08 \\ 11.22 \end{pmatrix} \cdot in$ $Diameter_{base.arm1} = \begin{pmatrix} 12 \\ 13 \end{pmatrix} \cdot in$ $L_{arm1} = \begin{pmatrix} 35.1 \\ 12.9 \end{pmatrix} ft$ $t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$

| $X_{signal.arm1_{i1}} =$ (ft) | $Sections_{signal.arm1_{i1}} =$ |
|---|---|
| 14 | 5 |
| 24 | 3 |
| 34 | 5 |

| $X_{panel.arm1_{j1}} =$ (ft) | $Area_{panel.arm1_{j1}} =$ ($ft^2$) |
|---|---|
| 6 | 20 |

## Arm 1 Combined Stress Ratio and Deflection

$max(CSR_{arm1}) = 0.602$ $max(\Delta_{arm1}) = 4.738 \cdot in$ $2 \cdot deg \cdot \sum (L_{arm1} - L_{splice.provided}) = 18.43 \cdot in$

## Arm 2 Analysis

DataFile = "Cortez 1 NE Prop.dat"  WindSpeed = 130 mph

Arm 2 Loads

$$SignalData_{arm2} = \begin{pmatrix} \text{"SignalNumber"} & \text{"DistanceToSignal(ft)"} & \text{"NumberOfSignalHeads"} & \text{"BackPlate"} \\ 1 & 0 & 0 & \text{"yes"} \\ 2 & 0 & 0 & \text{"yes"} \\ 3 & 0 & 0 & \text{"yes"} \\ 4 & 0 & 0 & \text{"yes"} \\ 5 & 0 & 0 & \text{"yes"} \\ 6 & 0 & 0 & \text{"yes"} \\ 7 & 0 & 0 & \text{"yes"} \\ 8 & 0 & 0 & \text{"yes"} \\ 9 & 0 & 0 & \text{"yes"} \\ 10 & 0 & 0 & \text{"yes"} \end{pmatrix}$$

*use X to zero out data*
*use 0 to keep current values*  *"yes" or "no"*

## New Values

| "SignalNumber" | "DistToSignal(ft)" | "#SignalHeads" | "BackPlate" |
|---|---|---|---|
| 1 | 0 | 0 | "yes" |
| 2 | 0 | 0 | "yes" |
| 3 | 0 | 0 | "yes" |
| 4 | 0 | 0 | "yes" |
| 5 | 0 | 0 | "yes" |
| 6 | 0 | 0 | "yes" |
| 7 | 0 | 0 | "yes" |
| 8 | 0 | 0 | "yes" |
| 9 | 0 | 0 | "yes" |
| 10 | 0 | 0 | "yes" |

$$SignData_{arm2} = \begin{pmatrix} \text{"PanelNumber"} & \text{"DistanceToPanelCentroid(ft)"} & \text{"PanelArea(sf)"} \\ 1 & 0 & 0 \\ 2 & 0 & 0 \\ 3 & 0 & 0 \\ 4 & 0 & 0 \\ 5 & 0 & 0 \end{pmatrix}$$

## New Values

| "Panel#" | "DistToCentroid(ft)" | "PanelArea(sf)" |
|---|---|---|
| 1 | 0 | 0 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |

*use X to zero out*
*use 0 to keep current values*

Arm 2 Loads

Arm 2 Properties

## Current Values

## New Values

$L_{total.arm2} = 0\,ft$ — *feet, 40 ft. max. for 1 piece arms, use X to zero out* *set* $L_{total.arm2} = 0ft$ *for NO ARM2*

$Diameter_{base.arm2} = 0 \cdot in$ — *inches, measured flat to flat, use X to zero out (SG)*

$Dist_{splice.from.base.arm2} = 0 \cdot ft$ — *feet, splice distance, for 2 piece arms, length of piece closest to pole, use X to zero out (SE)* *set* $Dist_{splice.from.base.arm2} = 0ft$ *for NO SPLICE*

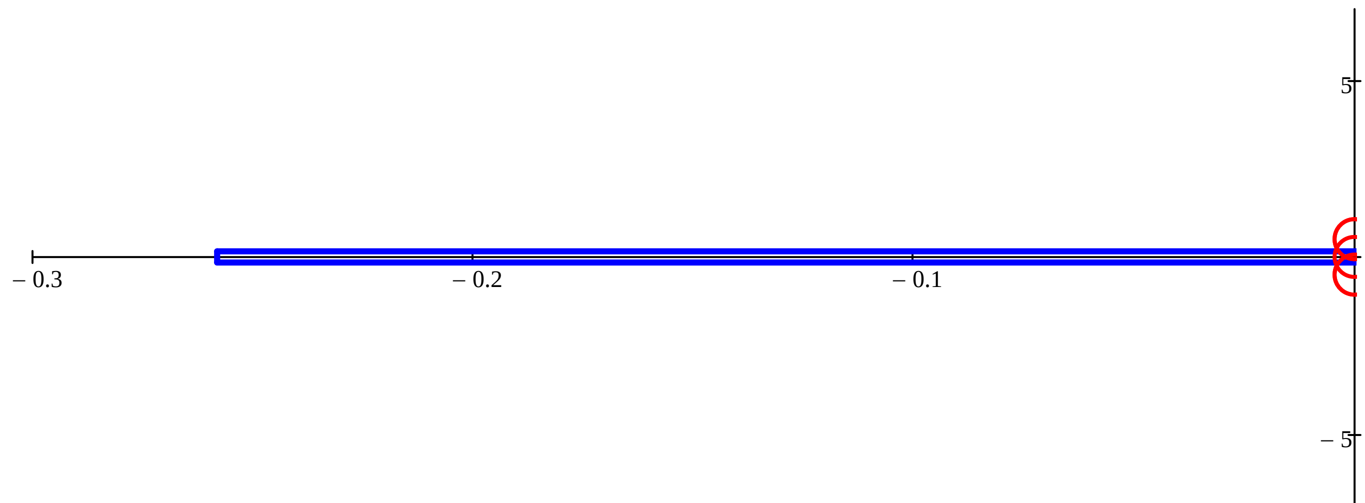
$t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ — *inches, use X to zero out (SD)*

*inches, for 2 piece arms, wall thickness of piece closest to the pole, use X to zero out (SH)*

Arm 2 Properties

## Summary - Arm 2 Geometry and Loading

Analyze Arm 2




Location of Signs and Signals

$WindSpeed = 130 \cdot mph$ $L_{total.arm2} = 0\,ft$

$Diameter_{tip.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ $Diameter_{base.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ $L_{arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} ft$ $t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$

$X_{signal.arm2_{i2}} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} ft$ $Sections_{signal.arm2_{i2}} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$ $X_{panel.arm2_{j2}} = 0.1\,ft$ $Area_{panel.arm2_{j2}} = 0.1\,ft^2$

## Arm 2 Combined Stress Ratio and Deflection

$\max(CSR_{arm2}) = 0$ $\max(\Delta_{arm2}) = 0 \cdot in$ $2 \cdot deg \cdot \sum (L_{arm2} - L_{splice.provided}) = -1.68 \cdot in$

## Luminaire Arm Analysis

DataFile = "Cortez 1 NE Prop.dat"    WindSpeed = 130·mph

Luminaire Properties

*See Design Standards 17743 and 17745 for input values.*

### Current Values

### New Values

*set* $Y_{luminaire} = 0ft$ *for NO LUMINAIRE*

| Current Values | New Values | |
|---|---|---|
| $Y_{luminaire} = 0\ ft$ | | *feet, use X to zero out (Standard LA = 40 feet)* |
| $X_{luminaire} = 10 \cdot ft$ | | *feet, use X to zero out (Standard LB = 10 feet)* |
| $Diameter_{base.lumarm} = 3 \cdot in$ | | *inches, use X to zero out (Standard LC = 3 inches)* |
| $t_{wall.lumarm} = 0.125 \cdot in$ | | *inches, use X to zero out (Standard LD = 0.125 inches)* |
| $Slope_{lumarm} = 0.5$ | | *rise/run, use X to zero out (Standard LE = 0.5)* |
| $r_{lumarm} = 8 \cdot ft$ | | *feet, use X to zero out (Standard LF = 8 feet)* |
| $d_{bolt.lum} = 0.5 \cdot in$ | | *inches, use X to zero out (Standard LG = 0.5 inches)* |
| $t_{baseplate.lum} = 0.75 \cdot in$ | | *inches, use X to zero out (Standard LH = 0.75 inches)* |

Luminaire Properties

Analyze Luminaire

### Summary - Luminaire Arm Geometry

$Y_{luminaire} = 0\ ft$    $X_{luminaire} = 0 \cdot ft$    $Diameter_{base.lumarm} = 0 \cdot in$    $t_{wall.lumarm} = 0 \cdot in$

$Slope_{lumarm} = 0$    $r_{lumarm} = 0 \cdot ft$    $d_{bolt.lum} = 0 \cdot in$    $t_{baseplate.lum} = 0 \cdot in$

$w_{base.lum} = 0 \cdot in$    $w_{channel.lum} = 0 \cdot in$

### Luminaire Arm Ratios

$CSR_{base.lumarm} = 0$    $PR_{bolt.lum} = 0$    $PR_{baseplate.lum} = 0$    $PR_{conn.plate.lum} = 0$

# Upright Analysis

DataFile = "Cortez 1 NE Prop.dat"  WindSpeed = $130 \cdot mph$

Pole Properties

## Current Values

## New Values

$Y_{pole} = 21.5\,ft$ — *feet (UA)*

$Y_{arm.conn} = 20\,ft$ — *feet (UB)*

$Diameter_{base.pole} = 16 \cdot in$ — *inches, measured flat to flat (UD)*

$t_{wall.pole} = 0.375 \cdot in$ — *inches (UE)*

$Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$ — *inches, clear distance between connection plate and upright*

*inches, use X to zero out*

*Common wall thicknesses:*
*0.1793 in.*
*0.2391 in.*
*0.25 in.*
*0.313 in.*
*0.375 in.*
*0.5 in.*

Pole Properties

## Summary - Upright Geometry

$Y_{pole} = 21.5\,ft$  $Y_{arm.conn} = 20\,ft$  $\alpha = 0 \cdot deg$  $Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$

$Diameter_{base.pole} = 16 \cdot in$  $t_{wall.pole} = 0.375 \cdot in$

## Upright Combined Stress Ratio and Deflections

$\max(CSR_{pole}) = 0.619$  $\max(\Delta_{x.dl}) = 0.89 \cdot in$  $\max(\Delta_{z.dl}) = 0 \cdot in$

# Mast Arm Connection(s) Analysis

DataFile = "Cortez 1 NE Prop.dat"   WindSpeed = 130·mph

Connection Properties

## Current Values

## New Values

$h_{conn.plate} = 22 \cdot in$

*inches, for two arm Mast Arms both connection plate heights must be equal (HT)*

$t_{vertical.plate} = \begin{pmatrix} 0.5 \\ 0 \end{pmatrix} \cdot in$

*inches (FL)*

*inches, use X to zero out (SL)*

$d_{bolt.conn} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \cdot in$

*inches (FP)*

*inches, use X to zero out (SP)*

$t_{baseplate.arm} = \begin{pmatrix} 2 \\ 0 \end{pmatrix} \cdot in$

*inches (FK)*

*inches, use X to zero out (SK)*

Connection Properties

## Summary - Connection Geometry

$h_{conn.plate} = 22 \cdot in$   $Gap = \begin{pmatrix} 7.5 \\ 0 \end{pmatrix} \cdot in$   $Offset_{conn} = \begin{pmatrix} 14.1146 \\ 0 \end{pmatrix} \cdot in$

$d_{bolt.conn} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \cdot in$   $\#ConnBolts = \begin{pmatrix} 6 \\ 0 \end{pmatrix}$   $Spacing_{bolts.conn} = \begin{pmatrix} 9 \\ 0 \end{pmatrix} \cdot in$

$t_{conn.plate} = \begin{pmatrix} 1.5 \\ 0 \end{pmatrix} \cdot in$   $b_{conn.plate} = \begin{pmatrix} 23 \\ 0 \end{pmatrix} \cdot in$   $t_{vertical.plate} = \begin{pmatrix} 0.5 \\ 0 \end{pmatrix} \cdot in$   $t_{baseplate.arm} = \begin{pmatrix} 2 \\ 0 \end{pmatrix} \cdot in$

$w_{conn.plate} = \begin{pmatrix} 0.3125 \\ 0 \end{pmatrix} \cdot in$   $w_{vertical.plate} = \begin{pmatrix} 0.3125 \\ 0 \end{pmatrix} \cdot in$

## Connection Ratios

$PR_{bolt} = \begin{pmatrix} 0.663 \\ 0 \end{pmatrix}$   $CSR_{t.vert.plate} = \begin{pmatrix} 0.661 \\ 0 \end{pmatrix}$   $PR_{t.baseplate.arm} = \begin{pmatrix} 0.839 \\ 0 \end{pmatrix}$   $PR_{t.connplate.arm} = \begin{pmatrix} 0.998 \\ 0 \end{pmatrix}$

# Base Plate Analysis

DataFile = "Cortez 1 NE Prop.dat"  WindSpeed = 130·mph

Base Plate Properties

## Current Values

## New Values

#AnchorRods = 6  *use 6 bolts minimum*

$d_{bolt.pole} = 1.5 \cdot in$  *inches (BC)*

Base Plate Properties

## Summary - Upright Base Plate Geometry

#AnchorRods = 6 & Anchors — $d_{bolt.pole} = 1.5 \cdot in$ — $t_{baseplate.pole} = 2.5 \cdot in$ — $Diameter_{baseplate.pole} = 28 \cdot in$

## Upright Base Plate Performance Ratios

$PR_{rod} = 0.772$  $PR_{plate.pole} = 1$

# Foundation Analysis  Cohesionless or Cohesive Soil

DataFile = "Cortez 1 NE Prop.dat"

Soil Properties

## Current Values

## New Values

SoilType = 1  ○ Clay ● Sand  *0 - clay 1 - sand*

$\phi_{soil} = 30 \cdot deg$  *degrees, soil friction angle (sand)*

$c_{soil} = 2000 \cdot psf$  *psf, soil shear strength (clay)*

$\gamma_{soil} = 42.6 \cdot pcf$  *pcf, soil density (typical design value = 45-50 pcf)*

Offset = 0 ft  *vertical distance between top of foundation and groundline*

$N_{blows} = 15$  *Number of blows per foot.*
*If N< 5, contact the district geotech Engineer*  ***SM V3 13.6***

Soil Properties

Analyze Foundation

## Switch values, set values for DataOut, and Write Out Data to DataFile and Temp.dat

$out := out + 1 \quad out = 35$

$SoilType := if(newSoilType = 0, 0, 1)$  $data_{out} := SoilType$  $data_{out} = 1$

$out := out + 1 \quad out = 36$

$\phi_{soil} := fSwitchData(\phi_{soil}, new\phi_{soil}, deg)$  $data_{out} := \frac{\phi_{soil}}{deg}$  $data_{out} = 30$

$out := out + 1 \quad out = 37$

$c_{soil} := \text{fSwitchData}(c_{soil}, newc_{soil}, psf)$ $\qquad data_{out} := \frac{c_{soil}}{psf} \qquad data_{out} = 2000$

$out := out + 1 \quad out = 38$

$\gamma_{soil} := \text{fSwitchData}(\gamma_{soil}, new\gamma_{soil}, pcf)$ $\qquad data_{out} := \frac{\gamma_{soil}}{pcf} \qquad data_{out} = 42.6$

$out := out + 1 \quad out = 39$

$\gamma_{water} := 62.4 \cdot pcf$ *(not used)* $\qquad data_{out} := \frac{\gamma_{water}}{pcf} \qquad data_{out} = 62.4$

$out := out + 1 \quad out = 40$

$Offset := \text{fSwitchData}(Offset, newOffset, ft)$ $\qquad data_{out} := \frac{Offset}{ft} \qquad data_{out} = 0$

$out := out + 1 \quad out = 41$

$N_{blows} := \text{fSwitchData}(N_{blows}, newN_{blows}, 1)$ $\qquad data_{out} := \frac{N_{blows}}{1} \qquad data_{out} = 15$

$out := out + 1 \quad out = 42$

**Subject** := if (**newSubject** = 0, **Subject**, **newSubject**) $\qquad data_{out} :=$ **Subject**

$data_{out} =$ "Cortez - 43rd St W NE Prop"

$out := out + 1 \quad out = 43$

**ProjectNo** := if (**newProjectNumber** = 0, **ProjectNo**, **newProjectNumber**) $\qquad data_{out} :=$ **ProjectNo**

$data_{out} =$ "404-6002870"

$out := out + 1 \quad out = 44$

**PoleLocation** := if (**newPoleLocation** = 0, **PoleLocation**, **newPoleLocation**) $\qquad data_{out} :=$ **PoleLocation**

$data_{out} =$ "Pole 1 - NE Corner"

$out := out + 1 \quad out = 45$

**Date** := if (**newDate** = 0, **Date**, **newDate**) $\qquad data_{out} :=$ **Date**

$data_{out} =$ "12/12/2017"

$out := out + 1 \quad out = 46$

**DesignedBy** := if (**newDesignedBy** = 0, **DesignedBy**, **newDesignedBy**) $\qquad data_{out} :=$ **DesignedBy**

$data_{out} =$ "SML"

$out := out + 1 \quad out = 47$

**CheckedBy** := if (**newCheckedBy** = 0, **CheckedBy**, **newCheckedBy**) $\qquad data_{out} :=$ **CheckedBy**

$data_{out} =$ " "

WRITEPRN(DataFile) := data $\qquad$ WRITEPRN("temp.dat") := data

## Foundation Design References

***LRFD = AASHTO LRFD Bridge Design Specifications***

*SM V3 = FDOT Structures Manual Volume 3*

*SDG = FDOT Structures Design Guidelines*

*Spec = FDOT Standard Specifications*

*ACI = ACI 318 Structural Concrete Building Code*

*UF Report = FDOT/University of Florida Report BD545 RPWO #54*

## Applied Loads

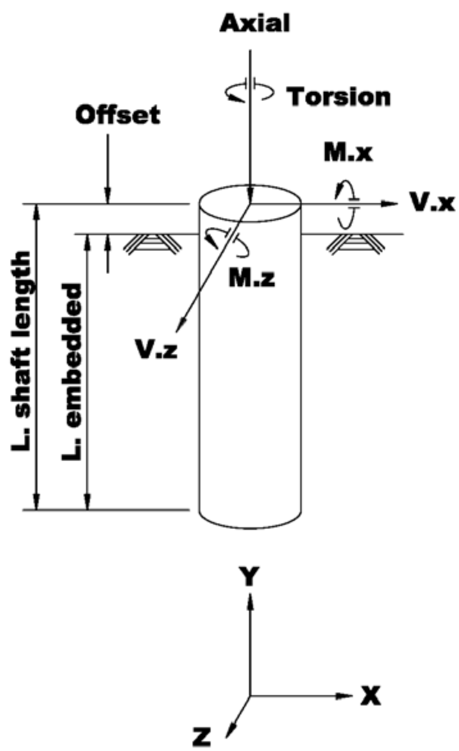
*(From Arm1 Design)*

$WindSpeed = 130 \cdot mph$

*(from Base Plate Design)*

$\#AnchorRods = 6$ $d_{bolt.pole} = 1.5 \cdot in$ $Diameter_{boltcircle.pole} = 22 \cdot in$ $T_{u.rod} = 41 \cdot kip$

*(from Upright Design)*




$M_{x.polebase} = \begin{pmatrix} 0 \\ 106 \\ 106 \end{pmatrix} \cdot kip \cdot ft$ $M_{y.polebase} = \begin{pmatrix} 96.9 \\ 0 \\ 96.9 \end{pmatrix} \cdot kip \cdot ft$ $M_{z.polebase} = \begin{pmatrix} 0 \\ 37.5 \\ 37.5 \end{pmatrix} \cdot kip \cdot ft$

$LoadCaseT = 0$

$LoadCaseOT = 1$

$LoadCaseCSR = 2$

$V_{x.polebase} = \begin{pmatrix} 0 \\ 0.2 \\ 0.2 \end{pmatrix} \cdot kip$ $AxialForce_{polebase} = \begin{pmatrix} 3.1 \\ 3.1 \\ 3.1 \end{pmatrix} \cdot kip$ $V_{z.polebase} = \begin{pmatrix} 0 \\ 5.7 \\ 5.7 \end{pmatrix} \cdot kip$

## Foundation Diameter

$\text{Diameter}_{shaft} := \text{Diameter}_{boltcircle.pole} + 12 \cdot in + 12 \cdot in$ $\qquad \text{Diameter}_{shaft} = 3.83 \cdot ft$

*round shaft diameter up to the nearest half foot dimension to accommodate available coring equipment*

$\text{Diameter}_{shaft} := \text{Ceil}\left(\text{Diameter}_{shaft}, \frac{1}{2} \cdot ft\right)$ $\qquad \text{Diameter}_{shaft} = 4\ ft$

$\text{Diameter}_{shaft.custom} := 3.5 \cdot ft$ *SML change from 0.0 ft to 3.5 ft for actual drilled shaft diamter*

$\text{Diameter}_{shaft} := \text{if}\left(\text{Diameter}_{shaft.custom} > 0 \cdot ft, \text{Diameter}_{shaft.custom}, \text{Diameter}_{shaft}\right) = 1.1$

$\text{Diameter}_{shaft} = 3.5\ ft$

$b := \text{Diameter}_{shaft}$

## Shaft Depth Required to Resist Overturning

$SF_{ot} := 2$ *Safety Factor against Overturning* ***SM V3 13.6*** $\qquad \text{Offset} = 0 \cdot ft$ *vertical distance between top of foundation and groundline*

$$M_{total} := SF_{ot} \cdot \frac{\sqrt{\left(M_{x.polebase_{LoadCaseOT}}\right)^2 + \left(M_{z.polebase_{LoadCaseOT}}\right)^2}}{C_{a.pole}} \qquad M_{total} = 225.7 \cdot kip \cdot ft$$

$$P_{total} := SF_{ot} \cdot \sqrt{\left(V_{x.polebase_{LoadCaseOT}}\right)^2 + \left(V_{z.polebase_{LoadCaseOT}}\right)^2} \qquad P_{total} = 11.5 \cdot kip$$

*short free-head pile in cohesionless soil using Broms method*

$$K_p := \tan\left(45 \cdot deg + \frac{\phi_{soil}}{2}\right)^2 \qquad e_{sand} := \text{Offset}$$

*Guess value* $L_{otSand} := 8 \cdot ft$

$$\text{Given} \qquad \frac{\gamma_{soil} \cdot b \cdot L_{otSand}^{\ 3} \cdot K_p}{2} - P_{total} \cdot \left(e_{sand} + L_{otSand}\right) - M_{total} = 0 \cdot kip \cdot ft$$

$\text{Temp} := \text{Find}\left(L_{otSand}\right)$ $\qquad L_{otSand} := \text{Temp}$ $\qquad L_{otSand} = 11.7 \cdot ft$

*(round up to next foot)* $\qquad L_{otSand} := \text{ceil}\left(\frac{L_{otSand}}{ft}\right) \cdot ft$ $\qquad L_{otSand} = 12\ ft$

$$PR_{otSand} := \frac{M_{total} + P_{total} \cdot \left(e_{sand} + L_{otSand}\right)}{\frac{\gamma_{soil} \cdot b \cdot L_{otSand}^{\ 3} \cdot K_p}{2}} \qquad PR_{otSand} = 0.9$$

*short free-head pile in cohesive soil using Modified Broms method for L < 3b (see reference file for derivation)*

$c_{soil} := \text{if}\left(c_{soil} = 0 \cdot ksf, 0.1 \cdot ksf, c_{soil}\right)$ $\quad$ $Slope := 8 \cdot \frac{c_{soil}}{3 \cdot b}$ $\quad$ $e_{clay} := \frac{M_{total}}{P_{total}} + Offset$

$nforce(M, N) := \left[Slope \cdot (2 \cdot M + N) + 2 \cdot c_{soil}\right] \cdot N \cdot \frac{b}{2}$ $\quad$ $mforce(M) := \left(2 \cdot c_{soil} + M \cdot Slope\right) \cdot M \cdot \frac{b}{2}$

$$m\_arm(M) := e_{clay} + \frac{M}{3} \cdot \frac{2 \cdot \left(M \cdot Slope + c_{soil}\right) + c_{soil}}{M \cdot Slope + 2 \cdot c_{soil}}$$

$$n\_arm(M, N) := e_{clay} + M + \frac{N}{3} \cdot \frac{2 \cdot \left(N \cdot Slope + M \cdot Slope + c_{soil}\right) + \left(M \cdot Slope + c_{soil}\right)}{Slope \cdot (2 \cdot M + N) + 2 \cdot c_{soil}}$$

*Guess value* $\quad$ $M := 4.0 \cdot ft$ $\quad$ $N := 4.0 \cdot ft$

Given $\quad$ $P_{total} + nforce(M, N) = mforce(M)$ $\quad$ $mforce(M) \cdot m\_arm(M) = nforce(M, N) \cdot n\_arm(M, N)$

$\begin{pmatrix} M \\ N \end{pmatrix} := Find(M, N)$ $\quad$ $L_{ot1Clay.temp} := M + N$ $\quad$ $L_{ot1Clay.temp} = 7 \cdot ft$

*(round up to next foot)* $\quad$ $L_{ot1Clay} := ceil\left(\frac{L_{ot1Clay.temp}}{ft}\right) \cdot ft$ $\quad$ $L_{ot1Clay} = 8 \cdot ft$

*short free-head pile in cohesive soil using Regular Broms method for L > 3b*

$f_{clay} := \frac{P_{total}}{9 \cdot c_{soil} \cdot b}$ $\quad$ $M_{maxtemp} := P_{total} \cdot \left(e_{clay} + 1.5 \cdot b + 0.5 \cdot f_{clay}\right)$ $\quad$ $g := \sqrt{\frac{M_{maxtemp}}{2.25 \cdot c_{soil} \cdot b}}$

$L_{ot2Clay} := \left(1.5 \cdot b + f_{clay} + g\right)$ $\quad$ $L_{ot2Clay} = 9.7\,ft$

*(round up to next foot)* $\quad$ $L_{ot2Clay} := ceil\left(\frac{L_{ot2Clay}}{ft}\right) \cdot ft$ $\quad$ $L_{ot2Clay} = 10 \cdot ft$

$L_{otClay} := \text{if}\left(L_{ot1Clay} < 3 \cdot b, L_{ot1Clay}, L_{ot2Clay}\right)$ $\quad$ $L_{otClay} = 8 \cdot ft$

*(If $L_{ot} < 3b$, use Modified Broms method)*

$$PR_{otClay} := \text{if}\left(L_{otClay} < 3 \cdot b, \frac{L_{ot1Clay.temp}}{L_{ot1Clay}}, \frac{\sqrt{\frac{M_{maxtemp}}{2.25 \cdot c_{soil} \cdot b}} + \frac{P_{total}}{9 \cdot c_{soil} \cdot b}}{L_{ot2Clay} - 1.5 \cdot b}\right)$$ $\quad$ $PR_{otClay} = 0.9$

$L_{reqdOT} := \text{if}(\text{SoilType} = 1, L_{otSand}, L_{otClay})$ $L_{reqdOT} = 12\ \text{ft}$

$PR_{ot} := \text{if}(\text{SoilType} = 1, PR_{otSand}, PR_{otClay})$ $PR_{.ot} = 0.9$

## Shaft Depth Required to Resist Torsion

$SF_{tor} := \mathbf{1.0}$ *Safety Factor against Torsion*
*1.0 for Mast Arm signal structures*

***SM V3 13.6***

*NOTE: $\omega_{fdot}$ and $\mu$ are based upon CONCRETE and soil interaction.* ***This torsion methodology is not to be used with permanent casing.***

$N_{blows} = 15$ *Number of blows per foot. If N< 5, contact the district geotech Engineer*

$\omega_{fdot} := \text{if}\left(N_{blows} < 5, 0, \text{if}\left(N_{blows} \geq 15, 1.5, 1.5 \cdot \frac{N_{blows}}{15}\right)\right) = 1.5$ *load transfer ratio*

$\mu := \tan(\phi_{soil}) = 0.6$ *coefficient of friction between concrete shaft and soil*

$\gamma_{concrete} := 150 \cdot \text{pcf}$ $\gamma_{concrete} := \gamma_{concrete} - \gamma_{water}$ $\gamma_{concrete} = 87.6 \cdot \text{pcf}$

$\text{CohesionFactor} := 0.55$ $f_{se} := \text{CohesionFactor} \cdot c_{soil}$

$\text{Torsion} := M_{y.polebase_{LoadCaseT}}$ $\text{Torsion} = 96.9 \cdot \text{kip} \cdot \text{ft}$

*short free-head pile in cohesionless soil*

*Guess value* $L_{torSand} := L_{reqdOT}$

Given

$$\text{Torsion} \cdot SF_{tor} = \left[\pi \cdot b \cdot (L_{torSand}) \cdot \gamma_{soil} \cdot \left(\frac{L_{torSand}}{2}\right) \cdot (\omega_{fdot}) \cdot \frac{b}{2} + \pi \cdot \left(\frac{b}{2}\right)^2 \cdot L_{torSand} \cdot (\gamma_{concrete}) \cdot \frac{b}{3} \cdot \mu\right]$$

$\text{Temp} := \text{Find}(L_{torSand})$ $L_{torSand} := \text{Temp}$ $L_{torSand} = 12.1\ \text{ft}$

*(round up to next foot)* $L_{torSand} := \text{ceil}\left(\frac{L_{torSand}}{\text{ft}}\right) \cdot \text{ft}$ $L_{torSand} = 13\ \text{ft}$

$$PR_{torSand} := \frac{\text{Torsion} \cdot SF_{tor}}{\pi \cdot b \cdot (L_{torSand}) \cdot \gamma_{soil} \cdot \left(\frac{L_{torSand}}{2}\right) \cdot (\omega_{fdot}) \cdot \frac{b}{2} + \pi \cdot \left(\frac{b}{2}\right)^2 \cdot L_{torSand} \cdot (\gamma_{concrete}) \cdot \frac{b}{3} \cdot \mu}$$ $PR_{torSand} = 0.9$

*short free-head pile in cohesive soil*

*Guess value* $L_{torClay} := L_{reqdOT}$

Given $\quad Torsion \cdot SF_{tor} = \left[f_{se} \cdot (\pi \cdot b) \cdot \left(L_{torClay} - 1.5 \cdot ft\right) \cdot \frac{b}{2}\right] + \left[f_{se} \cdot \pi \cdot \left(\frac{b}{2}\right)^2 \cdot \left(\frac{b}{3}\right)\right]$

$Temp := Find\left(L_{torClay}\right) \qquad L_{torClay} := Temp \qquad L_{torClay} = 5.5\,ft$

*(round up to next foot)* $\qquad L_{torClay} := ceil\left(\frac{L_{torClay}}{ft}\right) \cdot ft \qquad L_{torClay} = 6\,ft$

$$PR_{torClay} := \frac{Torsion \cdot SF_{tor}}{\left[f_{se} \cdot (\pi \cdot b) \cdot \left(L_{torClay} - 1.5 \cdot ft\right) \cdot \frac{b}{2}\right] + \left[f_{se} \cdot \pi \cdot \left(\frac{b}{2}\right)^2 \cdot \left(\frac{b}{3}\right)\right]} \qquad PR_{torClay} = 0.9$$

$L_{reqdTor} := if\left(SoilType = 1, L_{torSand}, L_{torClay}\right) \qquad L_{reqdTor} = 13\,ft$

$PR_{tor} := if\left(SoilType = 1, PR_{torSand}, PR_{torClay}\right) \qquad PR_{tor} = 0.9$

$L_{embedded} := if\left(L_{reqdTor} > L_{reqdOT}, L_{reqdTor}, L_{reqdOT}\right) \qquad L_{embedded} = 13\,ft$

$L_{shaft} := L_{embedded} + Offset \qquad L_{shaft} = 13\,ft$

$PR_{foundation} := if\left(L_{reqdTor} > L_{reqdOT}, PR_{tor}, PR_{ot}\right) \qquad PR_{foundation} = 0.871$

## Unfactored Maximum Moment in Shaft

*short free-head pile in cohesionless soil using Broms method*

$$f_{sand} := \sqrt{\frac{2 \cdot \frac{P_{total}}{SF_{ot}}}{3 \cdot \gamma_{soil} \cdot b \cdot K_p}} \qquad f_{sand} = 2.9\,ft$$

$$M_{maxSand} := \frac{P_{total}}{SF_{ot}} \cdot \left(e_{sand} + f_{sand}\right) - \frac{\frac{P_{total}}{SF_{ot}} \cdot f_{sand}}{3} + \frac{M_{total}}{SF_{ot}} \qquad M_{maxSand} = 124 \cdot kip \cdot ft$$

*short free-head pile in cohesive soil using Modified Broms method for L < 3b (see reference file for derivation)*

*Guess value* $\quad f_{mod} := 4.0 \cdot ft$

Given $\quad \frac{P_{total}}{SF_{ot}} = \frac{f_{mod} \cdot b}{2} \cdot \left(2 \cdot c_{soil} + f_{mod} \cdot Slope\right)$

$f_{mod} := Find\left(f_{mod}\right) \qquad f_{mod} = 0.7\,ft$

$$M_{modBroms} := \frac{P_{total}}{SF_{ot}} \cdot \left(e_{clay} + f_{mod}\right) - \frac{c_{soil} \cdot b \cdot f_{mod}^{\,2}}{2} - \frac{b \cdot f_{mod}^{\,3} \cdot Slope}{6} \qquad M_{modBroms} = 114.9 \cdot kip \cdot ft$$

*short free-head pile in cohesive soil using Regular Broms method for L > 3b*

$M_{Broms} := \frac{P_{total}}{SF_{ot}} \cdot (e_{clay} + 1.5 \cdot b + 0.5 \cdot f_{clay})$ $M_{Broms} = 143.4 \cdot kip \cdot ft$

$M_{maxClay} := \text{if}(L_{ot1Clay} < 3 \cdot b, M_{modBroms}, M_{Broms})$ $M_{maxClay} = 114.9 \cdot kip \cdot ft$

*(If $L_{ot} < 3b$, use Modified Broms method)*

$M_{max} := \text{if}(SoilType = 1, M_{maxSand}, M_{maxClay})$ *(this is a Service moment)* $M_{max} = 124 \cdot kip \cdot ft$

## Minimum Reinforcing and Spacing

| | | |
|---|---|---|
| $F_{y.rebar} := 60 \cdot ksi$ | *reinforcing yield strength* | |
| $f_c := 4.0 \cdot ksi$ | *concrete strength* **Spec 346-3** | |
| $cover := 6 \cdot in$ | *cover* **SDG Table 1.4.2-1** | *Cover okay at 6"* |
| $A_{bar} := 1.56 \cdot in^2$ | *longitudinal bar area* | *Main bar size okay, using #11s* |
| $d_{bar} := 1.41 \cdot in$ | *longitudinal bar diameter* | |
| | | *Stirrup bar size okay, using #5s* |
| $A_{v.bar} := 0.31 \cdot in^2$ | *stirrup area* | **SM V3 13.6.2** |
| $d_{v.bar} := 0.625 \cdot in$ | *stirrup diameter* | *Stirrup $s_{v1}$ spacing okay, using 4"* |
| $s_{v1} := 4 \cdot in$ | *stirrup spacing, depth = 0 ft-2 ft* | **SM V3 13.6.2** |
| $s_{v2} := 12 \cdot in$ | *stirrup spacing, depth = 2 ft-depth.stir* | *Stirrup $s_{v2}$ spa adj back to 12"from 18"* |
| $s_{v3} := 12 \cdot in$ | *stirrup spacing, depth > depth.stir* | *Stirrup $s_{v3}$ spa adj back to 12"from 18"* |
| $depth_{stir} := 12 \cdot ft$ | *stirrup depth, see s.v2 and s.v3 above* | |
| $b = 3.5\,ft$ | *shaft diameter* | |

$BarsProv_1 := \frac{0.01}{A_{bar}} \cdot \frac{\pi \cdot b^2}{4}$ $BarsProv_1 = 8.9$ **LRFD 5.7.4.2**

$BarsProv_2 := \frac{0.135}{A_{bar} \cdot F_{y.rebar}} \cdot \left(\frac{\pi \cdot b^2}{4} \cdot f_c\right)$ $BarsProv_2 = 8$

$BarsProv := ceil(max(BarsProv_1, BarsProv_2))$ $BarsProv = 9$ *number of longitudinal bars*

$BarsProv := 10$ $BarsProv = 10$ *Main bar No. adjusted to 10*

$$NumSpaces_{v.bar} := round\left(\frac{depth_{stir} - 2 \cdot ft}{s_{v2}}\right) \qquad NumSpaces_{v.bar} = 10$$

$$ReinfClearSpacing := \left[b - 2 \cdot \left(cover + d_{v.bar} + \frac{d_{bar}}{2}\right)\right] \cdot \frac{\pi}{BarsProv} - d_{bar} \qquad ReinfClearSpacing = 7.18 \cdot in$$

CheckReinfClearSpacing := if (ReinfClearSpacing ≥ 6in, "OK" , "No Good" )     CheckReinfClearSpacing = "OK"

***SDG 3.6.10***

## Check Shear and Torsion

| | | |
|---|---|---|
| $LF_{shr} := \mathbf{1.3}$ | *Shear Load Factor* | *1.3 is a reasonable Load Factor for combined WL + DL on sign and signal structures* |
| $LF_{tor} := \mathbf{1.3}$ | *Torsion Load Factor* | |
| $\phi_{shr} := \mathbf{0.90}$ | *Shear Resistance Factor* | ***LRFD 5.5.4.2.1*** |
| $\phi_{tor} := \mathbf{0.90}$ | *Torsion Resistance Factor* | ***LRFD 5.5.4.2.1*** |

$$V_u := LF_{shr} \cdot \sqrt{\left(V_{x.polebase_{LoadCaseOT}}\right)^2 + \left(V_{z.polebase_{LoadCaseOT}}\right)^2} \qquad V_u = 7.4 \cdot kip$$

$$T_u := LF_{tor} \cdot Torsion \qquad T_u = 126 \cdot kip \cdot ft$$

$$Torsion = 96.9 \cdot kip \cdot ft$$

*Area and perimeter of concrete cross-section*

$$A_{cp} := \pi \cdot \left(\frac{b}{2}\right)^2 \qquad A_{cp} = 1385.4 \cdot in^2$$

$$p_{cp} := 2 \cdot \pi \cdot \left(\frac{b}{2}\right) \qquad p_{cp} = 131.9 \cdot in$$

*Diameter, perimeter and area enclosed by the centerline of the outermost closed transverse torsion reinforcement*

$$d_{oh} := b - 2 \cdot \left(cover + \frac{d_{v.bar}}{2}\right) \qquad d_{oh} = 29.4 \cdot in$$

$$p_h := \pi \cdot d_{oh} \qquad p_h = 92.3 \cdot in$$

$$A_{oh} := \pi \left(\frac{d_{oh}}{2}\right)^2 \qquad A_{oh} = 677.7 \cdot in^2$$

$$A_o := 0.85 \cdot A_{oh} \qquad A_o = 576.1 \cdot in^2$$

***LRFD C5.8.2.1***

*Effective shear depth*

$$D_r := b - 2 \cdot \left(cover + d_{v.bar} + \frac{d_{bar}}{2}\right) \qquad d_e := \frac{b}{2} + \frac{D_r}{\pi} = 2.5\,ft$$

***LRFD C5.8.2.1***

$$d_v := \max\left(0.9 \cdot d_e, 0.72 \cdot b\right) = 2.5\,ft$$

*Check Shear Strength*

$V_c := 0.0316 \cdot (2.0) \cdot \sqrt{\frac{f_c}{ksi}} \cdot \left(\frac{d_v}{in}\right) \cdot \left(\frac{b}{in}\right) \cdot kip$ $\quad V_c = 160.5 \cdot kip$ $\quad$ ***LRFD Eqn 5.8.3.3-3*** ***LRFD 5.8.3.4.1***

***ACI 11.3.3***

$V_s := \frac{A_{v.bar} \cdot F_{y.rebar} \cdot (d_v)}{\max(s_{v1}, s_{v2}, s_{v3})}$ $\quad V_s = 46.9 \cdot kip$ $\quad$ ***LRFD Eqn 5.8.3.3-4***

$\phi_{shr} = 0.9$ $\quad V_u = 7.4 \cdot kip$

$ShearRatio := \frac{V_u - \phi_{shr} \cdot V_c}{\phi_{shr} \cdot V_s}$ $\quad ShearRatio = -3.2$

$ShearRatio := if(ShearRatio \le 0, 0, ShearRatio)$ $\quad ShearRatio = 0$

*Check Torsion Strength*

$T_{n1} := \frac{2 \cdot A_o \cdot A_{v.bar} \cdot F_{y.rebar}}{s_{v1}}$ $\quad T_{n1} = 446.4 \cdot kip \cdot ft$ $\quad$ ***LRFD Eqn 5.8.3.6.2-1*** ***LRFD 5.8.3.4.1***

$T_{n2} := \frac{2 \cdot A_o \cdot A_{v.bar} \cdot F_{y.rebar}}{s_{v2}}$ $\quad T_{n2} = 148.8 \cdot kip \cdot ft$

$T_{n3} := \frac{2 \cdot A_o \cdot A_{v.bar} \cdot F_{y.rebar}}{s_{v3}}$ $\quad T_{n3} = 148.8 \cdot kip \cdot ft$

$\phi_{tor} = 0.9$ $\quad T_u = 126 \cdot kip \cdot ft$ $\quad L_{reqdTor} = 13\,ft$

$$Tor2_{sand} := T_u - if\left[2 \cdot ft > Offset, \left[\pi \cdot b \cdot (2 \cdot ft - Offset) \cdot \gamma_{soil} \cdot \left(\frac{2 \cdot ft - Offset}{2}\right) \cdot (\omega_{fdot}) \cdot \frac{b}{2}\right], 0 \cdot kip \cdot ft\right] = 123.5 \cdot kip \cdot ft$$

$$Tor3_{sand} := T_u - if\left[depth_{stir} > Offset, \left[\pi \cdot b \cdot (depth_{stir} - Offset) \cdot \gamma_{soil} \cdot \left(\frac{depth_{stir} - Offset}{2}\right) \cdot (\omega_{fdot}) \cdot \frac{b}{2}\right], 0 \cdot kip \cdot ft\right] = 37.5 \cdot kip \cdot ft$$

$$Tor2_{clay} := T_u - if\left[2 \cdot ft - 1.5 \cdot ft > Offset, \left[f_{se} \cdot (\pi \cdot b) \cdot (2.0 \cdot ft - Offset - 1.5 \cdot ft) \cdot \frac{b}{2}\right], 0 \cdot kip \cdot ft\right] = 115.4 \cdot kip \cdot ft$$

$$Tor3_{clay} := T_u - if\left[depth_{stir} - 1.5 \cdot ft > Offset, \left[f_{se} \cdot (\pi \cdot b) \cdot (depth_{stir} - Offset - 1.5 \cdot ft) \cdot \frac{b}{2}\right], 0 \cdot kip \cdot ft\right] = -96.2 \cdot kip \cdot ft$$

$Tor2 := if(SoilType = 1, Tor2_{sand}, Tor2_{clay})$ $\quad Tor2 = 123.5 \cdot kip \cdot ft$

$Tor3 := if(SoilType = 1, Tor3_{sand}, Tor3_{clay})$ $\quad Tor3 = 37.5 \cdot kip \cdot ft$

$TorsionRatio_{n1} := \frac{T_u}{\phi_{tor} \cdot T_{n1}}$ $TorsionRatio_{n1} = 0.31$

$TorsionRatio_{n2} := \frac{Tor2}{\phi_{tor} \cdot T_{n2}}$ $TorsionRatio_{n2} = 0.92$

$TorsionRatio_{n3} := \frac{Tor3}{\phi_{tor} \cdot T_{n3}}$ $TorsionRatio_{n3} = 0.28$

$TorsionRatio := \max(TorsionRatio_{n1}, TorsionRatio_{n2}, TorsionRatio_{n3})$ $TorsionRatio = 0.92$

$T_{cr} := 0.125 \sqrt{\frac{f_c}{ksi}} \cdot \left(\frac{A_{cp}^{\,2}}{p_{cp} \cdot in^3}\right) \cdot kip \cdot in$ $T_{cr} = 303.1 \cdot kip \cdot ft$ ***LRFD Eqn 5.8.2.1-4***

$TorsionRatio := if(T_u \le 0.25 \cdot \phi_{tor} \cdot T_{cr}, 0, TorsionRatio)$ $TorsionRatio = 0.92$ ***LRFD Eqn 5.8.2.1-3***

$ShearRatio = 0$

$CheckShearTorsion := if(ShearRatio + TorsionRatio \le 1, "OK", "No Good")$ $CheckShearTorsion = "OK"$

$ShearRatio + TorsionRatio = 0.92$ *Should be 1.0 or less*

*Check Maximum Spacing Transverse Reinforcement*

$vu := \frac{V_u}{\phi_{shr} \cdot b \cdot (0.8 \cdot b)}$ $vu = 0.005862 \cdot ksi$ ***LRFD Eqn 5.8.2.9-1***

$0.125 \cdot f_c = 0.5 \cdot ksi$

$s_{max1} := if(0.8 \cdot d_v < 24 \cdot in, 0.8 \cdot d_v, 24 \cdot in)$ $s_{max1} = 24 \cdot in$ ***LRFD Eqn 5.8.2.7-1***

$s_{max2} := if(0.4 \cdot d_v < 12 \cdot in, 0.4 \cdot d_v, 12 \cdot in)$ $s_{max2} = 12 \cdot in$ ***LRFD Eqn 5.8.2.7-2***

$s_{max} := if(vu < 0.125 \cdot f_c, s_{max1}, s_{max2})$ $s_{max} = 24 \cdot in$

$\max(s_{v1}, s_{v2}, s_{v3}) = 12 \cdot in$

$CheckMaxSpacingTransvReinf := if(\max(s_{v1}, s_{v2}, s_{v3}) \le s_{max}, "OK", "No Good")$ $CheckMaxSpacingTransvReinf = "OK"$

*Check Longitudinal Reinforcement for Combined Shear and Torsion* ***LRFD Eqn 5.8.3.6.3-1***

***LRFD 5.8.3.4.1***

$M_u := LF_{tor} \cdot \sqrt{\left(M_{x.polebase_{LoadCaseOT}}\right)^2 + \left(M_{z.polebase_{LoadCaseOT}}\right)^2}$ $M_u = 146.2 \cdot kip \cdot ft$

$V_{temp} := if\left(\frac{V_u}{\phi_{shr}} - 0.5 \cdot V_s > 0 \cdot kip, \frac{V_u}{\phi_{shr}} - 0.5 \cdot V_s, 0 \cdot kip\right)$ $V_{temp} = 0 \cdot kip$

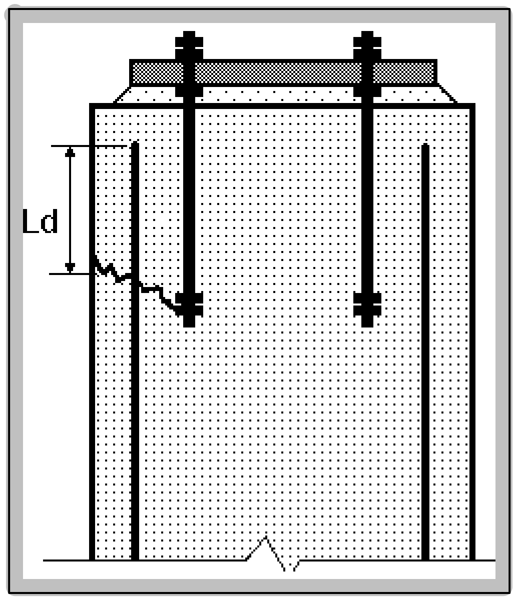
$$LongReinf_{shr.tor} := \frac{\dfrac{M_u}{\phi_{tor}\cdot(0.8\cdot b)} + \sqrt{\left(\dfrac{V_{temp}}{kip}\right)^2 + \left(\dfrac{0.45\cdot p_h\cdot T_u}{2\cdot A_o\cdot\phi_{tor}\cdot kip}\right)^2}\cdot kip}{F_{y.rebar}} \qquad LongReinf_{shr.tor} = 2\cdot in^2$$

$$BarsProv\cdot A_{bar} = 15.6\cdot in^2$$

$$CheckLongReinf_{shr.tor} := if\left(BarsProv\cdot A_{bar} \ge LongReinf_{shr.tor}, \text{"OK"}, \text{"No Good"}\right) \qquad CheckLongReinf_{shr.tor} = \text{"OK"}$$

## Anchor Bolt Embedment

$$Gap_{shaft} := \frac{b - 2\cdot cover - 2\cdot d_{v.bar} - Diameter_{boltcircle.pole} - d_{bar}}{2}$$




$$Gap_{shaft} = 2.67\cdot in$$

$$Diameter_{rebar.circle} := b - 2\cdot cover - d_{bar} - 2\cdot d_{v.bar}$$

$$Diameter_{rebar.circle} = 27.3\cdot in$$

$$\#BarsProvided := BarsProv \qquad \#BarsProvided = 10$$

$$\#BarsProvidedPerRod := min\left(\left(\begin{matrix}\dfrac{\#BarsProvided}{\#AnchorRods}\\ 3\end{matrix}\right)\right) \qquad \#BarsProvidedPerRod = 1.7$$

*Use a maximum of three rebar per anchor bolt (conservative)*

$$\phi := 0.9 \qquad \#BarsReqdPerRod := \frac{T_{u.rod}}{A_{bar}\cdot\left(\phi\cdot F_{y.rebar}\right)}\cdot\frac{Diameter_{boltcircle.pole}}{Diameter_{rebar.circle}} \qquad \#BarsReqdPerRod = 0.39$$

$$AreaRatio := \frac{\#BarsReqdPerRod}{\#BarsProvidedPerRod} \qquad AreaRatio = 0.24$$

$$AreaRatio := if(AreaRatio < 1, AreaRatio, 1) \qquad AreaRatio = 0.24$$

*2015 AASHTO Development Length of Deformed Bars in Tension* ***5.11.2.1***

$cover = 6 \cdot in$

$c_b$ = *the smaller of the distance from center of bar or wire being developed to the nearest concrete surface and one half the center-to-center spacing of the bars or wires being developed*

$$c_b := \min\left(cover + d_{v.bar} + \frac{d_{bar}}{2}, \frac{ReinfClearSpacing + d_{bar}}{2}\right) = 4.3 \cdot in$$

$k_{tr} := 0 \cdot in$ *assume no transverse bars:*

$$\lambda_{rc} := \min\left(1, \max\left(0.4, \frac{d_{bar}}{c_b + k_{tr}}\right)\right)$$ ***LRFD Eqn 5.11.2.1.3-1***

$\lambda_{rc} = 0.4$

$$L_{d.bar} := \max\left(12in, \lambda_{rc} \cdot 2.4 \cdot d_{bar} \cdot \frac{F_{y.rebar}}{\sqrt{f_c \cdot ksi}}\right)$$ *tension development length* ***LRFD Eqn 5.11.2.1.1-2***

$$SpacingFactor := \max\left(\begin{pmatrix} \#BarsProvidedPerRod \cdot 0.5 - 0.5 \\ 0.5 \end{pmatrix}\right)$$ $SpacingFactor = 0.5$

$$L_{embedment.added} := \sqrt{(ReinfClearSpacing \cdot SpacingFactor)^2 + Gap_{shaft}^{\ 2}}$$ $L_{embedment.added} = 4.5 \cdot in$

$$L_{embedment.rod} := \max\left[\begin{bmatrix} L_{d.bar} \cdot (AreaRatio) + 12 \cdot in + L_{embedment.added} \\ 20 \cdot d_{bolt.pole} \end{bmatrix}\right]$$

*Note:* $20d_{anchor}$ *minimum embedment was in old AASHTO LTS, 2nd Ed. 1985 and 3rd Ed. 1994 in Section 3 - 1.3.4. It was removed in the 4th Ed., but is still a good rule of thumb.*

$L_{embedment.rod} := Ceil(L_{embedment.rod}, in)$ $L_{embedment.rod} = 30 \cdot in$

$L_{anchor.rod} := Ceil[(L_{embedment.rod} + 8 \cdot in), in]$ $L_{anchor.rod} = 38 \cdot in$

## Anchor Bolt Shear Break-Out Strength

***References:***
***ACI 318-05 Appendix D.***
***FDOT/University of Florida Report BD545 RPWO #54,***
***Anchor Embedment Requirements for Signal/Sign Structures, July 2007.***

$\#AnchorRods = 6$ *number of anchor bolts*

$d_{bolt.pole} = 1.5 \cdot in$ *anchor bolt diameter*

$Diameter_{boltcircle.pole} = 22 \cdot in$ *anchor bolt circle diameter*

$L_{embedment.rod} = 30 \cdot in$ *anchor bolt embedment*

$b = 42 \cdot in$ *shaft diameter*

$r_b := \frac{Diameter_{boltcircle.pole}}{2}$ $r_b = 11 \cdot in$

$r := \frac{b}{2}$ $r = 21 \cdot in$

$c_{a1} := \frac{\sqrt{r_b^2 + 3.25 \cdot \left(r^2 - r_b^2\right)} - r_b}{3.25}$ $c_{a1} = 7.1 \cdot in$ *adjusted cover*

***UF Report Eqn 3-2***

$L_e := \min\left(8 \cdot d_{bolt.pole}, L_{embedment.rod}\right)$ $L_e = 12 \cdot in$ *load bearing length of anchor for shear*

***ACI D.6.2.2***

$V_b := 13 \cdot \left(\frac{L_e}{d_{bolt.pole}}\right)^{0.2} \cdot \sqrt{\frac{d_{bolt.pole}}{in}} \cdot \sqrt{\frac{f_c}{psi}} \left(\frac{c_{a1}}{in}\right)^{1.5} \cdot lbf$ *shear break-out strength (single anchor)*

***UF Report Eqn 2-11***

$V_b = 28.9 \cdot kip$

$A_{bolt.sector} := \frac{(360 \cdot deg)}{\#AnchorRods} = 60 \cdot deg$ ***UF Report Fig 3-7***

$alpha := 2\,asin\left[\frac{\left(1.5 \cdot c_{a1}\right)}{r}\right] = 60.9 \cdot deg$

OverlapTest := if($A_{bolt.sector} \le alpha$, "Overlap of Failure Cones" , "No Overlap of Failure Cones")

OverlapTest = "Overlap of Failure Cones"

$chord := 2 \cdot r \cdot \sin\left(\frac{A_{bolt.sector}}{2}\right)$ $chord = 21 \cdot in$ ***UF Report Fig 3-7***

$A_{Vco} := 4.5 \cdot c_{a1}^{\ 2}$ $A_{Vco} = 226.8 \cdot in^2$ *projected concrete failure area (single anchor)*

***ACI Eqn D-23***

$A_{Vc} := chord \cdot 1.5 \cdot c_{a1}$ $A_{Vc} = 223.6 \cdot in^2$ *projected concrete failure area (group)*

***ACI D.6.2.1***

$A_{Vc} := \text{if}(A_{Vc} > A_{Vco}, A_{Vco}, A_{Vc})$ $A_{Vc} = 223.6 \cdot in^2$

| | | | |
|---|---|---|---|
| $\psi_{ecV} := \mathbf{1.0}$ | *eccentric load modifier* | ***ACI D.6.2.5*** | |
| $\psi_{edV} := \mathbf{1.0}$ | *edge effect modifier* | ***ACI D.6.2.6*** | |
| $\psi_{cV} := \mathbf{1.4}$ | *cracked section modifier* | ***ACI D.6.2.7*** | *(stirrup spacing <= 4")* |
| $\psi_{hV} := \mathbf{1.0}$ | *member thickness modifier* | ***ACI D.6.2.8*** | |
| $\phi_{breakout} := \mathbf{0.75}$ | *strength reduction factor* | ***ACI D.4.4.c.i*** | *( shear breakout, condition A)* |

$V_{cbg} := \#AnchorRods \cdot \left(\frac{A_{Vc}}{A_{Vco}}\right) \cdot (\psi_{ecV} \cdot \psi_{edV} \cdot \psi_{cV} \cdot \psi_{hV}) \cdot V_b$ $V_{cbg} = 239.1 \cdot kip$ *concrete breakout strength - shear*

***ACI Eqn D-22*** *Shear force ⊥ to edge*

$V_{cbg\_parallel} := 2 \cdot V_{cbg}$ $V_{cbg\_parallel} = 478.3 \cdot kip$ ***ACI D.6.2.1.c*** *Shear force || to edge*

$T_{n.breakout} := V_{cbg\_parallel} \cdot r_b$ $T_{n.breakout} = 438.4 \cdot kip \cdot ft$ *concrete breakout strength - torsion*

$\phi_{breakout} \cdot T_{n.breakout} = 328.8 \cdot kip \cdot ft$

$T_u = 126 \cdot kip \cdot ft$

$BreakoutTest := \text{if}(\phi_{breakout} \cdot T_{n.breakout} \ge T_u, \text{"OK"}, \text{"No Good"})$ $BreakoutTest = \text{"OK"}$

$OverlapDesign := \text{if}(A_{bolt.sector} \le alpha, \text{"Based on Overlap of Failure Cones"}, \text{"Based on No Overlap of Failure Cones"})$

$OverlapDesign = \text{"Based on Overlap of Failure Cones"}$

$M_{x.polebase} = \begin{pmatrix} 0.0 \\ 106.0 \\ 106.0 \end{pmatrix} \cdot ki$ $M_{y.polebase} = \begin{pmatrix} 96.9 \\ 0.0 \\ 96.9 \end{pmatrix} \cdot kip \cdot f$ $M_{z.polebase} = \begin{pmatrix} 0.0 \\ 37.5 \\ 37.5 \end{pmatrix} \cdot kip \cdot ft$

*maximum torsion (Mx & Mz not used)*
*maximum overturning (My not used)*
*maximum CSR*

Analyze Foundation

## Summary - Soil Properties and Drilled Shaft Geometry

$SoilType = 1$ *0 - clay* *1 - sand* $\phi_{soil} = 30 \cdot deg$ $c_{soil} = 2000 \cdot psf$ $\gamma_{soil} = 42.6 \cdot pcf$ $Offset = 0\,ft$

$Diameter_{shaft} = 3.5\,ft$ $L_{shaft} = 13\,ft$ $L_{embedment.rod} = 30 \cdot in$ $L_{anchor.rod} = 38 \cdot in$

$\#BarsProvided = 10$ $d_{bar} = 1.41 \cdot in$

## Foundation Performance Ratios

$PR_{foundation} = 0.871$

## Fatigue Analysis

DataFile = "Cortez 1 NE Prop.dat" WindSpeed = 130 mph

*Use the member cross section adjacent to the weld toe to compute the nominal stress range.* ***LTS 11.9***

$FatigueCategory := 2$ ***SM V3 11.6***

Analyze Structure for Fatigue

*Arm and Pole Welds*

$f_{galloping.arm1} = 3.8 \cdot ksi$ $CAFT_{fullpengroove.weld.arm1} = 7 \cdot ksi$ $Check_{galloping.arm1} = $ "OK"

$f_{galloping.arm2} = 0 \cdot ksi$ $CAFT_{fullpengroove.weld.arm2} = $ "NA" $\cdot ksi$ $Check_{galloping.arm2} = $ "NA"

$f_{galloping.pole} = 2.5 \cdot ksi$ $CAFT_{fullpengroove.weld.pole} = 4.5 \cdot ksi$ $Check_{galloping.pole} = $ "OK"

$f_{nwg.arm1} = 2.5 \cdot ksi$ $Check_{nwg.arm1} = $ "OK"

$f_{nwg.arm2} = 0 \cdot ksi$ $Check_{nwg.arm2} = $ "NA"

$f_{nwg.pole} = 2.6 \cdot ksi$ $Check_{nwg.pole} = $ "OK"

*A325 Connection Bolts*

$f_{t.g.bolt} = \begin{pmatrix} 5.3 \\ 0.0 \end{pmatrix} \cdot ksi$ $CAFT_{conn.bolt} = 16 \cdot ksi$ $Check_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$f_{t.nwg.bolt} = \begin{pmatrix} 3.4 \\ 0.0 \end{pmatrix} \cdot ksi$ $Check_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

*Anchor Bolts*

$f_{t.g.rod} = 3.8 \cdot ksi$ $CAFT_{anchor.rods} = 7 \cdot ksi$ $Check_{g.rod} = $ "OK"

$f_{t.nwg.rod} = 4 \cdot ksi$ $Check_{nwg.rod} = $ "OK"

Summary

# Mast Arm Design and Analysis Summary

$DataFile = $ "Cortez 1 NE Prop.dat" $WindSpeed = 130 \cdot mph$

**Subject** = "Cortez - 43rd St W NE Prop" **DesignedBy** = "SML" **PoleLocation** = "Pole 1 - NE Corner"

**ProjectNo** = "404-6002870" **CheckedBy** = " " **Date** = "12/12/2017"

## 1st Mast Arm

$\#Signals_{arm1} = 3$ $\#Panels_{arm1} = 1$

$X_{signal.arm1} = \begin{pmatrix} 14 \\ 24 \\ 34 \end{pmatrix} ft$ $Sections_{signal.arm1} = \begin{pmatrix} 5 \\ 3 \\ 5 \end{pmatrix}$ $Backplate_{signal.arm1} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$

$X_{panel.arm1} = (6)\,ft$ $Area_{panel.arm1} = (20)\,ft^2$

$L_{total.arm1} = 46\,ft$ $L_{splice.provided.arm1} = 24 \cdot in$

'FA'= 'FE'= $L_{arm1} = \begin{pmatrix} 35.1 \\ 12.9 \end{pmatrix} \cdot ft$ 'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 7.0833 \\ 11.2173 \end{pmatrix} \cdot in$ 'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 11.9973 \\ 13 \end{pmatrix} \cdot in$

'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.25 \\ 0.375 \end{pmatrix} \cdot in$ $\max(\Delta_{arm1}) = 4.74 \cdot in$ $\max(CSR_{arm1}) = 0.602$

## 2nd Mast Arm

$\#Signals_{arm2} = 0$ $\#Panels_{arm2} = 1$

$X_{signal.arm2} = (0)\,ft$ $Sections_{signal.arm2} = (0)$ $Backplate_{signal.arm2} = (0)$

$X_{panel.arm2} = (0.1)\,ft$ $Area_{panel.arm2} = (0.1)\,ft^2$

$L_{total.arm2} = 0\,ft$ $L_{splice.provided.arm2} = 24 \cdot in$ 'UF'= $\alpha = 0 \cdot deg$ **(Angle Between Arms)**

'SA'= 'SE'= $L_{arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot ft$ 'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ 'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$

'SD'=
'SH'= $t_{wall.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot in$ $\max(\Delta_{arm2}) = 0 \cdot in$ $\max(CSR_{arm2}) = 0$

## Luminaire Arm and Connection

DataFile = "Cortez 1 NE Prop.dat' WindSpeed = $130 \cdot mph$

*(use MC10x33.6 channel for connection)*

'LA'= $Y_{luminaire} = 0\ ft$ 'LB'= $X_{luminaire} = 0\ ft$ 'LC'= $Diameter_{base.lumarm} = 0 \cdot in$

'LD'= $t_{wall.lumarm} = 0 \cdot in$ 'LE'= $Slope_{lumarm} = 0$ 'LF'= $r_{lumarm} = 0\ ft$

'LG'= $d_{bolt.lum} = 0 \cdot in$ 'LH'= $t_{baseplate.lum} = 0 \cdot in$

'LJ'= $w_{base.lum} = 0 \cdot in$ 'LK'= $w_{channel.lum} = 0 \cdot in$

$CSR_{base.lumarm} = 0$ $PR_{bolt.lum} = 0$ $PR_{baseplate.lum} = 0$ $PR_{conn.plate.lum} = 0$

## Upright

'UA'= $Y_{pole} = 21.5 \cdot ft$ 'UB'= $Y_{arm.conn} = 20 \cdot ft$ 'UC'= $Diameter_{tip.pole} = 13.0192 \cdot in$

'UD'= $Diameter_{base.pole} = 16 \cdot in$ 'UE'= $t_{wall.pole} = 0.375 \cdot in$ 'UF'= $\alpha = 0 \cdot deg$

'UG'= $Y_{lum.conn} = 0\ ft$ $\Delta_{x.dl} = 0.89 \cdot in$ $Slope_x = 0.47 \cdot deg$

$\Delta_{z.dl} = 0 \cdot in$ $Slope_z = 0 \cdot deg$ $C_{a.pole} = 0.996$

$\max(CSR_{pole}) = 0.619$

## 1st Arm/Upright Connection

$\#ConnBolts_0 = 6$ 'HT'= $h_{conn.plate} = 22 \cdot in$ 'FJ'= $b_{conn.plate_0} = 23 \cdot in$

'FK'= $t_{baseplate.arm_0} = 2 \cdot in$ 'FL'= $t_{vertical.plate_0} = 0.5 \cdot in$

'FN'= $w_{vertical.plate_0} = 0.3125 \cdot in$ 'FO'= $Offset_{conn_0} = 14.1146 \cdot in$

'FP'= $d_{bolt.conn_0} = 1 \cdot in$ 'FR'= $t_{conn.plate_0} = 1.5 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 9 \cdot in$ 'FT'= $w_{conn.plate_0} = 0.3125 \cdot in$

$$\begin{pmatrix} PR_{bolt_0} \\ PR_{t.baseplate.arm_0} \\ PR_{t.connplate.arm_0} \\ CSR_{t.vert.plate_0} \end{pmatrix} = \begin{pmatrix} 0.663 \\ 0.839 \\ 0.998 \\ 0.661 \end{pmatrix}$$

## 2nd Arm/Upright Connection

$\#ConnBolts_1 = 0$ 'HT'= $h_{conn.plate} = 22 \cdot in$ 'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SK'= $t_{baseplate.arm_1} = 0 \cdot in$ 'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

$$\begin{pmatrix} PR_{bolt_1} \\ PR_{t.baseplate.arm_1} \\ PR_{t.connplate.arm_1} \\ CSR_{t.vert.plate_1} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

## Pole Baseplate

DataFile = "Cortez 1 NE Prop.dat' WindSpeed = 130·mph

#AnchorRods = 6

'BA'= $Diameter_{baseplate.pole} = 28 \cdot in$

'BB'= $t_{baseplate.pole} = 2.5 \cdot in$

'BC'= $d_{bolt.pole} = 1.5 \cdot in$

'BF'= $L_{embedment.rod} = 30 \cdot in$

$Diameter_{boltcircle.pole} = 22 \cdot in$

$PR_{rod} = 0.772$

$PR_{plate.pole} = 1$

## Foundation

'DA'= $L_{shaft} = 13 \cdot ft$

'DB'= $Diameter_{shaft} = 3.5 \cdot ft$

$d_{bar} = 1.41 \cdot in$ Offset = 0 ft

'RA'= $round\left(\frac{d_{bar}}{0.125in}\right) = 11$

'RB'= #BarsProvided = 10

$Diameter_{rebar.circle} = 2.2783\, ft$

'RC'= $NumSpaces_{v.bar} = 10$

'RD'= $s_{v2} = 12 \cdot in$

$PR_{foundation} = 0.871$

WRITEPRN to Line 1-2-3

## Mast Arm Tip Deflection

*Compare Mast Arm deflection of each arm to a proposed camber*

$Camber_{arm1} := \mathbf{2} \cdot deg$ $Camber_{arm2} := \mathbf{2} \cdot deg$

$L_{arm1} := \sum L_{arm1} - if\left[\left(L_{arm1_1} = 0 \cdot ft\right), 0 \cdot ft, 2 \cdot ft\right]$

$L_{arm2} := \sum L_{arm2} - if\left[\left(L_{arm2_1} = 0 \cdot ft\right), 0 \cdot ft, 2 \cdot ft\right]$

$Deflection_{arm1} := Slope_x \cdot L_{arm1} + max\left(\Delta_{arm1}\right)$

$Deflection_{arm1} = 9.3 \cdot in$

$CamberArm1_{upward} := sin\left(Camber_{arm1}\right) \cdot L_{arm1}$

$CamberArm1_{upward} = 19.26 \cdot in$

$Deflection_{arm2} := \left[Slope_z \cdot L_{arm2} \cdot (sin(\alpha))\right] + Slope_x \cdot L_{arm2} \cdot cos(\alpha) + max\left(\Delta_{arm2}\right)$

$Deflection_{arm2} = 0 \cdot in$

$CamberArm2_{upward} := sin\left(Camber_{arm2}\right) \cdot L_{arm2}$

$CamberArm2_{upward} = 0 \cdot in$

## Check Clearance Between Connection Plates

*(for Two Arm Structures only)*

$\alpha = 0 \cdot deg$

$\alpha := if[(\alpha > 180 \cdot deg), (360 \cdot deg - \alpha), \alpha]$

$Offset_{conn_0} = 14.1 \cdot in$

$b_{conn.plate_0} = 23 \cdot in$

$h_{conn.plate} = 22 \cdot in$

$\alpha = 0 \cdot deg$

$Offset_{conn_1} = 0 \cdot in$

$b_{conn.plate_1} = 0 \cdot in$

$$x_1 := \text{Offset}_{\text{conn}_0} - t_{\text{conn.plate}_0} - h_{\text{conn.plate}} \cdot \frac{\sin(\text{Camber}_{\text{arm1}})}{2} \qquad y_1 := \frac{b_{\text{conn.plate}_0}}{2} \qquad x_1 = 12.23 \cdot \text{in} \quad y_1 = 11.5 \cdot \text{in}$$

$$x_2 := \left(\text{Offset}_{\text{conn}_1} - t_{\text{conn.plate}_1} - h_{\text{conn.plate}} \cdot \frac{\sin(\text{Camber}_{\text{arm2}})}{2}\right) \cdot \cos(\alpha) + \frac{b_{\text{conn.plate}_1}}{2} \cdot \sin(\alpha)$$

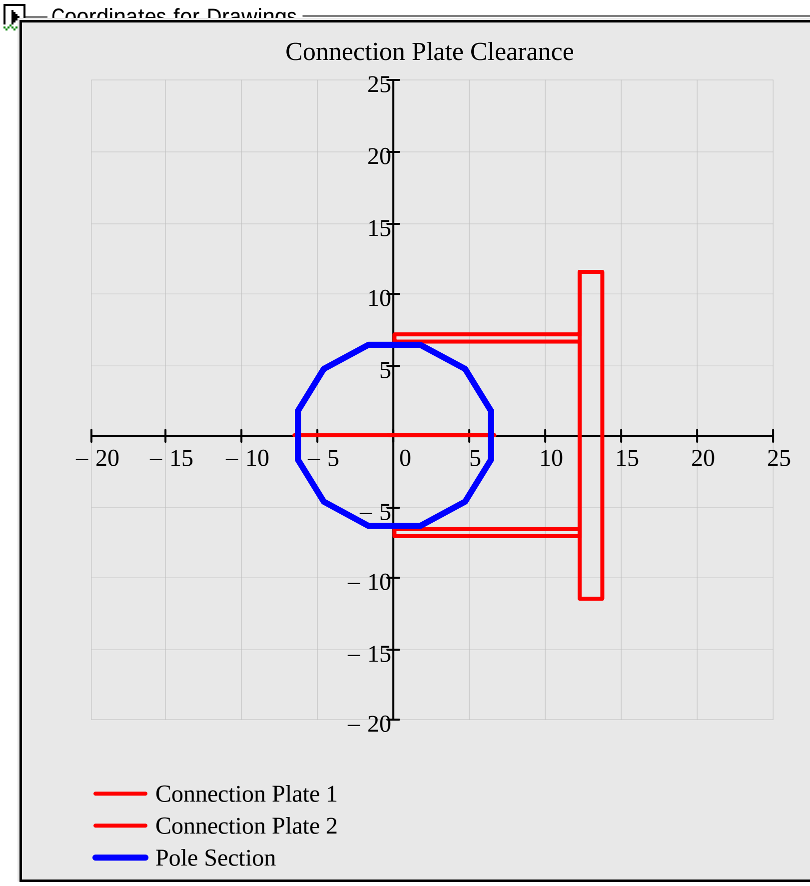
$$y_2 := \left(\text{Offset}_{\text{conn}_1} - t_{\text{conn.plate}_1} - h_{\text{conn.plate}} \cdot \frac{\sin(\text{Camber}_{\text{arm2}})}{2}\right) \cdot \sin(\alpha) - \frac{b_{\text{conn.plate}_1}}{2} \cdot \cos(\alpha) \qquad x_2 = -0.38 \cdot \text{in} \quad y_2 = 0 \cdot \text{in}$$

$$\text{Clearance} := \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \quad \text{Clearance} := \text{if}\left[(y_2 \le y_1), \text{if}\left[(x_1 > x_2), \text{Clearance}, 0 \cdot \text{in}\right], \text{Clearance}\right] \quad \text{Clearance} = 17.07 \cdot \text{in}$$

***(if Clearance equals 0, then Connection Plates intersect and redesign is required.***

## Plan View - Connection Plate Clearance for Two Arm Connections

Coordinates for Drawings




$\text{Clearance} = 17.07 \cdot \text{in}$

$\text{Diameter}_{\text{conn.pole}} = 13.2292 \cdot \text{in}$

$t_{\text{conn.plate}_0} = 1.5 \cdot \text{in}$

$b_{\text{conn.plate}_0} = 23 \cdot \text{in}$

$t_{\text{vertical.plate}_0} = 0.5 \cdot \text{in}$

$\text{Offset}_{\text{conn}_0} = 14.1146 \cdot \text{in}$

$\text{Gap}_0 = 7.5 \cdot \text{in}$

$t_{\text{conn.plate}_1} = 0 \cdot \text{in}$

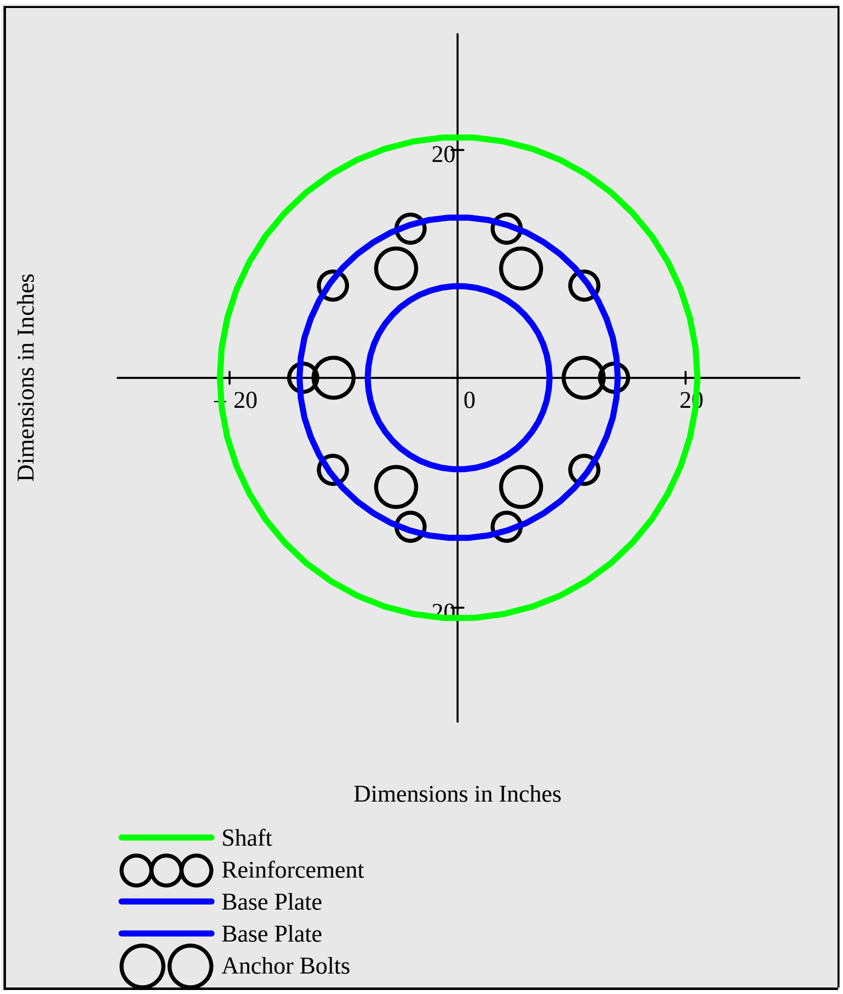
$b_{\text{conn.plate}_1} = 0 \cdot \text{in}$

$t_{\text{vertical.plate}_1} = 0 \cdot \text{in}$

$\text{Offset}_{\text{conn}_1} = 0 \cdot \text{in}$

$\text{Gap}_1 = 0 \cdot \text{in}$

## Plan View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$\text{Diameter}_{base.pole} = 16 \cdot in$

$\text{Diameter}_{baseplate.pole} = 28 \cdot in$

$\text{Diameter}_{shaft} = 42 \cdot in$

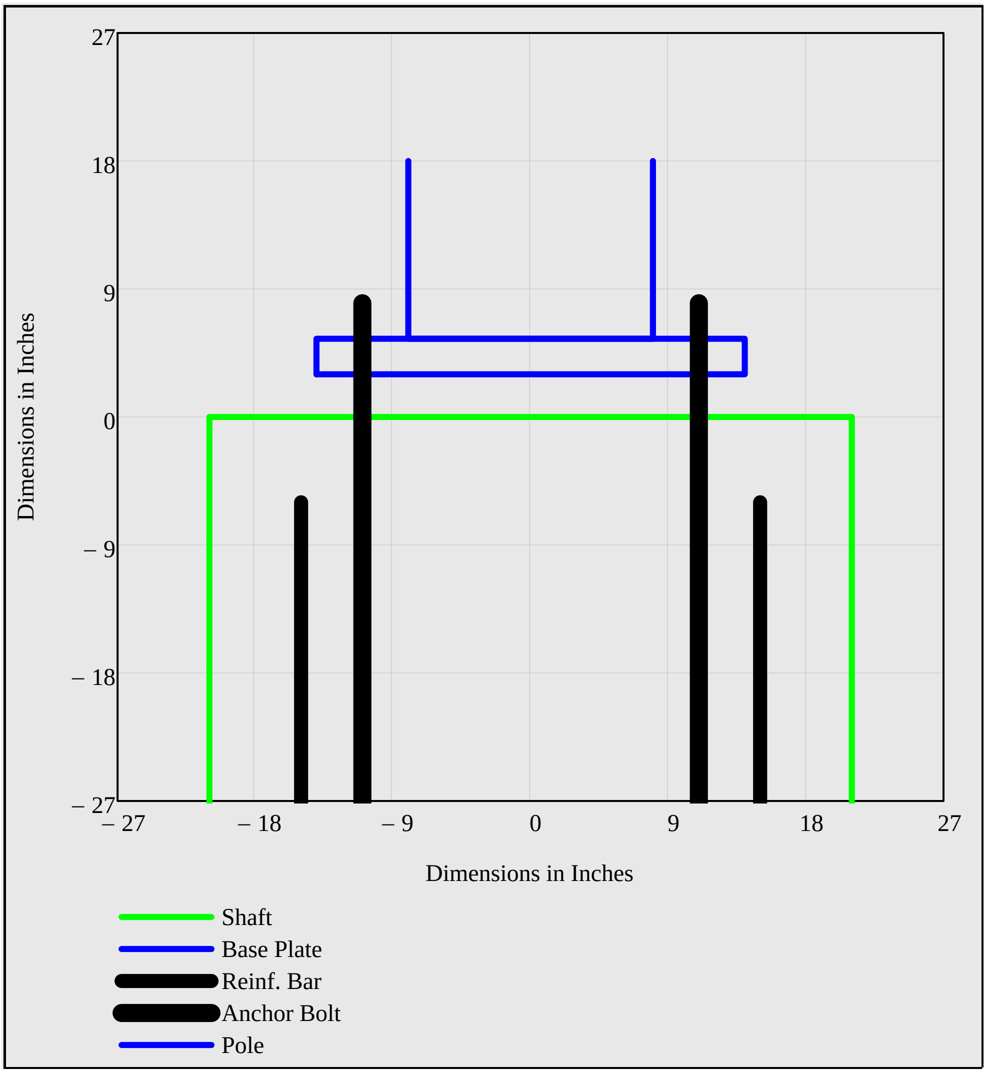
$\text{Diameter}_{boltcircle.pole} = 22 \cdot in$

$\text{Diameter}_{rebar.circle} = 27.34 \cdot in$

#AnchorRods = 6

#BarsProvided = 10

## Elevation View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$Diameter_{base.pole} = 16 \cdot in$

$Diameter_{baseplate.pole} = 28 \cdot in$

$t_{baseplate.pole} = 2.5 \cdot in$

$Diameter_{shaft} = 3.5 \cdot ft$

$Diameter_{boltcircle.pole} = 22 \cdot in$

$Diameter_{rebar.circle} = 27.3 \cdot in$

# Appendix E. Supporting Analytical Calculations – Poles 2 thru 4

# Calculation Cover Sheets

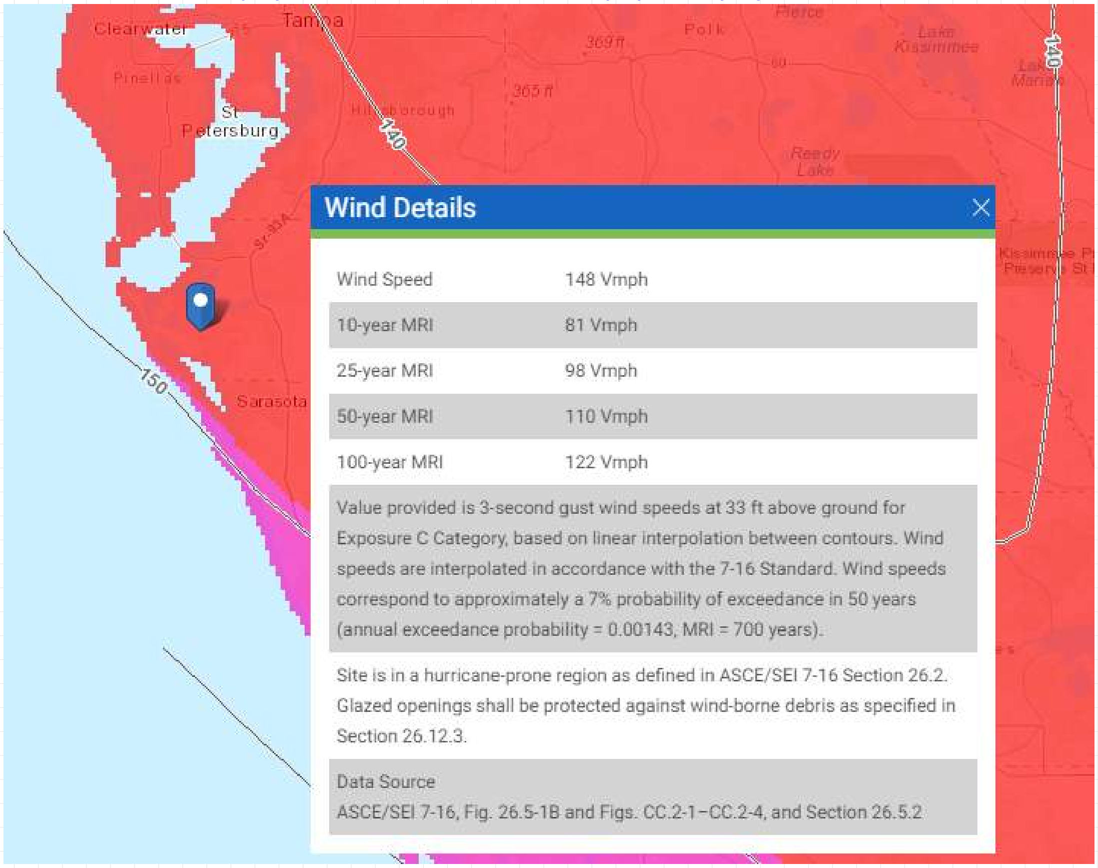
| | | | |
|---|---|---|---|
| Client: | **Manatee County Public Works** | | |
| Project: | **43rd St West Right Turn Lane North of Cortez Road West** | | |
| Project No: | 10226260 | Rev: | |
| Calculation No: | 1 | Page: | 1 of 99 |
| Title: | Ancillary Structures Calculation | | |
| Purpose: | Analyze the existing and proposed configurations of Poles 2 thru 4 for a comparative analysis | | |
| Originator: | CMH | Date: | 7/6/2021 |
| Checked by: | CAS | Date: | 7/20/2021 |
| QC Review by: | NEC | Date: | 8/6/2021 |
| Approved by: | CAS | Date: | 8/6/2021 |

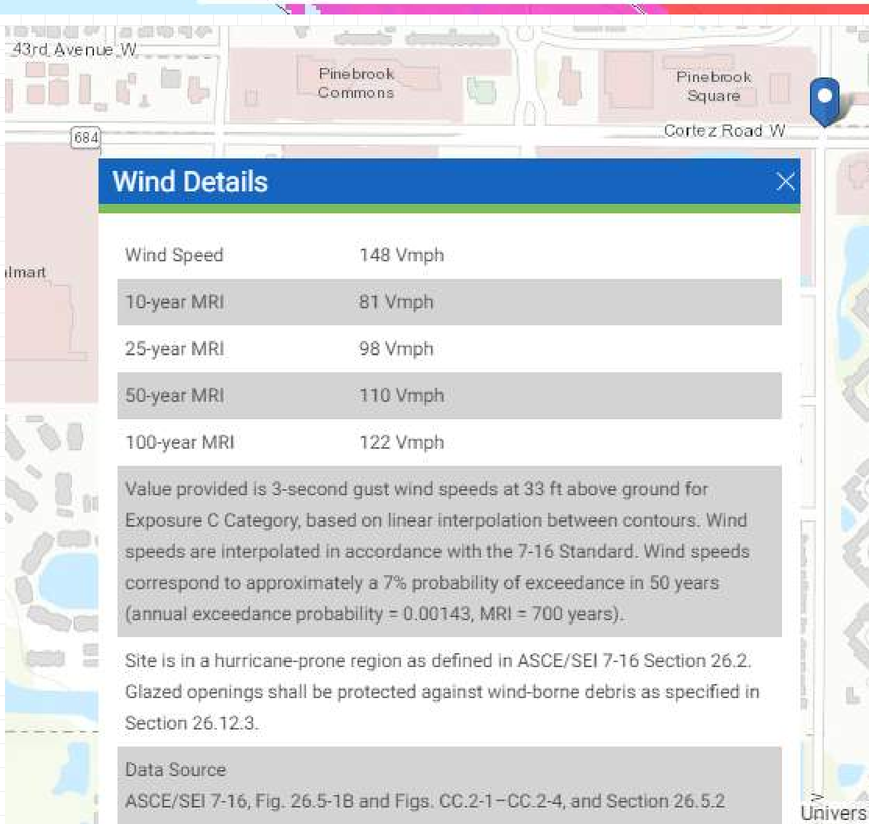
Supersedes Calculation No:

Superseded by Calculation No:

| | | | | | |
|---|---|---|---|---|---|
| Project: | 43rd Street at Cortez | Computed: | CMH | Date: | 06/30/2021 |
| Subject: | Analysis of Existing Mast Arms | Checked: | | Date: | |
| Task: | Wind Speed | Page: | | of: | |
| Job #: | 10226260 | No: | | | |

Wind speed based on ASCE-07 (https://asce7hazardtool.online/) specific project location with 700 Year MRI = 148 mph.



# FDOT Mast Arm Traffic Signal Support Analysis Program V1.2

State Structures Design Office

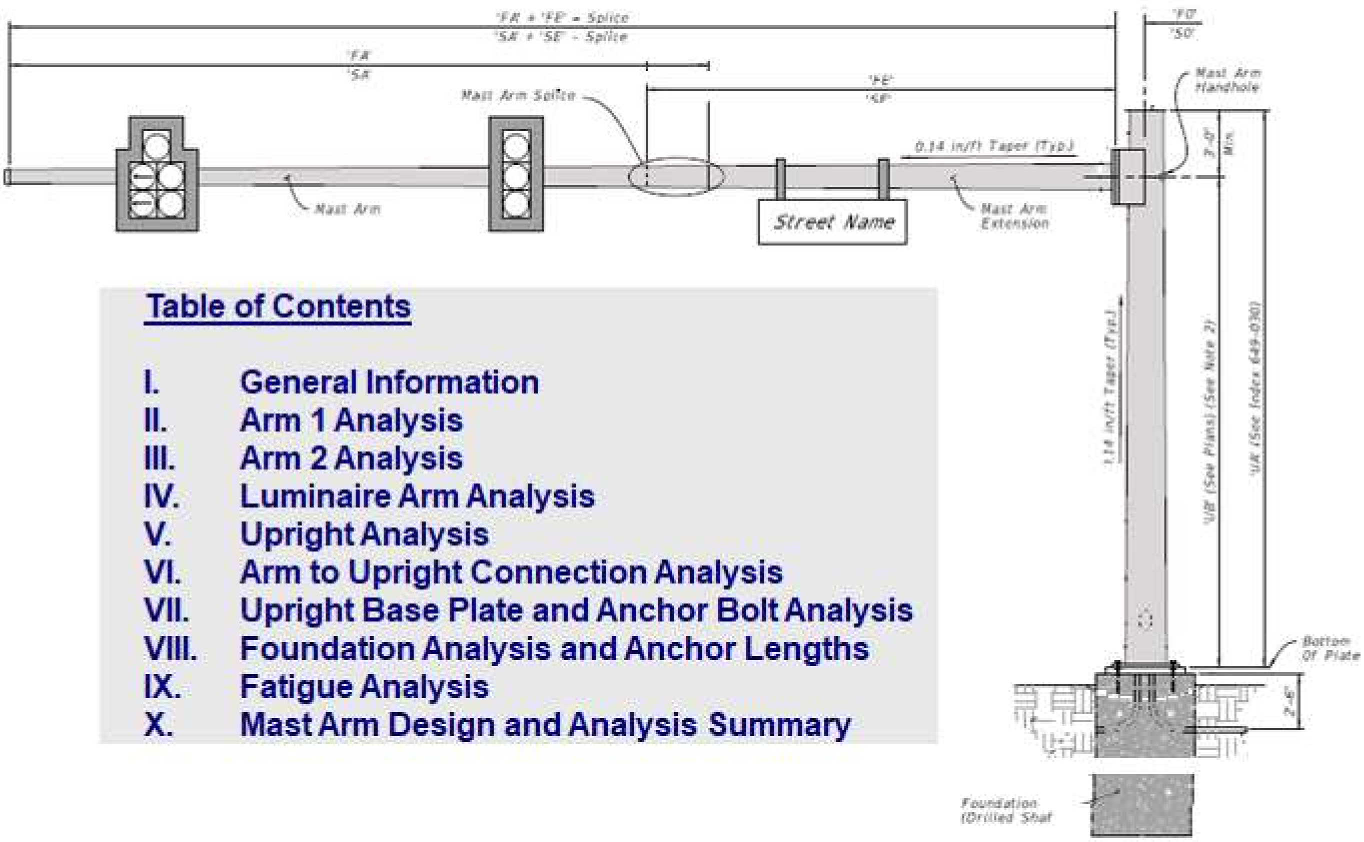


*This program works in conjunction with FDOT Mast Arm Standard Plans 649-030 & 649-031.*

*References:*
*AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (LRFDLTS).*
*FDOT Structures Manual Volume 3 (SM V3).*
*AISC Steel Construction Manual*

*Reference*

*For more information see Reference.xmcd and Changes.xmcd.*




## Table of Contents



## Data Folder and Files

***Data Files Folder***

Change Folder

C:\PWWORKING\east01\d2477925\MastArmV1.2\Data\

***Required** - Open Existing Data File. To save New Data Files, enter data variables at the end of Section IX.*

Pole 2.dat
Pole 2_Existing.dat

Refresh List

Open File

## I. General Information and Sign & Signal Data

### Enter Project Information

| | |
|---|---|
| *Project Name* | 43rd St. at Cortez |
| *Project No.* | 10226260 |
| *Designed by* | CMH |
| *Date* | 06/30/2021 |
| *Checked by* | XXX |
| *Date* | XX/XX/XXXX |
| *Signal Name* | Pole 2 |
| *Station/Offset* | 300+34.2 / 62.09' RT |

### Enter Wind Speed

*Design Wind Speed* 148 *mph*

*Extreme Event Wind Speed*

**SDG Wind Speeds by County**

### Enter Arm Lengths, Signal and Sign Data

***Arm 1***

*Arm 1 Length* 60

Reset Arm 1 Data

| *Arm1 Signal Number* | *Distance to Signal (ft)* | *Number of Heads* |
|---|---|---|
| 1 | 29 | 3 |
| 2 | 41 | 3 |
| 3 | 53 | 4 |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

***Arm 2*** *Set Arm 2 Length = 0 for single arm Mast Arms*

*Arm 2 Length* 0

Reset Arm 2 Data

| *Arm2 Signal Number* | *Distance to Signal (ft)* | *Number of Heads* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

***Arm 1 Sign Panels***

| *Arm1 Sign Panel Number* | *Distance to Panel (ft)* | *Panel Area (sf)* |
|---|---|---|
| 1 | 8 | 20 |
| 2 | 50 | 7.5 |
| 3 | 47 | 1 |
| 4 | 35 | 1 |
| 5 | | |

*Note: The VVDS and MVDS is assumed to be a 1 ft x 1 ft sign for analysis purposes.*

***Arm 2 Sign Panels***

| *Arm2 Sign Panel Number* | *Distance to Panel (ft)* | *Panel Area (sf)* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

Save Data for Signs and Signals

## II. Arm 1 Analysis

InputDataFile = "Pole 2.dat"   $V_{extreme} = 148 \cdot mph$

*Values for* $Dist_{splice.from.base.arm}$ *that give a base diameter in even inches*

| "Wall Thickness" | "dia-1in" | "dia-2in" | "dia-3in" | "dia-4in" | "dia-5in" | "d-6in" |
|---|---|---|---|---|---|---|
| $t_{wall.arm}$ = 0.179·in | ***9.9***·ft | ***17.0***·ft | ***24.2***·ft | ***31.3***·ft | ***38.5***·ft | ***45.6***·ft |
| $t_{wall.arm}$ = 0.25·in | ***10.9***·ft | ***18.0***·ft | ***25.2***·ft | ***32.3***·ft | ***39.4***·ft | ***46.6***·ft |

Help - Base Diameters | Help - Arm Tip Diameter | Help - Tube Wall Thickness | Help - Arm Lengths | Recommended Distance to Splice

Reference:C:\PWWORKING\east01\d2477925\MastArmV1.2\LRFD Equation Module.xmcd(R)

**Enter Arm 1 Data**

| *Arm Length (ft)* | *Base Diameter (in)* | *Wall Thickness 1 (in)* | *Wall Thickness 2 (in)* | *Distance to Splice (ft)* |
|---|---|---|---|---|
| $L_{total.arm1} = 60\,ft$ | 14 | 0.375 | 0.5 | 24 |
| *feet, 40 ft. max. for 1 piece arms* | *Measured flat to flat* 'FG' | *for 1 & 2 piece arms* 'FD' | *for 2 piece arms only* 'FH' | *for 2 piece arms only* ('Larm' - 'FA') |

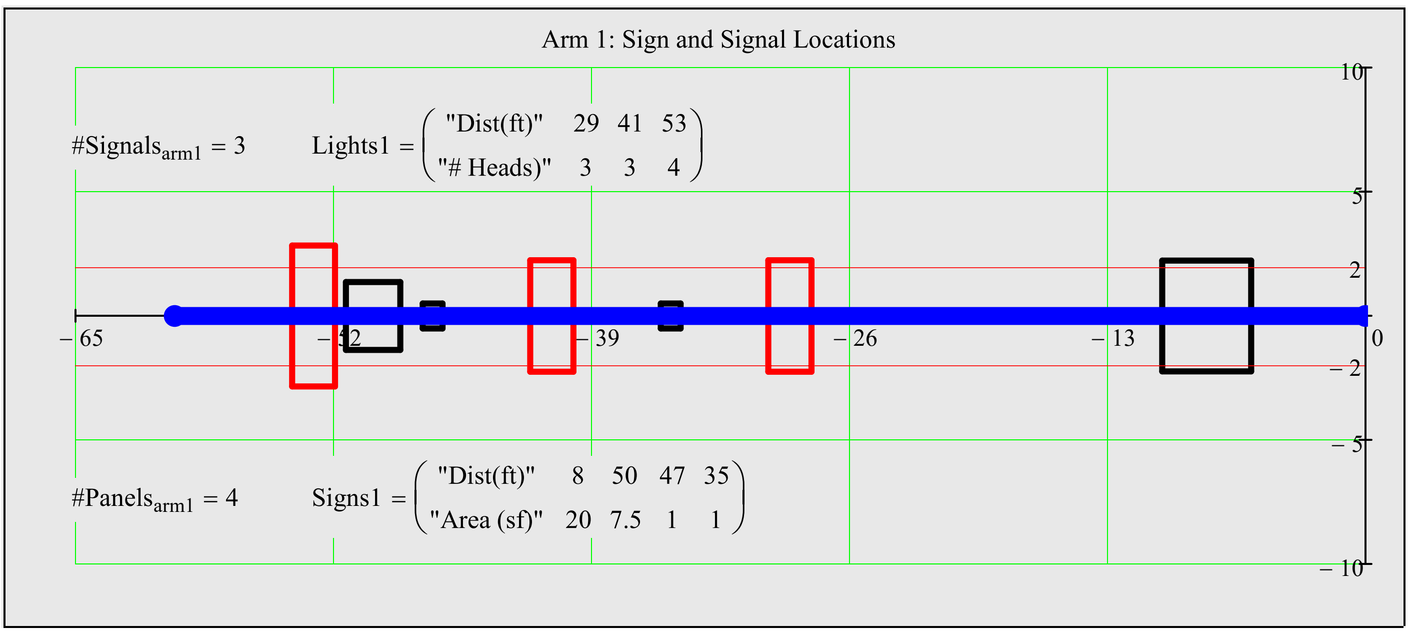
Arm 1 Analysis including Existing Mast Arm Analysis (Additional Variables Required)

*Arm 1 Combined Force Interaction Ratio and Deflection*

BackPlate = "Rigid, 6 inches wide"

$\max(CFI_{arm1}) = 0.53$   $\max(\Delta_{arm1}) = 14.0 \cdot in$   $2 \cdot deg \cdot L_{total.arm1} = 25.1 \cdot in$

*Summary - Arm 1 Geometry and Loading*




$\max(CFI_{arm1}) = 0.53$

$\max(\Delta_{arm1}) = 14.0 \cdot in$

$L_{total.arm1} = 60\,ft$

'FA'= 'FE'= $L_{fabricated.arm1} = \begin{pmatrix} 36.0 \\ 26.0 \end{pmatrix} \cdot ft$

'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 6.37 \\ 10.36 \end{pmatrix} \cdot in$

'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 11.41 \\ 14.00 \end{pmatrix} \cdot in$

'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.375 \\ 0.500 \end{pmatrix} \cdot in$

$Classification_{arm1} = \begin{pmatrix} \text{"Compact"} \\ \text{"Compact"} \end{pmatrix}$

$L_{splice.provided.arm1} = 2 \cdot ft$

## III. Arm 2 Analysis

InputDataFile = "Pole 2.dat" $V_{extreme} = 148 \cdot mph$

$Dist_{splice.from.base.arm}$ *values that give a base diameter in even inches*

| "Wall Thickness" | $\Delta dia = 1 \cdot in$ | $\Delta dia = 2 \cdot in$ | $\Delta dia = 3 \cdot in$ | $\Delta dia = 4 \cdot in$ | $\Delta dia = 5 \cdot in$ | $\Delta dia = 6 \cdot in$ |
|---|---|---|---|---|---|---|
| $t_{wall.arm} = 0.179 \cdot in$ | ***9.9***·ft | ***17.0***·ft | ***24.2***·ft | ***31.3***·ft | ***38.5***·ft | ***45.6***·ft |
| $t_{wall.arm} = 0.25 \cdot in$ | ***10.9***·ft | ***18.0***·ft | ***25.2***·ft | ***32.3***·ft | ***39.4***·ft | ***46.6***·ft |

Help - Base Diameters | Help - Arm Tip Diameter | Help - Tube Wall Thickness | Help - Arm Lengths | Recommended Distance to Splice

**Enter Arm 2 Data**

| *Arm Length (ft)* | *Base Diameter (in)* | *Wall Thickness 1 (in)* | *Wall Thickness 2 (in)* | *Distance to Splice (ft)* |
|---|---|---|---|---|
| $L_{total.arm2} = 0$ ft | | | | |
| *feet, 40 ft. max. for 1 piece arms* | *Measured flat to flat* 'SG' | *for 1 & 2 piece arms* 'SD' | *for 2 piece arms only* 'SH' | *for 2 piece arms only* ('Larm' - 'SA') |

Arm 2 Analysis including Existing Mast Arm Analysis

*Arm 2 Combined Force Interaction Ratio and Deflection*

$\max(CFI_{arm2}) = 0.00$ BackPlate = "Rigid, 6 inches wide"

*Summary - Arm 2 Geometry and Loading* $\max(\Delta_{arm2}) = 0.0 \cdot in$ $2 \cdot deg \cdot L_{total.arm2} = 0 \cdot in$

Arm 2: Sign and Signal Locations

10

$\#Signals_{arm2} = 0$ $Lights2 = \begin{pmatrix} \text{"Dist(ft)"} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \text{"\# Heads)"} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

$\#Panels_{arm2} = 0$ $Signs2 = \begin{pmatrix} \text{"Dist(ft)"} & 0 & 0 & 0 & 0 & 0 \\ \text{"Area (sf)"} & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

– 10

$-(L_{total.arm2} + 5 \cdot ft)$ 0

$\max(CFI_{arm2}) = 0.00$

'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix} \cdot in$ $Classification_{arm2} = \begin{pmatrix} \text{"Compact"} \\ \text{"N/A"} \end{pmatrix}$

$\max(\Delta_{arm2}) = 0.0 \cdot in$

$L_{total.arm2} = 0$ ft 'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix} \cdot in$ $L_{splice.provided.arm2} = 0 \cdot ft$

'SA'= 'SE'= $L_{fabricated.arm2} = \begin{pmatrix} 0.0 \\ 0.0 \end{pmatrix} \cdot ft$ 'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0.000 \\ 0.000 \end{pmatrix} \cdot in$

## IV. Luminaire Arm Analysis

InputDataFile = "Pole 2.dat" $V_{extreme} = 148 \cdot mph$

### Enter Luminaire Data

*Set Lum. Ht. = 0 for no Luminaire*

*See Design Standards 649-030 and 649-031 for input values.*

| Luminaire Height (ft) | Lum Horiz Length (ft) | Lum Arm Base Dia (in) | Lum Wall Thickness (in) | Slope | Lum Arm Radius (ft) | Lum Bolt Dia (in) | Lum Base Plate Thickness (in) |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | |
| *Std = 40 feet* | *10 feet* | *3 inches* | *0.125 inches* | *0.5* | *8 feet* | *0.5 inches* | *0.75 inches* |

Analyze Luminaire

*Summary - Luminaire Arm Geometry*

$$\begin{pmatrix} CFI_{base.lumarm} \\ CSR_{bolt.lum} \\ D/C_{baseplate.lum} \\ D/C_{conn.plate.lum} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

'LA'= $Y_{luminaire} = 0\,ft$

'LB'= $X_{luminaire} = 0\,ft$

'LC'= $Diameter_{base.lumarm} = 0 \cdot in$

'LD'= $t_{wall.lumarm} = 0 \cdot in$

'LE'= $Slope_{lumarm} = 0$

'LF'= $r_{lumarm} = 0\,ft$

'LG'= $d_{bolt.lum} = 0 \cdot in$

'LH'= $t_{baseplate.lum} = 0 \cdot in$

'LJ'= $w_{base.lum} = 0 \cdot in$

'LK'= $w_{channel.lum} = 0 \cdot in$

## V. Upright Analysis

InputDataFile = "Pole 2.dat" $V_{extreme} = 148 \cdot mph$

Help - Upright Base Diameter and Wall Thickness

Help - Gap Distance

### Enter Upright Data

| Total Height (ft) | Height to Arm Connection (ft) | Base Diameter (in) | Wall Thickness (in) | Gap (in) | |
|---|---|---|---|---|---|
| 21.5 | 20 | 19 | 0.375 | 11.34 | arm 1 gap |
| | | | | | arm 2 gap |
| 'UA' | 'UB' | 'UD' *measured flat to flat* | 'UE' | | |

Analyze Upright

*Upright Combined Force Interaction Ratio and Deflections*

$Classification_{pole} = \text{"Compact"}$

$\max(CFI_{pole}) = 0.53$

$Check_{slope} = \text{"OK"}$

$Check_{deflection} = \text{"OK"}$

$\max(\Delta_{x.dl}) = 1.32 \cdot in$

$\max(\Delta_{z.dl}) = 0 \cdot in$

$Slope_z = 0 \cdot deg$

$Slope_x = 0.69 \cdot deg$

$Diameter_{conn.pole} = 16.2 \cdot in$

$$\max\left(\begin{pmatrix} Diameter_{base.arm1_0} \\ Diameter_{base.arm2_0} \end{pmatrix}\right) = 11.4 \cdot in$$

'UA'= $Y_{pole} = 21.5\,ft$

'UB'= $Y_{arm.conn} = 20\,ft$

'UC'= $Diameter_{tip.pole} = 16 \cdot in$

'UD'= $Diameter_{base.pole} = 19 \cdot in$

'UE'= $t_{wall.pole} = 0.375\,in$

'UF'= $\alpha = 0 \cdot deg$

'UG'= $Y_{lum.conn} = 0\,ft$

## VI. Arm to Upright Connection Analysis

InputDataFile = "Pole 2.dat"

*for double arms, both connection plate heights must be equal*

Help - Arm Connection Dimensions

**Enter Connection Data**

| Connection Plate Height(in) | Connection Plate Width (in) | Vertical Plate Thickness (in) | Bolt Diameter (in) | Arm Base Plate Thickness (in) |
|---|---|---|---|---|
| 30 | 32 | 0.75 | 1.25 | 2.75 |
| | | | | |
| 'HT' | 'FJ', 'SJ' | 'FL', 'SL' | 'FP', 'SP' | 'FK', 'SK' |

Analyze Connection

*Connection Summary*

'HT'= $h_{conn.plate} = 30 \cdot in$ $\quad D/C_{ht.conn.plate} = 0.68$ $\quad CheckHt_{conn.plate} = \text{"OK"}$

$D/C_{width.conn.plate_0} = 0.88$

$CheckWidth_{conn.plate_0} = \text{"OK"}$

$$\begin{pmatrix} D/C_{t.baseplate.arm_0} \\ CFI_{t.vert.plate_0} \\ CSR_{bolt.conn_0} \end{pmatrix} = \begin{pmatrix} 0.73 \\ 0.36 \\ 0.31 \end{pmatrix}$$

$\#Bolts_{conn_0} = 6$

'FJ'= $b_{conn.plate_0} = 32 \cdot in$

'FK'= $t_{baseplate.arm_0} = 2.75 \cdot in$

'FL'= $t_{vertical.plate_0} = 0.75 \cdot in$

'FN'= $w_{vertical.plate_0} = \frac{3}{8} \cdot in$

'FO'= $Offset_{conn_0} = 19.5 \cdot in$

'FP'= $d_{bolt.conn_0} = 1.25 \cdot in$

'FR'= $t_{conn.plate_0} = 2.00 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 12.5 \cdot in$

'FT'= $w_{conn.plate_0} = \frac{3}{8} \cdot in$

$D/C_{width.conn.plate_1} = 0.00$

$CheckWidth_{conn.plate_1} = \text{"OK"}$

$$\begin{pmatrix} D/C_{t.baseplate.arm_1} \\ CFI_{t.vert.plate_1} \\ CSR_{bolt.conn_1} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

$\#Bolts_{conn_1} = 0$

'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SK'= $t_{baseplate.arm_1} = 0.00 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0.00 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0.00 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

## VII. Upright Base Plate & Anchor Bolt Analysis

InputDataFile = "Pole 2.dat"

**Enter Anchorage Data**

| *Anchor Bolt Diameter (in)* | *Number of Anchor Bolts* |
|---|---|
| 2 | 6 |
| 'BC' | '#Bolts' |

Help - Number of Anchor Bolts

$\text{Diameter}_{\text{base.pole}} = 19 \cdot \text{in}$

Analyze Base Plate & Anchors

*Base Plate and Anchor Summary*

'#Bolts'= $\#\text{AnchorBolts} = 6$

'BB'= $t_{\text{baseplate.pole}} = 1.75 \cdot \text{in}$

$CSR_{\text{anchor}} = 0.22$

$\text{Diameter}_{\text{boltcircle.pole}} = 27 \cdot \text{in}$

'BC'= $d_{\text{anchorbolt}} = 2.00 \cdot \text{in}$

$\text{CheckCSR}_{\text{anchorbolt}} = \text{"OK"}$

'BA'= $\text{Diameter}_{\text{baseplate.pole}} = 35 \cdot \text{in}$

## VIII. Foundation Analysis & Anchor Bolt Lengths

InputDataFile = "Pole 2.dat"

**Enter Drilled Shaft Data**

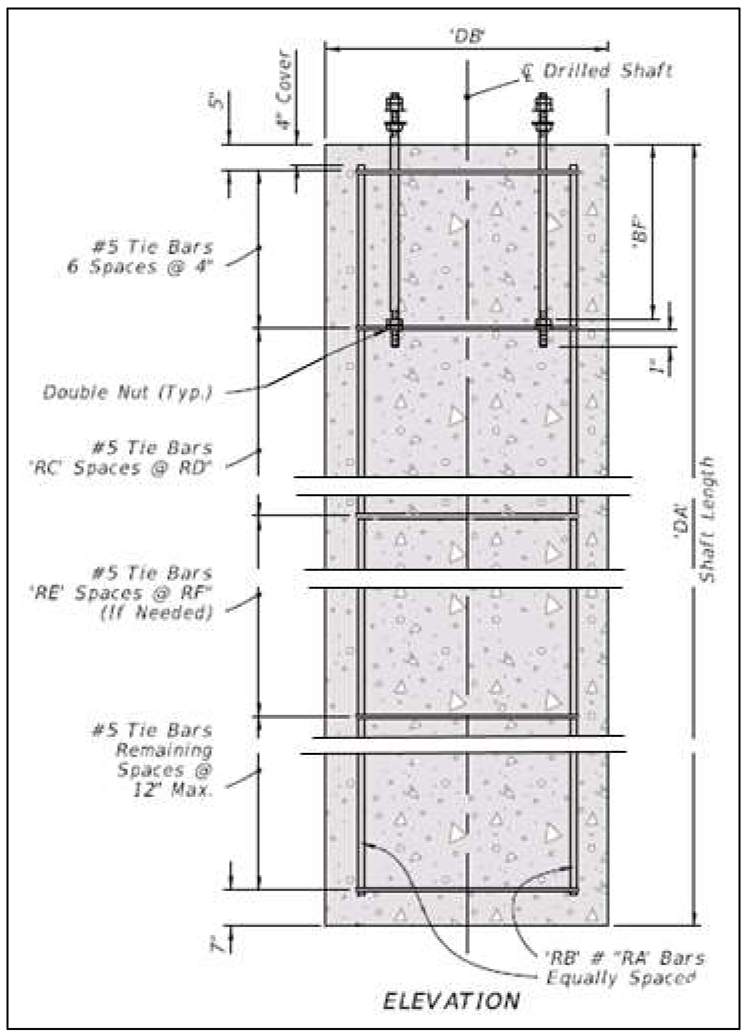
| | | | |
|---|---|---|---|
| *Soil Type* | | Sand / Clay (Sand selected) | |
| *Soil Density, $\gamma_{soil}$ (45-50 pcf typ.)* | | 42.6 | pcf |
| *Friction Angle, $\phi$ (Sands)* | | 30 | deg |
| *SPT Number ($N_{blows}$ 5 min.) (Sands)* | | 15 | |
| *Shear Strength, c (Clays)* | | 2000 | psf |
| *Ground to Top of Shaft Offset* | | 0.5 | ft |

***First Set of User Defined Stirrups:***

| | | | |
|---|---|---|---|
| *Number of Stirrup Spaces* | 'RC' | 1 | |
| *Stirrup Spacing* | 'RD' | 12 | in |

***Second Set of User Defined Stirrups:***

| | | | |
|---|---|---|---|
| *Number of Stirrup Spaces enter zero for 12 inch spacing* | 'RE' | 1 | |
| *Stirrup Spacing enter zero for 12 inch spacing* | 'RF' | 12 | in |
| *Stirrup Bar Size, use #5 for all Standard Shafts* | | #5 / #6 (#5 selected) | |

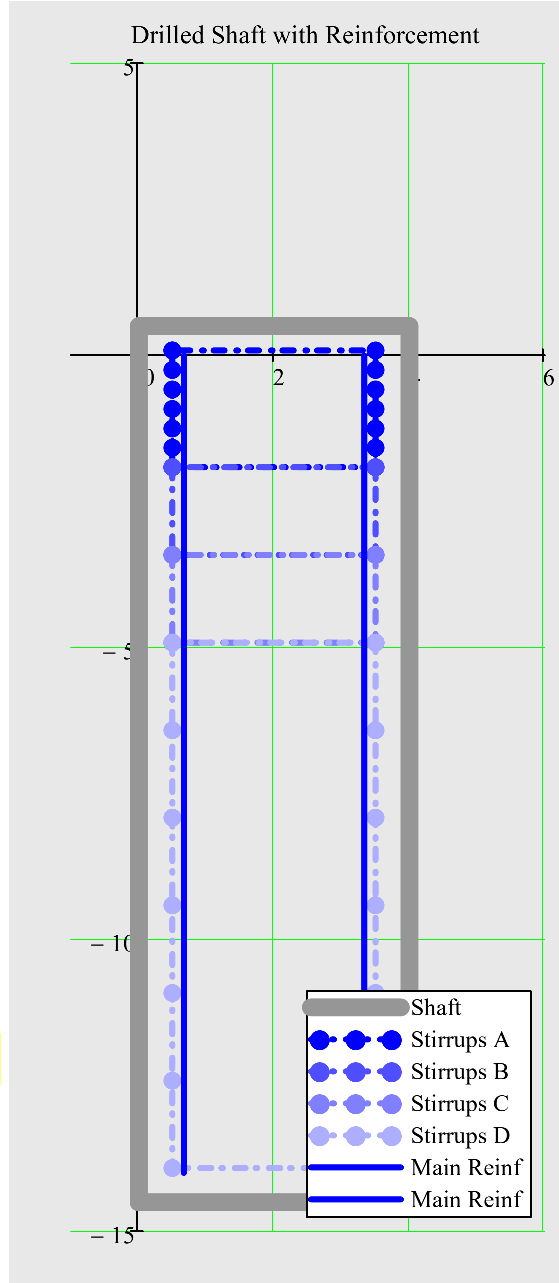



Analyze Foundation

*Shaft Length* $L_{shaft} = 15\ ft$

*Stirrup spacing* $s_v = \begin{pmatrix} 4 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot in$

*Number of stirrup spaces* $\#Spaces_{vbar} = \begin{pmatrix} 6 \\ 1 \\ 1 \\ 6 \end{pmatrix}$




*Foundation Summary*

CheckReinfClearSpacing = "No Good"

*Note: Category 1 Evaluation, Consider O.K.*

$CheckLongReinf_{shr.tor}$ = "OK"

CheckMaxSpacingTransvReinf = "OK"

OverlapDesign = "Based on No Overlap of Failure Cones"

OverlapTest = "No Overlap of Failure Cones"

BreakoutTest = "OK"

*Stirrups* $s_{v_0} = 4 \cdot in$ @ $\#Spaces_{vbar_0} = 6$ : $D/C_{torsion_0} = 0.3$

*Stirrups* 'RC' ( $s_{v_1} = 18 \cdot in$ ) @ 'RD' ( $\#Spaces_{vbar_1} = 1$ ): $D/C_{torsion_1} = 1.1$

*Stirrups* 'RE' ( $s_{v_2} = 18 \cdot in$ ) @ 'RF' ( $\#Spaces_{vbar_2} = 1$ ): $D/C_{torsion_2} = 1.1$

*Stirrups* $s_{v_3} = 18 \cdot in$ @ $\#Spaces_{vbar_3} = 6$

Offset = 0.5 ft

$d_{long.bar} = 1.41 \cdot in$

$Dia_{bar.circle} = 33.3 \cdot in$

'DA'= $L_{shaft} = 15 \cdot ft$

'DB'= $Diameter_{shaft} = 4 \cdot ft$

'BF'= $L_{embedment.anchor} = 40 \cdot in$

$L_{anchor.bolt} = 52 \cdot in$

'RA'= $round\left(\frac{d_{long.bar}}{0.125in}\right) = 11$

'RB'= $\#LongBars_{prov} = 15$

$\#Spaces_{vbar_0} = 6$

$s_{v_0} = 4 \cdot in$

'RC'= $\#Spaces_{vbar_1} = 1$

'RD'= $s_{v_1} = 18 \cdot in$

'RE'= $\#Spaces_{vbar_2} = 1$

'RF'= $s_{v_2} = 18 \cdot in$

$\#Spaces_{vbar_3} = 6$

$s_{v_3} = 18 \cdot in$

## IX. Fatigue Analysis

$\text{InputDataFile} = \text{"Pole 2.dat"}$

$\text{FatigueCategory}_{galloping} := 2$ $\text{FatigueCategory}_{natural.wind} := 2$

***SM V3 11.6***

Analyze Structure for Fatigue

## Fatigue Summary

*K1 values within 2% of LTS thresholds of 3.0 and 4.0 may use next higher CAFT values*

*Arm and Pole Welds*

$\text{Check}_{galloping.arm1} = \text{"OK"}$ $f_{galloping.arm1} = 4.3\cdot ksi$ $\text{CAFT}_{fullpengroove.weld.arm1} = 4.5\cdot ksi$

$\text{Check}_{galloping.arm2} = \text{"NA"}$ $f_{galloping.arm2} = 0.0\cdot ksi$ $\text{CAFT}_{fullpengroove.weld.arm2} = \text{"NA"}\cdot ksi$

$\text{Check}_{galloping.pole} = \text{"No Good"}$ $f_{galloping.pole} = 3.0\cdot ksi$ $\text{CAFT}_{fullpengroove.weld.pole} = 2.6\cdot ksi$

*Note: Category 1 Evaluation, Consider O.K.*

$\text{Check}_{nwg.arm1} = \text{"OK"}$ $f_{nwg.arm1} = 2.6\cdot ksi$ $\text{CAFT}_{fullpengroove.weld.arm1} = 4.5\cdot ksi$

$\text{Check}_{nwg.arm2} = \text{"NA"}$ $f_{nwg.arm2} = 0.0\cdot ksi$ $\text{CAFT}_{fullpengroove.weld.arm2} = \text{"NA"}\cdot ksi$

$\text{Check}_{nwg.pole} = \text{"OK"}$ $f_{nwg.pole} = 1.9\cdot ksi$ $\text{CAFT}_{fullpengroove.weld.pole} = 2.6\cdot ksi$

$$\text{CheckK1Values} = \begin{pmatrix} \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \end{pmatrix} \qquad \begin{pmatrix} K_{I.arm1} \\ K_{I.arm2} \\ K_{I.pole} \end{pmatrix} = \begin{pmatrix} 4.342 \\ 100.000 \\ 9.057 \end{pmatrix} \begin{pmatrix} \text{"Arm 1 Base Weld"} \\ \text{"Arm 2 Base Weld"} \\ \text{"Upright Base Weld"} \end{pmatrix}$$

*A325 Connection Bolts*

$$\text{Check}_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix} \qquad f_{t.g.bolt} = \begin{pmatrix} 5.6 \\ 0.0 \end{pmatrix}\cdot ksi$$

$$\text{CAFT}_{conn.bolt} = 16\cdot ksi$$

$$\text{Check}_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix} \qquad f_{t.nwg.bolt} = \begin{pmatrix} 3.4 \\ 0.0 \end{pmatrix}\cdot ksi$$

*Anchor Bolts*

$\text{Check}_{g.anchor} = \text{"OK"}$ $f_{t.g.anchor} = 2.6\cdot ksi$ $\text{CAFT}_{anchor.bolts} = 7\cdot ksi$

$\text{Check}_{nwg.anchor} = \text{"OK"}$ $f_{t.nwg.anchor} = 1.6\cdot ksi$

***Save Data File (optional)***

☑ Use current input file

*File Name* Pole 2.dat

*Note: Select an output folder by using the "Change Folder" option above.*

Save Data

*Arm Designation Example*

A70/D-A30/D/H-P5/D/L-DS/16/5

| | |
|---|---|
| A70/D - | *Arm 70 feet long, Double Arm* |
| A30/D/H - | *Arm 30 feet long, Double Arm, Heavy Duty* |
| P5/D/L - | *Pole 5 , Double Arm, with Luminaire* |
| DS/16/5 - | *Drilled Shaft 16 ft deep, 5 foot diameter* |

## X. Mast Arm Design and Analysis Summary

InputDataFile = "Pole 2.dat"

*If comparing results to Standard Index 649-030, some values in the index have been increased to reduce the number of variations.*

**Subject** = "43rd St. at Cortez" **DesignedBy** = "CMH" **PoleLocation** = "300+34.2 / 62.09' RT"

**ProjectNo** = "10226260" **CheckedBy** = "XXX" **Date** = "06/30/2021"

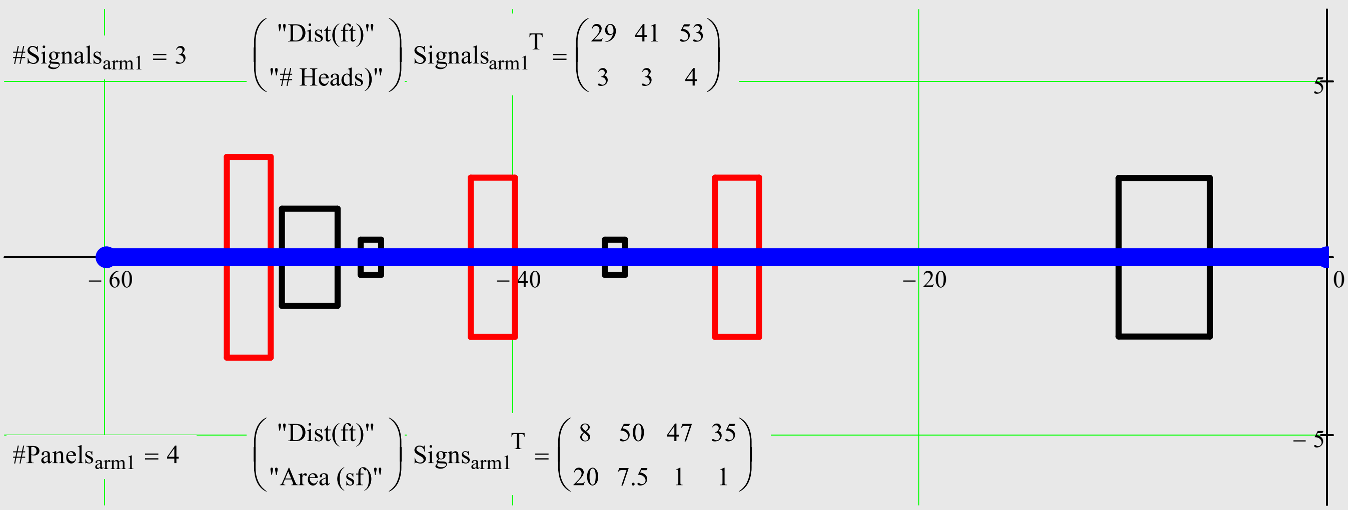
ExistingMastArm = "Yes"

***For FDOT Mast Arm Support Structures,*** max(CFI) ≤ 0.95 ***(See Structures Manual Volume3)***

### 1st Mast Arm

$V_{extreme} = 148 \cdot mph$ ExistingMastArm = "Yes" BackPlate = "Rigid, 6 inches wide"

Arm 1: Locations of Signs and Signals




$\#Signals_{arm1} = 3$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"\# Heads)"} \end{pmatrix}$ $Signals_{arm1}{}^{T} = \begin{pmatrix} 29 & 41 & 53 \\ 3 & 3 & 4 \end{pmatrix}$

$\#Panels_{arm1} = 4$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"Area (sf)"} \end{pmatrix}$ $Signs_{arm1}{}^{T} = \begin{pmatrix} 8 & 50 & 47 & 35 \\ 20 & 7.5 & 1 & 1 \end{pmatrix}$

$\max(CFI_{arm1}) = 0.53$ $L_{total.arm1} = 60\,ft$ $L_{splice.provided.arm1} = 2 \cdot ft$ $\max(\Delta_{arm1}) = 14 \cdot in$

'FA'= 'FE'= $L_{fabricated.arm1} = \begin{pmatrix} 36 \\ 26 \end{pmatrix} \cdot ft$ 'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 11.41 \\ 14.00 \end{pmatrix} \cdot in$

'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 6.37 \\ 10.36 \end{pmatrix} \cdot in$ 'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.375 \\ 0.500 \end{pmatrix} \cdot in$

## 2nd Mast Arm

Arm 2: Locations of Signs and Signals

7

$\#Signals_{arm2} = 0$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"\# Heads)"} \end{pmatrix}$ $Signals_{arm2}^{T} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

$\#Panels_{arm2} = 0$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"Area (sf)"} \end{pmatrix}$ $Signs_{arm2}^{T} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

−7

$-\left(L_{total.arm2}+5\cdot ft\right)$ 0

$\max\left(CFI_{arm2}\right) = 0.00$ $L_{total.arm2} = 0\,ft$ $L_{splice.provided.arm2} = 0\cdot ft$ $\max\left(\Delta_{arm2}\right) = 0\cdot in$

'SA'= 'SE'= $L_{fabricated.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot ft$

'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix}\cdot in$

'UF'= $\alpha = 0\cdot deg$ **(Angle Between Arms)**

'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix}\cdot in$

'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0.000 \\ 0.000 \end{pmatrix}\cdot in$

## Luminaire Arm and Connection *(use MC10x33.6 channel for connection)*

$$\begin{pmatrix} CFI_{base.lumarm} \\ CSR_{bolt.lum} \\ D/C_{baseplate.lum} \\ D/C_{conn.plate.lum} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 6.82\times 10^{-9} \\ 0.00 \\ 0.00 \end{pmatrix}$$

'LA'= $Y_{luminaire} = 0\,ft$

'LB'= $X_{luminaire} = 0\,ft$

'LC'= $Diameter_{base.lumarm} = 0\cdot in$

'LD'= $t_{wall.lumarm} = 0\cdot in$

'LE'= $Slope_{lumarm} = 0$

'LF'= $r_{lumarm} = 0\,ft$

'LG'= $d_{bolt.lum} = 0\cdot in$

'LH'= $t_{baseplate.lum} = 0\cdot in$

'LJ'= $w_{base.lum} = 0\cdot in$

'LK'= $w_{channel.lum} = 0\cdot in$

## Upright

$\max\left(CFI_{pole}\right) = 0.53$ $Check_{deflection} = \text{"OK"}$ $Check_{slope} = \text{"OK"}$

'UA'= $Y_{pole} = 21.5\,ft$

'UB'= $Y_{arm.conn} = 20\cdot ft$

'UC'= $Diameter_{tip.pole} = 16\cdot in$

'UD'= $Diameter_{base.pole} = 19\cdot in$

'UE'= $t_{wall.pole} = 0.375\,in$

'UF'= $\alpha = 0\cdot deg$

'UG'= $Y_{lum.conn} = 0\,ft$

## 1st Arm to Upright Connection

$D/C_{ht.conn.plate} = 0.68$

'HT'= $h_{conn.plate} = 30 \cdot in$

$CheckHt_{conn.plate} = $ "OK"

$\#Bolts_{conn_0} = 6$

'FO'= $Offset_{conn_0} = 19.5 \cdot in$

$D/C_{width.conn.plate_0} = 0.88$

'FJ'= $b_{conn.plate_0} = 32 \cdot in$

'FP'= $d_{bolt.conn_0} = 1.25 \cdot in$

$CheckWidth_{conn.plate_0} = $ "OK"

'FK'= $t_{baseplate.arm_0} = 2.75 \cdot in$

'FR'= $t_{conn.plate_0} = 2 \cdot in$

$$\begin{pmatrix} D/C_{t.baseplate.arm_0} \\ CFI_{t.vert.plate_0} \\ CSR_{bolt.conn_0} \end{pmatrix} = \begin{pmatrix} 0.73 \\ 0.36 \\ 0.31 \end{pmatrix}$$

'FL'= $t_{vertical.plate_0} = 0.75 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 12.5 \cdot in$

'FN'= $w_{vertical.plate_0} = \frac{3}{8} \cdot in$

'FT'= $w_{conn.plate_0} = \frac{3}{8} \cdot in$

## 2nd Arm to Upright Connection

'HT'= $h_{conn.plate} = 30 \cdot in$

$D/C_{width.conn.plate_1} = 0.00$

$\#Bolts_{conn_1} = 0$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

$CheckWidth_{conn.plate_1} = $ "OK"

'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

'SK'= $t_{baseplate.arm_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

$$\begin{pmatrix} D/C_{t.baseplate.arm_1} \\ CFI_{t.vert.plate_1} \\ CSR_{bolt.conn_1} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

## Pole Base Plate

$CSR_{anchor} = 0.22$

'#Bolts'= $\#AnchorBolts = 6$

'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

$CheckCSR_{anchorbolt} = $ "OK"

$Diameter_{boltcircle.pole} = 27 \cdot in$

'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

'BC'= $d_{anchorbolt} = 2.00 \cdot in$

'BF'= $L_{embedment.anchor} = 40 \cdot in$

$L_{anchor.bolt} = 52 \cdot in$

## Foundation

$D/C_{torsion.max} = 1.14$

$CheckD/C_{shear.and.torsion}$ = "No Good"

CheckReinfClearSpacing = "No Good"

*Note: Category 1 Evaluation, Consider O.K.*

$CheckLongReinf_{shr.tor}$ = "OK"

CheckMaxSpacingTransvReinf = "OK"

OverlapDesign = "Based on No Overlap of Failure Cones"

OverlapTest = "No Overlap of Failure Cones"

BreakoutTest = "OK"

$Clearance_{csl.to.nut} = 0 \cdot in$

$Offset = 0.5\ ft$

$d_{long.bar} = 1.41 \cdot in$

$Dia_{bar.circle} = 33.3 \cdot in$

'DA'= $L_{shaft} = 15 \cdot ft$

'DB'= $Diameter_{shaft} = 4 \cdot ft$

'RA'= $round\left(\frac{d_{long.bar}}{0.125in}\right) = 11$

'RB'= $\#LongBars_{prov} = 15$

'RC'= $\#Spaces_{vbar_1} = 1$

'RD'= $s_{v_1} = 18 \cdot in$

'RE'= $\#Spaces_{vbar_2} = 1$

'RF'= $s_{v_2} = 18 \cdot in$

## Fatigue

$Check_{galloping.arm1}$ = "OK"

$Check_{galloping.arm2}$ = "NA"

$Check_{galloping.pole}$ = "No Good"

*Note: Category 1 Evaluation, Consider O.K.*

$Check_{nwg.arm1}$ = "OK"

$Check_{nwg.arm2}$ = "NA"

$Check_{nwg.pole}$ = "OK"

$Check_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$Check_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$Check_{g.anchor}$ = "OK"

$Check_{nwg.anchor}$ = "OK"

*K1 values within 2% of LTS thresholds may use next higher CAFT values*

$CheckK1Values = \begin{pmatrix} \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \end{pmatrix}$

$\begin{pmatrix} K_{I.arm1} \\ K_{I.arm2} \\ K_{I.pole} \end{pmatrix} = \begin{pmatrix} 4.342 \\ 100.000 \\ 9.057 \end{pmatrix} \begin{pmatrix} \text{"Arm 1 Base Weld"} \\ \text{"Arm 2 Base Weld"} \\ \text{"Upright Base Weld"} \end{pmatrix}$

WRITEPRN to Line 1-2-3 for Mast Arm Data Table

## Mast Arm Tip Deflection

*Compare Mast Arm deflection of each arm to a proposed camber*

$Camber_{arm1} := \mathbf{2} \cdot deg$ $\qquad Camber_{arm2} := \mathbf{2} \cdot deg$

$Deflection_{arm1} := Slope_x \cdot L_{total.arm1} + max(\Delta_{arm1}) = 22.7 \cdot in$

$CamberArm1_{upward} := \sin(Camber_{arm1}) \cdot L_{total.arm1} = 25.1 \cdot in$

$Deflection_{arm2} := [Slope_z \cdot L_{total.arm2} \cdot (\sin(\alpha))] + Slope_x \cdot L_{total.arm2} \cdot \cos(\alpha) + \max(\Delta_{arm2}) = 0 \cdot in$

$CamberArm2_{upward} := \sin(Camber_{arm2}) \cdot L_{total.arm2} = 0 \cdot in$

## Check Clearance Between Connection Plates *(for Two Arm Structures only)*

$\alpha = 0 \cdot deg$ $\quad \alpha := if[(\alpha > 180 \cdot deg), (360 \cdot deg - \alpha), \alpha]$

$Offset_{conn_0} = 19.5 \cdot in$ $\quad b_{conn.plate_0} = 32 \cdot in$ $\quad h_{conn.plate} = 30 \cdot in$ $\quad \alpha = 0 \cdot deg$

$Offset_{conn_1} = 0 \cdot in$ $\quad b_{conn.plate_1} = 0 \cdot in$

$x1 := Offset_{conn_0} - t_{conn.plate_0} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm1})}{2} = 16.9 \cdot in$ $\quad y1 := \frac{b_{conn.plate_0}}{2} = 16 \cdot in$

$x2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \cos(\alpha) + \frac{b_{conn.plate_1}}{2} \cdot \sin(\alpha) = -0.5 \cdot in$

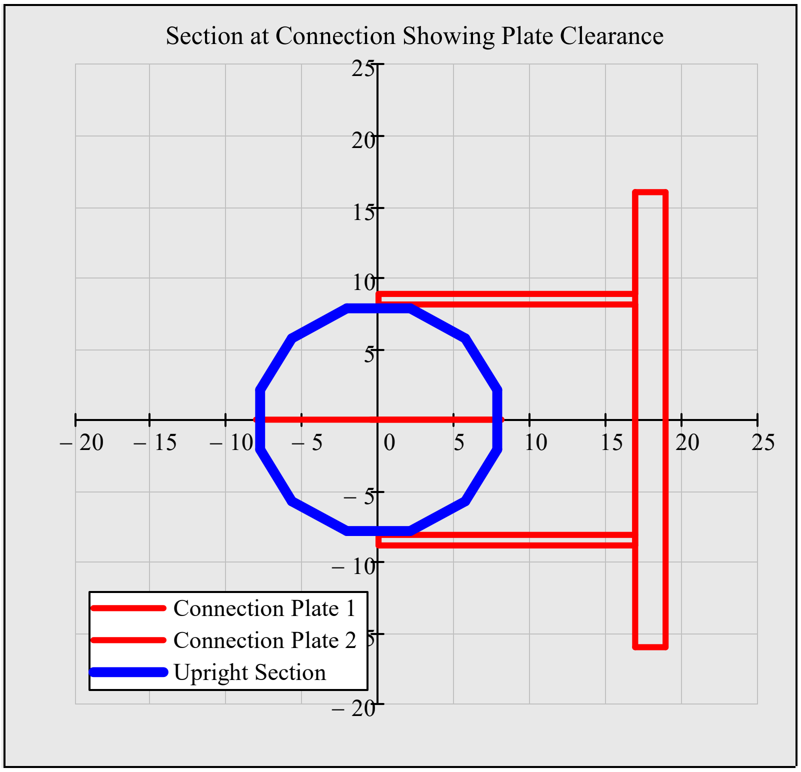
$y2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \sin(\alpha) - \frac{b_{conn.plate_1}}{2} \cdot \cos(\alpha) = 0 \cdot in$

$Clearance_{plate.to.plate} := if\left[(x1 > x2) \cdot (y2 > y1), \sqrt{(x1 - x2)^2 + (y1 - y2)^2}, 0 \cdot in\right] = 0 \cdot in$

***(if Clearance < 2 inches, a redesign is required.***

Coordinates for Drawings

## Plan View - Connection Plate Clearance for Two Arm Connections




$Clearance_{plate.to.plate} = 0 \cdot in$

$Diameter_{conn.pole} = 16.2 \cdot in$

'FR'= $t_{conn.plate_0} = 2 \cdot in$

'FJ'= $b_{conn.plate_0} = 32 \cdot in$

'FL'= $t_{vertical.plate_0} = 0.75 \cdot in$

'FO'= $Offset_{conn_0} = 19.5 \cdot in$

$Gap_0 = 11.34 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

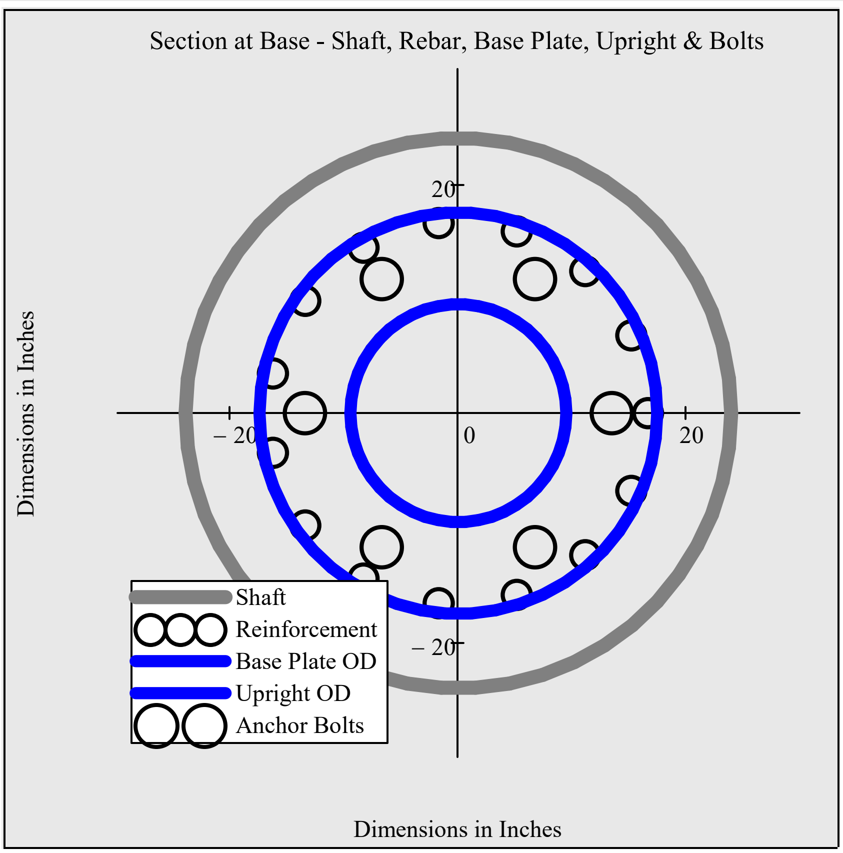
'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

$Gap_1 = 0 \cdot in$

## Plan View - Drilled Shaft, Base Plate, Upright, Anchor Bolts, & Reinforcing Steel




$Clearance_{bar.to.nut} = 0.6 \cdot in$

'UD'= $Diameter_{base.pole} = 19 \cdot in$

'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

'DB'= $Diameter_{shaft} = 48 \cdot in$

$Diameter_{boltcircle.pole} = 27 \cdot in$

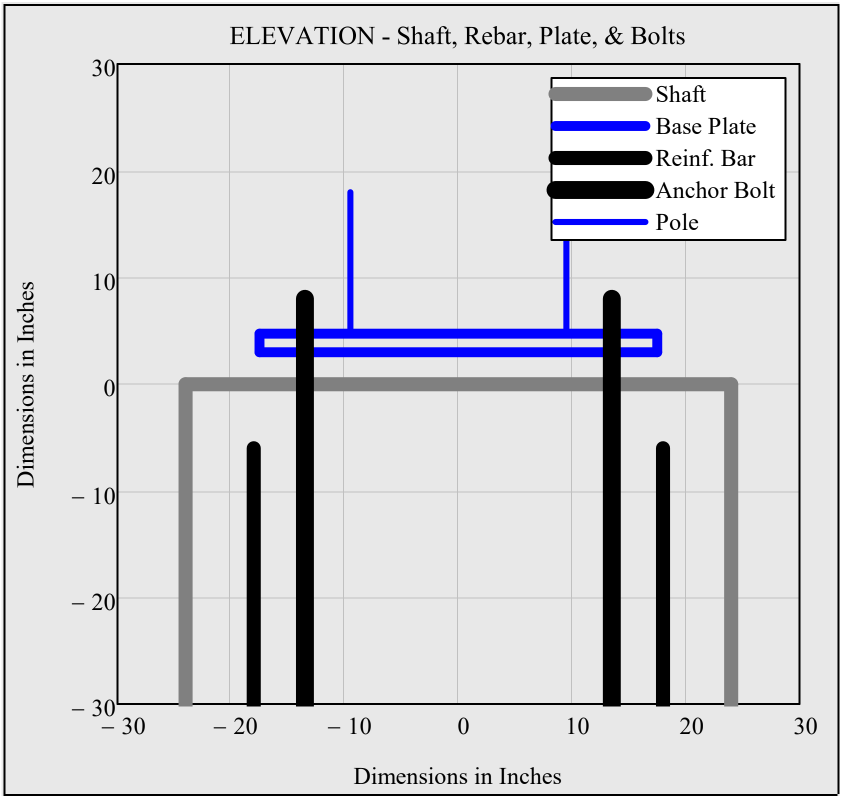
$Dia_{bar.circle} = 33.3 \cdot in$

#AnchorBolts = 6

$\#LongBars_{prov} = 15$

*Note: The Plan and Elevation Views do not show the 4 or 5 1.9" O.D. Nondestructive Integrity Testing Access Tubes that are tied to the inside of the reinforcing cage (see FDOT Spec 455-16.4).*

## Elevation View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$Clearance_{bar.to.nut} = 0.6 \cdot in$

'UD'= $Diameter_{base.pole} = 19 \cdot in$

'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

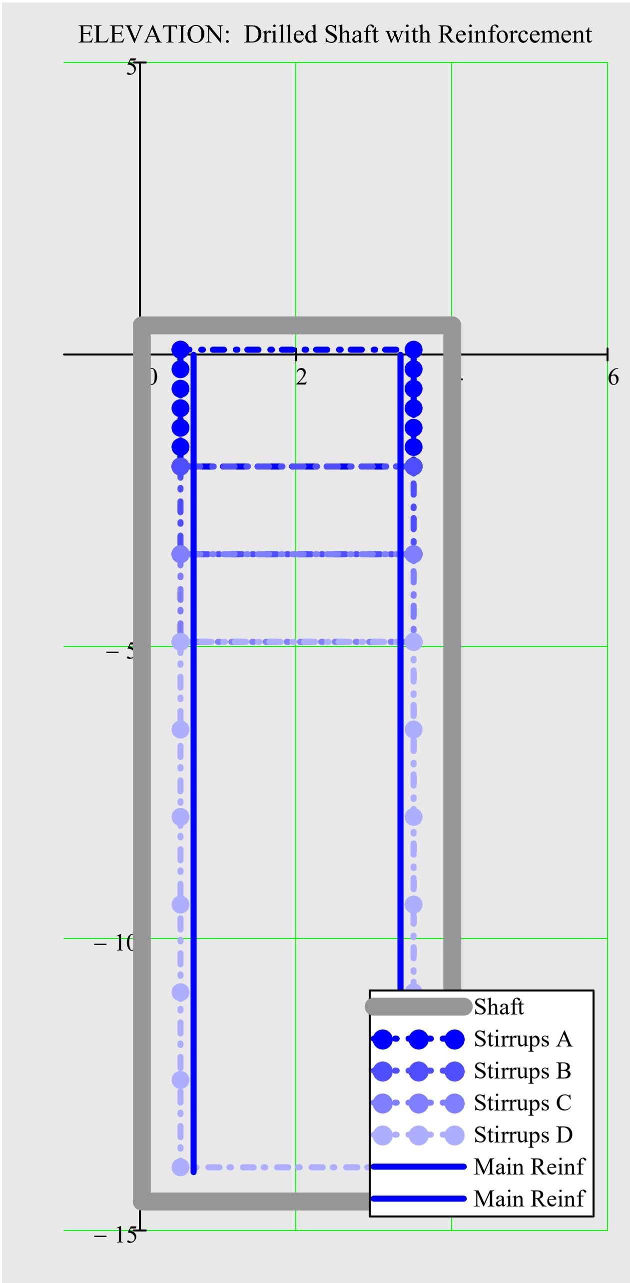
'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

'DB'= $Diameter_{shaft} = 48 \cdot in$

$Diameter_{boltcircle.pole} = 27 \cdot in$

$Dia_{bar.circle} = 33.3 \cdot in$

## Elevation View - Drilled Shaft with Main Reinforcement and Stirrups




$$s_v = \begin{pmatrix} 4 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot in$$ *stirrup spacing*

$$\#Spaces_{vbar} = \begin{pmatrix} 6 \\ 1 \\ 1 \\ 6 \end{pmatrix}$$ *number of stirrup spaces*

# FDOT Mast Arm Traffic Signal Support Analysis Program V1.2

FDOT
State Structures Design Office

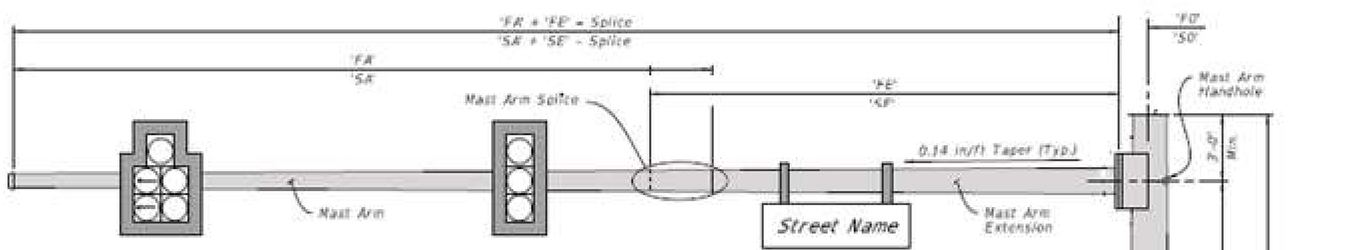


*This program works in conjunction with FDOT Mast Arm Standard Plans 649-030 & 649-031.*

*References:*
*AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (LRFDLTS).*
*FDOT Structures Manual Volume 3 (SM V3).*
*AISC Steel Construction Manual*

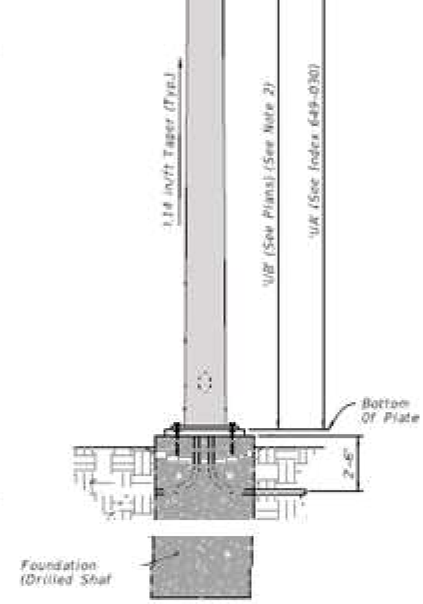
*For more information see Reference.xmcd and Changes.xmcd.*

*Reference*




## Table of Contents






## Data Folder and Files

***Data Files Folder***

Change Folder

C:\PWWORKING\east01\d2113432\MastArmV1.2\Data\

***Required - Open Existing Data File. To save New Data Files, enter data variables at the end of Section IX.***

Pole 2.dat
Pole 2_Existing.dat

Refresh List

Open File

## I. General Information and Sign & Signal Data

### Enter Project Information

| | |
|---|---|
| *Project Name* | 43rd St. at Cortez |
| *Project No.* | 10226260 |
| *Designed by* | CMH |
| *Date* | 06/30/2021 |
| *Checked by* | XXX |
| *Date* | XX/XX/XXXX |
| *Signal Name* | Pole 2 |
| *Station/Offset* | 300+34.2 / 62.09' RT |

### Enter Wind Speed

*Design Wind Speed* 148 *mph*

*Extreme Event Wind Speed*

**SDG Wind Speeds by County**

### Enter Arm Lengths, Signal and Sign Data

***Arm 1***

*Arm 1 Length* 60

Reset Arm 1 Data

| *Arm1 Signal Number* | *Distance to Signal (ft)* | *Number of Heads* |
|---|---|---|
| 1 | 29 | 3 |
| 2 | 40.5 | 3 |
| 3 | 52 | 4 |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

***Arm 2*** *Set Arm 2 Length = 0 for single arm Mast Arms*

*Arm 2 Length* 0

Reset Arm 2 Data

| *Arm2 Signal Number* | *Distance to Signal (ft)* | *Number of Heads* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

***Arm 1 Sign Panels***

| *Arm1 Sign Panel Number* | *Distance to Panel (ft)* | *Panel Area (sf)* |
|---|---|---|
| 1 | 15 | 20 |
| 2 | 46.5 | 1 |
| 3 | 59 | 7.5 |
| 4 | | |
| 5 | | |

*Note: The VVDS is assumed to be a 1 ft x 1 ft sign for analysis purposes.*

***Arm 2 Sign Panels***

| *Arm2 Sign Panel Number* | *Distance to Panel (ft)* | *Panel Area (sf)* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

Save Data for Signs and Signals

## II. Arm 1 Analysis

InputDataFile = "Pole 2_Existing.dat"    $V_{extreme} = 148 \cdot mph$

*Values for* $Dist_{splice.from.base.arm}$ *that give a base diameter in even inches*

| "Wall Thickness" | "dia-1in" | "dia-2in" | "dia-3in" | "dia-4in" | "dia-5in" | "d-6in" |
|---|---|---|---|---|---|---|
| $t_{wall.arm}$ = 0.179·in | ***9.9***·ft | ***17.0***·ft | ***24.2***·ft | ***31.3***·ft | ***38.5***·ft | ***45.6***·ft |
| $t_{wall.arm}$ = 0.25·in | ***10.9***·ft | ***18.0***·ft | ***25.2***·ft | ***32.3***·ft | ***39.4***·ft | ***46.6***·ft |

Help - Base Diameters | Help - Arm Tip Diameter | Help - Tube Wall Thickness | Help - Arm Lengths | Recommended Distance to Splice

Reference:C:\PWWORKING\east01\d2113432\MastArmV1.2\LRFD Equation Module.xmcd(R)

**Enter Arm 1 Data**

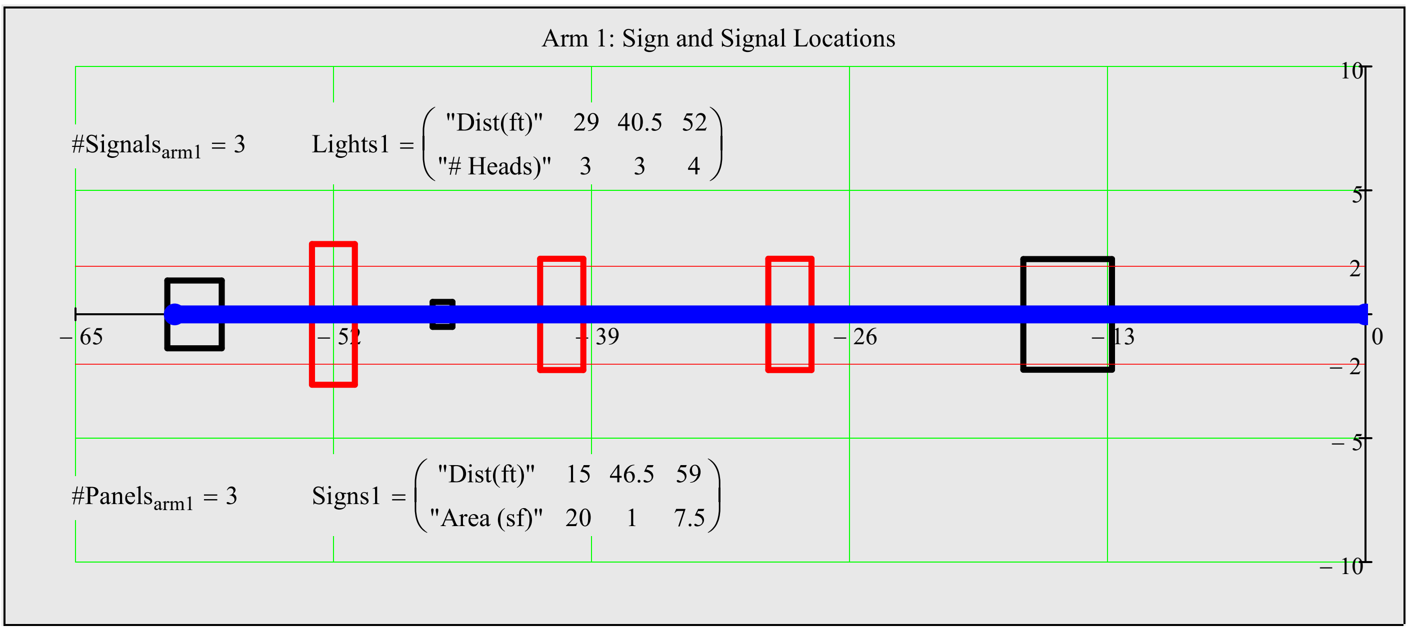
| *Arm Length (ft)* | *Base Diameter (in)* | *Wall Thickness 1 (in)* | *Wall Thickness 2 (in)* | *Distance to Splice (ft)* |
|---|---|---|---|---|
| $L_{total.arm1} = 60\,ft$ | 14 | 0.375 | 0.5 | 24 |
| *feet, 40 ft. max. for 1 piece arms* | *Measured flat to flat* 'FG' | *for 1 & 2 piece arms* 'FD' | *for 2 piece arms only* 'FH' | *for 2 piece arms only* ('Larm' - 'FA') |

Arm 1 Analysis including Existing Mast Arm Analysis (Additional Variables Required)

*Arm 1 Combined Force Interaction Ratio and Deflection*    BackPlate = "Rigid, 6 inches wide"

$\max(CFI_{arm1}) = 0.55$    $\max(\Delta_{arm1}) = 14.2 \cdot in$    $2 \cdot deg \cdot L_{total.arm1} = 25.1 \cdot in$

*Summary - Arm 1 Geometry and Loading*




$\max(CFI_{arm1}) = 0.55$

'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 6.37 \\ 10.36 \end{pmatrix} \cdot in$

$Classification_{arm1} = \begin{pmatrix} \text{"Compact"} \\ \text{"Compact"} \end{pmatrix}$

$\max(\Delta_{arm1}) = 14.2 \cdot in$

$L_{total.arm1} = 60\,ft$

'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 11.41 \\ 14.00 \end{pmatrix} \cdot in$

$L_{splice.provided.arm1} = 2 \cdot ft$

'FA'= 'FE'= $L_{fabricated.arm1} = \begin{pmatrix} 36.0 \\ 26.0 \end{pmatrix} \cdot ft$

'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.375 \\ 0.500 \end{pmatrix} \cdot in$

## III. Arm 2 Analysis

InputDataFile = "Pole 2_Existing.dat" $V_{extreme} = 148 \cdot mph$

$Dist_{splice.from.base.arm}$ *values that give a base diameter in even inches*

$$\begin{pmatrix} \text{"Wall Thickness"} & \Delta dia = 1 \cdot in & \Delta dia = 2 \cdot in & \Delta dia = 3 \cdot in & \Delta dia = 4 \cdot in & \Delta dia = 5 \cdot in & \Delta dia = 6 \cdot in \\ t_{wall.arm} = 0.179 \cdot in & 9.9 \cdot ft & 17.0 \cdot ft & 24.2 \cdot ft & 31.3 \cdot ft & 38.5 \cdot ft & 45.6 \cdot ft \\ t_{wall.arm} = 0.25 \cdot in & 10.9 \cdot ft & 18.0 \cdot ft & 25.2 \cdot ft & 32.3 \cdot ft & 39.4 \cdot ft & 46.6 \cdot ft \end{pmatrix}$$

Help - Base Diameters | Help - Arm Tip Diameter | Help - Tube Wall Thickness | Help - Arm Lengths | Recommended Distance to Splice

**Enter Arm 2 Data**

| Arm Length (ft) | Base Diameter (in) | Wall Thickness 1 (in) | Wall Thickness 2 (in) | Distance to Splice (ft) |
|---|---|---|---|---|
| $L_{total.arm2} = 0$ ft | | | | |
| *feet, 40 ft. max. for 1 piece arms* | *Measured flat to flat* 'SG' | *for 1 & 2 piece arms* 'SD' | *for 2 piece arms only* 'SH' | *for 2 piece arms only* ('Larm' - 'SA') |

Arm 2 Analysis including Existing Mast Arm Analysis

*Arm 2 Combined Force Interaction Ratio and Deflection*

$\max(CFI_{arm2}) = 0.00$ BackPlate = "Rigid, 6 inches wide"

*Summary - Arm 2 Geometry and Loading* $\max(\Delta_{arm2}) = 0.0 \cdot in$ $2 \cdot deg \cdot L_{total.arm2} = 0 \cdot in$

Arm 2: Sign and Signal Locations

10

$\#Signals_{arm2} = 0$ $Lights2 = \begin{pmatrix} \text{"Dist(ft)"} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \text{"\# Heads)"} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

$\#Panels_{arm2} = 0$ $Signs2 = \begin{pmatrix} \text{"Dist(ft)"} & 0 & 0 & 0 & 0 & 0 \\ \text{"Area (sf)"} & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

– 10

$-(L_{total.arm2} + 5 \cdot ft)$ 0

$\max(CFI_{arm2}) = 0.00$

'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix} \cdot in$

$Classification_{arm2} = \begin{pmatrix} \text{"Compact"} \\ \text{"N/A"} \end{pmatrix}$

$\max(\Delta_{arm2}) = 0.0 \cdot in$

$L_{total.arm2} = 0$ ft

'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix} \cdot in$

$L_{splice.provided.arm2} = 0 \cdot ft$

'SA'= 'SE'= $L_{fabricated.arm2} = \begin{pmatrix} 0.0 \\ 0.0 \end{pmatrix} \cdot ft$

'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0.000 \\ 0.000 \end{pmatrix} \cdot in$

## IV. Luminaire Arm Analysis

InputDataFile = "Pole 2_Existing.dat"   $V_{extreme} = 148 \cdot mph$

### Enter Luminaire Data

*Set Lum. Ht. = 0 for no Luminaire*

*See Design Standards 649-030 and 649-031 for input values.*

| Luminaire Height (ft) | Lum Horiz Length (ft) | Lum Arm Base Dia (in) | Lum Wall Thickness (in) | Slope | Lum Arm Radius (ft) | Lum Bolt Dia (in) | Lum Base Plate Thickness (in) |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | |
| *Std = 40 feet* | *10 feet* | *3 inches* | *0.125 inches* | *0.5* | *8 feet* | *0.5 inches* | *0.75 inches* |

Analyze Luminaire

*Summary - Luminaire Arm Geometry*

$$\begin{pmatrix} CFI_{base.lumarm} \\ CSR_{bolt.lum} \\ D/C_{baseplate.lum} \\ D/C_{conn.plate.lum} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

'LA'= $Y_{luminaire} = 0\,ft$

'LB'= $X_{luminaire} = 0\,ft$

'LC'= $Diameter_{base.lumarm} = 0 \cdot in$

'LD'= $t_{wall.lumarm} = 0 \cdot in$

'LE'= $Slope_{lumarm} = 0$

'LF'= $r_{lumarm} = 0\,ft$

'LG'= $d_{bolt.lum} = 0 \cdot in$

'LH'= $t_{baseplate.lum} = 0 \cdot in$

'LJ'= $w_{base.lum} = 0 \cdot in$

'LK'= $w_{channel.lum} = 0 \cdot in$

## V. Upright Analysis

InputDataFile = "Pole 2_Existing.dat"   $V_{extreme} = 148 \cdot mph$

Help - Upright Base Diameter and Wall Thickness   Help - Gap Distance

### Enter Upright Data

| Total Height (ft) | Height to Arm Connection (ft) | Base Diameter (in) | Wall Thickness (in) | Gap (in) | |
|---|---|---|---|---|---|
| 21.5 | 20 | 19 | 0.375 | 11.34 | **arm 1 gap** |
| 'UA' | 'UB' | 'UD' *measured flat to flat* | 'UE' | | **arm 2 gap** |

Analyze Upright

*Upright Combined Force Interaction Ratio and Deflections*

$Classification_{pole} = \text{"Compact"}$

$\max(CFI_{pole}) = 0.56$

$Check_{slope} = \text{"OK"}$

$Check_{deflection} = \text{"OK"}$

$\max(\Delta_{x.dl}) = 1.33 \cdot in$

$\max(\Delta_{z.dl}) = 0 \cdot in$

$Slope_z = 0 \cdot deg$

$Slope_x = 0.69 \cdot deg$

$Diameter_{conn.pole} = 16.2 \cdot in$

$$\max\left(\begin{pmatrix} Diameter_{base.arm1_0} \\ Diameter_{base.arm2_0} \end{pmatrix}\right) = 11.4 \cdot in$$

'UA'= $Y_{pole} = 21.5\,ft$

'UB'= $Y_{arm.conn} = 20\,ft$

'UC'= $Diameter_{tip.pole} = 16 \cdot in$

'UD'= $Diameter_{base.pole} = 19 \cdot in$

'UE'= $t_{wall.pole} = 0.375\,in$

'UF'= $\alpha = 0 \cdot deg$

'UG'= $Y_{lum.conn} = 0\,ft$

## VI. Arm to Upright Connection Analysis

InputDataFile = "Pole 2_Existing.dat"

*for double arms, both connection plate heights must be equal*

Help - Arm Connection Dimensions

**Enter Connection Data**

| Connection Plate Height(in) | Connection Plate Width (in) | Vertical Plate Thickness (in) | Bolt Diameter (in) | Arm Base Plate Thickness (in) |
|---|---|---|---|---|
| 30 | 32 | 0.75 | 1.25 | 2.75 |
| | | | | |
| 'HT' | 'FJ', 'SJ' | 'FL', 'SL' | 'FP', 'SP' | 'FK', 'SK' |

Analyze Connection

*Connection Summary*

'HT'= $h_{conn.plate} = 30 \cdot in$ $D/C_{ht.conn.plate} = 0.68$ $CheckHt_{conn.plate} = \text{"OK"}$

$D/C_{width.conn.plate_0} = 0.88$

$CheckWidth_{conn.plate_0} = \text{"OK"}$

$$\begin{pmatrix} D/C_{t.baseplate.arm_0} \\ CFI_{t.vert.plate_0} \\ CSR_{bolt.conn_0} \end{pmatrix} = \begin{pmatrix} 0.73 \\ 0.38 \\ 0.32 \end{pmatrix}$$

$\#Bolts_{conn_0} = 6$

'FJ'= $b_{conn.plate_0} = 32 \cdot in$

'FK'= $t_{baseplate.arm_0} = 2.75 \cdot in$

'FL'= $t_{vertical.plate_0} = 0.75 \cdot in$

'FN'= $w_{vertical.plate_0} = \frac{3}{8} \cdot in$

'FO'= $Offset_{conn_0} = 19.5 \cdot in$

'FP'= $d_{bolt.conn_0} = 1.25 \cdot in$

'FR'= $t_{conn.plate_0} = 2.00 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 12.5 \cdot in$

'FT'= $w_{conn.plate_0} = \frac{3}{8} \cdot in$

$D/C_{width.conn.plate_1} = 0.00$

$CheckWidth_{conn.plate_1} = \text{"OK"}$

$$\begin{pmatrix} D/C_{t.baseplate.arm_1} \\ CFI_{t.vert.plate_1} \\ CSR_{bolt.conn_1} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

$\#Bolts_{conn_1} = 0$

'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SK'= $t_{baseplate.arm_1} = 0.00 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0.00 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0.00 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

## VII. Upright Base Plate & Anchor Bolt Analysis

InputDataFile = "Pole 2_Existing.dat"

**Enter Anchorage Data**

| *Anchor Bolt Diameter (in)* | *Number of Anchor Bolts* |
|---|---|
| 2 | 6 |
| 'BC' | '#Bolts' |

Help - Number of Anchor Bolts

$Diameter_{base.pole} = 19 \cdot in$

Analyze Base Plate & Anchors

*Base Plate and Anchor Summary*

'#Bolts'= $\#AnchorBolts = 6$

'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

$CSR_{anchor} = 0.23$

$Diameter_{boltcircle.pole} = 27 \cdot in$

'BC'= $d_{anchorbolt} = 2.00 \cdot in$

$CheckCSR_{anchorbolt} = \text{"OK"}$

'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

## VIII. Foundation Analysis & Anchor Bolt Lengths

InputDataFile = "Pole 2_Existing.dat"

**Enter Drilled Shaft Data**

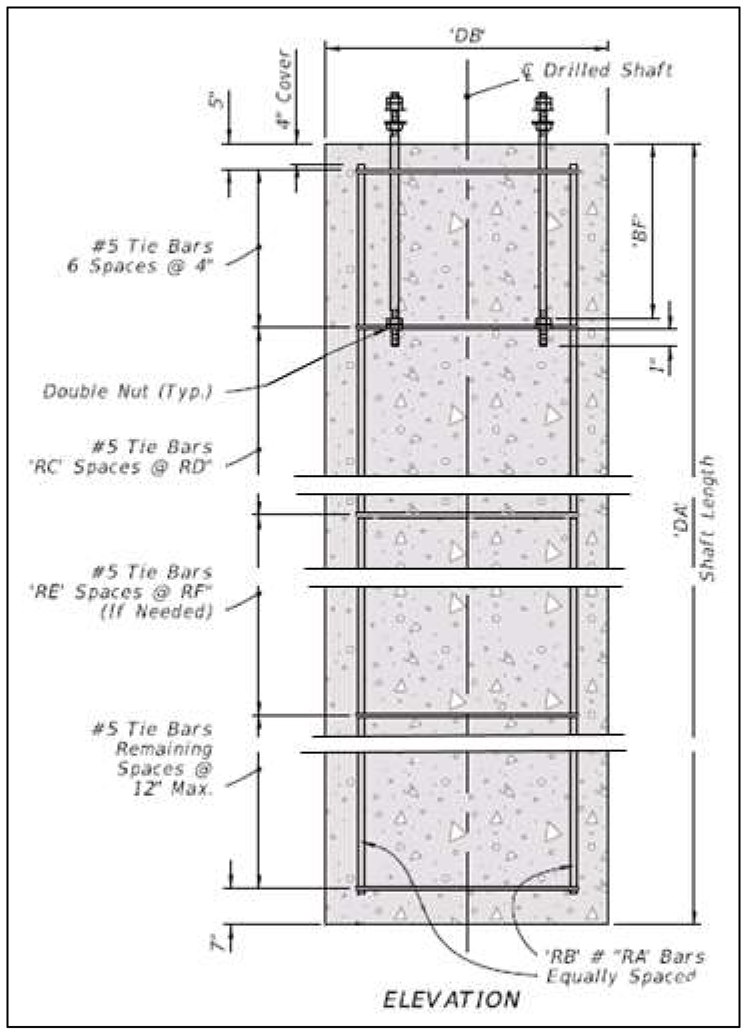
| | | |
|---|---|---|
| *Soil Type* | Sand / Clay (Sand selected) | |
| *Soil Density, $\gamma_{soil}$ (45-50 pcf typ.)* | 42.6 | pcf |
| *Friction Angle, $\phi$ (Sands)* | 30 | deg |
| *SPT Number ($N_{blows}$ 5 min. ) (Sands)* | 15 | |
| *Shear Strength, c (Clays)* | 2000 | psf |
| *Ground to Top of Shaft Offset* | 0.5 | ft |

***First Set of User Defined Stirrups:***

| | | |
|---|---|---|
| *Number of Stirrup Spaces* 'RC' | 1 | |
| *Stirrup Spacing* 'RD' | 12 | in |

***Second Set of User Defined Stirrups:***

| | | |
|---|---|---|
| *Number of Stirrup Spaces* 'RE'<br>*enter zero for 12 inch spacing* | 1 | |
| *Stirrup Spacing* 'RF'<br>*enter zero for 12 inch spacing* | 12 | in |
| *Stirrup Bar Size, use #5*<br>*for all Standard Shafts* | #5 / #6 (#5 selected) | |




Analyze Foundation

*Shaft Length* *Stirrup spacing* *Number of stirrup spaces*

$L_{shaft} = 15\,ft$ $s_v = \begin{pmatrix} 4 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot in$ $\#Spaces_{vbar} = \begin{pmatrix} 6 \\ 1 \\ 1 \\ 6 \end{pmatrix}$

*Foundation Summary*

CheckReinfClearSpacing = "No Good"

$CheckLongReinf_{shr.tor}$ = "OK"

CheckMaxSpacingTransvReinf = "OK"

OverlapDesign = "Based on No Overlap of Failure Cones"

OverlapTest = "No Overlap of Failure Cones"

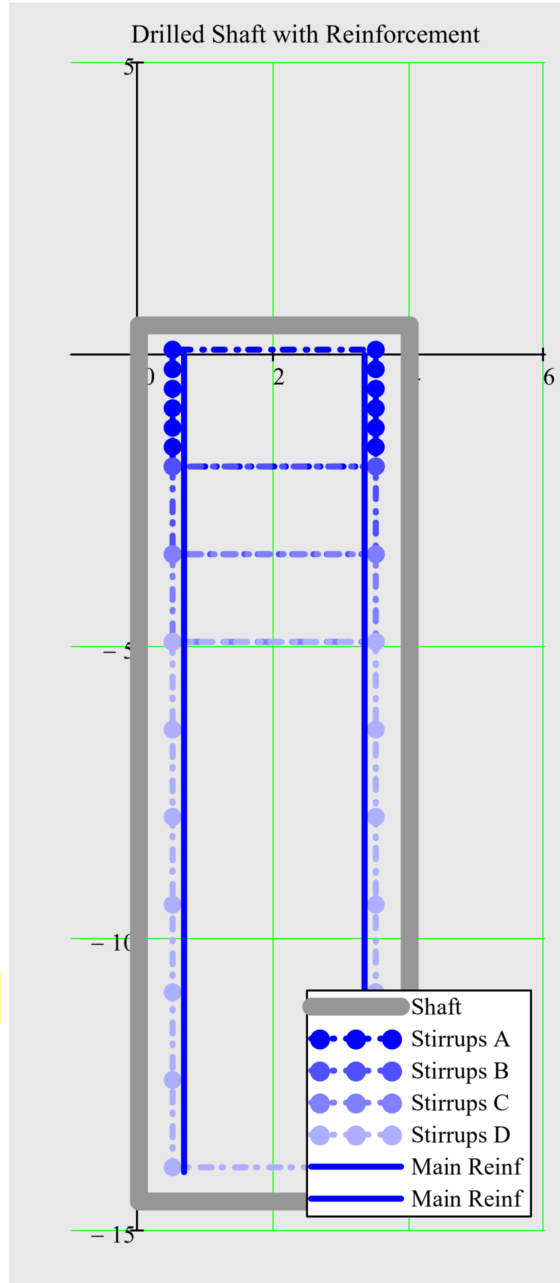
BreakoutTest = "OK"

*Stirrups* $s_{v_0} = 4 \cdot in$ @ $\#Spaces_{vbar_0} = 6$ : $D/C_{torsion_0} = 0.3$

*Stirrups* 'RC' ( $s_{v_1} = 18 \cdot in$ ) @ 'RD' ( $\#Spaces_{vbar_1} = 1$ ): $D/C_{torsion_1} = 1.2$

*Stirrups* 'RE' ( $s_{v_2} = 18 \cdot in$ ) @ 'RF' ( $\#Spaces_{vbar_2} = 1$ ): $D/C_{torsion_2} = 1.2$

*Stirrups* $s_{v_3} = 18 \cdot in$ @ $\#Spaces_{vbar_3} = 6$




Offset = 0.5 ft

$d_{long.bar} = 1.41 \cdot in$

$Dia_{bar.circle} = 33.3 \cdot in$

'DA'= $L_{shaft} = 15 \cdot ft$

'DB'= $Diameter_{shaft} = 4 \cdot ft$

'BF'= $L_{embedment.anchor} = 40 \cdot in$

$L_{anchor.bolt} = 52 \cdot in$

'RA'= $\text{round}\left(\frac{d_{long.bar}}{0.125in}\right) = 11$

'RB'= $\#LongBars_{prov} = 15$

$\#Spaces_{vbar_0} = 6$

$s_{v_0} = 4 \cdot in$

'RC'= $\#Spaces_{vbar_1} = 1$

'RD'= $s_{v_1} = 18 \cdot in$

'RE'= $\#Spaces_{vbar_2} = 1$

'RF'= $s_{v_2} = 18 \cdot in$

$\#Spaces_{vbar_3} = 6$

$s_{v_3} = 18 \cdot in$

## IX. Fatigue Analysis

InputDataFile = "Pole 2_Existing.dat"

$FatigueCategory_{galloping} := 2$ $FatigueCategory_{natural.wind} := 2$

SM V3 11.6

Analyze Structure for Fatigue

## Fatigue Summary

*Arm and Pole Welds*

*K1 values within 2% of LTS thresholds of 3.0 and 4.0 may use next higher CAFT values*

$Check_{galloping.arm1} = \text{"No Good"}$ $f_{galloping.arm1} = 4.7 \cdot ksi$ $CAFT_{fullpengroove.weld.arm1} = 4.5 \cdot ksi$

$Check_{galloping.arm2} = \text{"NA"}$ $f_{galloping.arm2} = 0.0 \cdot ksi$ $CAFT_{fullpengroove.weld.arm2} = \text{"NA"} \cdot ksi$

$Check_{galloping.pole} = \text{"No Good"}$ $f_{galloping.pole} = 3.3 \cdot ksi$ $CAFT_{fullpengroove.weld.pole} = 2.6 \cdot ksi$

$Check_{nwg.arm1} = \text{"OK"}$ $f_{nwg.arm1} = 2.8 \cdot ksi$ $CAFT_{fullpengroove.weld.arm1} = 4.5 \cdot ksi$

$Check_{nwg.arm2} = \text{"NA"}$ $f_{nwg.arm2} = 0.0 \cdot ksi$ $CAFT_{fullpengroove.weld.arm2} = \text{"NA"} \cdot ksi$

$Check_{nwg.pole} = \text{"OK"}$ $f_{nwg.pole} = 1.8 \cdot ksi$ $CAFT_{fullpengroove.weld.pole} = 2.6 \cdot ksi$

$$CheckK1Values = \begin{pmatrix} \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \end{pmatrix} \qquad \begin{pmatrix} K_{I.arm1} \\ K_{I.arm2} \\ K_{I.pole} \end{pmatrix} = \begin{pmatrix} 4.342 \\ 100.000 \\ 9.057 \end{pmatrix} \begin{pmatrix} \text{"Arm 1 Base Weld"} \\ \text{"Arm 2 Base Weld"} \\ \text{"Upright Base Weld"} \end{pmatrix}$$

*A325 Connection Bolts*

$$Check_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix} \qquad f_{t.g.bolt} = \begin{pmatrix} 5.9 \\ 0.0 \end{pmatrix} \cdot ksi$$

$$CAFT_{conn.bolt} = 16 \cdot ksi$$

$$Check_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix} \qquad f_{t.nwg.bolt} = \begin{pmatrix} 3.5 \\ 0.0 \end{pmatrix} \cdot ksi$$

*Anchor Bolts*

$Check_{g.anchor} = \text{"OK"}$ $f_{t.g.anchor} = 2.8 \cdot ksi$ $CAFT_{anchor.bolts} = 7 \cdot ksi$

$Check_{nwg.anchor} = \text{"OK"}$ $f_{t.nwg.anchor} = 1.5 \cdot ksi$

***Save Data File (optional)***

☑ Use current input file

*File Name* Pole 2_Existing.dat

*Note: Select an output folder by using the "Change Folder" option above.*

Save Data

*Arm Designation Example*

A70/D-A30/D/H-P5/D/L-DS/16/5

| | |
|---|---|
| A70/D - | *Arm 70 feet long, Double Arm* |
| A30/D/H - | *Arm 30 feet long, Double Arm, Heavy Duty* |
| P5/D/L - | *Pole 5 , Double Arm, with Luminaire* |
| DS/16/5 - | *Drilled Shaft 16 ft deep, 5 foot diameter* |

## X. Mast Arm Design and Analysis Summary

InputDataFile = "Pole 2_Existing.dat"

*If comparing results to Standard Index 649-030, some values in the index have been increased to reduce the number of variations.*

**Subject** = "43rd St. at Cortez" **DesignedBy** = "CMH" **PoleLocation** = "300+34.2 / 62.09' RT"

**ProjectNo** = "10226260" **CheckedBy** = "XXX" **Date** = "06/30/2021"

ExistingMastArm = "Yes"

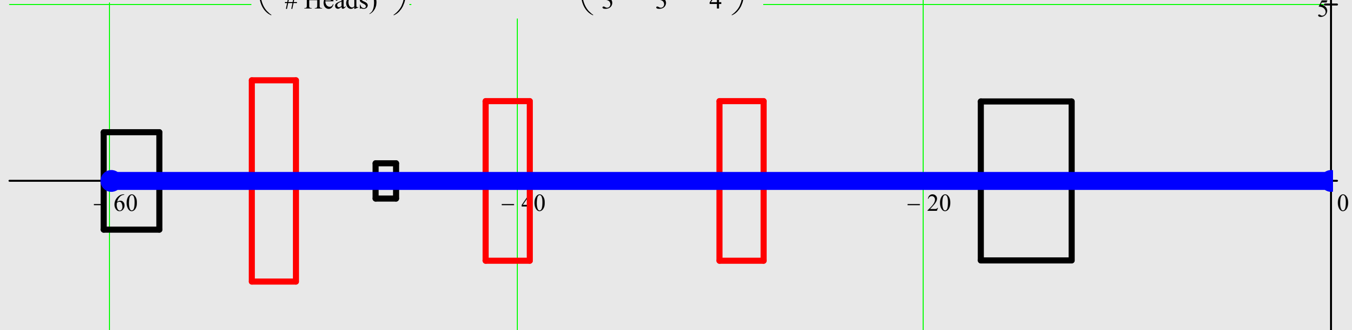
***For FDOT Mast Arm Support Structures,*** $\max(\mathrm{CFI}) \leq 0.95$ ***(See Structures Manual Volume3)***

## 1st Mast Arm

$V_{extreme} = 148 \cdot mph$ ExistingMastArm = "Yes" BackPlate = "Rigid, 6 inches wide"

Arm 1: Locations of Signs and Signals

$\#Signals_{arm1} = 3$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"\# Heads)"} \end{pmatrix}$ $Signals_{arm1}^{T} = \begin{pmatrix} 29 & 40.5 & 52 \\ 3 & 3 & 4 \end{pmatrix}$




$\#Panels_{arm1} = 3$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"Area (sf)"} \end{pmatrix}$ $Signs_{arm1}^{T} = \begin{pmatrix} 15 & 46.5 & 59 \\ 20 & 1 & 7.5 \end{pmatrix}$

$\max(CFI_{arm1}) = 0.55$ $L_{total.arm1} = 60\,ft$ $L_{splice.provided.arm1} = 2 \cdot ft$ $\max(\Delta_{arm1}) = 14.2 \cdot in$

'FA'= 'FE'= $L_{fabricated.arm1} = \begin{pmatrix} 36 \\ 26 \end{pmatrix} \cdot ft$ 'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 11.41 \\ 14.00 \end{pmatrix} \cdot in$

'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 6.37 \\ 10.36 \end{pmatrix} \cdot in$ 'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.375 \\ 0.500 \end{pmatrix} \cdot in$

## 2nd Mast Arm

Arm 2: Locations of Signs and Signals

7

$\#Signals_{arm2} = 0$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"\# Heads)"} \end{pmatrix}$ $Signals_{arm2}{}^{T} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

$\#Panels_{arm2} = 0$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"Area (sf)"} \end{pmatrix}$ $Signs_{arm2}{}^{T} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

−7

$-\left(L_{total.arm2}+5\cdot ft\right)$ 0

$\max\left(CFI_{arm2}\right) = 0.00$ $L_{total.arm2} = 0\,ft$ $L_{splice.provided.arm2} = 0\cdot ft$ $\max\left(\Delta_{arm2}\right) = 0\cdot in$

'SA'= 'SE'= $L_{fabricated.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot ft$

'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix}\cdot in$

'UF'= $\alpha = 0\cdot deg$ **(Angle Between Arms)**

'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix}\cdot in$

'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0.000 \\ 0.000 \end{pmatrix}\cdot in$

## Luminaire Arm and Connection *(use MC10x33.6 channel for connection)*

$$\begin{pmatrix} CFI_{base.lumarm} \\ CSR_{bolt.lum} \\ D/C_{baseplate.lum} \\ D/C_{conn.plate.lum} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 6.82\times 10^{-9} \\ 0.00 \\ 0.00 \end{pmatrix}$$

'LA'= $Y_{luminaire} = 0\,ft$

'LB'= $X_{luminaire} = 0\,ft$

'LC'= $Diameter_{base.lumarm} = 0\cdot in$

'LD'= $t_{wall.lumarm} = 0\cdot in$

'LE'= $Slope_{lumarm} = 0$

'LF'= $r_{lumarm} = 0\,ft$

'LG'= $d_{bolt.lum} = 0\cdot in$

'LH'= $t_{baseplate.lum} = 0\cdot in$

'LJ'= $w_{base.lum} = 0\cdot in$

'LK'= $w_{channel.lum} = 0\cdot in$

## Upright

$\max\left(CFI_{pole}\right) = 0.56$ $Check_{deflection} = \text{"OK"}$ $Check_{slope} = \text{"OK"}$

'UA'= $Y_{pole} = 21.5\,ft$

'UB'= $Y_{arm.conn} = 20\cdot ft$

'UC'= $Diameter_{tip.pole} = 16\cdot in$

'UD'= $Diameter_{base.pole} = 19\cdot in$

'UE'= $t_{wall.pole} = 0.375\,in$

'UF'= $\alpha = 0\cdot deg$

'UG'= $Y_{lum.conn} = 0\,ft$

## 1st Arm to Upright Connection

$D/C_{ht.conn.plate} = 0.68$

'HT'= $h_{conn.plate} = 30 \cdot in$

$CheckHt_{conn.plate} = "OK"$

$\#Bolts_{conn_0} = 6$

'FO'= $Offset_{conn_0} = 19.5 \cdot in$

$D/C_{width.conn.plate_0} = 0.88$

'FJ'= $b_{conn.plate_0} = 32 \cdot in$

'FP'= $d_{bolt.conn_0} = 1.25 \cdot in$

$CheckWidth_{conn.plate_0} = "OK"$

'FK'= $t_{baseplate.arm_0} = 2.75 \cdot in$

'FR'= $t_{conn.plate_0} = 2 \cdot in$

$$\begin{pmatrix} D/C_{t.baseplate.arm_0} \\ CFI_{t.vert.plate_0} \\ CSR_{bolt.conn_0} \end{pmatrix} = \begin{pmatrix} 0.73 \\ 0.38 \\ 0.32 \end{pmatrix}$$

'FL'= $t_{vertical.plate_0} = 0.75 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 12.5 \cdot in$

'FN'= $w_{vertical.plate_0} = \frac{3}{8} \cdot in$

'FT'= $w_{conn.plate_0} = \frac{3}{8} \cdot in$

## 2nd Arm to Upright Connection

'HT'= $h_{conn.plate} = 30 \cdot in$

$D/C_{width.conn.plate_1} = 0.00$

$\#Bolts_{conn_1} = 0$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

$CheckWidth_{conn.plate_1} = "OK"$

'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

$$\begin{pmatrix} D/C_{t.baseplate.arm_1} \\ CFI_{t.vert.plate_1} \\ CSR_{bolt.conn_1} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

'SK'= $t_{baseplate.arm_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

## Pole Base Plate

$CSR_{anchor} = 0.23$

'#Bolts'= $\#AnchorBolts = 6$

'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

$CheckCSR_{anchorbolt} = "OK"$

$Diameter_{boltcircle.pole} = 27 \cdot in$

'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

'BC'= $d_{anchorbolt} = 2.00 \cdot in$

'BF'= $L_{embedment.anchor} = 40 \cdot in$

$L_{anchor.bolt} = 52 \cdot in$

## Foundation

$D/C_{torsion.max} = 1.21$

$CheckD/C_{shear.and.torsion} =$ "No Good"

CheckReinfClearSpacing = "No Good"

$CheckLongReinf_{shr.tor} =$ "OK"

CheckMaxSpacingTransvReinf = "OK"

OverlapDesign = "Based on No Overlap of Failure Cones"

OverlapTest = "No Overlap of Failure Cones"

BreakoutTest = "OK"

$Clearance_{csl.to.nut} = 0 \cdot in$

$Offset = 0.5\,ft$

$d_{long.bar} = 1.41 \cdot in$

$Dia_{bar.circle} = 33.3 \cdot in$

'DA'= $L_{shaft} = 15 \cdot ft$

'DB'= $Diameter_{shaft} = 4 \cdot ft$

'RA'= $round\left(\frac{d_{long.bar}}{0.125in}\right) = 11$

'RB'= $\#LongBars_{prov} = 15$

'RC'= $\#Spaces_{vbar_1} = 1$

'RD'= $s_{v_1} = 18 \cdot in$

'RE'= $\#Spaces_{vbar_2} = 1$

'RF'= $s_{v_2} = 18 \cdot in$

## Fatigue

$Check_{galloping.arm1} =$ "No Good"

$Check_{galloping.arm2} =$ "NA"

$Check_{galloping.pole} =$ "No Good"

$Check_{nwg.arm1} =$ "OK"

$Check_{nwg.arm2} =$ "NA"

$Check_{nwg.pole} =$ "OK"

$Check_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$Check_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$Check_{g.anchor} =$ "OK"

$Check_{nwg.anchor} =$ "OK"

*K1 values within 2% of LTS thresholds may use next higher CAFT values*

$CheckK1Values = \begin{pmatrix} \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \end{pmatrix}$

$\begin{pmatrix} K_{I.arm1} \\ K_{I.arm2} \\ K_{I.pole} \end{pmatrix} = \begin{pmatrix} 4.342 \\ 100.000 \\ 9.057 \end{pmatrix} \begin{pmatrix} \text{"Arm 1 Base Weld"} \\ \text{"Arm 2 Base Weld"} \\ \text{"Upright Base Weld"} \end{pmatrix}$

WRITEPRN to Line 1-2-3 for Mast Arm Data Table

## Mast Arm Tip Deflection

*Compare Mast Arm deflection of each arm to a proposed camber*

$Camber_{arm1} := \mathbf{2} \cdot deg$ $\qquad Camber_{arm2} := \mathbf{2} \cdot deg$

$Deflection_{arm1} := Slope_x \cdot L_{total.arm1} + \max(\Delta_{arm1}) = 22.9 \cdot in$

$CamberArm1_{upward} := \sin(Camber_{arm1}) \cdot L_{total.arm1} = 25.1 \cdot in$

$Deflection_{arm2} := \left[Slope_z \cdot L_{total.arm2} \cdot (\sin(\alpha))\right] + Slope_x \cdot L_{total.arm2} \cdot \cos(\alpha) + \max(\Delta_{arm2}) = 0 \cdot in$

$CamberArm2_{upward} := \sin(Camber_{arm2}) \cdot L_{total.arm2} = 0 \cdot in$

## Check Clearance Between Connection Plates *(for Two Arm Structures only)*

$\alpha = 0 \cdot deg$ $\qquad \alpha := if[(\alpha > 180 \cdot deg),(360 \cdot deg - \alpha),\alpha]$

$Offset_{conn_0} = 19.5 \cdot in$ $\qquad b_{conn.plate_0} = 32 \cdot in$ $\qquad h_{conn.plate} = 30 \cdot in$ $\qquad \alpha = 0 \cdot deg$

$Offset_{conn_1} = 0 \cdot in$ $\qquad b_{conn.plate_1} = 0 \cdot in$

$$x1 := Offset_{conn_0} - t_{conn.plate_0} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm1})}{2} = 16.9 \cdot in \qquad y1 := \frac{b_{conn.plate_0}}{2} = 16 \cdot in$$

$$x2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \cos(\alpha) + \frac{b_{conn.plate_1}}{2} \cdot \sin(\alpha) = -0.5 \cdot in$$

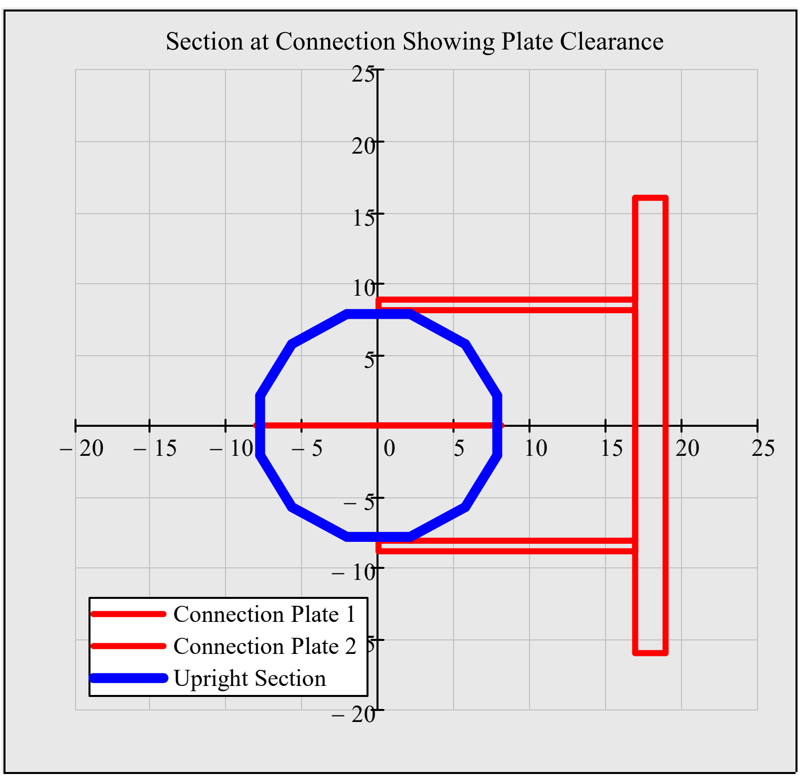
$$y2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \sin(\alpha) - \frac{b_{conn.plate_1}}{2} \cdot \cos(\alpha) = 0 \cdot in$$

$$Clearance_{plate.to.plate} := if\left[(x1 > x2) \cdot (y2 > y1), \sqrt{(x1 - x2)^2 + (y1 - y2)^2}, 0 \cdot in\right] = 0 \cdot in$$

***(if Clearance < 2 inches, a redesign is required.***

Coordinates for Drawings

## Plan View - Connection Plate Clearance for Two Arm Connections




$Clearance_{plate.to.plate} = 0 \cdot in$

$Diameter_{conn.pole} = 16.2 \cdot in$

'FR'= $t_{conn.plate_0} = 2 \cdot in$

'FJ'= $b_{conn.plate_0} = 32 \cdot in$

'FL'= $t_{vertical.plate_0} = 0.75 \cdot in$

'FO'= $Offset_{conn_0} = 19.5 \cdot in$

$Gap_0 = 11.34 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

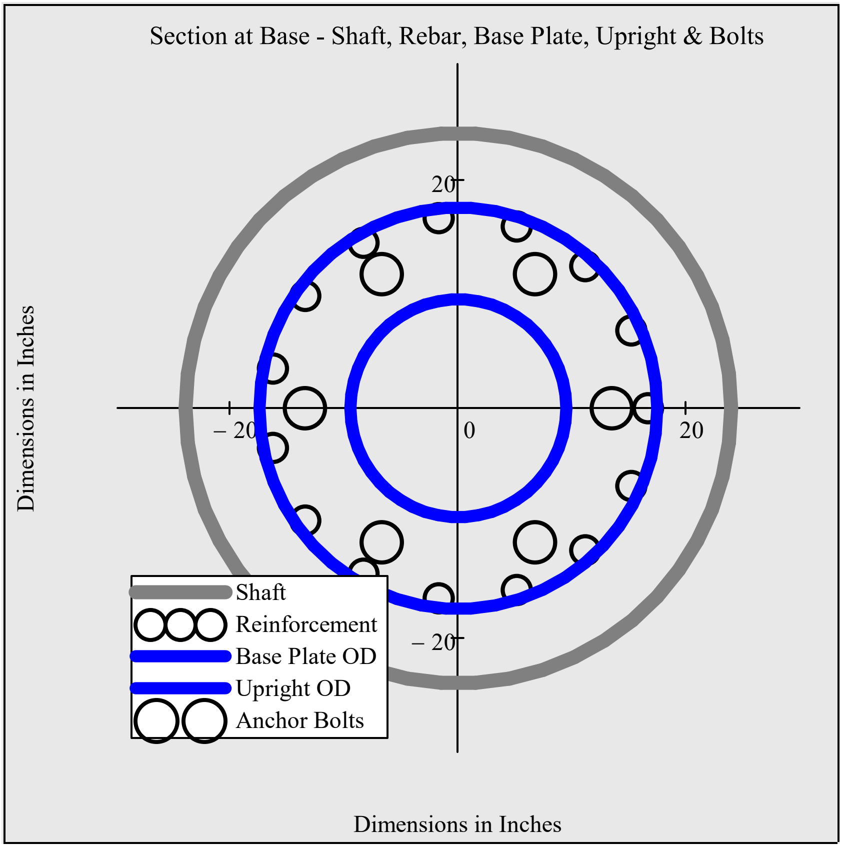
'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

$Gap_1 = 0 \cdot in$

## Plan View - Drilled Shaft, Base Plate, Upright, Anchor Bolts, & Reinforcing Steel




$Clearance_{bar.to.nut} = 0.6 \cdot in$

'UD'= $Diameter_{base.pole} = 19 \cdot in$

'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

'DB'= $Diameter_{shaft} = 48 \cdot in$

$Diameter_{boltcircle.pole} = 27 \cdot in$

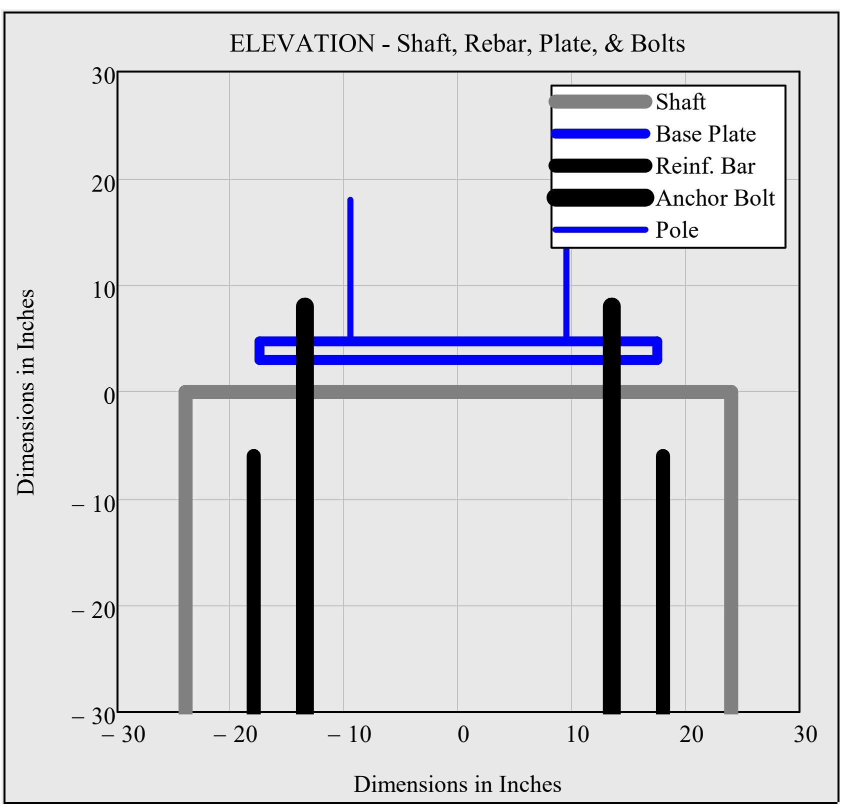
$Dia_{bar.circle} = 33.3 \cdot in$

$\#AnchorBolts = 6$

$\#LongBars_{prov} = 15$

*Note: The Plan and Elevation Views do not show the 4 or 5 1.9" O.D. Nondestructive Integrity Testing Access Tubes that are tied to the inside of the reinforcing cage (see FDOT Spec 455-16.4).*

## Elevation View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$Clearance_{bar.to.nut} = 0.6 \cdot in$

'UD'= $Diameter_{base.pole} = 19 \cdot in$

'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

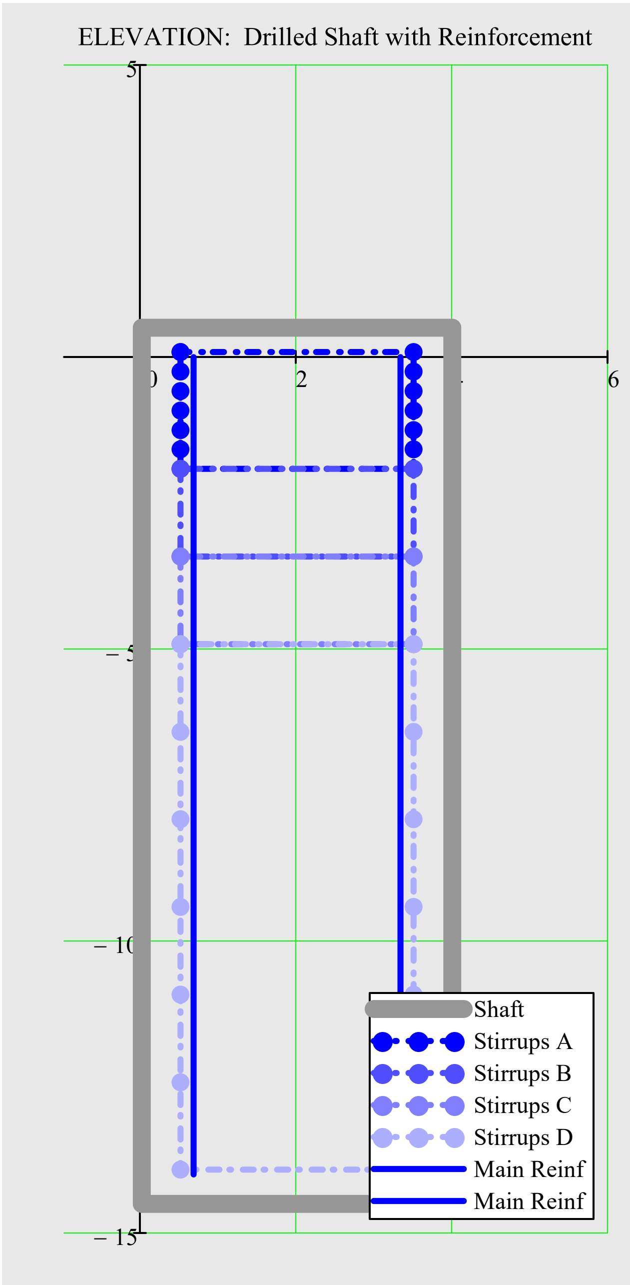
'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

'DB'= $Diameter_{shaft} = 48 \cdot in$

$Diameter_{boltcircle.pole} = 27 \cdot in$

$Dia_{bar.circle} = 33.3 \cdot in$

## Elevation View - Drilled Shaft with Main Reinforcement and Stirrups




$$s_v = \begin{pmatrix} 4 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot in$$ *stirrup spacing*

$$\#Spaces_{vbar} = \begin{pmatrix} 6 \\ 1 \\ 1 \\ 6 \end{pmatrix}$$ *number of stirrup spaces*

# FDOT Mast Arm Traffic Signal Support Analysis Program V1.2

State Structures Design Office

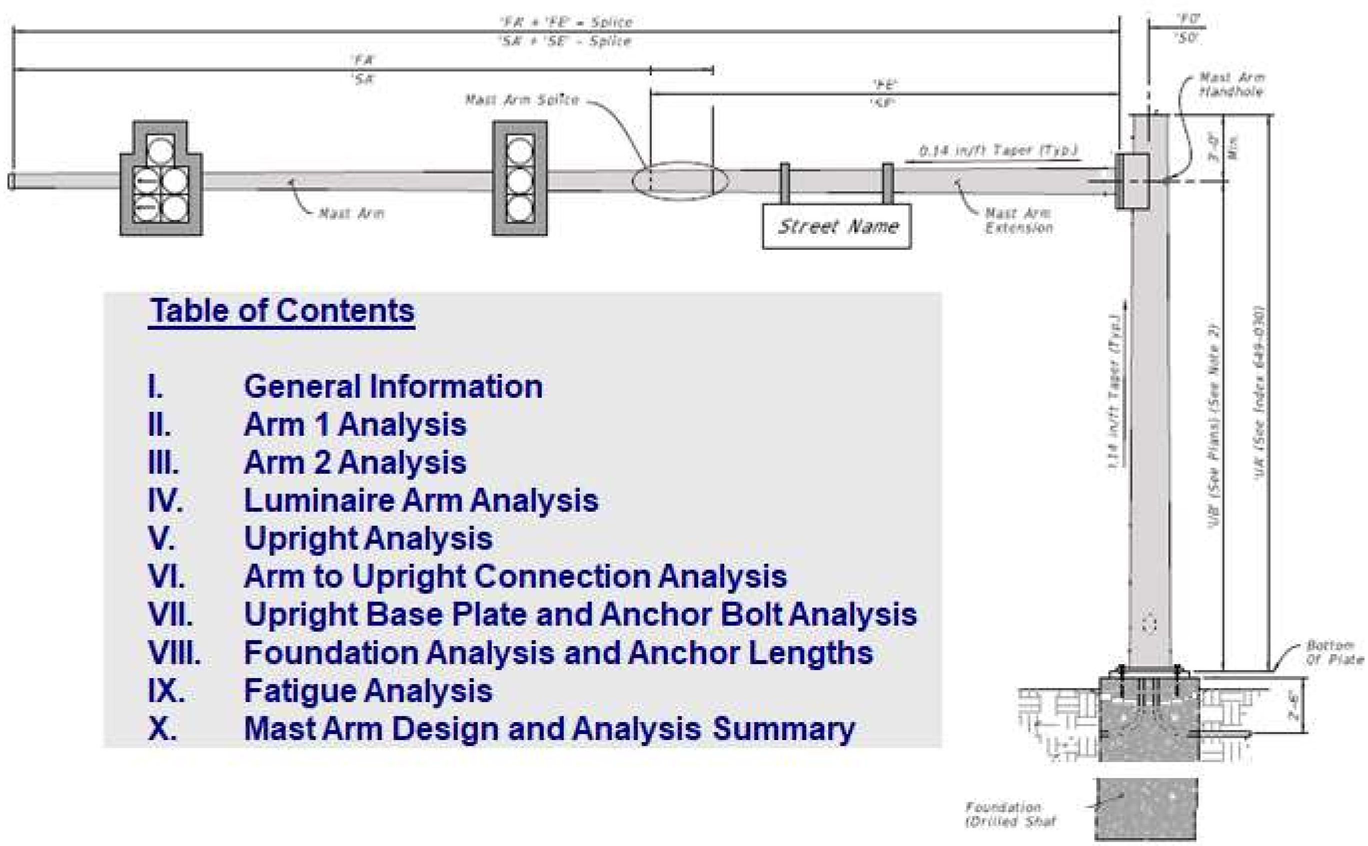


*This program works in conjunction with FDOT Mast Arm Standard Plans 649-030 & 649-031.*

*References:*
*AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (LRFDLTS).*
*FDOT Structures Manual Volume 3 (SM V3).*
*AISC Steel Construction Manual*

*For more information see Reference.xmcd and Changes.xmcd.*

*Reference*




## Table of Contents



## Data Folder and Files

***Data Files Folder***

Change Folder

C:\PWWORKING\east01\d2113434\MastArmV1.2\Data\

***Required - Open Existing Data File. To save New Data Files, enter data variables at the end of Section IX.***

Pole 3.dat
Pole 3_Existing.dat

Refresh List

Open File

## I. General Information and Sign & Signal Data

### Enter Project Information

| | |
|---|---|
| *Project Name* | 43rd St. at Cortez |
| *Project No.* | 10226260 |
| *Designed by* | CMH |
| *Date* | 06/30/2021 |
| *Checked by* | XXX |
| *Date* | XX/XX/XXXX |
| *Signal Name* | Pole 3 |
| *Station/Offset* | 300+15.6 / 79.48' RT |

### Enter Wind Speed

*Design Wind Speed* 148 *mph*

*Extreme Event Wind Speed*

**SDG Wind Speeds by County**

### Enter Arm Lengths, Signal and Sign Data

***Arm 1***

*Arm 1 Length* 46

Reset Arm 1 Data

| *Arm1 Signal Number* | *Distance to Signal (ft)* | *Number of Heads* |
|---|---|---|
| 1 | 14 | 5 |
| 2 | 22 | 3 |
| 3 | 32 | 4 |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

***Arm 2*** *Set Arm 2 Length = 0 for single arm Mast Arms*

*Arm 2 Length* 0

Reset Arm 2 Data

| *Arm2 Signal Number* | *Distance to Signal (ft)* | *Number of Heads* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

***Arm 1 Sign Panels***

| *Arm1 Sign Panel Number* | *Distance to Panel (ft)* | *Panel Area (sf)* |
|---|---|---|
| 1 | 5 | 20 |
| 2 | 27 | 1 |
| 3 | | |
| 4 | | |
| 5 | | |

*Note: The VVDS and is assumed to be a 1 ft x 1 ft sign for analysis purposes.*

***Arm 2 Sign Panels***

| *Arm2 Sign Panel Number* | *Distance to Panel (ft)* | *Panel Area (sf)* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

Save Data for Signs and Signals

## II. Arm 1 Analysis

InputDataFile = "Pole 3.dat"  $V_{extreme} = 148 \cdot mph$

*Values for* $Dist_{splice.from.base.arm}$ *that give a base diameter in even inches*

$$\begin{pmatrix} \text{"Wall Thickness"} & \text{"dia-1in"} & \text{"dia-2in"} & \text{"dia-3in"} & \text{"dia-4in"} & \text{"dia-5in"} & \text{"d-6in"} \\ t_{wall.arm} = 0.179 \cdot in & \mathbf{9.9} \cdot ft & \mathbf{17.0} \cdot ft & \mathbf{24.2} \cdot ft & \mathbf{31.3} \cdot ft & \mathbf{38.5} \cdot ft & \mathbf{45.6} \cdot ft \\ t_{wall.arm} = 0.25 \cdot in & \mathbf{10.9} \cdot ft & \mathbf{18.0} \cdot ft & \mathbf{25.2} \cdot ft & \mathbf{32.3} \cdot ft & \mathbf{39.4} \cdot ft & \mathbf{46.6} \cdot ft \end{pmatrix}$$

Help - Base Diameters | Help - Arm Tip Diameter | Help - Tube Wall Thickness | Help - Arm Lengths | Recommended Distance to Splice

Reference:C:\PWWORKING\east01\d2113434\MastArmV1.2\LRFD Equation Module.xmcd(R)

### Enter Arm 1 Data

| Arm Length (ft) | Base Diameter (in) | Wall Thickness 1 (in) | Wall Thickness 2 (in) | Distance to Splice (ft) |
|---|---|---|---|---|
| $L_{total.arm1} = 46\,ft$ | 13 | 0.25 | 0.375 | 9.7 |
| *feet, 40 ft. max. for 1 piece arms* | *Measured flat to flat* 'FG' | *for 1 & 2 piece arms* 'FD' | *arms only* 'FH' *for 2 piece* | *for 2 piece arms only* ('Larm' - 'FA') |

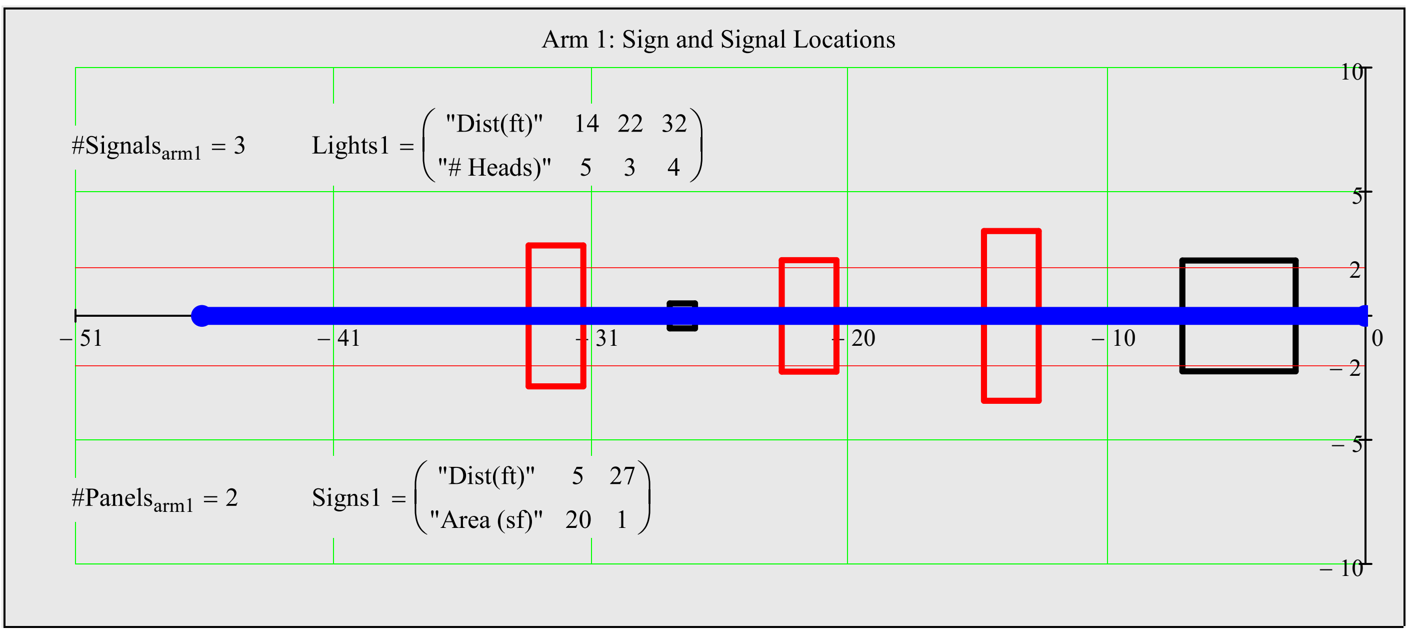
Arm 1 Analysis including Existing Mast Arm Analysis (Additional Variables Required)

*Arm 1 Combined Force Interaction Ratio and Deflection*

BackPlate = "Rigid, 6 inches wide"

$\max(CFI_{arm1}) = 0.42$  $\max(\Delta_{arm1}) = 5.2 \cdot in$  $2 \cdot deg \cdot L_{total.arm1} = 19.3 \cdot in$

*Summary - Arm 1 Geometry and Loading*




$\max(CFI_{arm1}) = 0.42$

$\max(\Delta_{arm1}) = 5.2 \cdot in$

$L_{total.arm1} = 46\,ft$

'FA'= 'FE'= $L_{fabricated.arm1} = \begin{pmatrix} 36.3 \\ 11.7 \end{pmatrix} \cdot ft$

'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 7.08 \\ 11.36 \end{pmatrix} \cdot in$

'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 12.17 \\ 13.00 \end{pmatrix} \cdot in$

'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.250 \\ 0.375 \end{pmatrix} \cdot in$

$Classification_{arm1} = \begin{pmatrix} \text{"Compact"} \\ \text{"Compact"} \end{pmatrix}$

$L_{splice.provided.arm1} = 2 \cdot ft$

## III. Arm 2 Analysis

InputDataFile = "Pole 3.dat"  $V_{extreme} = 148 \cdot mph$

$Dist_{splice.from.base.arm}$ *values that give a base diameter in even inches*

| "Wall Thickness" | $\Delta dia = 1 \cdot in$ | $\Delta dia = 2 \cdot in$ | $\Delta dia = 3 \cdot in$ | $\Delta dia = 4 \cdot in$ | $\Delta dia = 5 \cdot in$ | $\Delta dia = 6 \cdot in$ |
|---|---|---|---|---|---|---|
| $t_{wall.arm} = 0.179 \cdot in$ | $9.9 \cdot ft$ | $17.0 \cdot ft$ | $24.2 \cdot ft$ | $31.3 \cdot ft$ | $38.5 \cdot ft$ | $45.6 \cdot ft$ |
| $t_{wall.arm} = 0.25 \cdot in$ | $10.9 \cdot ft$ | $18.0 \cdot ft$ | $25.2 \cdot ft$ | $32.3 \cdot ft$ | $39.4 \cdot ft$ | $46.6 \cdot ft$ |

Help - Base Diameters | Help - Arm Tip Diameter | Help - Tube Wall Thickness | Help - Arm Lengths | Recommended Distance to Splice

**Enter Arm 2 Data**

| *Arm Length (ft)* | *Base Diameter (in)* | *Wall Thickness 1 (in)* | *Wall Thickness 2 (in)* | *Distance to Splice (ft)* |
|---|---|---|---|---|
| $L_{total.arm2} = 0$ ft | | | | |
| *feet, 40 ft. max. for 1 piece arms* | *Measured flat to flat* 'SG' | *for 1 & 2 piece arms* 'SD' | *for 2 piece arms only* 'SH' | *for 2 piece arms only* ('Larm' - 'SA') |

Arm 2 Analysis including Existing Mast Arm Analysis

*Arm 2 Combined Force Interaction Ratio and Deflection*

$\max(CFI_{arm2}) = 0.00$ BackPlate = "Rigid, 6 inches wide"

*Summary - Arm 2 Geometry and Loading* $\max(\Delta_{arm2}) = 0.0 \cdot in$ $2 \cdot deg \cdot L_{total.arm2} = 0 \cdot in$

Arm 2: Sign and Signal Locations

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$\#Signals_{arm2} = 0$ $Lights2 = \begin{pmatrix} \text{"Dist(ft)"} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \text{"\# Heads)"} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

$\#Panels_{arm2} = 0$ $Signs2 = \begin{pmatrix} \text{"Dist(ft)"} & 0 & 0 & 0 & 0 & 0 \\ \text{"Area (sf)"} & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

−10

$-(L_{total.arm2}+5 \cdot ft)$ 0

$\max(CFI_{arm2}) = 0.00$

'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix} \cdot in$ $Classification_{arm2} = \begin{pmatrix} \text{"Compact"} \\ \text{"N/A"} \end{pmatrix}$

$\max(\Delta_{arm2}) = 0.0 \cdot in$

$L_{total.arm2} = 0$ ft

'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix} \cdot in$ $L_{splice.provided.arm2} = 0 \cdot ft$

'SA'= 'SE'= $L_{fabricated.arm2} = \begin{pmatrix} 0.0 \\ 0.0 \end{pmatrix} \cdot ft$ 'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0.000 \\ 0.000 \end{pmatrix} \cdot in$

## IV. Luminaire Arm Analysis

InputDataFile = "Pole 3.dat" $V_{extreme} = 148 \cdot mph$

## Enter Luminaire Data

*Set Lum. Ht. = 0 for no Luminaire*

*See Design Standards 649-030 and 649-031 for input values.*

| *Luminaire Height (ft)* | *Lum Horiz Length (ft)* | *Lum Arm Base Dia (in)* | *Lum Wall Thickness (in)* | *Slope* | *Lum Arm Radius (ft)* | *Lum Bolt Dia (in)* | *Lum Base Plate Thickness (in)* |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | |
| *Std = 40 feet* | *10 feet* | *3 inches* | *0.125 inches* | *0.5* | *8 feet* | *0.5 inches* | *0.75 inches* |

Analyze Luminaire

*Summary - Luminaire Arm Geometry*

$$\begin{pmatrix} CFI_{base.lumarm} \\ CSR_{bolt.lum} \\ D/C_{baseplate.lum} \\ D/C_{conn.plate.lum} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

'LA'= $Y_{luminaire} = 0\ ft$

'LB'= $X_{luminaire} = 0\ ft$

'LC'= $Diameter_{base.lumarm} = 0 \cdot in$

'LD'= $t_{wall.lumarm} = 0 \cdot in$

'LE'= $Slope_{lumarm} = 0$

'LF'= $r_{lumarm} = 0\ ft$

'LG'= $d_{bolt.lum} = 0 \cdot in$

'LH'= $t_{baseplate.lum} = 0 \cdot in$

'LJ'= $w_{base.lum} = 0 \cdot in$

'LK'= $w_{channel.lum} = 0 \cdot in$

## V. Upright Analysis

InputDataFile = "Pole 3.dat" $V_{extreme} = 148 \cdot mph$

Help - Upright Base Diameter and Wall Thickness

Help - Gap Distance

**Enter Upright Data**

| *Total Height (ft)* | *Height to Arm Connection (ft)* | *Base Diameter (in)* | *Wall Thickness (in)* | *Gap (in)* | |
|---|---|---|---|---|---|
| 21.5 | 20 | 16 | 0.375 | 7.34 | ***arm 1 gap*** |
| | | | | | ***arm 2 gap*** |
| 'UA' | 'UB' | 'UD' *measured flat to flat* | 'UE' | | |

Analyze Upright

*Upright Combined Force Interaction Ratio and Deflections*

$Classification_{pole} = "Compact"$

$\max(CFI_{pole}) = 0.44$

$Check_{slope} = "OK"$

$Check_{deflection} = "OK"$

$\max(\Delta_{x.dl}) = 0.95 \cdot in$

$\max(\Delta_{z.dl}) = 0 \cdot in$

$Slope_z = 0 \cdot deg$

$Slope_x = 0.5 \cdot deg$

$Diameter_{conn.pole} = 13.2 \cdot in$

$$\max\left(\begin{pmatrix} Diameter_{base.arm1_0} \\ Diameter_{base.arm2_0} \end{pmatrix}\right) = 12.2 \cdot in$$

'UA'= $Y_{pole} = 21.5 \cdot ft$

'UB'= $Y_{arm.conn} = 20 \cdot ft$

'UC'= $Diameter_{tip.pole} = 13 \cdot in$

'UD'= $Diameter_{base.pole} = 16 \cdot in$

'UE'= $t_{wall.pole} = 0.375 \cdot in$

'UF'= $\alpha = 0 \cdot deg$

'UG'= $Y_{lum.conn} = 0\ ft$

## VI. Arm to Upright Connection Analysis

InputDataFile = "Pole 3.dat"

*for double arms, both connection plate heights must be equal*

Help - Arm Connection Dimensions

**Enter Connection Data**

| Connection Plate Height(in) | Connection Plate Width (in) | Vertical Plate Thickness (in) | Bolt Diameter (in) | Arm Base Plate Thickness (in) |
|---|---|---|---|---|
| 22 | 23 | 0.5 | 1 | 2 |
| | | | | |
| 'HT' | 'FJ', 'SJ' | 'FL', 'SL' | 'FP', 'SP' | 'FK', 'SK' |

Analyze Connection

*Connection Summary*

'HT'= $h_{conn.plate} = 22 \cdot in$   $D/C_{ht.conn.plate} = 0.90$   $CheckHt_{conn.plate} = \text{"OK"}$

$D/C_{width.conn.plate_0} = 0.98$

$CheckWidth_{conn.plate_0} = \text{"OK"}$

$$\begin{pmatrix} D/C_{t.baseplate.arm_0} \\ CFI_{t.vert.plate_0} \\ CSR_{bolt.conn_0} \end{pmatrix} = \begin{pmatrix} 1.00 \\ 0.49 \\ 0.30 \end{pmatrix}$$

$\#Bolts_{conn_0} = 6$

'FJ'= $b_{conn.plate_0} = 23 \cdot in$

'FK'= $t_{baseplate.arm_0} = 2.00 \cdot in$

'FL'= $t_{vertical.plate_0} = 0.5 \cdot in$

'FN'= $w_{vertical.plate_0} = \frac{3}{8} \cdot in$

'FO'= $Offset_{conn_0} = 14.0 \cdot in$

'FP'= $d_{bolt.conn_0} = 1 \cdot in$

'FR'= $t_{conn.plate_0} = 2.00 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 9 \cdot in$

'FT'= $w_{conn.plate_0} = \frac{3}{8} \cdot in$

$D/C_{width.conn.plate_1} = 0.00$

$CheckWidth_{conn.plate_1} = \text{"OK"}$

$$\begin{pmatrix} D/C_{t.baseplate.arm_1} \\ CFI_{t.vert.plate_1} \\ CSR_{bolt.conn_1} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

$\#Bolts_{conn_1} = 0$

'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SK'= $t_{baseplate.arm_1} = 0.00 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0.00 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0.00 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

## VII. Upright Base Plate & Anchor Bolt Analysis

InputDataFile = "Pole 3.dat"

**Enter Anchorage Data**

| Anchor Bolt Diameter (in) | Number of Anchor Bolts |
|---|---|
| 1.5 | 6 |
| 'BC' | '#Bolts' |

Help - Number of Anchor Bolts

$\text{Diameter}_{base.pole} = 16 \cdot in$

Analyze Base Plate & Anchors

*Base Plate and Anchor Summary*

'#Bolts'= $\#\text{AnchorBolts} = 6$

'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

$CSR_{anchor} = 0.47$

$\text{Diameter}_{boltcircle.pole} = 22 \cdot in$

'BC'= $d_{anchorbolt} = 1.50 \cdot in$

$\text{CheckCSR}_{anchorbolt} = \text{"OK"}$

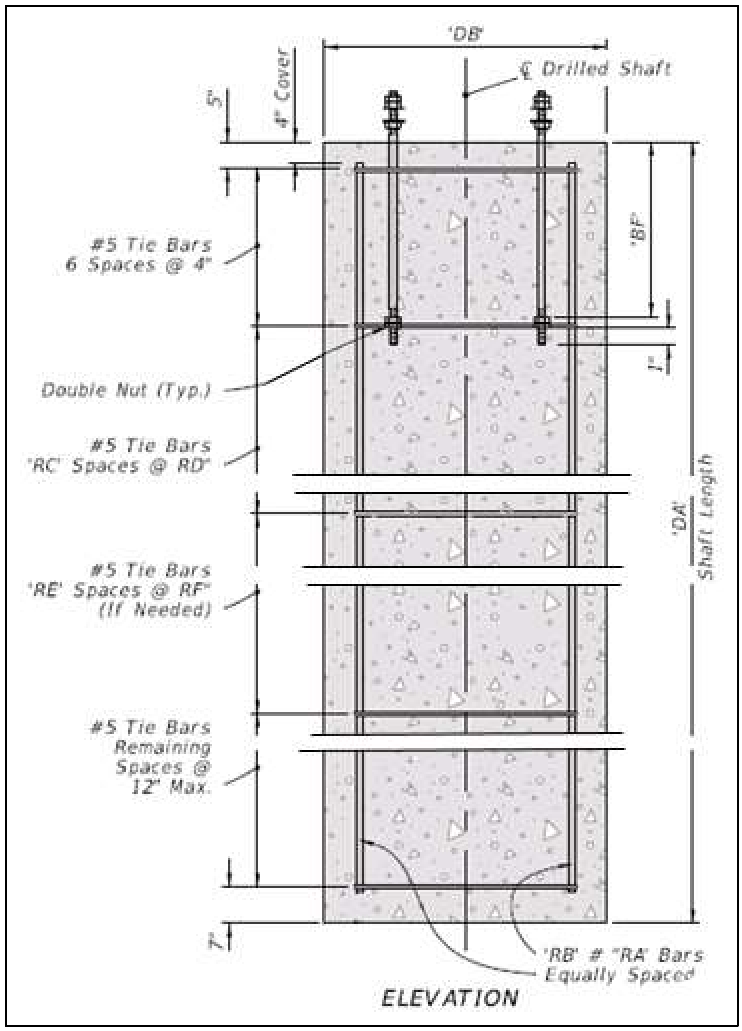
'BA'= $\text{Diameter}_{baseplate.pole} = 28 \cdot in$

## VIII. Foundation Analysis & Anchor Bolt Lengths

InputDataFile = "Pole 3.dat"

**Enter Drilled Shaft Data**

| | | |
|---|---|---|
| *Soil Type* | Sand / Clay | |
| *Soil Density, $\gamma_{soil}$ (45-50 pcf typ.)* | 42.6 | pcf |
| *Friction Angle, $\phi$ (Sands)* | 30 | deg |
| *SPT Number ($N_{blows}$ 5 min.) (Sands)* | 15 | |
| *Shear Strength, c (Clays)* | 2000 | psf |
| *Ground to Top of Shaft Offset* | 0.5 | ft |
| ***First Set of User Defined Stirrups:*** | | |
| *Number of Stirrup Spaces* 'RC' | 1 | |
| *Stirrup Spacing* 'RD' | 12 | in |
| ***Second Set of User Defined Stirrups:*** | | |
| *Number of Stirrup Spaces* 'RE' *enter zero for 12 inch spacing* | 1 | |
| *Stirrup Spacing* 'RF' *enter zero for 12 inch spacing* | 12 | in |
| *Stirrup Bar Size, use #5 for all Standard Shafts* | #5 / #6 | |




Analyze Foundation

*Shaft Length* *Stirrup spacing* *Number of stirrup spaces*

$L_{shaft} = 14\,ft$  $s_v = \begin{pmatrix} 4 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot in$  $\#Spaces_{vbar} = \begin{pmatrix} 6 \\ 1 \\ 1 \\ 5 \end{pmatrix}$

*Foundation Summary*

CheckReinfClearSpacing = "OK"

$CheckLongReinf_{shr.tor}$ = "OK"

CheckMaxSpacingTransvReinf = "OK"

OverlapDesign = "Based on Overlap of Failure Cones"

OverlapTest = "Overlap of Failure Cones"

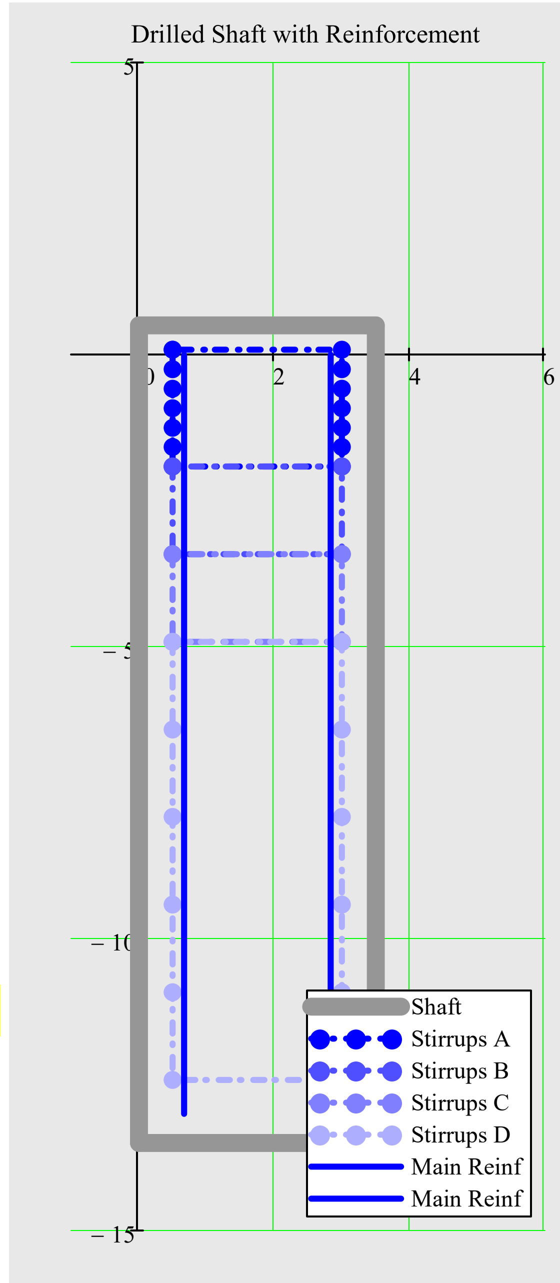
BreakoutTest = "OK"

*Stirrups* $s_{v_0} = 4 \cdot in$ @ $\#Spaces_{vbar_0} = 6$ : $D/C_{torsion_0} = 0.2$

*Stirrups* 'RC' ( $s_{v_1} = 18 \cdot in$ ) @ 'RD' ( $\#Spaces_{vbar_1} = 1$ ) : $D/C_{torsion_1} = 0.9$

*Stirrups* 'RE' ( $s_{v_2} = 18 \cdot in$ ) @ 'RF' ( $\#Spaces_{vbar_2} = 1$ ) : $D/C_{torsion_2} = 0.9$

*Stirrups* $s_{v_3} = 18 \cdot in$ @ $\#Spaces_{vbar_3} = 5$




$Offset = 0.5\,ft$

'DA'= $L_{shaft} = 14 \cdot ft$

'RA'= $round\left(\frac{d_{long.bar}}{0.125in}\right) = 11$

$\#Spaces_{vbar_0} = 6$

$s_{v_0} = 4 \cdot in$

$d_{long.bar} = 1.41 \cdot in$

'DB'= $Diameter_{shaft} = 3.5 \cdot ft$

'RB'= $\#LongBars_{prov} = 10$

'RC'= $\#Spaces_{vbar_1} = 1$

$Dia_{bar.circle} = 27.3 \cdot in$

'BF'= $L_{embedment.anchor} = 36 \cdot in$

'RD'= $s_{v_1} = 18 \cdot in$

$L_{anchor.bolt} = 46 \cdot in$

'RE'= $\#Spaces_{vbar_2} = 1$

'RF'= $s_{v_2} = 18 \cdot in$

$\#Spaces_{vbar_3} = 5$

$s_{v_3} = 18 \cdot in$

## IX. Fatigue Analysis

InputDataFile = "Pole 3.dat"

$\text{FatigueCategory}_{galloping} := 2$  $\text{FatigueCategory}_{natural.wind} := 2$

SM V3 11.6

Analyze Structure for Fatigue

## Fatigue Summary

*Arm and Pole Welds*

*K1 values within 2% of LTS thresholds of 3.0 and 4.0 may use next higher CAFT values*

$\text{Check}_{galloping.arm1} = \text{"OK"}$  $f_{galloping.arm1} = 3.2\cdot\text{ksi}$  $\text{CAFT}_{fullpengroove.weld.arm1} = 7\cdot\text{ksi}$

$\text{Check}_{galloping.arm2} = \text{"NA"}$  $f_{galloping.arm2} = 0.0\cdot\text{ksi}$  $\text{CAFT}_{fullpengroove.weld.arm2} = \text{"NA"}\cdot\text{ksi}$

$\text{Check}_{galloping.pole} = \text{"OK"}$  $f_{galloping.pole} = 2.1\cdot\text{ksi}$  $\text{CAFT}_{fullpengroove.weld.pole} = 2.6\cdot\text{ksi}$

$\text{Check}_{nwg.arm1} = \text{"OK"}$  $f_{nwg.arm1} = 2.1\cdot\text{ksi}$  $\text{CAFT}_{fullpengroove.weld.arm1} = 7\cdot\text{ksi}$

$\text{Check}_{nwg.arm2} = \text{"NA"}$  $f_{nwg.arm2} = 0.0\cdot\text{ksi}$  $\text{CAFT}_{fullpengroove.weld.arm2} = \text{"NA"}\cdot\text{ksi}$

$\text{Check}_{nwg.pole} = \text{"OK"}$  $f_{nwg.pole} = 2.3\cdot\text{ksi}$  $\text{CAFT}_{fullpengroove.weld.pole} = 2.6\cdot\text{ksi}$

$$\text{CheckK1Values} = \begin{pmatrix} \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \end{pmatrix} \quad \begin{pmatrix} K_{I.arm1} \\ K_{I.arm2} \\ K_{I.pole} \end{pmatrix} = \begin{pmatrix} 3.395 \\ 100.000 \\ 6.895 \end{pmatrix} \begin{pmatrix} \text{"Arm 1 Base Weld"} \\ \text{"Arm 2 Base Weld"} \\ \text{"Upright Base Weld"} \end{pmatrix}$$

*A325 Connection Bolts*

$$\text{Check}_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix} \quad f_{t.g.bolt} = \begin{pmatrix} 5.2 \\ 0.0 \end{pmatrix}\cdot\text{ksi}$$

$$\text{CAFT}_{conn.bolt} = 16\cdot\text{ksi}$$

$$\text{Check}_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix} \quad f_{t.nwg.bolt} = \begin{pmatrix} 3.5 \\ 0.0 \end{pmatrix}\cdot\text{ksi}$$

*Anchor Bolts*

$\text{Check}_{g.anchor} = \text{"OK"}$  $f_{t.g.anchor} = 2.7\cdot\text{ksi}$  $\text{CAFT}_{anchor.bolts} = 7\cdot\text{ksi}$

$\text{Check}_{nwg.anchor} = \text{"OK"}$  $f_{t.nwg.anchor} = 3\cdot\text{ksi}$

***Save Data File (optional)***

☑ Use current input file

*File Name* Pole 3.dat

*Note: Select an output folder by using the "Change Folder" option above.*

Save Data

*Arm Designation Example*

A70/D-A30/D/H-P5/D/L-DS/16/5

| | |
|---|---|
| A70/D - | *Arm 70 feet long, Double Arm* |
| A30/D/H - | *Arm 30 feet long, Double Arm, Heavy Duty* |
| P5/D/L - | *Pole 5 , Double Arm, with Luminaire* |
| DS/16/5 - | *Drilled Shaft 16 ft deep, 5 foot diameter* |

# X. Mast Arm Design and Analysis Summary

InputDataFile = "Pole 3.dat"

*If comparing results to Standard Index 649-030, some values in the index have been increased to reduce the number of variations.*

**Subject** = "43rd St. at Cortez" **DesignedBy** = "CMH" **PoleLocation** = "300+15.6 / 79.48' RT"

**ProjectNo** = "10226260" **CheckedBy** = "XXX" **Date** = "06/30/2021"

ExistingMastArm = "Yes"

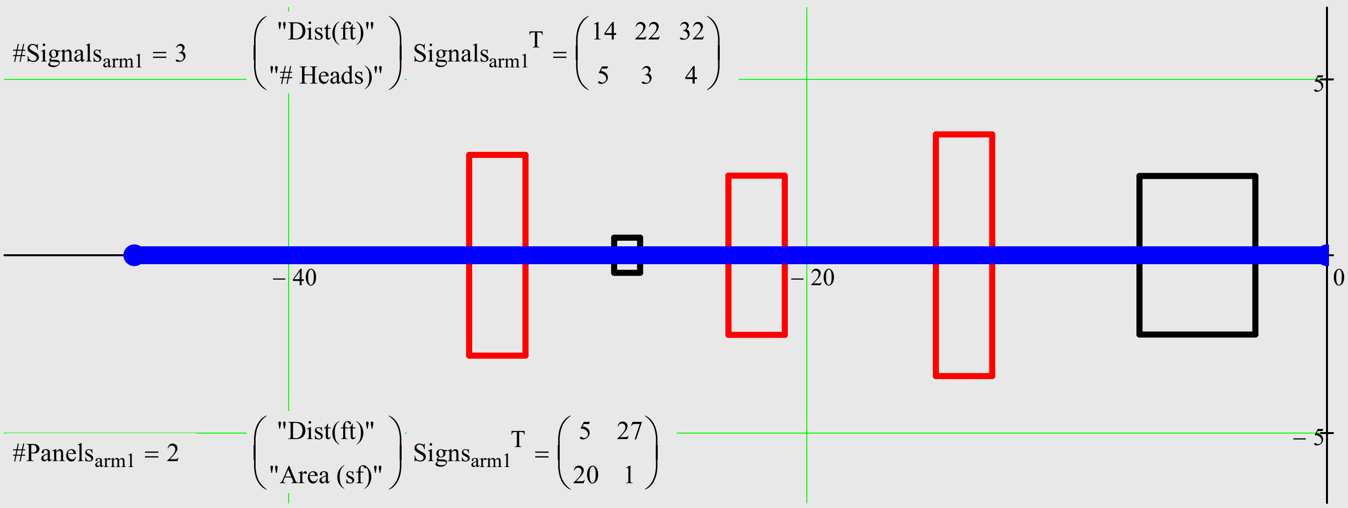
***For FDOT Mast Arm Support Structures,*** max(CFI) ≤ 0.95 ***(See Structures Manual Volume3)***

## 1st Mast Arm

$V_{extreme} = 148 \cdot mph$ ExistingMastArm = "Yes" BackPlate = "Rigid, 6 inches wide"

Arm 1: Locations of Signs and Signals

$\#Signals_{arm1} = 3$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"\# Heads)"} \end{pmatrix}$ $Signals_{arm1}^{T} = \begin{pmatrix} 14 & 22 & 32 \\ 5 & 3 & 4 \end{pmatrix}$




$\#Panels_{arm1} = 2$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"Area (sf)"} \end{pmatrix}$ $Signs_{arm1}^{T} = \begin{pmatrix} 5 & 27 \\ 20 & 1 \end{pmatrix}$

$\max(CFI_{arm1}) = 0.42$ $L_{total.arm1} = 46\,ft$ $L_{splice.provided.arm1} = 2 \cdot ft$ $\max(\Delta_{arm1}) = 5.2 \cdot in$

'FA'= 'FE'= $L_{fabricated.arm1} = \begin{pmatrix} 36.3 \\ 11.7 \end{pmatrix} \cdot ft$ 'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 12.17 \\ 13.00 \end{pmatrix} \cdot in$

'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 7.08 \\ 11.36 \end{pmatrix} \cdot in$ 'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.250 \\ 0.375 \end{pmatrix} \cdot in$

## 2nd Mast Arm

Arm 2: Locations of Signs and Signals

7

$\#Signals_{arm2} = 0$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"\# Heads)"} \end{pmatrix}$ $Signals_{arm2}^{T} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

$\#Panels_{arm2} = 0$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"Area (sf)"} \end{pmatrix}$ $Signs_{arm2}^{T} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

−7

$-\left(L_{total.arm2}+5\cdot ft\right)$ 0

$\max\left(CFI_{arm2}\right) = 0.00$ $L_{total.arm2} = 0\ ft$ $L_{splice.provided.arm2} = 0\cdot ft$ $\max\left(\Delta_{arm2}\right) = 0\cdot in$

'SA'= 'SE'= $L_{fabricated.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot ft$

'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix}\cdot in$

'UF'= $\alpha = 0\cdot deg$ **(Angle Between Arms)**

'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix}\cdot in$

'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0.000 \\ 0.000 \end{pmatrix}\cdot in$

## Luminaire Arm and Connection *(use MC10x33.6 channel for connection)*

$$\begin{pmatrix} CFI_{base.lumarm} \\ CSR_{bolt.lum} \\ D/C_{baseplate.lum} \\ D/C_{conn.plate.lum} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 6.82\times 10^{-9} \\ 0.00 \\ 0.00 \end{pmatrix}$$

'LA'= $Y_{luminaire} = 0\ ft$

'LB'= $X_{luminaire} = 0\ ft$

'LC'= $Diameter_{base.lumarm} = 0\cdot in$

'LD'= $t_{wall.lumarm} = 0\cdot in$

'LE'= $Slope_{lumarm} = 0$

'LF'= $r_{lumarm} = 0\ ft$

'LG'= $d_{bolt.lum} = 0\cdot in$

'LH'= $t_{baseplate.lum} = 0\cdot in$

'LJ'= $w_{base.lum} = 0\cdot in$

'LK'= $w_{channel.lum} = 0\cdot in$

## Upright

$\max\left(CFI_{pole}\right) = 0.44$ $Check_{deflection} = \text{"OK"}$ $Check_{slope} = \text{"OK"}$

'UA'= $Y_{pole} = 21.5\cdot ft$

'UB'= $Y_{arm.conn} = 20\cdot ft$

'UC'= $Diameter_{tip.pole} = 13\cdot in$

'UD'= $Diameter_{base.pole} = 16\cdot in$

'UE'= $t_{wall.pole} = 0.375\cdot in$

'UF'= $\alpha = 0\cdot deg$

'UG'= $Y_{lum.conn} = 0\ ft$

## 1st Arm to Upright Connection

$D/C_{ht.conn.plate} = 0.90$

'HT'= $h_{conn.plate} = 22\cdot in$

$CheckHt_{conn.plate} = "OK"$

$\#Bolts_{conn_0} = 6$

'FO'= $Offset_{conn_0} = 14.0\cdot in$

$D/C_{width.conn.plate_0} = 0.98$

'FJ'= $b_{conn.plate_0} = 23\cdot in$

'FP'= $d_{bolt.conn_0} = 1\cdot in$

$CheckWidth_{conn.plate_0} = "OK"$

'FK'= $t_{baseplate.arm_0} = 2\cdot in$

'FR'= $t_{conn.plate_0} = 2\cdot in$

$$\begin{pmatrix} D/C_{t.baseplate.arm_0} \\ CFI_{t.vert.plate_0} \\ CSR_{bolt.conn_0} \end{pmatrix} = \begin{pmatrix} 1.00 \\ 0.49 \\ 0.30 \end{pmatrix}$$

'FL'= $t_{vertical.plate_0} = 0.5\cdot in$

'FS'= $Spacing_{bolts.conn_0} = 9\cdot in$

'FN'= $w_{vertical.plate_0} = \frac{3}{8}\cdot in$

'FT'= $w_{conn.plate_0} = \frac{3}{8}\cdot in$

## 2nd Arm to Upright Connection

'HT'= $h_{conn.plate} = 22\cdot in$

$D/C_{width.conn.plate_1} = 0.00$

$CheckWidth_{conn.plate_1} = "OK"$

$\#Bolts_{conn_1} = 0$

'SO'= $Offset_{conn_1} = 0.0\cdot in$

'SJ'= $b_{conn.plate_1} = 0\cdot in$

'SP'= $d_{bolt.conn_1} = 0\cdot in$

$$\begin{pmatrix} D/C_{t.baseplate.arm_1} \\ CFI_{t.vert.plate_1} \\ CSR_{bolt.conn_1} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

'SK'= $t_{baseplate.arm_1} = 0\cdot in$

'SR'= $t_{conn.plate_1} = 0\cdot in$

'SL'= $t_{vertical.plate_1} = 0\cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0\cdot in$

'SN'= $w_{vertical.plate_1} = 0\cdot in$

'ST'= $w_{conn.plate_1} = 0\cdot in$

## Pole Base Plate

$CSR_{anchor} = 0.47$

'#Bolts'= $\#AnchorBolts = 6$

'BA'= $Diameter_{baseplate.pole} = 28\cdot in$

$CheckCSR_{anchorbolt} = "OK"$

$Diameter_{boltcircle.pole} = 22\cdot in$

'BB'= $t_{baseplate.pole} = 1.75\cdot in$

'BC'= $d_{anchorbolt} = 1.50\cdot in$

'BF'= $L_{embedment.anchor} = 36\cdot in$

$L_{anchor.bolt} = 46\cdot in$

## Foundation

$D/C_{torsion.max} = 0.92$

$CheckD/C_{shear.and.torsion} = "OK"$

$CheckReinfClearSpacing = "OK"$

$CheckLongReinf_{shr.tor} = "OK"$

$CheckMaxSpacingTransvReinf = "OK"$

$OverlapDesign = "Based\ on\ Overlap\ of\ Failure\ Cones"$

$OverlapTest = "Overlap\ of\ Failure\ Cones"$

$BreakoutTest = "OK"$

$Clearance_{csl.to.nut} = -0 \cdot in$

$Offset = 0.5\ ft$

$d_{long.bar} = 1.41 \cdot in$

$Dia_{bar.circle} = 27.3 \cdot in$

'DA'= $L_{shaft} = 14 \cdot ft$

'DB'= $Diameter_{shaft} = 3.5 \cdot ft$

'RA'= $round\left(\frac{d_{long.bar}}{0.125in}\right) = 11$

'RB'= $\#LongBars_{prov} = 10$

'RC'= $\#Spaces_{vbar_1} = 1$

'RD'= $s_{v_1} = 18 \cdot in$

'RE'= $\#Spaces_{vbar_2} = 1$

'RF'= $s_{v_2} = 18 \cdot in$

## Fatigue

$Check_{galloping.arm1} = "OK"$

$Check_{galloping.arm2} = "NA"$

$Check_{galloping.pole} = "OK"$

$Check_{nwg.arm1} = "OK"$

$Check_{nwg.arm2} = "NA"$

$Check_{nwg.pole} = "OK"$

$Check_{g.conn.bolt} = \begin{pmatrix} "OK" \\ "OK" \end{pmatrix}$

$Check_{nwg.conn.bolt} = \begin{pmatrix} "OK" \\ "OK" \end{pmatrix}$

$Check_{g.anchor} = "OK"$

$Check_{nwg.anchor} = "OK"$

*K1 values within 2% of LTS thresholds may use next higher CAFT values*

$CheckK1Values = \begin{pmatrix} "K1\ is\ outside\ of\ 2\%\ of\ K1\ thresholds" \\ "K1\ is\ outside\ of\ 2\%\ of\ K1\ thresholds" \\ "K1\ is\ outside\ of\ 2\%\ of\ K1\ thresholds" \end{pmatrix}$

$\begin{pmatrix} K_{I.arm1} \\ K_{I.arm2} \\ K_{I.pole} \end{pmatrix} = \begin{pmatrix} 3.395 \\ 100.000 \\ 6.895 \end{pmatrix} \begin{pmatrix} "Arm\ 1\ Base\ Weld" \\ "Arm\ 2\ Base\ Weld" \\ "Upright\ Base\ Weld" \end{pmatrix}$

WRITEPRN to Line 1-2-3 for Mast Arm Data Table

## Mast Arm Tip Deflection

*Compare Mast Arm deflection of each arm to a proposed camber*

$Camber_{arm1} := \mathbf{2} \cdot deg$ $Camber_{arm2} := \mathbf{2} \cdot deg$

$Deflection_{arm1} := Slope_x \cdot L_{total.arm1} + max(\Delta_{arm1}) = 10 \cdot in$

$CamberArm1_{upward} := sin(Camber_{arm1}) \cdot L_{total.arm1} = 19.3 \cdot in$

$Deflection_{arm2} := [Slope_z \cdot L_{total.arm2} \cdot (sin(\alpha))] + Slope_x \cdot L_{total.arm2} \cdot cos(\alpha) + max(\Delta_{arm2}) = 0 \cdot in$

$CamberArm2_{upward} := sin(Camber_{arm2}) \cdot L_{total.arm2} = 0 \cdot in$

## Check Clearance Between Connection Plates *(for Two Arm Structures only)*

$\alpha = 0 \cdot deg$ $\alpha := if[(\alpha > 180 \cdot deg), (360 \cdot deg - \alpha), \alpha]$

$Offset_{conn_0} = 14 \cdot in$ $b_{conn.plate_0} = 23 \cdot in$ $h_{conn.plate} = 22 \cdot in$ $\alpha = 0 \cdot deg$

$Offset_{conn_1} = 0 \cdot in$ $b_{conn.plate_1} = 0 \cdot in$

$x1 := Offset_{conn_0} - t_{conn.plate_0} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm1})}{2} = 11.6 \cdot in$ $y1 := \frac{b_{conn.plate_0}}{2} = 11.5 \cdot in$

$x2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \cos(\alpha) + \frac{b_{conn.plate_1}}{2} \cdot \sin(\alpha) = -0.4 \cdot in$

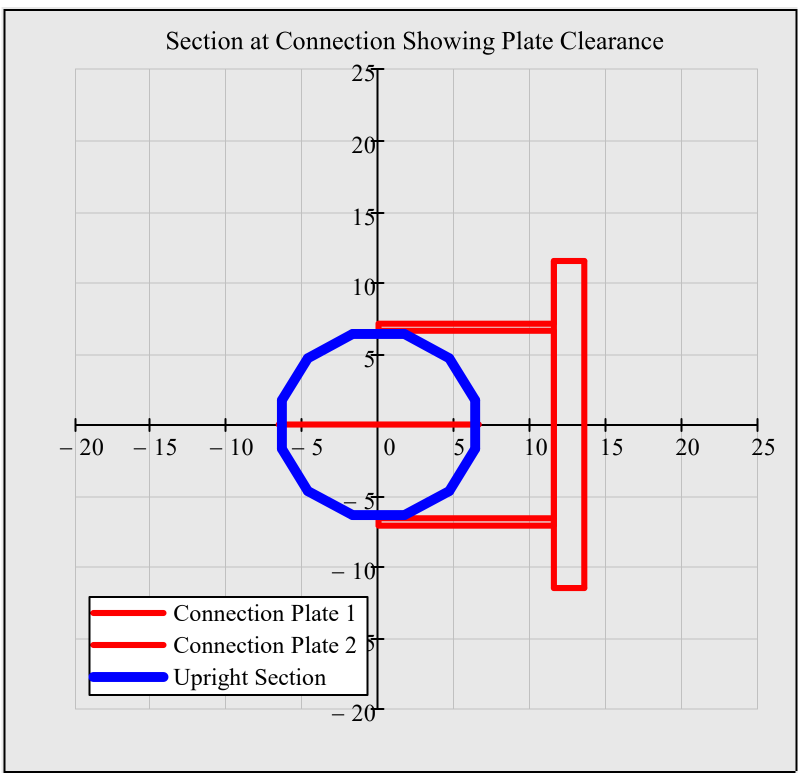
$y2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \sin(\alpha) - \frac{b_{conn.plate_1}}{2} \cdot \cos(\alpha) = 0 \cdot in$

$Clearance_{plate.to.plate} := if\left[(x1 > x2) \cdot (y2 > y1), \sqrt{(x1 - x2)^2 + (y1 - y2)^2}, 0 \cdot in\right] = 0 \cdot in$

***(if Clearance < 2 inches, a redesign is required.***

Coordinates for Drawings

## Plan View - Connection Plate Clearance for Two Arm Connections




$Clearance_{plate.to.plate} = 0 \cdot in$

$Diameter_{conn.pole} = 13.2 \cdot in$

'FR'= $t_{conn.plate_0} = 2 \cdot in$

'FJ'= $b_{conn.plate_0} = 23 \cdot in$

'FL'= $t_{vertical.plate_0} = 0.5 \cdot in$

'FO'= $Offset_{conn_0} = 14.0 \cdot in$

$Gap_0 = 7.34 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

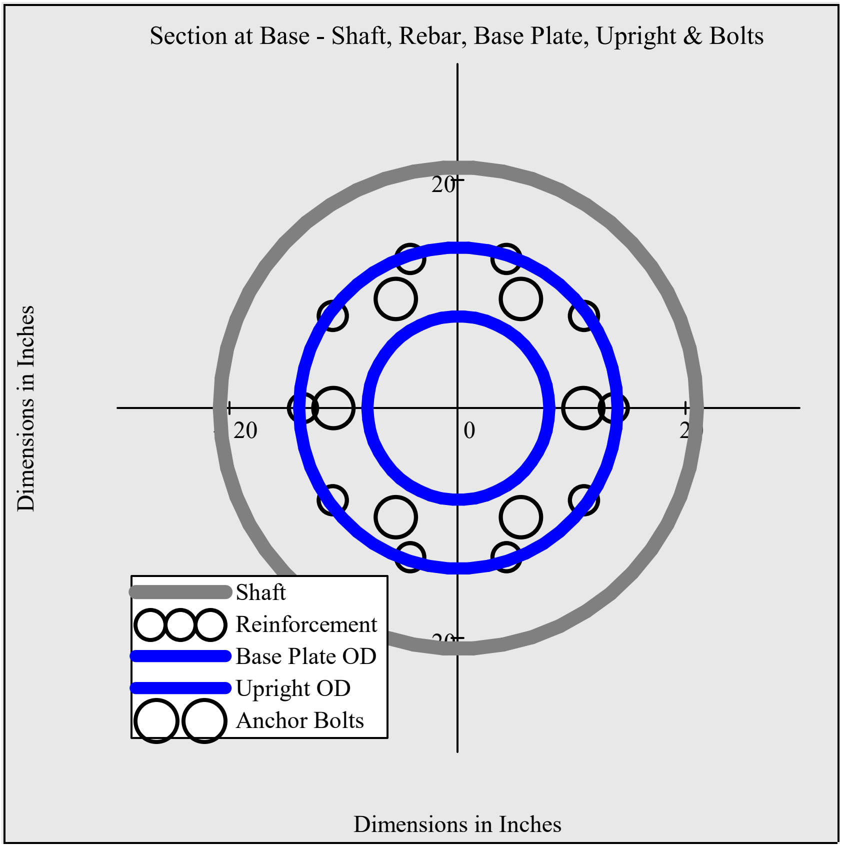
'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

$Gap_1 = 0 \cdot in$

## Plan View - Drilled Shaft, Base Plate, Upright, Anchor Bolts, & Reinforcing Steel




$\text{Clearance}_{bar.to.nut} = 0.6 \cdot in$

'UD'= $\text{Diameter}_{base.pole} = 16 \cdot in$

'BA'= $\text{Diameter}_{baseplate.pole} = 28 \cdot in$

'DB'= $\text{Diameter}_{shaft} = 42 \cdot in$

$\text{Diameter}_{boltcircle.pole} = 22 \cdot in$

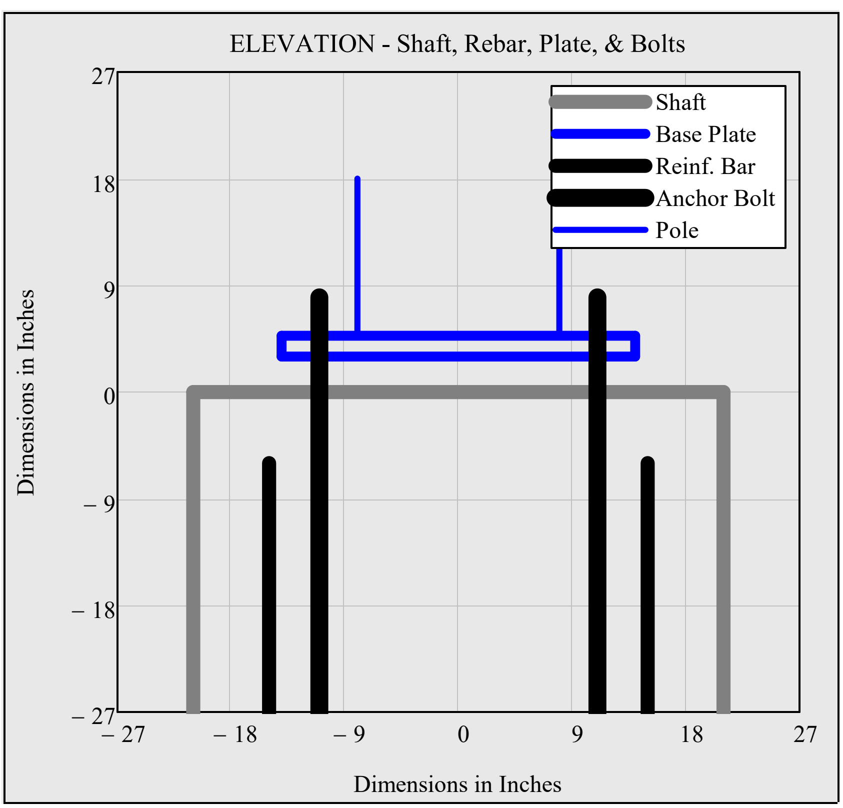
$\text{Dia}_{bar.circle} = 27.3 \cdot in$

$\#\text{AnchorBolts} = 6$

$\#\text{LongBars}_{prov} = 10$

*Note: The Plan and Elevation Views do not show the 4 or 5 1.9" O.D. Nondestructive Integrity Testing Access Tubes that are tied to the inside of the reinforcing cage (see FDOT Spec 455-16.4).*

## Elevation View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$\text{Clearance}_{bar.to.nut} = 0.6 \cdot in$

'UD'= $\text{Diameter}_{base.pole} = 16 \cdot in$

'BA'= $\text{Diameter}_{baseplate.pole} = 28 \cdot in$

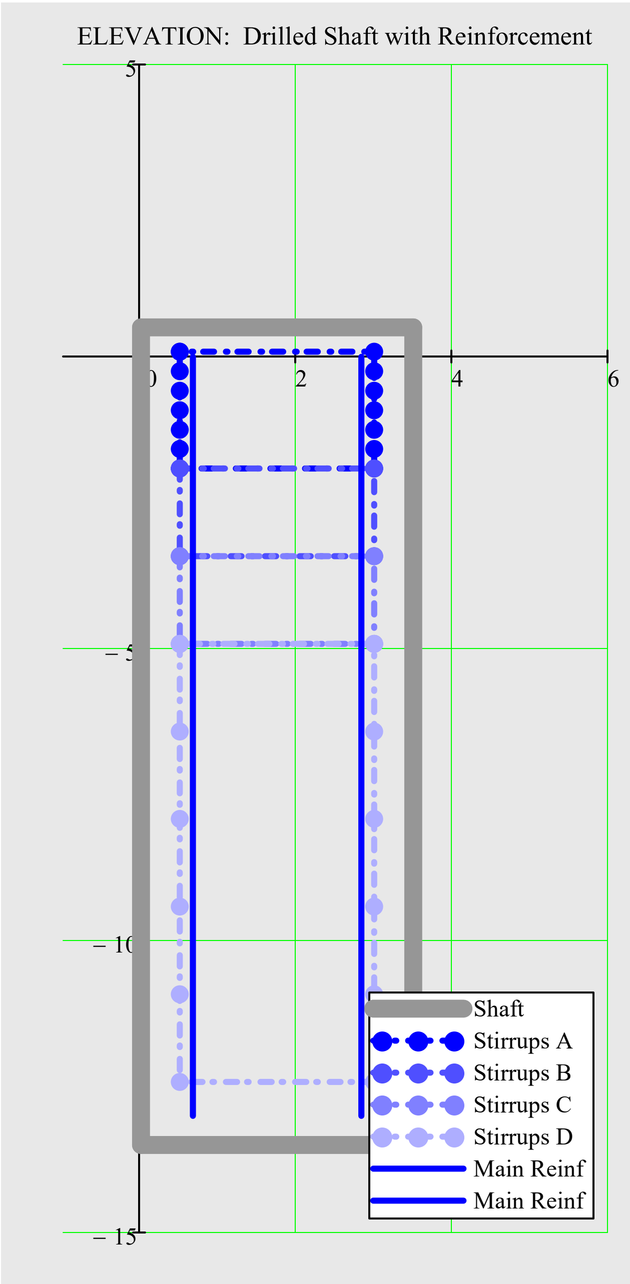
'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

'DB'= $\text{Diameter}_{shaft} = 42 \cdot in$

$\text{Diameter}_{boltcircle.pole} = 22 \cdot in$

$\text{Dia}_{bar.circle} = 27.3 \cdot in$

## Elevation View - Drilled Shaft with Main Reinforcement and Stirrups




$$s_v = \begin{pmatrix} 4 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot in$$ *stirrup spacing*

$$\#Spaces_{vbar} = \begin{pmatrix} 6 \\ 1 \\ 1 \\ 5 \end{pmatrix}$$ *number of stirrup spaces*

# FDOT Mast Arm Traffic Signal Support Analysis Program V1.2

State Structures Design Office

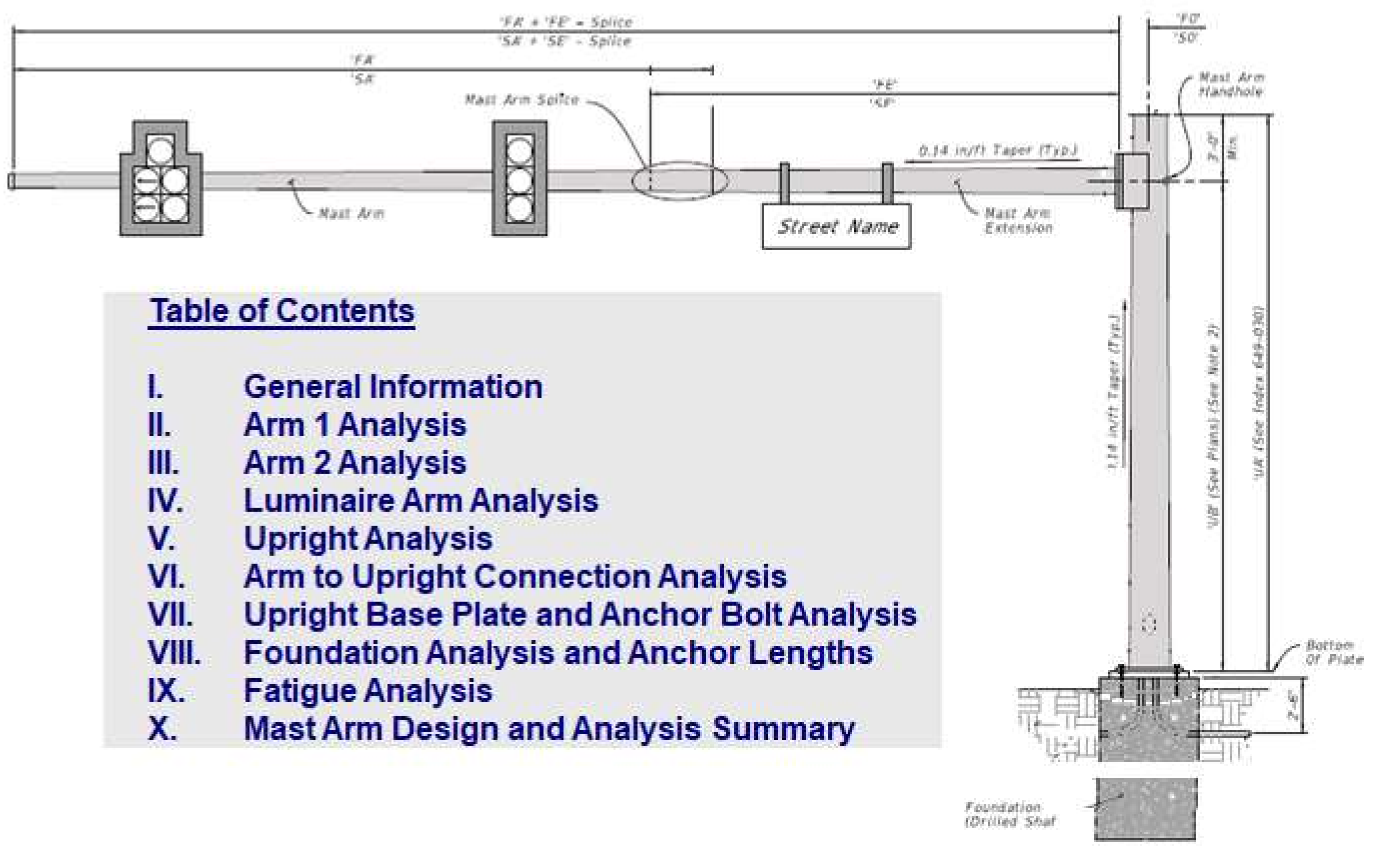


*This program works in conjunction with FDOT Mast Arm Standard Plans 649-030 & 649-031.*

*References:*
*AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (LRFDLTS).*
*FDOT Structures Manual Volume 3 (SM V3).*
*AISC Steel Construction Manual*

*For more information see Reference.xmcd and Changes.xmcd.*

*Reference*




## Table of Contents



## Data Folder and Files

***Data Files Folder***

Change Folder

C:\PWWORKING\east01\d2113434\MastArmV1.2\Data\

***Required*** *- Open Existing Data File. To save New Data Files, enter data variables at the end of Section IX.*

Pole 3.dat
Pole 3_Existing.dat

Refresh List

Open File

## I. General Information and Sign & Signal Data

### Enter Project Information

| | |
|---|---|
| *Project Name* | 43rd St. at Cortez |
| *Project No.* | 10226260 |
| *Designed by* | CMH |
| *Date* | 06/30/2021 |
| *Checked by* | XXX |
| *Date* | XX/XX/XXXX |
| *Signal Name* | Pole 3 |
| *Station/Offset* | 300+15.6 / 79.48' RT |

### Enter Wind Speed

*Design Wind Speed* 148 *mph*

*Extreme Event Wind Speed*

**SDG Wind Speeds by County**

### Enter Arm Lengths, Signal and Sign Data

***Arm 1***

*Arm 1 Length* 46

Reset Arm 1 Data

| *Arm1 Signal Number* | *Distance to Signal (ft)* | *Number of Heads* |
|---|---|---|
| 1 | 17 | 3 |
| 2 | 27 | 3 |
| 3 | 37 | 4 |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

***Arm 2*** *Set Arm 2 Length = 0 for single arm Mast Arms*

*Arm 2 Length* 0

Reset Arm 2 Data

| *Arm2 Signal Number* | *Distance to Signal (ft)* | *Number of Heads* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

***Arm 1 Sign Panels***

| *Arm1 Sign Panel Number* | *Distance to Panel (ft)* | *Panel Area (sf)* |
|---|---|---|
| 1 | 9 | 20 |
| 2 | 45 | 7.5 |
| 3 | 32 | 1 |
| 4 | | |
| 5 | | |

*Note: The VVDS is assumed to be a 1 ft x 1 ft sign for analysis purposes.*

***Arm 2 Sign Panels***

| *Arm2 Sign Panel Number* | *Distance to Panel (ft)* | *Panel Area (sf)* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

▶ Save Data for Signs and Signals

# II. Arm 1 Analysis

InputDataFile = "Pole 3_Existing.dat"    $V_{extreme} = 148 \cdot mph$

*Values for* $Dist_{splice.from.base.arm}$ *that give a base diameter in even inches*

| "Wall Thickness" | "dia-1in" | "dia-2in" | "dia-3in" | "dia-4in" | "dia-5in" | "d-6in" |
|---|---|---|---|---|---|---|
| $t_{wall.arm}$ = 0.179·in | **9.9**·ft | **17.0**·ft | **24.2**·ft | **31.3**·ft | **38.5**·ft | **45.6**·ft |
| $t_{wall.arm}$ = 0.25·in | **10.9**·ft | **18.0**·ft | **25.2**·ft | **32.3**·ft | **39.4**·ft | **46.6**·ft |

Help - Base Diameters | Help - Arm Tip Diameter | Help - Tube Wall Thickness | Help - Arm Lengths | Recommended Distance to Splice

➔ Reference:C:\PWWORKING\east01\d2113434\MastArmV1.2\LRFD Equation Module.xmcd(R)

## Enter Arm 1 Data

| Arm Length (ft) | Base Diameter (in) | Wall Thickness 1 (in) | Wall Thickness 2 (in) | Distance to Splice (ft) |
|---|---|---|---|---|
| $L_{total.arm1} = 46\,ft$ | 13 | 0.25 | 0.375 | 9.7 |
| *feet, 40 ft. max. for 1 piece arms* | *Measured flat to flat* 'FG' | *for 1 & 2 piece arms* 'FD' | *for 2 piece arms only* 'FH' | *for 2 piece arms only* ('Larm' - 'FA') |

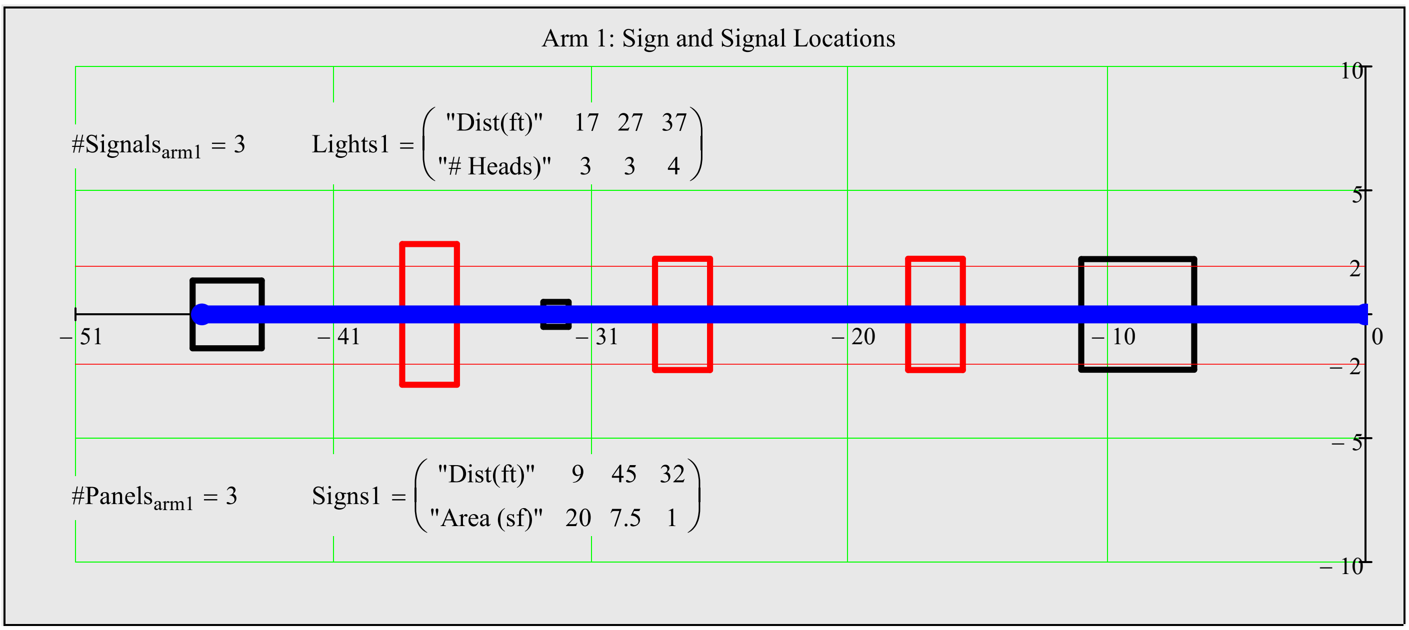
▶ Arm 1 Analysis including Existing Mast Arm Analysis (Additional Variables Required)

*Arm 1 Combined Force Interaction Ratio and Deflection*

BackPlate = "Rigid, 6 inches wide"

$\max(CFI_{arm1}) = 0.55$    $\max(\Delta_{arm1}) = 5.8 \cdot in$    $2 \cdot deg \cdot L_{total.arm1} = 19.3 \cdot in$

*Summary - Arm 1 Geometry and Loading*




$\max(CFI_{arm1}) = 0.55$

$\max(\Delta_{arm1}) = 5.8 \cdot in$

$L_{total.arm1} = 46\,ft$

'FA'= 'FE'= $L_{fabricated.arm1} = \begin{pmatrix} 36.3 \\ 11.7 \end{pmatrix} \cdot ft$

'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 7.08 \\ 11.36 \end{pmatrix} \cdot in$

'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 12.17 \\ 13.00 \end{pmatrix} \cdot in$

'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.250 \\ 0.375 \end{pmatrix} \cdot in$

$Classification_{arm1} = \begin{pmatrix} \text{"Compact"} \\ \text{"Compact"} \end{pmatrix}$

$L_{splice.provided.arm1} = 2 \cdot ft$

## III. Arm 2 Analysis

InputDataFile = "Pole 3_Existing.dat"   $V_{extreme} = 148 \cdot mph$

$Dist_{splice.from.base.arm}$ *values that give a base diameter in even inches*

$$\begin{pmatrix} \text{"Wall Thickness"} & \Delta dia = 1 \cdot in & \Delta dia = 2 \cdot in & \Delta dia = 3 \cdot in & \Delta dia = 4 \cdot in & \Delta dia = 5 \cdot in & \Delta dia = 6 \cdot in \\ t_{wall.arm} = 0.179 \cdot in & 9.9 \cdot ft & 17.0 \cdot ft & 24.2 \cdot ft & 31.3 \cdot ft & 38.5 \cdot ft & 45.6 \cdot ft \\ t_{wall.arm} = 0.25 \cdot in & 10.9 \cdot ft & 18.0 \cdot ft & 25.2 \cdot ft & 32.3 \cdot ft & 39.4 \cdot ft & 46.6 \cdot ft \end{pmatrix}$$

Help - Base Diameters | Help - Arm Tip Diameter | Help - Tube Wall Thickness | Help - Arm Lengths | Recommended Distance to Splice

**Enter Arm 2 Data**

| Arm Length (ft) | Base Diameter (in) | Wall Thickness 1 (in) | Wall Thickness 2 (in) | Distance to Splice (ft) |
|---|---|---|---|---|
| $L_{total.arm2} = 0$ ft | | | | |
| *feet, 40 ft. max. for 1 piece arms* | *Measured flat to flat* **'SG'** | *for 1 & 2 piece arms* **'SD'** | *for 2 piece arms only* **'SH'** | *for 2 piece arms only* (**'Larm' - 'SA'**) |

Arm 2 Analysis including Existing Mast Arm Analysis

*Arm 2 Combined Force Interaction Ratio and Deflection*

$\max(CFI_{arm2}) = 0.00$   BackPlate = "Rigid, 6 inches wide"

*Summary - Arm 2 Geometry and Loading*   $\max(\Delta_{arm2}) = 0.0 \cdot in$   $2 \cdot deg \cdot L_{total.arm2} = 0 \cdot in$

Arm 2: Sign and Signal Locations

10

$\#Signals_{arm2} = 0$   $Lights2 = \begin{pmatrix} \text{"Dist(ft)"} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \text{"\# Heads)"} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

$\#Panels_{arm2} = 0$   $Signs2 = \begin{pmatrix} \text{"Dist(ft)"} & 0 & 0 & 0 & 0 & 0 \\ \text{"Area (sf)"} & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

−10

$-(L_{total.arm2} + 5 \cdot ft)$   0

$\max(CFI_{arm2}) = 0.00$

$\max(\Delta_{arm2}) = 0.0 \cdot in$

$L_{total.arm2} = 0$ ft

'SB'= 'SF'=   $Diameter_{tip.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix} \cdot in$   $Classification_{arm2} = \begin{pmatrix} \text{"Compact"} \\ \text{"N/A"} \end{pmatrix}$

'SC'= 'SG'=   $Diameter_{base.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix} \cdot in$   $L_{splice.provided.arm2} = 0 \cdot ft$

'SA'= 'SE'=   $L_{fabricated.arm2} = \begin{pmatrix} 0.0 \\ 0.0 \end{pmatrix} \cdot ft$   'SD'= 'SH'=   $t_{wall.arm2} = \begin{pmatrix} 0.000 \\ 0.000 \end{pmatrix} \cdot in$

## IV. Luminaire Arm Analysis InputDataFile = "Pole 3_Existing.dat" $V_{extreme} = 148 \cdot mph$

### Enter Luminaire Data

*Set Lum. Ht. = 0 for no Luminaire*

*See Design Standards 649-030 and 649-031 for input values.*

| Luminaire Height (ft) | Lum Horiz Length (ft) | Lum Arm Base Dia (in) | Lum Wall Thickness (in) | Slope | Lum Arm Radius (ft) | Lum Bolt Dia (in) | Lum Base Plate Thickness (in) |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | |
| *Std = 40 feet* | *10 feet* | *3 inches* | *0.125 inches* | *0.5* | *8 feet* | *0.5 inches* | *0.75 inches* |

Analyze Luminaire

*Summary - Luminaire Arm Geometry*

$$\begin{pmatrix} CFI_{base.lumarm} \\ CSR_{bolt.lum} \\ D/C_{baseplate.lum} \\ D/C_{conn.plate.lum} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

'LA'= $Y_{luminaire} = 0\,ft$

'LB'= $X_{luminaire} = 0\,ft$

'LC'= $Diameter_{base.lumarm} = 0 \cdot in$

'LD'= $t_{wall.lumarm} = 0 \cdot in$

'LE'= $Slope_{lumarm} = 0$

'LF'= $r_{lumarm} = 0\,ft$

'LG'= $d_{bolt.lum} = 0 \cdot in$

'LH'= $t_{baseplate.lum} = 0 \cdot in$

'LJ'= $w_{base.lum} = 0 \cdot in$

'LK'= $w_{channel.lum} = 0 \cdot in$

## V. Upright Analysis InputDataFile = "Pole 3_Existing.dat" $V_{extreme} = 148 \cdot mph$

Help - Upright Base Diameter and Wall Thickness | Help - Gap Distance

### Enter Upright Data

| Total Height (ft) | Height to Arm Connection (ft) | Base Diameter (in) | Wall Thickness (in) | Gap (in) | |
|---|---|---|---|---|---|
| 21.5 | 20 | 16 | 0.375 | 7.34 | ***arm 1 gap*** |
| 'UA' | 'UB' | 'UD' *measured flat to flat* | 'UE' | | ***arm 2 gap*** |

Analyze Upright

*Upright Combined Force Interaction Ratio and Deflections*

$Classification_{pole} = \text{"Compact"}$

$\max(CFI_{pole}) = 0.50$

$Check_{slope} = \text{"OK"}$

$Check_{deflection} = \text{"OK"}$

$\max(\Delta_{x.dl}) = 1 \cdot in$

$\max(\Delta_{z.dl}) = 0 \cdot in$

$Slope_z = 0 \cdot deg$

$Slope_x = 0.53 \cdot deg$

$Diameter_{conn.pole} = 13.2 \cdot in$

$$\max\left(\begin{pmatrix} Diameter_{base.arm1_0} \\ Diameter_{base.arm2_0} \end{pmatrix}\right) = 12.2 \cdot in$$

'UA'= $Y_{pole} = 21.5\,ft$

'UB'= $Y_{arm.conn} = 20\,ft$

'UC'= $Diameter_{tip.pole} = 13 \cdot in$

'UD'= $Diameter_{base.pole} = 16 \cdot in$

'UE'= $t_{wall.pole} = 0.375\,in$

'UF'= $\alpha = 0 \cdot deg$

'UG'= $Y_{lum.conn} = 0\,ft$

## VI. Arm to Upright Connection Analysis

InputDataFile = "Pole 3_Existing.dat"

*for double arms, both connection plate heights must be equal*

Help - Arm Connection Dimensions

**Enter Connection Data**

| Connection Plate Height(in) | Connection Plate Width (in) | Vertical Plate Thickness (in) | Bolt Diameter (in) | Arm Base Plate Thickness (in) |
|---|---|---|---|---|
| 22 | 23 | 0.5 | 1 | 2 |
| | | | | |
| 'HT' | 'FJ', 'SJ' | 'FL', 'SL' | 'FP', 'SP' | 'FK', 'SK' |

Analyze Connection

*Connection Summary*

'HT'= $h_{conn.plate} = 22 \cdot in$ $D/C_{ht.conn.plate} = 0.90$ $CheckHt_{conn.plate} = \text{"OK"}$

$D/C_{width.conn.plate_0} = 0.98$

$CheckWidth_{conn.plate_0} = \text{"OK"}$

$$\begin{pmatrix} D/C_{t.baseplate.arm_0} \\ CFI_{t.vert.plate_0} \\ CSR_{bolt.conn_0} \end{pmatrix} = \begin{pmatrix} 1.00 \\ 0.61 \\ 0.45 \end{pmatrix}$$

$\#Bolts_{conn_0} = 6$

'FJ'= $b_{conn.plate_0} = 23 \cdot in$

'FK'= $t_{baseplate.arm_0} = 2.00 \cdot in$

'FL'= $t_{vertical.plate_0} = 0.5 \cdot in$

'FN'= $w_{vertical.plate_0} = \frac{3}{8} \cdot in$

'FO'= $Offset_{conn_0} = 14.0 \cdot in$

'FP'= $d_{bolt.conn_0} = 1 \cdot in$

'FR'= $t_{conn.plate_0} = 2.00 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 9 \cdot in$

'FT'= $w_{conn.plate_0} = \frac{3}{8} \cdot in$

$D/C_{width.conn.plate_1} = 0.00$

$CheckWidth_{conn.plate_1} = \text{"OK"}$

$$\begin{pmatrix} D/C_{t.baseplate.arm_1} \\ CFI_{t.vert.plate_1} \\ CSR_{bolt.conn_1} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

$\#Bolts_{conn_1} = 0$

'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SK'= $t_{baseplate.arm_1} = 0.00 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0.00 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0.00 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

## VII. Upright Base Plate & Anchor Bolt Analysis

InputDataFile = "Pole 3_Existing.dat"

**Enter Anchorage Data**

| Anchor Bolt Diameter (in) | Number of Anchor Bolts |
|---|---|
| 1.5 | 6 |
| 'BC' | '#Bolts' |

Help - Number of Anchor Bolts

$Diameter_{base.pole} = 16 \cdot in$

Analyze Base Plate & Anchors

*Base Plate and Anchor Summary*

'#Bolts'= $\#AnchorBolts = 6$

'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

$CSR_{anchor} = 0.60$

$Diameter_{boltcircle.pole} = 22 \cdot in$

'BC'= $d_{anchorbolt} = 1.50 \cdot in$

$CheckCSR_{anchorbolt} =$ "OK"

'BA'= $Diameter_{baseplate.pole} = 28 \cdot in$

## VIII. Foundation Analysis & Anchor Bolt Lengths

InputDataFile = "Pole 3_Existing.dat"

**Enter Drilled Shaft Data**

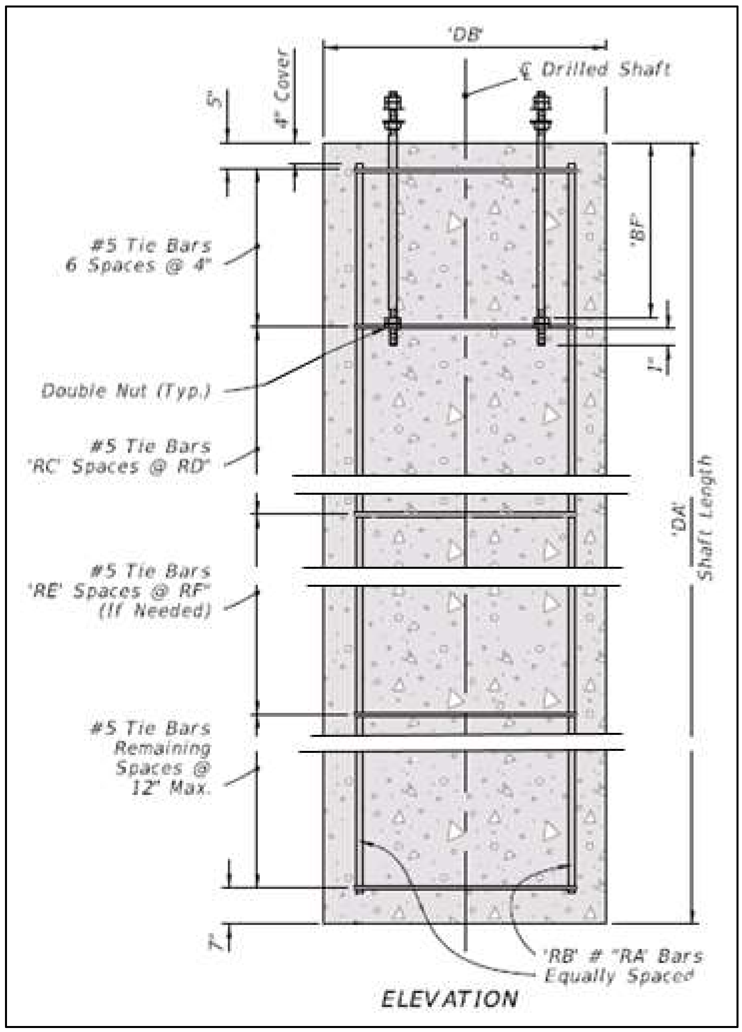
| | | |
|---|---|---|
| *Soil Type* | Sand / Clay | |
| *Soil Density, $\gamma_{soil}$ (45-50 pcf typ.)* | 42.6 | pcf |
| *Friction Angle, $\phi$ (Sands)* | 30 | deg |
| *SPT Number ($N_{blows}$ 5 min. ) (Sands)* | 15 | |
| *Shear Strength, c (Clays)* | 2000 | psf |
| *Ground to Top of Shaft Offset* | 0.5 | ft |

***First Set of User Defined Stirrups:***

| | | | |
|---|---|---|---|
| *Number of Stirrup Spaces* | 'RC' | 1 | |
| *Stirrup Spacing* | 'RD' | 12 | in |

***Second Set of User Defined Stirrups:***

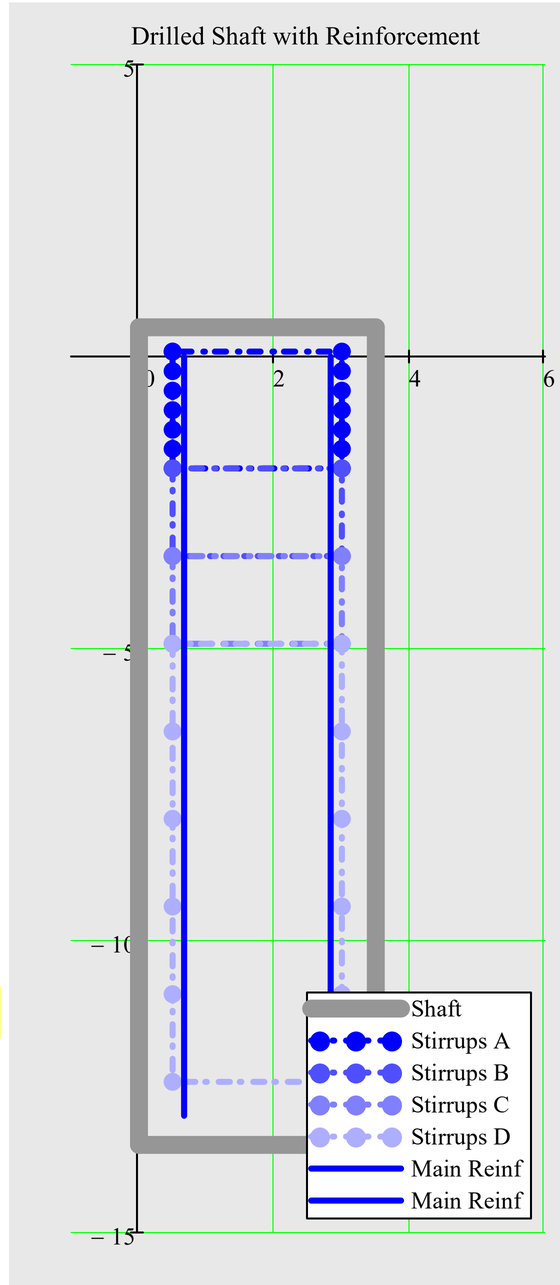
| | | | |
|---|---|---|---|
| *Number of Stirrup Spaces*<br>*enter zero for 12 inch spacing* | 'RE' | 1 | |
| *Stirrup Spacing*<br>*enter zero for 12 inch spacing* | 'RF' | 12 | in |
| *Stirrup Bar Size, use #5*<br>*for all Standard Shafts* | | #5 / #6 | |




Analyze Foundation

*Shaft Length* *Stirrup spacing* *Number of stirrup spaces*

$L_{shaft} = 14\,ft$ $s_v = \begin{pmatrix} 4 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot in$ $\#Spaces_{vbar} = \begin{pmatrix} 6 \\ 1 \\ 1 \\ 5 \end{pmatrix}$




*Foundation Summary*

CheckReinfClearSpacing = "OK"

$CheckLongReinf_{shr.tor}$ = "OK"

CheckMaxSpacingTransvReinf = "OK"

OverlapDesign = "Based on Overlap of Failure Cones"

OverlapTest = "Overlap of Failure Cones"

BreakoutTest = "OK"

*Stirrups* $s_{v_0} = 4 \cdot in$ @ $\#Spaces_{vbar_0} = 6$ : $D/C_{torsion_0} = 0.3$

*Stirrups* 'RC' ( $s_{v_1} = 18 \cdot in$ ) @ 'RD' ( $\#Spaces_{vbar_1} = 1$ ): $D/C_{torsion_1} = 1.2$

*Stirrups* 'RE' ( $s_{v_2} = 18 \cdot in$ ) @ 'RF' ( $\#Spaces_{vbar_2} = 1$ ): $D/C_{torsion_2} = 1.2$

*Stirrups* $s_{v_3} = 18 \cdot in$ @ $\#Spaces_{vbar_3} = 5$

Offset = 0.5 ft

$d_{long.bar} = 1.41 \cdot in$

$Dia_{bar.circle} = 27.3 \cdot in$

'DA'= $L_{shaft} = 14 \cdot ft$

'DB'= $Diameter_{shaft} = 3.5 \cdot ft$

'BF'= $L_{embedment.anchor} = 36 \cdot in$

$L_{anchor.bolt} = 46 \cdot in$

'RA'= $round\left(\frac{d_{long.bar}}{0.125in}\right) = 11$

'RB'= $\#LongBars_{prov} = 10$

$\#Spaces_{vbar_0} = 6$

$s_{v_0} = 4 \cdot in$

'RC'= $\#Spaces_{vbar_1} = 1$

'RD'= $s_{v_1} = 18 \cdot in$

'RE'= $\#Spaces_{vbar_2} = 1$

'RF'= $s_{v_2} = 18 \cdot in$

$\#Spaces_{vbar_3} = 5$

$s_{v_3} = 18 \cdot in$

## IX. Fatigue Analysis

InputDataFile = "Pole 3_Existing.dat"

$FatigueCategory_{galloping} := 2$ $FatigueCategory_{natural.wind} := 2$ **SM V3 11.6**

Analyze Structure for Fatigue

## Fatigue Summary

*K1 values within 2% of LTS thresholds of 3.0 and 4.0 may use next higher CAFT values*

*Arm and Pole Welds*

| | | |
|---|---|---|
| $Check_{galloping.arm1}$ = "OK" | $f_{galloping.arm1} = 4.8 \cdot ksi$ | $CAFT_{fullpengroove.weld.arm1} = 7 \cdot ksi$ |
| $Check_{galloping.arm2}$ = "NA" | $f_{galloping.arm2} = 0.0 \cdot ksi$ | $CAFT_{fullpengroove.weld.arm2}$ = "NA"·ksi |
| $Check_{galloping.pole}$ = "No Good" | $f_{galloping.pole} = 3.2 \cdot ksi$ | $CAFT_{fullpengroove.weld.pole} = 2.6 \cdot ksi$ |
| $Check_{nwg.arm1}$ = "OK" | $f_{nwg.arm1} = 2.7 \cdot ksi$ | $CAFT_{fullpengroove.weld.arm1} = 7 \cdot ksi$ |
| $Check_{nwg.arm2}$ = "NA" | $f_{nwg.arm2} = 0.0 \cdot ksi$ | $CAFT_{fullpengroove.weld.arm2}$ = "NA"·ksi |
| $Check_{nwg.pole}$ = "OK" | $f_{nwg.pole} = 2.3 \cdot ksi$ | $CAFT_{fullpengroove.weld.pole} = 2.6 \cdot ksi$ |

$$CheckK1Values = \begin{pmatrix} \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \end{pmatrix} \quad \begin{pmatrix} K_{I.arm1} \\ K_{I.arm2} \\ K_{I.pole} \end{pmatrix} = \begin{pmatrix} 3.395 \\ 100.000 \\ 6.895 \end{pmatrix} \begin{pmatrix} \text{"Arm 1 Base Weld"} \\ \text{"Arm 2 Base Weld"} \\ \text{"Upright Base Weld"} \end{pmatrix}$$

*A325 Connection Bolts*

$$Check_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix} \quad f_{t.g.bolt} = \begin{pmatrix} 7.4 \\ 0.0 \end{pmatrix} \cdot ksi$$

$$CAFT_{conn.bolt} = 16 \cdot ksi$$

$$Check_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix} \quad f_{t.nwg.bolt} = \begin{pmatrix} 4.2 \\ 0.0 \end{pmatrix} \cdot ksi$$

*Anchor Bolts*

| | | |
|---|---|---|
| $Check_{g.anchor}$ = "OK" | $f_{t.g.anchor} = 4.1 \cdot ksi$ | $CAFT_{anchor.bolts} = 7 \cdot ksi$ |
| $Check_{nwg.anchor}$ = "OK" | $f_{t.nwg.anchor} = 3 \cdot ksi$ | |

***Save Data File (optional)***

☑ Use current input file

*File Name* Pole 3_Existing.dat

*Note: Select an output folder by using the "Change Folder" option above.*

Save Data

*Arm Designation Example*

A70/D-A30/D/H-P5/D/L-DS/16/5

| | |
|---|---|
| A70/D - | *Arm 70 feet long, Double Arm* |
| A30/D/H - | *Arm 30 feet long, Double Arm, Heavy Duty* |
| P5/D/L - | *Pole 5 , Double Arm, with Luminaire* |
| DS/16/5 - | *Drilled Shaft 16 ft deep, 5 foot diameter* |

## X. Mast Arm Design and Analysis Summary

InputDataFile = "Pole 3_Existing.dat"

*If comparing results to Standard Index 649-030, some values in the index have been increased to reduce the number of variations.*

**Subject** = "43rd St. at Cortez" **DesignedBy** = "CMH" **PoleLocation** = "300+15.6 / 79.48' RT"

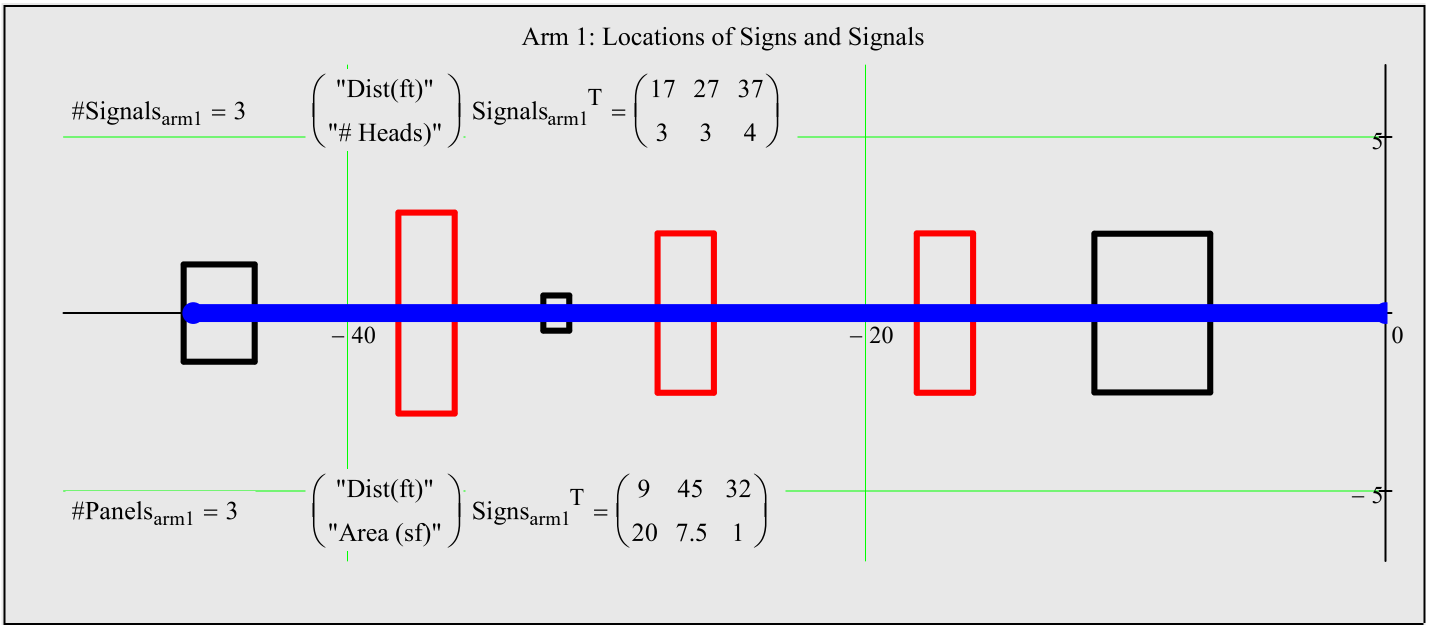
**ProjectNo** = "10226260" **CheckedBy** = "XXX" **Date** = "06/30/2021"

ExistingMastArm = "Yes"

***For FDOT Mast Arm Support Structures,*** max(CFI) $\le$ 0.95 ***(See Structures Manual Volume3)***

## 1st Mast Arm

$V_{extreme} = 148 \cdot mph$ ExistingMastArm = "Yes" BackPlate = "Rigid, 6 inches wide"




$\max(CFI_{arm1}) = 0.55$ $L_{total.arm1} = 46\,ft$ $L_{splice.provided.arm1} = 2 \cdot ft$ $\max(\Delta_{arm1}) = 5.8 \cdot in$

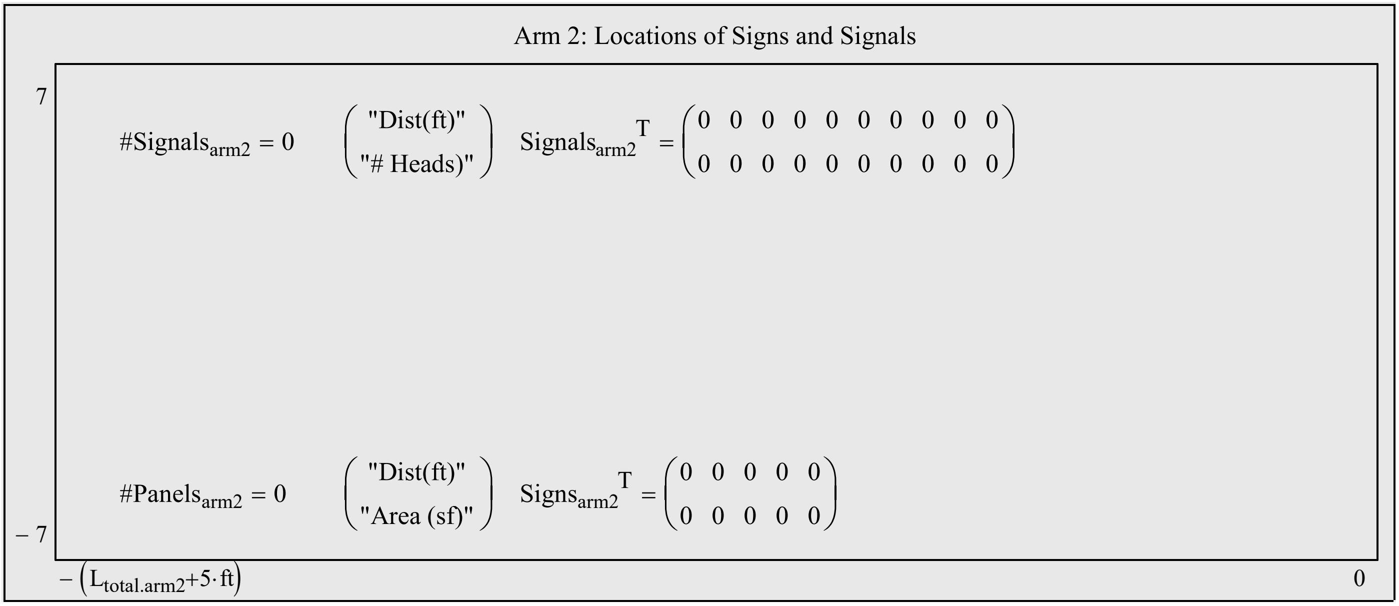
'FA'= 'FE'= $L_{fabricated.arm1} = \begin{pmatrix} 36.3 \\ 11.7 \end{pmatrix} \cdot ft$

'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 12.17 \\ 13.00 \end{pmatrix} \cdot in$

'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 7.08 \\ 11.36 \end{pmatrix} \cdot in$

'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.250 \\ 0.375 \end{pmatrix} \cdot in$

## 2nd Mast Arm




$\max\left(CFI_{arm2}\right) = 0.00$ $\quad L_{total.arm2} = 0\,ft$ $\quad L_{splice.provided.arm2} = 0\cdot ft$ $\quad \max\left(\Delta_{arm2}\right) = 0\cdot in$

'SA'= 'SE'= $L_{fabricated.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot ft$

'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix}\cdot in$

'UF'= $\alpha = 0\cdot deg$ **(Angle Between Arms)**

'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix}\cdot in$

'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0.000 \\ 0.000 \end{pmatrix}\cdot in$

## Luminaire Arm and Connection *(use MC10x33.6 channel for connection)*

$$\begin{pmatrix} CFI_{base.lumarm} \\ CSR_{bolt.lum} \\ D/C_{baseplate.lum} \\ D/C_{conn.plate.lum} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 6.82\times 10^{-9} \\ 0.00 \\ 0.00 \end{pmatrix}$$

'LA'= $Y_{luminaire} = 0\,ft$

'LB'= $X_{luminaire} = 0\,ft$

'LC'= $Diameter_{base.lumarm} = 0\cdot in$

'LD'= $t_{wall.lumarm} = 0\cdot in$

'LE'= $Slope_{lumarm} = 0$

'LF'= $r_{lumarm} = 0\,ft$

'LG'= $d_{bolt.lum} = 0\cdot in$

'LH'= $t_{baseplate.lum} = 0\cdot in$

'LJ'= $w_{base.lum} = 0\cdot in$

'LK'= $w_{channel.lum} = 0\cdot in$

## Upright

$\max\left(CFI_{pole}\right) = 0.50$ $\quad Check_{deflection} = \text{"OK"}$ $\quad Check_{slope} = \text{"OK"}$

'UA'= $Y_{pole} = 21.5\,ft$

'UB'= $Y_{arm.conn} = 20\cdot ft$

'UC'= $Diameter_{tip.pole} = 13\cdot in$

'UD'= $Diameter_{base.pole} = 16\cdot in$

'UE'= $t_{wall.pole} = 0.375\,in$

'UF'= $\alpha = 0\cdot deg$

'UG'= $Y_{lum.conn} = 0\,ft$

## 1st Arm to Upright Connection

$D/C_{ht.conn.plate} = 0.90$

'HT'= $h_{conn.plate} = 22 \cdot in$

$CheckHt_{conn.plate} = "OK"$

$\#Bolts_{conn_0} = 6$

'FO'= $Offset_{conn_0} = 14.0 \cdot in$

$D/C_{width.conn.plate_0} = 0.98$

'FJ'= $b_{conn.plate_0} = 23 \cdot in$

'FP'= $d_{bolt.conn_0} = 1 \cdot in$

$CheckWidth_{conn.plate_0} = "OK"$

'FK'= $t_{baseplate.arm_0} = 2 \cdot in$

'FR'= $t_{conn.plate_0} = 2 \cdot in$

$$\begin{pmatrix} D/C_{t.baseplate.arm_0} \\ CFI_{t.vert.plate_0} \\ CSR_{bolt.conn_0} \end{pmatrix} = \begin{pmatrix} 1.00 \\ 0.61 \\ 0.45 \end{pmatrix}$$

'FL'= $t_{vertical.plate_0} = 0.5 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 9 \cdot in$

'FN'= $w_{vertical.plate_0} = \frac{3}{8} \cdot in$

'FT'= $w_{conn.plate_0} = \frac{3}{8} \cdot in$

## 2nd Arm to Upright Connection

'HT'= $h_{conn.plate} = 22 \cdot in$

$D/C_{width.conn.plate_1} = 0.00$

$CheckWidth_{conn.plate_1} = "OK"$

$\#Bolts_{conn_1} = 0$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

$$\begin{pmatrix} D/C_{t.baseplate.arm_1} \\ CFI_{t.vert.plate_1} \\ CSR_{bolt.conn_1} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

'SK'= $t_{baseplate.arm_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

## Pole Base Plate

$CSR_{anchor} = 0.60$

'#Bolts'= $\#AnchorBolts = 6$

'BA'= $Diameter_{baseplate.pole} = 28 \cdot in$

$CheckCSR_{anchorbolt} = "OK"$

$Diameter_{boltcircle.pole} = 22 \cdot in$

'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

'BC'= $d_{anchorbolt} = 1.50 \cdot in$

'BF'= $L_{embedment.anchor} = 36 \cdot in$

$L_{anchor.bolt} = 46 \cdot in$

## Foundation

$D/C_{torsion.max} = 1.21$

$CheckD/C_{shear.and.torsion}$ = "No Good"

CheckReinfClearSpacing = "OK"

$CheckLongReinf_{shr.tor}$ = "OK"

CheckMaxSpacingTransvReinf = "OK"

OverlapDesign = "Based on Overlap of Failure Cones"

OverlapTest = "Overlap of Failure Cones"

BreakoutTest = "OK"

$Clearance_{csl.to.nut} = -0 \cdot in$

$Offset = 0.5\,ft$

$d_{long.bar} = 1.41 \cdot in$

$Dia_{bar.circle} = 27.3 \cdot in$

'DA'= $L_{shaft} = 14 \cdot ft$

'DB'= $Diameter_{shaft} = 3.5 \cdot ft$

'RA'= $round\left(\frac{d_{long.bar}}{0.125 in}\right) = 11$

'RB'= $\#LongBars_{prov} = 10$

'RC'= $\#Spaces_{vbar_1} = 1$

'RD'= $s_{v_1} = 18 \cdot in$

'RE'= $\#Spaces_{vbar_2} = 1$

'RF'= $s_{v_2} = 18 \cdot in$

## Fatigue

$Check_{galloping.arm1}$ = "OK"

$Check_{galloping.arm2}$ = "NA"

$Check_{galloping.pole}$ = "No Good"

$Check_{nwg.arm1}$ = "OK"

$Check_{nwg.arm2}$ = "NA"

$Check_{nwg.pole}$ = "OK"

$Check_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$Check_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$Check_{g.anchor}$ = "OK"

$Check_{nwg.anchor}$ = "OK"

*K1 values within 2% of LTS thresholds may use next higher CAFT values*

$CheckK1Values = \begin{pmatrix} \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \end{pmatrix}$

$\begin{pmatrix} K_{I.arm1} \\ K_{I.arm2} \\ K_{I.pole} \end{pmatrix} = \begin{pmatrix} 3.395 \\ 100.000 \\ 6.895 \end{pmatrix}$ $\begin{pmatrix} \text{"Arm 1 Base Weld"} \\ \text{"Arm 2 Base Weld"} \\ \text{"Upright Base Weld"} \end{pmatrix}$

WRITEPRN to Line 1-2-3 for Mast Arm Data Table

## Mast Arm Tip Deflection

*Compare Mast Arm deflection of each arm to a proposed camber*

$Camber_{arm1} := \mathbf{2} \cdot deg$ $Camber_{arm2} := \mathbf{2} \cdot deg$

$Deflection_{arm1} := Slope_x \cdot L_{total.arm1} + max(\Delta_{arm1}) = 11 \cdot in$

$CamberArm1_{upward} := sin(Camber_{arm1}) \cdot L_{total.arm1} = 19.3 \cdot in$

$Deflection_{arm2} := [Slope_z \cdot L_{total.arm2} \cdot (sin(\alpha))] + Slope_x \cdot L_{total.arm2} \cdot cos(\alpha) + max(\Delta_{arm2}) = 0 \cdot in$

$CamberArm2_{upward} := sin(Camber_{arm2}) \cdot L_{total.arm2} = 0 \cdot in$

## Check Clearance Between Connection Plates *(for Two Arm Structures only)*

$\alpha = 0 \cdot deg$ $\quad\quad$ $\alpha := if[(\alpha > 180 \cdot deg), (360 \cdot deg - \alpha), \alpha]$

$Offset_{conn_0} = 14 \cdot in$ $\quad$ $b_{conn.plate_0} = 23 \cdot in$ $\quad$ $h_{conn.plate} = 22 \cdot in$ $\quad$ $\alpha = 0 \cdot deg$

$Offset_{conn_1} = 0 \cdot in$ $\quad$ $b_{conn.plate_1} = 0 \cdot in$

$$x1 := Offset_{conn_0} - t_{conn.plate_0} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm1})}{2} = 11.6 \cdot in \qquad y1 := \frac{b_{conn.plate_0}}{2} = 11.5 \cdot in$$

$$x2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \cos(\alpha) + \frac{b_{conn.plate_1}}{2} \cdot \sin(\alpha) = -0.4 \cdot in$$

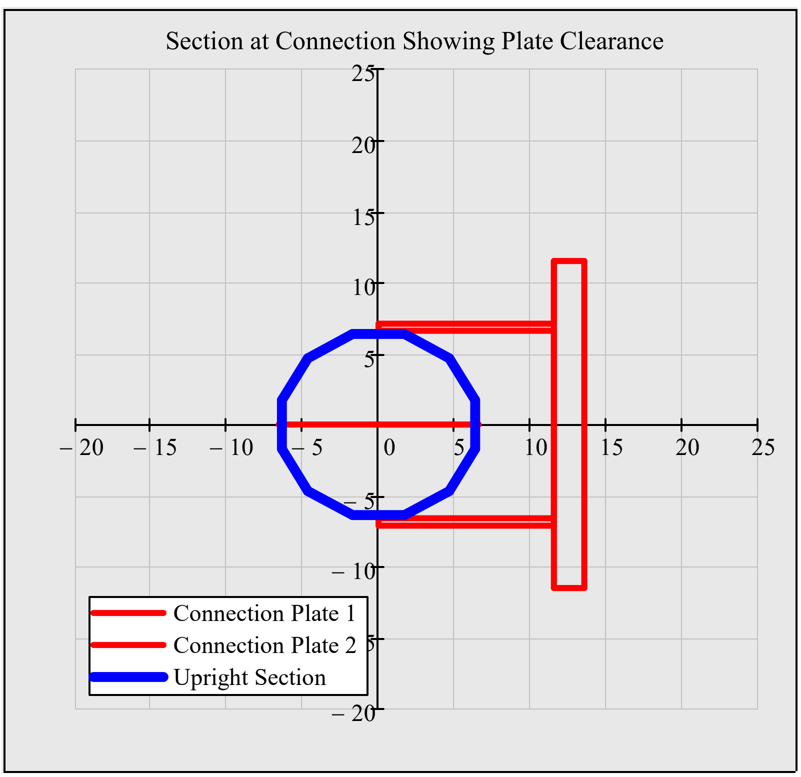
$$y2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \sin(\alpha) - \frac{b_{conn.plate_1}}{2} \cdot \cos(\alpha) = 0 \cdot in$$

$$Clearance_{plate.to.plate} := if\left[(x1 > x2) \cdot (y2 > y1), \sqrt{(x1 - x2)^2 + (y1 - y2)^2}, 0 \cdot in\right] = 0 \cdot in$$

***(if Clearance < 2 inches, a redesign is required.***

▶ Coordinates for Drawings

## Plan View - Connection Plate Clearance for Two Arm Connections




$Clearance_{plate.to.plate} = 0 \cdot in$

$Diameter_{conn.pole} = 13.2 \cdot in$

'FR'= $t_{conn.plate_0} = 2 \cdot in$

'FJ'= $b_{conn.plate_0} = 23 \cdot in$

'FL'= $t_{vertical.plate_0} = 0.5 \cdot in$

'FO'= $Offset_{conn_0} = 14.0 \cdot in$

$Gap_0 = 7.34 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

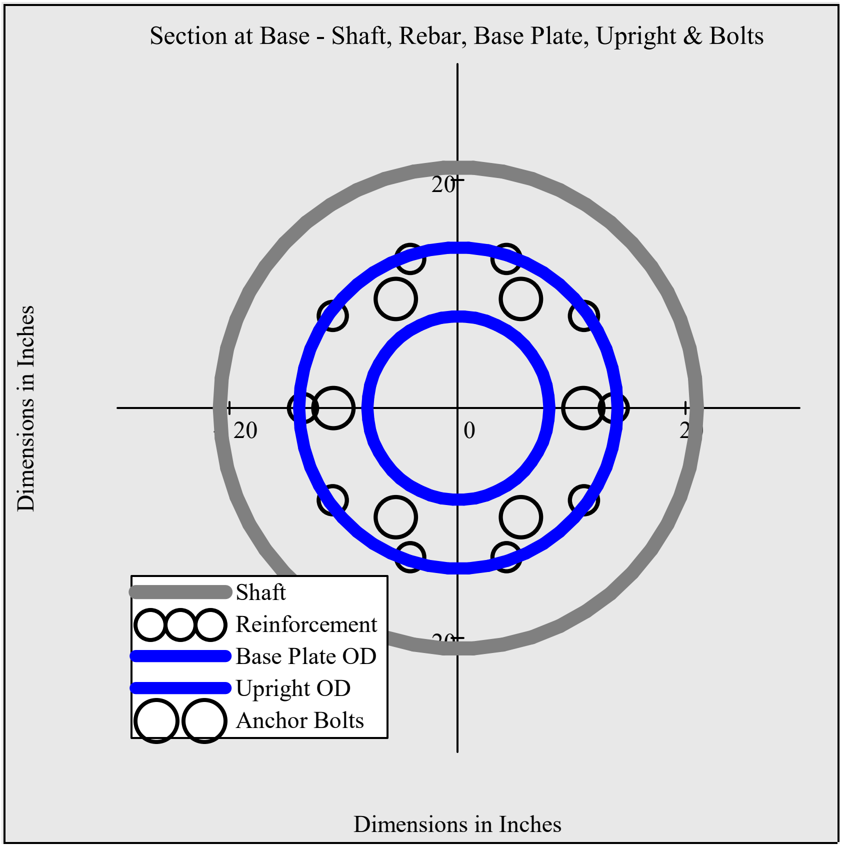
'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

$Gap_1 = 0 \cdot in$

## Plan View - Drilled Shaft, Base Plate, Upright, Anchor Bolts, & Reinforcing Steel




$\text{Clearance}_{bar.to.nut} = 0.6 \cdot in$

'UD'= $\text{Diameter}_{base.pole} = 16 \cdot in$

'BA'= $\text{Diameter}_{baseplate.pole} = 28 \cdot in$

'DB'= $\text{Diameter}_{shaft} = 42 \cdot in$

$\text{Diameter}_{boltcircle.pole} = 22 \cdot in$

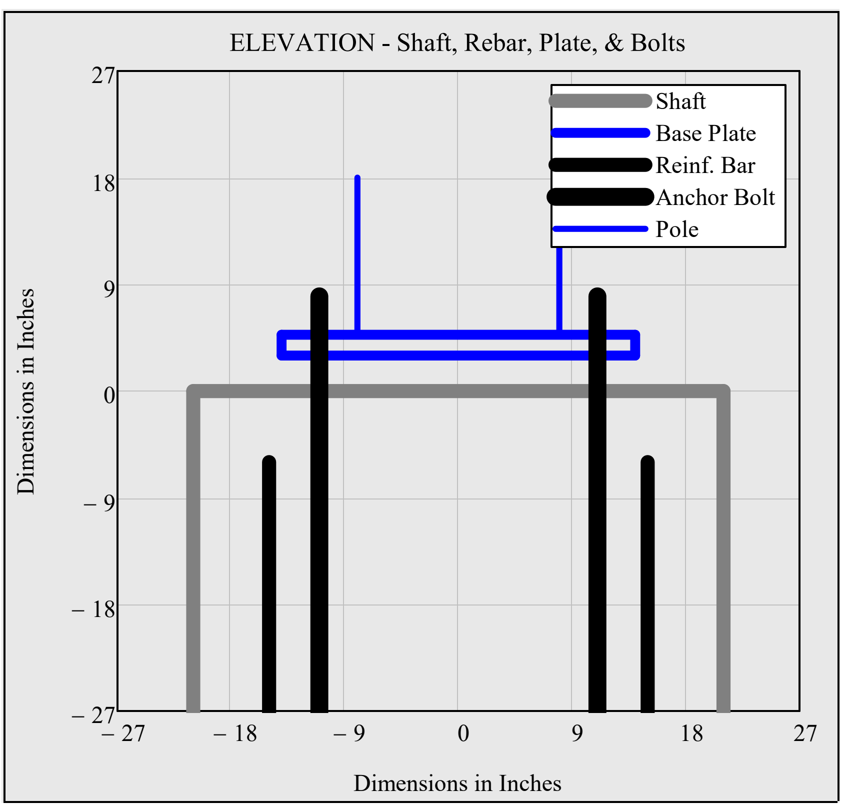
$\text{Dia}_{bar.circle} = 27.3 \cdot in$

$\#\text{AnchorBolts} = 6$

$\#\text{LongBars}_{prov} = 10$

*Note: The Plan and Elevation Views do not show the 4 or 5 1.9" O.D. Nondestructive Integrity Testing Access Tubes that are tied to the inside of the reinforcing cage (see FDOT Spec 455-16.4).*

## Elevation View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$\text{Clearance}_{bar.to.nut} = 0.6 \cdot in$

'UD'= $\text{Diameter}_{base.pole} = 16 \cdot in$

'BA'= $\text{Diameter}_{baseplate.pole} = 28 \cdot in$

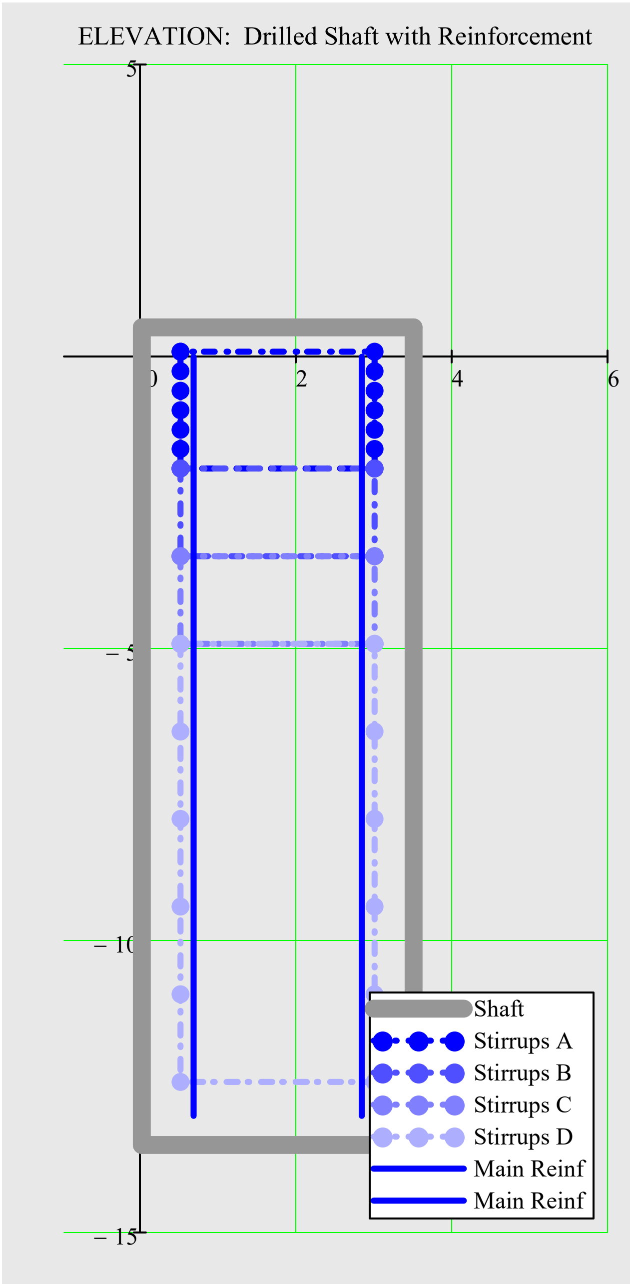
'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

'DB'= $\text{Diameter}_{shaft} = 42 \cdot in$

$\text{Diameter}_{boltcircle.pole} = 22 \cdot in$

$\text{Dia}_{bar.circle} = 27.3 \cdot in$

## Elevation View - Drilled Shaft with Main Reinforcement and Stirrups




$$s_v = \begin{pmatrix} 4 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot in$$ *stirrup spacing*

$$\#Spaces_{vbar} = \begin{pmatrix} 6 \\ 1 \\ 1 \\ 5 \end{pmatrix}$$ *number of stirrup spaces*

# FDOT Mast Arm Traffic Signal Support Analysis Program V1.2

State Structures Design Office



*This program works in conjunction with FDOT Mast Arm Standard Plans 649-030 & 649-031.*

*References:*
*AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (LRFDLTS).*
*FDOT Structures Manual Volume 3 (SM V3).*
*AISC Steel Construction Manual*

*For more information see Reference.xmcd and Changes.xmcd.*

*Reference*

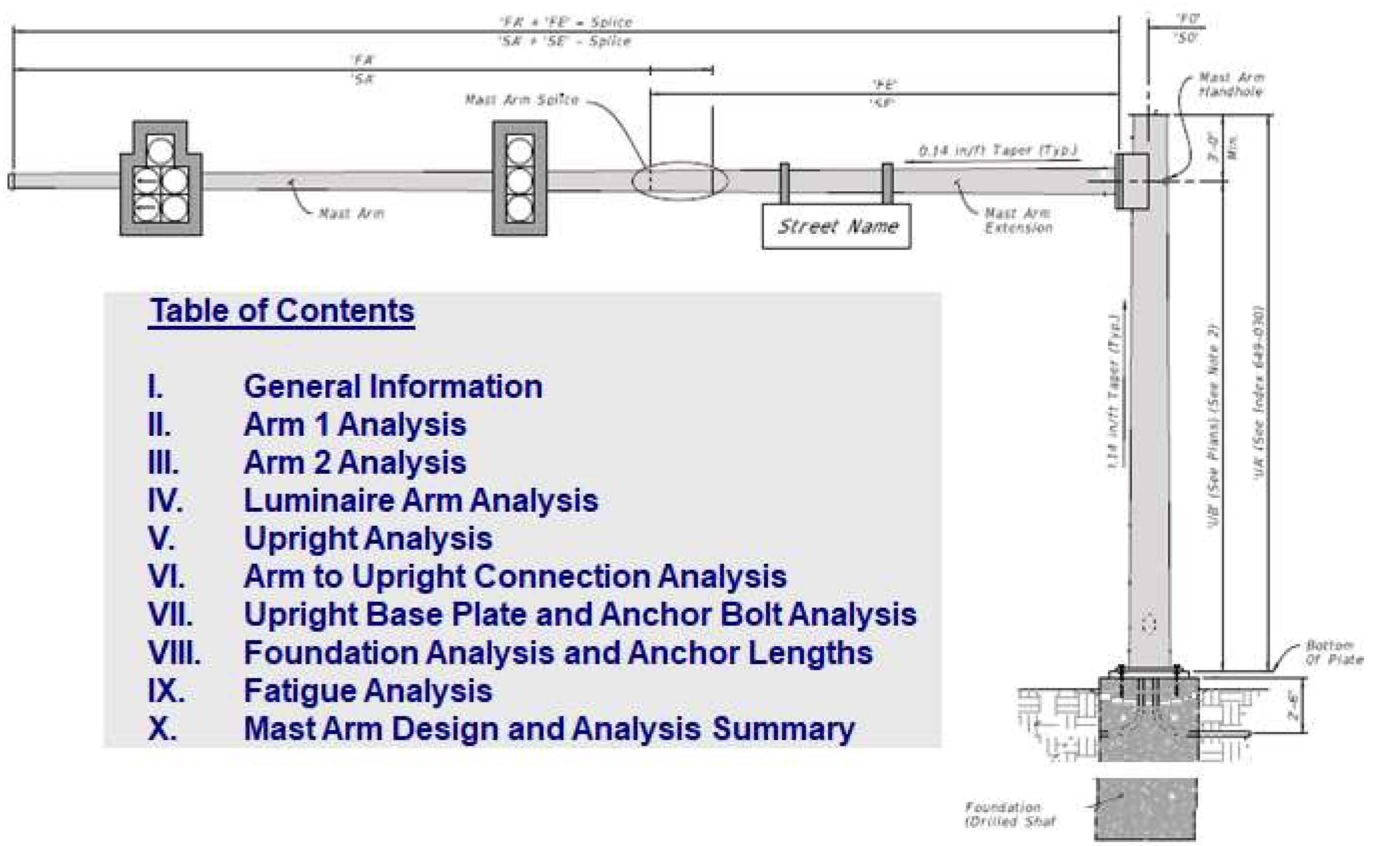



Table of Contents



## Data Folder and Files

***Data Files Folder***

Change Folder

C:\PWWORKING\east01\d2476894\MastArmV1.2\Data\

***Required** - Open Existing Data File. To save New Data Files, enter data variables at the end of Section IX.*

Pole 4.dat

Refresh List

Open File

## I. General Information and Sign & Signal Data

### Enter Project Information

| | |
|---|---|
| *Project Name* | 43rd St. at Cortez |
| *Project No.* | 10226260 |
| *Designed by* | CMH |
| *Date* | 06/30/2021 |
| *Checked by* | XXX |
| *Date* | XX/XX/XXXX |
| *Signal Name* | Pole 4 |
| *Station/Offset* | 301+62.6 / 67.18' LT |

### Enter Wind Speed

*Design Wind Speed* 148 *mph*

*Extreme Event Wind Speed*

**SDG Wind Speeds by County**

### Enter Arm Lengths, Signal and Sign Data

***Arm 1***

*Arm 1 Length* 60

Reset Arm 1 Data

| *Arm1 Signal Number* | *Distance to Signal (ft)* | *Number of Heads* |
|---|---|---|
| 1 | 34 | 3 |
| 2 | 46 | 3 |
| 3 | 58 | 4 |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

***Arm 2*** *Set Arm 2 Length = 0 for single arm Mast Arms*

*Arm 2 Length* 0

Reset Arm 2 Data

| *Arm2 Signal Number* | *Distance to Signal (ft)* | *Number of Heads* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

***Arm 1 Sign Panels***

| *Arm1 Sign Panel Number* | *Distance to Panel (ft)* | *Panel Area (sf)* |
|---|---|---|
| 1 | 12 | 20 |
| 2 | 55 | 7.5 |
| 3 | 52 | 1 |
| 4 | 40 | 1 |
| 5 | | |

*Note: The VVDS and MVDS is assumed to be a 1 ft x 1 ft sign for analysis purposes.*

***Arm 2 Sign Panels***

| *Arm2 Sign Panel Number* | *Distance to Panel (ft)* | *Panel Area (sf)* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

▸ Save Data for Signs and Signals

## II. Arm 1 Analysis

InputDataFile = "Pole 4.dat"  $V_{extreme} = 148 \cdot mph$

*Values for* $Dist_{splice.from.base.arm}$ *that give a base diameter in even inches*

| "Wall Thickness" | "dia-1in" | "dia-2in" | "dia-3in" | "dia-4in" | "dia-5in" | "d-6in" |
|---|---|---|---|---|---|---|
| $t_{wall.arm} = 0.179 \cdot in$ | ***9.9***·ft | ***17.0***·ft | ***24.2***·ft | ***31.3***·ft | ***38.5***·ft | ***45.6***·ft |
| $t_{wall.arm} = 0.25 \cdot in$ | ***10.9***·ft | ***18.0***·ft | ***25.2***·ft | ***32.3***·ft | ***39.4***·ft | ***46.6***·ft |

Help - Base Diameters | Help - Arm Tip Diameter | Help - Tube Wall Thickness | Help - Arm Lengths | Recommended Distance to Splice

➔ Reference:C:\PWWORKING\east01\d2476894\MastArmV1.2\LRFD Equation Module.xmcd(R)

### Enter Arm 1 Data

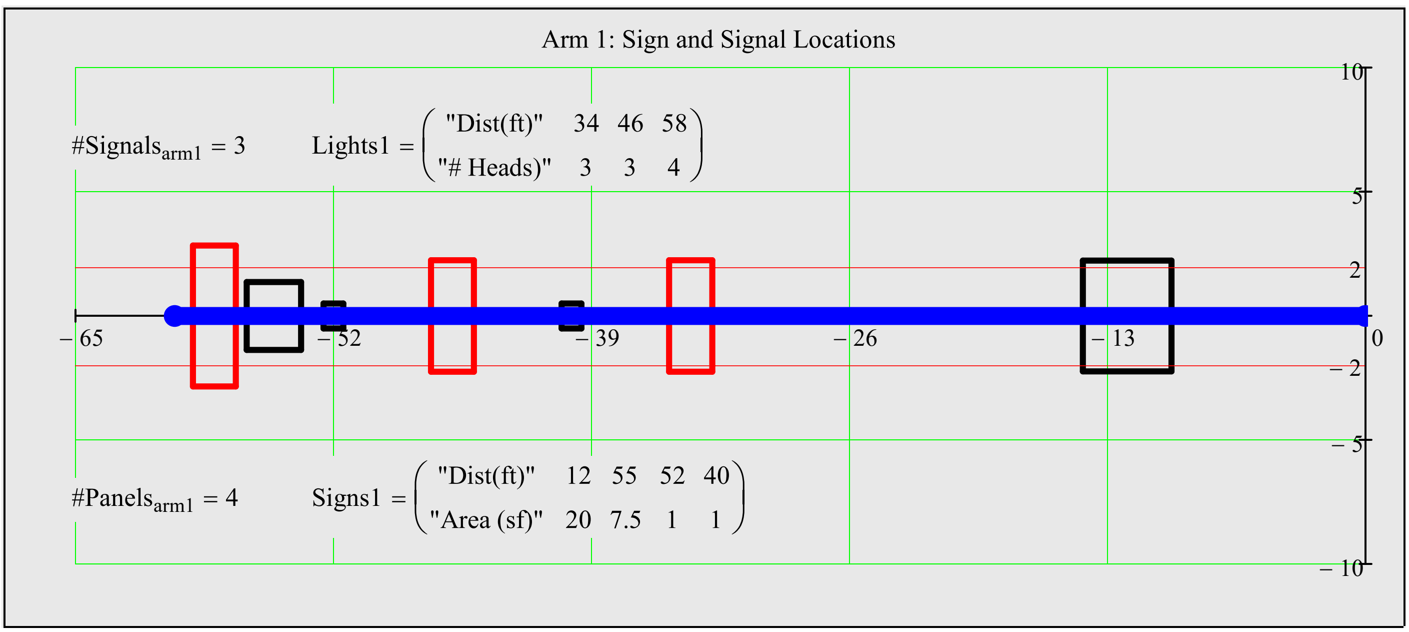
| *Arm Length (ft)* | *Base Diameter (in)* | *Wall Thickness 1 (in)* | *Wall Thickness 2 (in)* | *Distance to Splice (ft)* |
|---|---|---|---|---|
| $L_{total.arm1} = 60\,ft$ | 14 | 0.375 | 0.5 | 24 |
| *feet, 40 ft. max. for 1 piece arms* | *Measured flat to flat* **'FG'** | *for 1 & 2 piece arms* **'FD'** | *for 2 piece arms only* **'FH'** | *for 2 piece arms only* **('Larm' - 'FA')** |

▸ Arm 1 Analysis including Existing Mast Arm Analysis (Additional Variables Required)

*Arm 1 Combined Force Interaction Ratio and Deflection*  BackPlate = "Rigid, 6 inches wide"

$\max(CFI_{arm1}) = 0.58$  $\max(\Delta_{arm1}) = 14.5 \cdot in$  $2 \cdot deg \cdot L_{total.arm1} = 25.1 \cdot in$

*Summary - Arm 1 Geometry and Loading*




$\max(CFI_{arm1}) = 0.58$

$\max(\Delta_{arm1}) = 14.5 \cdot in$

$L_{total.arm1} = 60\,ft$

**'FA'=** **'FE'=** $L_{fabricated.arm1} = \begin{pmatrix} 36.0 \\ 26.0 \end{pmatrix} \cdot ft$

**'FB'=** **'FF'=** $Diameter_{tip.arm1} = \begin{pmatrix} 6.37 \\ 10.36 \end{pmatrix} \cdot in$

**'FC'=** **'FG'=** $Diameter_{base.arm1} = \begin{pmatrix} 11.41 \\ 14.00 \end{pmatrix} \cdot in$

**'FD'=** **'FH'=** $t_{wall.arm1} = \begin{pmatrix} 0.375 \\ 0.500 \end{pmatrix} \cdot in$

$Classification_{arm1} = \begin{pmatrix} \text{"Compact"} \\ \text{"Compact"} \end{pmatrix}$

$L_{splice.provided.arm1} = 2 \cdot ft$

## III. Arm 2 Analysis

InputDataFile = "Pole 4.dat"  $V_{extreme} = 148 \cdot mph$

$Dist_{splice.from.base.arm}$ *values that give a base diameter in even inches*

| "Wall Thickness" | $\Delta dia = 1 \cdot in$ | $\Delta dia = 2 \cdot in$ | $\Delta dia = 3 \cdot in$ | $\Delta dia = 4 \cdot in$ | $\Delta dia = 5 \cdot in$ | $\Delta dia = 6 \cdot in$ |
|---|---|---|---|---|---|---|
| $t_{wall.arm} = 0.179 \cdot in$ | ***9.9***·ft | ***17.0***·ft | ***24.2***·ft | ***31.3***·ft | ***38.5***·ft | ***45.6***·ft |
| $t_{wall.arm} = 0.25 \cdot in$ | ***10.9***·ft | ***18.0***·ft | ***25.2***·ft | ***32.3***·ft | ***39.4***·ft | ***46.6***·ft |

Help - Base Diameters | Help - Arm Tip Diameter | Help - Tube Wall Thickness | Help - Arm Lengths | Recommended Distance to Splice

**Enter Arm 2 Data**

| *Arm Length (ft)* | *Base Diameter (in)* | *Wall Thickness 1 (in)* | *Wall Thickness 2 (in)* | *Distance to Splice (ft)* |
|---|---|---|---|---|
| $L_{total.arm2} = 0 \text{ ft}$ | | | | |
| *feet, 40 ft. max. for 1 piece arms* | *Measured flat to flat* **'SG'** | *for 1 & 2 piece arms* **'SD'** | *for 2 piece arms only* **'SH'** | *for 2 piece arms only* (**'Larm' - 'SA'**) |

Arm 2 Analysis including Existing Mast Arm Analysis

*Arm 2 Combined Force Interaction Ratio and Deflection*

$\max(CFI_{arm2}) = 0.00$  BackPlate = "Rigid, 6 inches wide"

*Summary - Arm 2 Geometry and Loading*  $\max(\Delta_{arm2}) = 0.0 \cdot in$  $2 \cdot deg \cdot L_{total.arm2} = 0 \cdot in$

Arm 2: Sign and Signal Locations

10

$\#Signals_{arm2} = 0$  $Lights2 = \begin{pmatrix} \text{"Dist(ft)"} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \text{"\# Heads)"} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

$\#Panels_{arm2} = 0$  $Signs2 = \begin{pmatrix} \text{"Dist(ft)"} & 0 & 0 & 0 & 0 & 0 \\ \text{"Area (sf)"} & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

– 10

$-(L_{total.arm2} + 5 \cdot ft)$  0

$\max(CFI_{arm2}) = 0.00$

'SB'= 'SF'=  $Diameter_{tip.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix} \cdot in$  $Classification_{arm2} = \begin{pmatrix} \text{"Compact"} \\ \text{"N/A"} \end{pmatrix}$

$\max(\Delta_{arm2}) = 0.0 \cdot in$

$L_{total.arm2} = 0 \text{ ft}$  'SC'= 'SG'=  $Diameter_{base.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix} \cdot in$  $L_{splice.provided.arm2} = 0 \cdot ft$

'SA'= 'SE'=  $L_{fabricated.arm2} = \begin{pmatrix} 0.0 \\ 0.0 \end{pmatrix} \cdot ft$  'SD'= 'SH'=  $t_{wall.arm2} = \begin{pmatrix} 0.000 \\ 0.000 \end{pmatrix} \cdot in$

## IV. Luminaire Arm Analysis

InputDataFile = "Pole 4.dat" $V_{extreme} = 148 \cdot mph$

### Enter Luminaire Data

*Set Lum. Ht. = 0 for no Luminaire*

*See Design Standards 649-030 and 649-031 for input values.*

| Luminaire Height (ft) | Lum Horiz Length (ft) | Lum Arm Base Dia (in) | Lum Wall Thickness (in) | Slope | Lum Arm Radius (ft) | Lum Bolt Dia (in) | Lum Base Plate Thickness (in) |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | |
| *Std = 40 feet* | *10 feet* | *3 inches* | *0.125 inches* | *0.5* | *8 feet* | *0.5 inches* | *0.75 inches* |

Analyze Luminaire

*Summary - Luminaire Arm Geometry*

$$\begin{pmatrix} CFI_{base.lumarm} \\ CSR_{bolt.lum} \\ D/C_{baseplate.lum} \\ D/C_{conn.plate.lum} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

'LA'= $Y_{luminaire} = 0\ ft$

'LB'= $X_{luminaire} = 0\ ft$

'LC'= $Diameter_{base.lumarm} = 0 \cdot in$

'LD'= $t_{wall.lumarm} = 0 \cdot in$

'LE'= $Slope_{lumarm} = 0$

'LF'= $r_{lumarm} = 0\ ft$

'LG'= $d_{bolt.lum} = 0 \cdot in$

'LH'= $t_{baseplate.lum} = 0 \cdot in$

'LJ'= $w_{base.lum} = 0 \cdot in$

'LK'= $w_{channel.lum} = 0 \cdot in$

## V. Upright Analysis

InputDataFile = "Pole 4.dat" $V_{extreme} = 148 \cdot mph$

### Enter Upright Data

| Total Height (ft) | Height to Arm Connection (ft) | Base Diameter (in) | Wall Thickness (in) | Gap (in) | |
|---|---|---|---|---|---|
| 21.5 | 20 | 19 | 0.375 | 11.34 | ***arm 1 gap*** |
| 'UA' | 'UB' | 'UD' *measured flat to flat* | 'UE' | | ***arm 2 gap*** |

Analyze Upright

*Upright Combined Force Interaction Ratio and Deflections*

$Classification_{pole} = "Compact"$

$\max(CFI_{pole}) = 0.58$

$Check_{slope} = "OK"$

$Check_{deflection} = "OK"$

$\max(\Delta_{x.dl}) = 1.35 \cdot in$

$\max(\Delta_{z.dl}) = 0 \cdot in$

$Slope_z = 0 \cdot deg$

$Slope_x = 0.7 \cdot deg$

$Diameter_{conn.pole} = 16.2 \cdot in$

$$\max\left(\begin{pmatrix} Diameter_{base.arm1_0} \\ Diameter_{base.arm2_0} \end{pmatrix}\right) = 11.4 \cdot in$$

'UA'= $Y_{pole} = 21.5 \cdot ft$

'UB'= $Y_{arm.conn} = 20 \cdot ft$

'UC'= $Diameter_{tip.pole} = 16 \cdot in$

'UD'= $Diameter_{base.pole} = 19 \cdot in$

'UE'= $t_{wall.pole} = 0.375 \cdot in$

'UF'= $\alpha = 0 \cdot deg$

'UG'= $Y_{lum.conn} = 0\ ft$

## VI. Arm to Upright Connection Analysis

InputDataFile = "Pole 4.dat"

*for double arms, both connection plate heights must be equal*

**Enter Connection Data**

| Connection Plate Height(in) | Connection Plate Width (in) | Vertical Plate Thickness (in) | Bolt Diameter (in) | Arm Base Plate Thickness (in) |
|---|---|---|---|---|
| 30 | 32 | 0.75 | 1.25 | 2.75 |
| | | | | |
| 'HT' | 'FJ', 'SJ' | 'FL', 'SL' | 'FP', 'SP' | 'FK', 'SK' |

Analyze Connection

*Connection Summary*

'HT'= $h_{conn.plate} = 30 \cdot in$ $D/C_{ht.conn.plate} = 0.68$ $CheckHt_{conn.plate} = \text{"OK"}$

$D/C_{width.conn.plate_0} = 0.88$

$CheckWidth_{conn.plate_0} = \text{"OK"}$

$$\begin{pmatrix} D/C_{t.baseplate.arm_0} \\ CFI_{t.vert.plate_0} \\ CSR_{bolt.conn_0} \end{pmatrix} = \begin{pmatrix} 0.73 \\ 0.39 \\ 0.34 \end{pmatrix}$$

$\#Bolts_{conn_0} = 6$

'FJ'= $b_{conn.plate_0} = 32 \cdot in$

'FK'= $t_{baseplate.arm_0} = 2.75 \cdot in$

'FL'= $t_{vertical.plate_0} = 0.75 \cdot in$

'FN'= $w_{vertical.plate_0} = \frac{3}{8} \cdot in$

'FO'= $Offset_{conn_0} = 19.5 \cdot in$

'FP'= $d_{bolt.conn_0} = 1.25 \cdot in$

'FR'= $t_{conn.plate_0} = 2.00 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 12.5 \cdot in$

'FT'= $w_{conn.plate_0} = \frac{3}{8} \cdot in$

$D/C_{width.conn.plate_1} = 0.00$

$CheckWidth_{conn.plate_1} = \text{"OK"}$

$$\begin{pmatrix} D/C_{t.baseplate.arm_1} \\ CFI_{t.vert.plate_1} \\ CSR_{bolt.conn_1} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

$\#Bolts_{conn_1} = 0$

'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SK'= $t_{baseplate.arm_1} = 0.00 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0.00 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0.00 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

## VII. Upright Base Plate & Anchor Bolt Analysis

InputDataFile = "Pole 4.dat"

**Enter Anchorage Data**

| Anchor Bolt Diameter (in) | Number of Anchor Bolts |
|---|---|
| 2 | 6 |
| 'BC' | '#Bolts' |

$Diameter_{base.pole} = 19 \cdot in$

Analyze Base Plate & Anchors

*Base Plate and Anchor Summary*

'#Bolts'= $\#AnchorBolts = 6$

'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

$CSR_{anchor} = 0.24$

$Diameter_{boltcircle.pole} = 27 \cdot in$

'BC'= $d_{anchorbolt} = 2.00 \cdot in$

$CheckCSR_{anchorbolt} = \text{"OK"}$

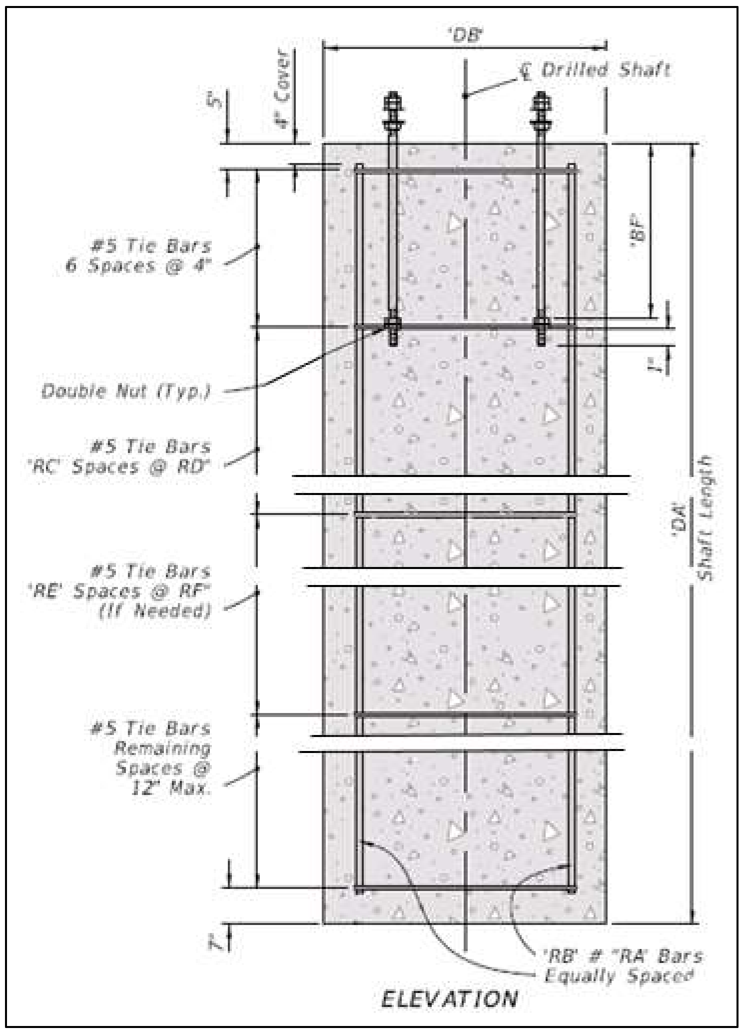
'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

## VIII. Foundation Analysis & Anchor Bolt Lengths

InputDataFile = "Pole 4.dat"

**Enter Drilled Shaft Data**

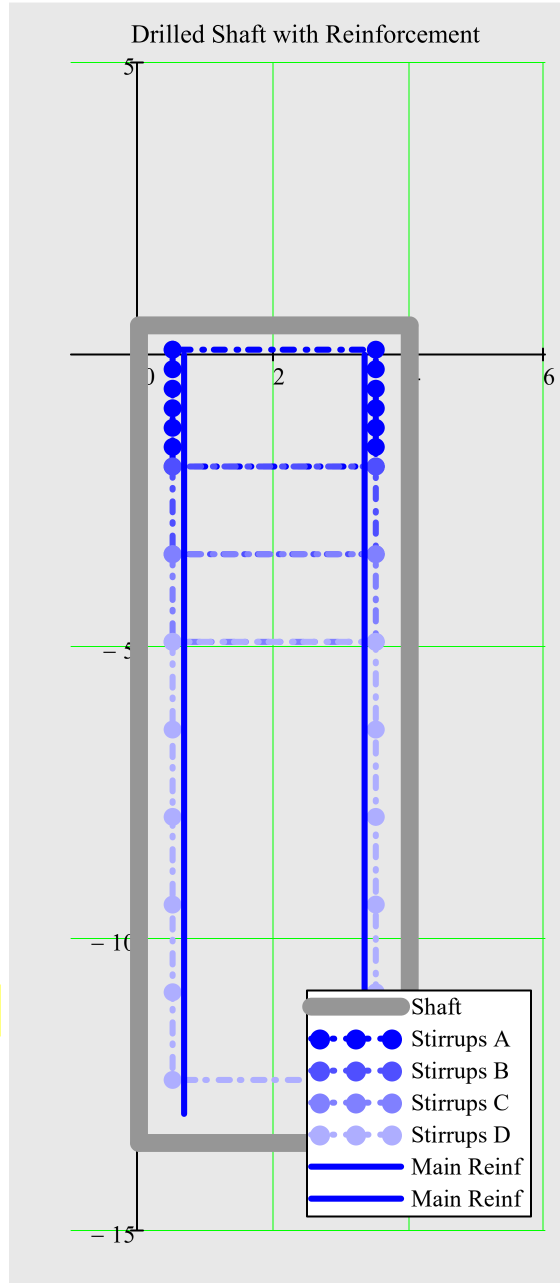
| | | |
|---|---|---|
| *Soil Type* | | |
| *Soil Density, $\gamma_{soil}$ (45-50 pcf typ.)* | 42.6 | pcf |
| *Friction Angle, $\phi$ (Sands)* | 30 | deg |
| *SPT Number ($N_{blows}$ 5 min.) (Sands)* | 15 | |
| *Shear Strength, c (Clays)* | 2000 | psf |
| *Ground to Top of Shaft Offset* | 0.5 | ft |
| ***First Set of User Defined Stirrups:*** | | |
| *Number of Stirrup Spaces* 'RC' | 1 | |
| *Stirrup Spacing* 'RD' | 12 | in |
| ***Second Set of User Defined Stirrups:*** | | |
| *Number of Stirrup Spaces* 'RE' *enter zero for 12 inch spacing* | 1 | |
| *Stirrup Spacing* 'RF' *enter zero for 12 inch spacing* | 12 | in |
| *Stirrup Bar Size, use #5 for all Standard Shafts* | | |




Analyze Foundation

*Shaft Length* *Stirrup spacing* *Number of stirrup spaces*

$L_{shaft} = 14\,ft$ $s_v = \begin{pmatrix} 4 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot in$ $\#Spaces_{vbar} = \begin{pmatrix} 6 \\ 1 \\ 1 \\ 5 \end{pmatrix}$




*Foundation Summary*

CheckReinfClearSpacing = "OK"

$CheckLongReinf_{shr.tor}$ = "OK"

CheckMaxSpacingTransvReinf = "OK"

OverlapDesign = "Based on No Overlap of Failure Cones"

OverlapTest = "No Overlap of Failure Cones"

BreakoutTest = "OK"

*Stirrups* $s_{v_0} = 4 \cdot in$ @ $\#Spaces_{vbar_0} = 6$ : $D/C_{torsion_0} = 0.3$

*Stirrups* 'RC' ( $s_{v_1} = 18 \cdot in$ ) @ 'RD' ( $\#Spaces_{vbar_1} = 1$ ) : $D/C_{torsion_1} = 1.3$

*Stirrups* 'RE' ( $s_{v_2} = 18 \cdot in$ ) @ 'RF' ( $\#Spaces_{vbar_2} = 1$ ) : $D/C_{torsion_2} = 1.2$

*Stirrups* $s_{v_3} = 18 \cdot in$ @ $\#Spaces_{vbar_3} = 5$

Offset = 0.5 ft

$d_{long.bar} = 1.41 \cdot in$

$Dia_{bar.circle} = 33.3 \cdot in$

'DA'= $L_{shaft} = 14 \cdot ft$

'DB'= $Diameter_{shaft} = 4 \cdot ft$

'BF'= $L_{embedment.anchor} = 36 \cdot in$

$L_{anchor.bolt} = 48 \cdot in$

'RA'= $round\left(\dfrac{d_{long.bar}}{0.125in}\right) = 11$

'RB'= $\#LongBars_{prov} = 10$

$\#Spaces_{vbar_0} = 6$

$s_{v_0} = 4 \cdot in$

'RC'= $\#Spaces_{vbar_1} = 1$

'RD'= $s_{v_1} = 18 \cdot in$

'RE'= $\#Spaces_{vbar_2} = 1$

'RF'= $s_{v_2} = 18 \cdot in$

$\#Spaces_{vbar_3} = 5$

$s_{v_3} = 18 \cdot in$

## IX. Fatigue Analysis

InputDataFile = "Pole 4.dat"

$FatigueCategory_{galloping} := 2$ $FatigueCategory_{natural.wind} := 2$ SM V3 11.6

Analyze Structure for Fatigue

## Fatigue Summary

*Arm and Pole Welds*

*K1 values within 2% of LTS thresholds of 3.0 and 4.0 may use next higher CAFT values*

$Check_{galloping.arm1} = \text{"No Good"}$ $f_{galloping.arm1} = 5.0 \cdot ksi$ $CAFT_{fullpengroove.weld.arm1} = 4.5 \cdot ksi$

*Note: Category 1 Evaluation, Consider O.K.*

$Check_{galloping.arm2} = \text{"NA"}$ $f_{galloping.arm2} = 0.0 \cdot ksi$ $CAFT_{fullpengroove.weld.arm2} = \text{"NA"} \cdot ksi$

$Check_{galloping.pole} = \text{"No Good"}$ $f_{galloping.pole} = 3.5 \cdot ksi$ $CAFT_{fullpengroove.weld.pole} = 2.6 \cdot ksi$

*Note: Category 1 Evaluation, Consider O.K.*

$Check_{nwg.arm1} = \text{"OK"}$ $f_{nwg.arm1} = 2.9 \cdot ksi$ $CAFT_{fullpengroove.weld.arm1} = 4.5 \cdot ksi$

$Check_{nwg.arm2} = \text{"NA"}$ $f_{nwg.arm2} = 0.0 \cdot ksi$ $CAFT_{fullpengroove.weld.arm2} = \text{"NA"} \cdot ksi$

$Check_{nwg.pole} = \text{"OK"}$ $f_{nwg.pole} = 1.9 \cdot ksi$ $CAFT_{fullpengroove.weld.pole} = 2.6 \cdot ksi$

$$CheckK1Values = \begin{pmatrix} \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \end{pmatrix} \qquad \begin{pmatrix} K_{I.arm1} \\ K_{I.arm2} \\ K_{I.pole} \end{pmatrix} = \begin{pmatrix} 4.342 \\ 100.000 \\ 9.057 \end{pmatrix} \begin{pmatrix} \text{"Arm 1 Base Weld"} \\ \text{"Arm 2 Base Weld"} \\ \text{"Upright Base Weld"} \end{pmatrix}$$

*A325 Connection Bolts*

$$Check_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix} \qquad f_{t.g.bolt} = \begin{pmatrix} 6.2 \\ 0.0 \end{pmatrix} \cdot ksi$$

$$CAFT_{conn.bolt} = 16 \cdot ksi$$

$$Check_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix} \qquad f_{t.nwg.bolt} = \begin{pmatrix} 3.6 \\ 0.0 \end{pmatrix} \cdot ksi$$

*Anchor Bolts*

$Check_{g.anchor} = \text{"OK"}$ $f_{t.g.anchor} = 2.9 \cdot ksi$ $CAFT_{anchor.bolts} = 7 \cdot ksi$

$Check_{nwg.anchor} = \text{"OK"}$ $f_{t.nwg.anchor} = 1.6 \cdot ksi$

***Save Data File (optional)***

☐ Use current input file

*File Name* Pole 4.dat

*Note: Select an output folder by using the "Change Folder" option above.*

Save Data

*Arm Designation Example*

A70/D-A30/D/H-P5/D/L-DS/16/5

A70/D - *Arm 70 feet long, Double Arm*

A30/D/H - *Arm 30 feet long, Double Arm, Heavy Duty*

P5/D/L - *Pole 5 , Double Arm, with Luminaire*

## X. Mast Arm Design and Analysis Summary

InputDataFile = "Pole 4.dat"

*If comparing results to Standard Index 649-030, some values in the index have been increased to reduce the number of variations.*

**Subject** = "43rd St. at Cortez" **DesignedBy** = "CMH" **PoleLocation** = "301+62.6 / 67.18' LT"

**ProjectNo** = "10226260" **CheckedBy** = "XXX" **Date** = "06/30/2021"

ExistingMastArm = "Yes"

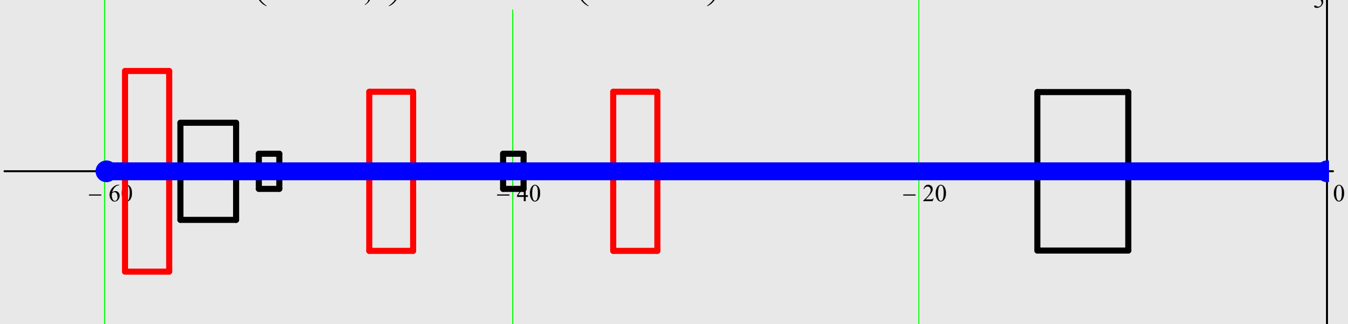
***For FDOT Mast Arm Support Structures,*** max(CFI) ≤ 0.95 ***(See Structures Manual Volume3)***

### 1st Mast Arm

$V_{extreme} = 148 \cdot mph$ ExistingMastArm = "Yes" BackPlate = "Rigid, 6 inches wide"

Arm 1: Locations of Signs and Signals

$\#Signals_{arm1} = 3$ $\begin{pmatrix}\text{"Dist(ft)"}\\ \text{"\# Heads)"}\end{pmatrix}$ $Signals_{arm1}{}^{T} = \begin{pmatrix}34 & 46 & 58\\ 3 & 3 & 4\end{pmatrix}$




$\#Panels_{arm1} = 4$ $\begin{pmatrix}\text{"Dist(ft)"}\\ \text{"Area (sf)"}\end{pmatrix}$ $Signs_{arm1}{}^{T} = \begin{pmatrix}12 & 55 & 52 & 40\\ 20 & 7.5 & 1 & 1\end{pmatrix}$

$\max(CFI_{arm1}) = 0.58$ $L_{total.arm1} = 60\,ft$ $L_{splice.provided.arm1} = 2 \cdot ft$ $\max(\Delta_{arm1}) = 14.5 \cdot in$

'FA'= 'FE'= $L_{fabricated.arm1} = \begin{pmatrix}36\\ 26\end{pmatrix} \cdot ft$ 'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix}11.41\\ 14.00\end{pmatrix} \cdot in$

'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix}6.37\\ 10.36\end{pmatrix} \cdot in$ 'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix}0.375\\ 0.500\end{pmatrix} \cdot in$

## 2nd Mast Arm

Arm 2: Locations of Signs and Signals

7

$\#Signals_{arm2} = 0$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"\# Heads)"} \end{pmatrix}$ $Signals_{arm2}^{T} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

$\#Panels_{arm2} = 0$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"Area (sf)"} \end{pmatrix}$ $Signs_{arm2}^{T} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

– 7

$-\left(L_{total.arm2}+5\cdot ft\right)$ 0

$\max\left(CFI_{arm2}\right) = 0.00$ $L_{total.arm2} = 0\ ft$ $L_{splice.provided.arm2} = 0\cdot ft$ $\max\left(\Delta_{arm2}\right) = 0\cdot in$

'SA'= 'SE'= $L_{fabricated.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot ft$

'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix}\cdot in$

'UF'= $\alpha = 0\cdot deg$ **(Angle Between Arms)**

'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix}\cdot in$

'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0.000 \\ 0.000 \end{pmatrix}\cdot in$

## Luminaire Arm and Connection *(use MC10x33.6 channel for connection)*

$$\begin{pmatrix} CFI_{base.lumarm} \\ CSR_{bolt.lum} \\ D/C_{baseplate.lum} \\ D/C_{conn.plate.lum} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 6.82\times 10^{-9} \\ 0.00 \\ 0.00 \end{pmatrix}$$

'LA'= $Y_{luminaire} = 0\ ft$

'LF'= $r_{lumarm} = 0\ ft$

'LB'= $X_{luminaire} = 0\ ft$

'LG'= $d_{bolt.lum} = 0\cdot in$

'LC'= $Diameter_{base.lumarm} = 0\cdot in$

'LH'= $t_{baseplate.lum} = 0\cdot in$

'LD'= $t_{wall.lumarm} = 0\cdot in$

'LJ'= $w_{base.lum} = 0\cdot in$

'LE'= $Slope_{lumarm} = 0$

'LK'= $w_{channel.lum} = 0\cdot in$

## Upright

$\max\left(CFI_{pole}\right) = 0.58$ $Check_{deflection} = \text{"OK"}$ $Check_{slope} = \text{"OK"}$

'UA'= $Y_{pole} = 21.5\cdot ft$

'UC'= $Diameter_{tip.pole} = 16\cdot in$

'UE'= $t_{wall.pole} = 0.375\cdot in$

'UB'= $Y_{arm.conn} = 20\cdot ft$

'UD'= $Diameter_{base.pole} = 19\cdot in$

'UF'= $\alpha = 0\cdot deg$

'UG'= $Y_{lum.conn} = 0\ ft$

## 1st Arm to Upright Connection

$D/C_{ht.conn.plate} = 0.68$

'HT'= $h_{conn.plate} = 30 \cdot in$

$CheckHt_{conn.plate} = \text{"OK"}$

$\#Bolts_{conn_0} = 6$

'FO'= $Offset_{conn_0} = 19.5 \cdot in$

$D/C_{width.conn.plate_0} = 0.88$

'FJ'= $b_{conn.plate_0} = 32 \cdot in$

'FP'= $d_{bolt.conn_0} = 1.25 \cdot in$

$CheckWidth_{conn.plate_0} = \text{"OK"}$

'FK'= $t_{baseplate.arm_0} = 2.75 \cdot in$

'FR'= $t_{conn.plate_0} = 2 \cdot in$

$$\begin{pmatrix} D/C_{t.baseplate.arm_0} \\ CFI_{t.vert.plate_0} \\ CSR_{bolt.conn_0} \end{pmatrix} = \begin{pmatrix} 0.73 \\ 0.39 \\ 0.34 \end{pmatrix}$$

'FL'= $t_{vertical.plate_0} = 0.75 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 12.5 \cdot in$

'FN'= $w_{vertical.plate_0} = \frac{3}{8} \cdot in$

'FT'= $w_{conn.plate_0} = \frac{3}{8} \cdot in$

## 2nd Arm to Upright Connection

'HT'= $h_{conn.plate} = 30 \cdot in$

$D/C_{width.conn.plate_1} = 0.00$

$CheckWidth_{conn.plate_1} = \text{"OK"}$

$\#Bolts_{conn_1} = 0$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

$$\begin{pmatrix} D/C_{t.baseplate.arm_1} \\ CFI_{t.vert.plate_1} \\ CSR_{bolt.conn_1} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

'SK'= $t_{baseplate.arm_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

## Pole Base Plate

$CSR_{anchor} = 0.24$

'#Bolts'= $\#AnchorBolts = 6$

'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

$CheckCSR_{anchorbolt} = \text{"OK"}$

$Diameter_{boltcircle.pole} = 27 \cdot in$

'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

'BC'= $d_{anchorbolt} = 2.00 \cdot in$

'BF'= $L_{embedment.anchor} = 36 \cdot in$

$L_{anchor.bolt} = 48 \cdot in$

## Foundation

$D/C_{torsion.max} = 1.26$

$CheckD/C_{shear.and.torsion} =$ "No Good"

*Note: Category 1 Evaluation, Consider O.K.*

CheckReinfClearSpacing = "OK"

$CheckLongReinf_{shr.tor} =$ "OK"

CheckMaxSpacingTransvReinf = "OK"

OverlapDesign = "Based on No Overlap of Failure Cones"

OverlapTest = "No Overlap of Failure Cones"

BreakoutTest = "OK"

$Clearance_{csl.to.nut} = 0 \cdot in$

$Offset = 0.5\,ft$

$d_{long.bar} = 1.41 \cdot in$

$Dia_{bar.circle} = 33.3 \cdot in$

'DA'= $L_{shaft} = 14 \cdot ft$

'DB'= $Diameter_{shaft} = 4 \cdot ft$

'RA'= $round\left(\frac{d_{long.bar}}{0.125in}\right) = 11$

'RB'= $\#LongBars_{prov} = 10$

'RC'= $\#Spaces_{vbar_1} = 1$

'RD'= $s_{v_1} = 18 \cdot in$

'RE'= $\#Spaces_{vbar_2} = 1$

'RF'= $s_{v_2} = 18 \cdot in$

## Fatigue

$Check_{galloping.arm1} =$ "No Good"

*Note: Category 1 Evaluation, Consider O.K.*

$Check_{galloping.arm2} =$ "NA"

$Check_{galloping.pole} =$ "No Good"

*Note: Category 1 Evaluation, Consider O.K.*

$Check_{nwg.arm1} =$ "OK"

$Check_{nwg.arm2} =$ "NA"

$Check_{nwg.pole} =$ "OK"

$Check_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$Check_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$Check_{g.anchor} =$ "OK"

$Check_{nwg.anchor} =$ "OK"

*K1 values within 2% of LTS thresholds may use next higher CAFT values*

$CheckK1Values = \begin{pmatrix} \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \end{pmatrix}$

$\begin{pmatrix} K_{I.arm1} \\ K_{I.arm2} \\ K_{I.pole} \end{pmatrix} = \begin{pmatrix} 4.342 \\ 100.000 \\ 9.057 \end{pmatrix} \begin{pmatrix} \text{"Arm 1 Base Weld"} \\ \text{"Arm 2 Base Weld"} \\ \text{"Upright Base Weld"} \end{pmatrix}$

WRITEPRN to Line 1-2-3 for Mast Arm Data Table

## Mast Arm Tip Deflection

*Compare Mast Arm deflection of each arm to a proposed camber*

$Camber_{arm1} := \mathbf{2} \cdot deg$ $Camber_{arm2} := \mathbf{2} \cdot deg$

$Deflection_{arm1} := Slope_x \cdot L_{total.arm1} + \max(\Delta_{arm1}) = 23.3 \cdot in$

$CamberArm1_{upward} := \sin(Camber_{arm1}) \cdot L_{total.arm1} = 25.1 \cdot in$

$Deflection_{arm2} := \left[Slope_z \cdot L_{total.arm2} \cdot (\sin(\alpha))\right] + Slope_x \cdot L_{total.arm2} \cdot \cos(\alpha) + \max(\Delta_{arm2}) = 0 \cdot in$

$CamberArm2_{upward} := \sin(Camber_{arm2}) \cdot L_{total.arm2} = 0 \cdot in$

## Check Clearance Between Connection Plates *(for Two Arm Structures only)*

$\alpha = 0 \cdot deg$ $\quad\quad \alpha := \text{if}[(\alpha > 180 \cdot deg), (360 \cdot deg - \alpha), \alpha]$

$Offset_{conn_0} = 19.5 \cdot in$ $\quad b_{conn.plate_0} = 32 \cdot in$ $\quad h_{conn.plate} = 30 \cdot in$ $\quad \alpha = 0 \cdot deg$

$Offset_{conn_1} = 0 \cdot in$ $\quad b_{conn.plate_1} = 0 \cdot in$

$x1 := Offset_{conn_0} - t_{conn.plate_0} - h_{conn.plate} \cdot \dfrac{\sin(Camber_{arm1})}{2} = 16.9 \cdot in$ $\quad y1 := \dfrac{b_{conn.plate_0}}{2} = 16 \cdot in$

$$x2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \cos(\alpha) + \frac{b_{conn.plate_1}}{2} \cdot \sin(\alpha) = -0.5 \cdot in$$

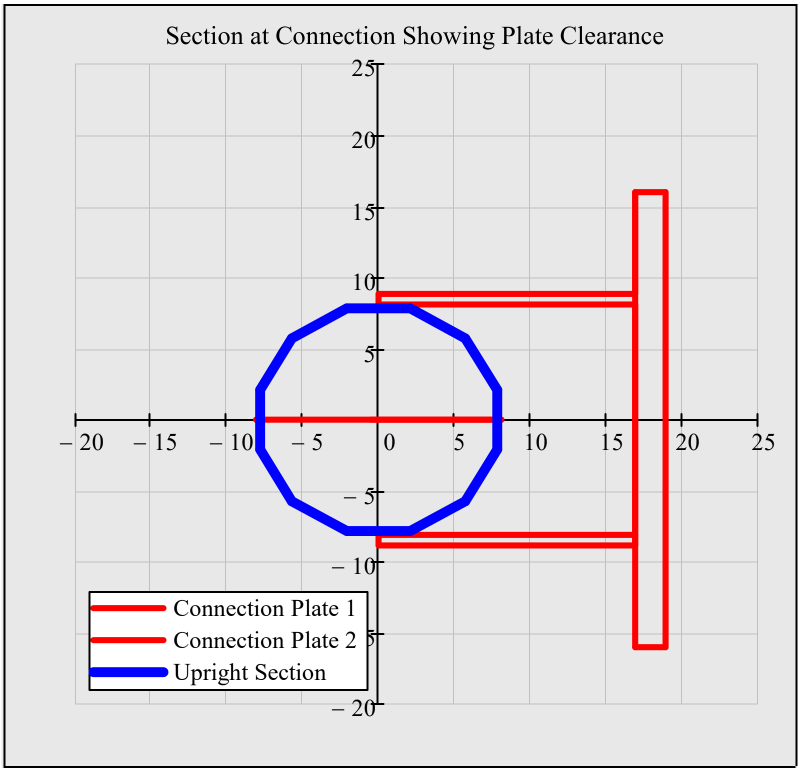
$$y2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \sin(\alpha) - \frac{b_{conn.plate_1}}{2} \cdot \cos(\alpha) = 0 \cdot in$$

$$Clearance_{plate.to.plate} := \text{if}\left[(x1 > x2) \cdot (y2 > y1), \sqrt{(x1 - x2)^2 + (y1 - y2)^2}, 0 \cdot in\right] = 0 \cdot in$$

***(if Clearance < 2 inches, a redesign is required.***

Coordinates for Drawings

## Plan View - Connection Plate Clearance for Two Arm Connections




$Clearance_{plate.to.plate} = 0 \cdot in$

$Diameter_{conn.pole} = 16.2 \cdot in$

'FR'= $t_{conn.plate_0} = 2 \cdot in$

'FJ'= $b_{conn.plate_0} = 32 \cdot in$

'FL'= $t_{vertical.plate_0} = 0.75 \cdot in$

'FO'= $Offset_{conn_0} = 19.5 \cdot in$

$Gap_0 = 11.34 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

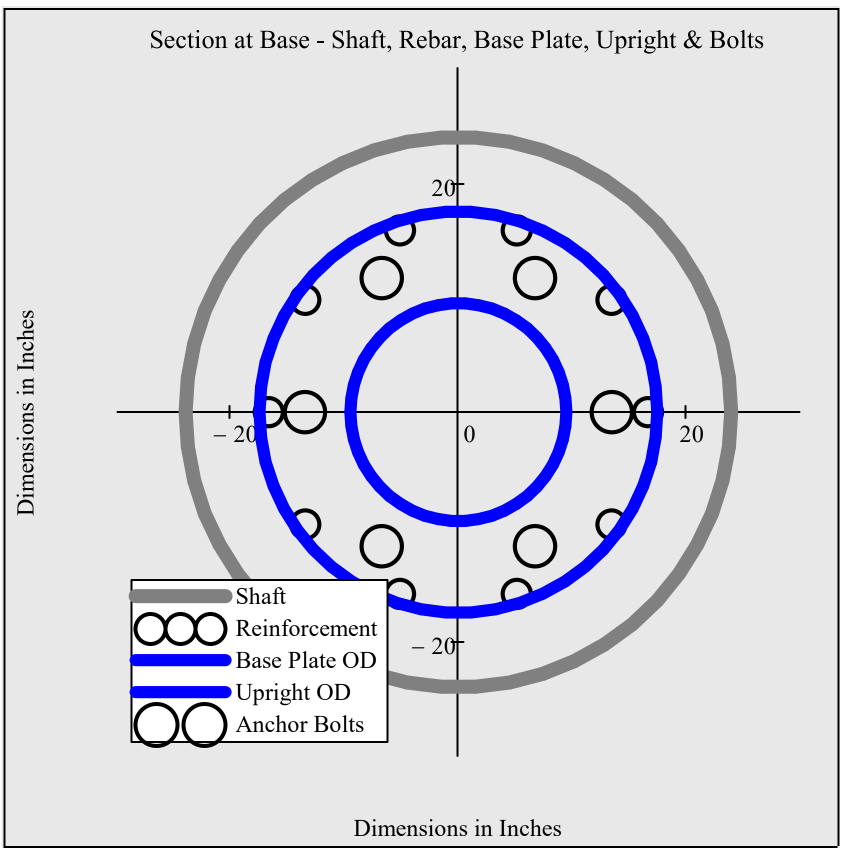
'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

$Gap_1 = 0 \cdot in$

## Plan View - Drilled Shaft, Base Plate, Upright, Anchor Bolts, & Reinforcing Steel




$Clearance_{bar.to.nut} = 0.6 \cdot in$

'UD'= $Diameter_{base.pole} = 19 \cdot in$

'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

'DB'= $Diameter_{shaft} = 48 \cdot in$

$Diameter_{boltcircle.pole} = 27 \cdot in$

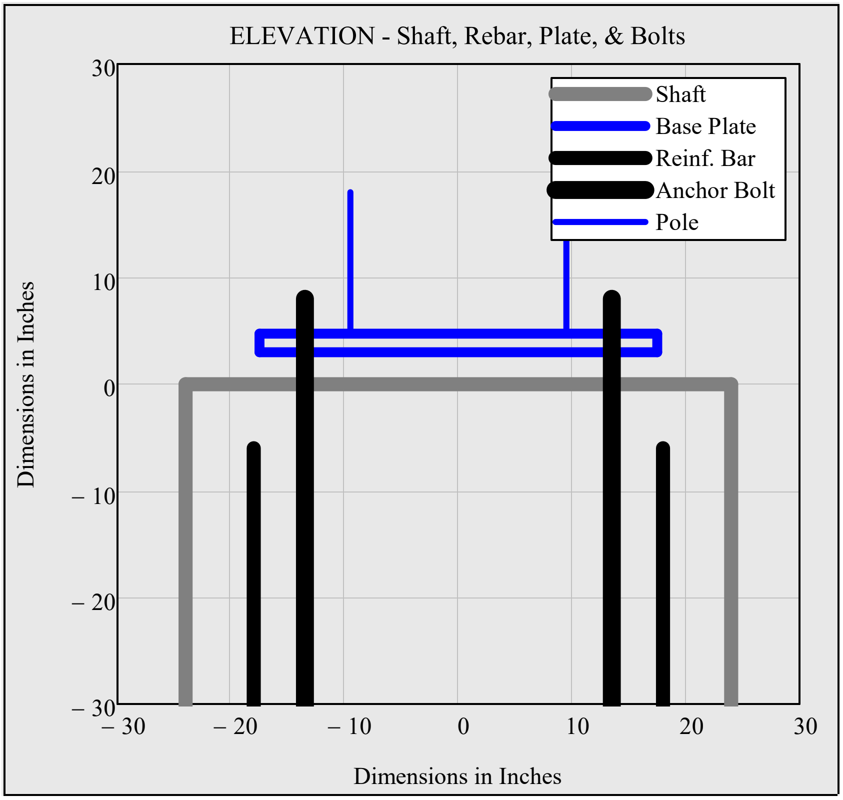
$Dia_{bar.circle} = 33.3 \cdot in$

$\#AnchorBolts = 6$

$\#LongBars_{prov} = 10$

*Note: The Plan and Elevation Views do not show the 4 or 5 1.9" O.D. Nondestructive Integrity Testing Access Tubes that are tied to the inside of the reinforcing cage (see FDOT Spec 455-16.4).*

## Elevation View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$Clearance_{bar.to.nut} = 0.6 \cdot in$

'UD'= $Diameter_{base.pole} = 19 \cdot in$

'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

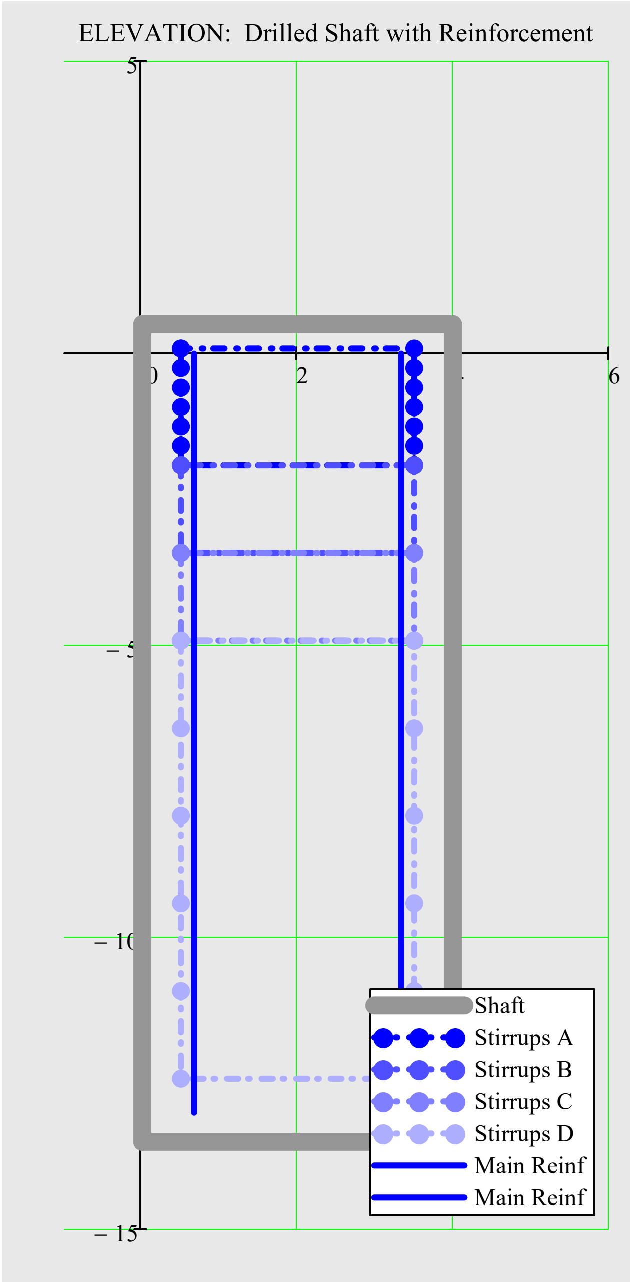
'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

'DB'= $Diameter_{shaft} = 48 \cdot in$

$Diameter_{boltcircle.pole} = 27 \cdot in$

$Dia_{bar.circle} = 33.3 \cdot in$

## Elevation View - Drilled Shaft with Main Reinforcement and Stirrups




$$s_v = \begin{pmatrix} 4 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot in$$ *stirrup spacing*

$$\#Spaces_{vbar} = \begin{pmatrix} 6 \\ 1 \\ 1 \\ 5 \end{pmatrix}$$ *number of stirrup spaces*

# FDOT Mast Arm Traffic Signal Support Analysis Program V1.2

FDOT State Structures Design Office

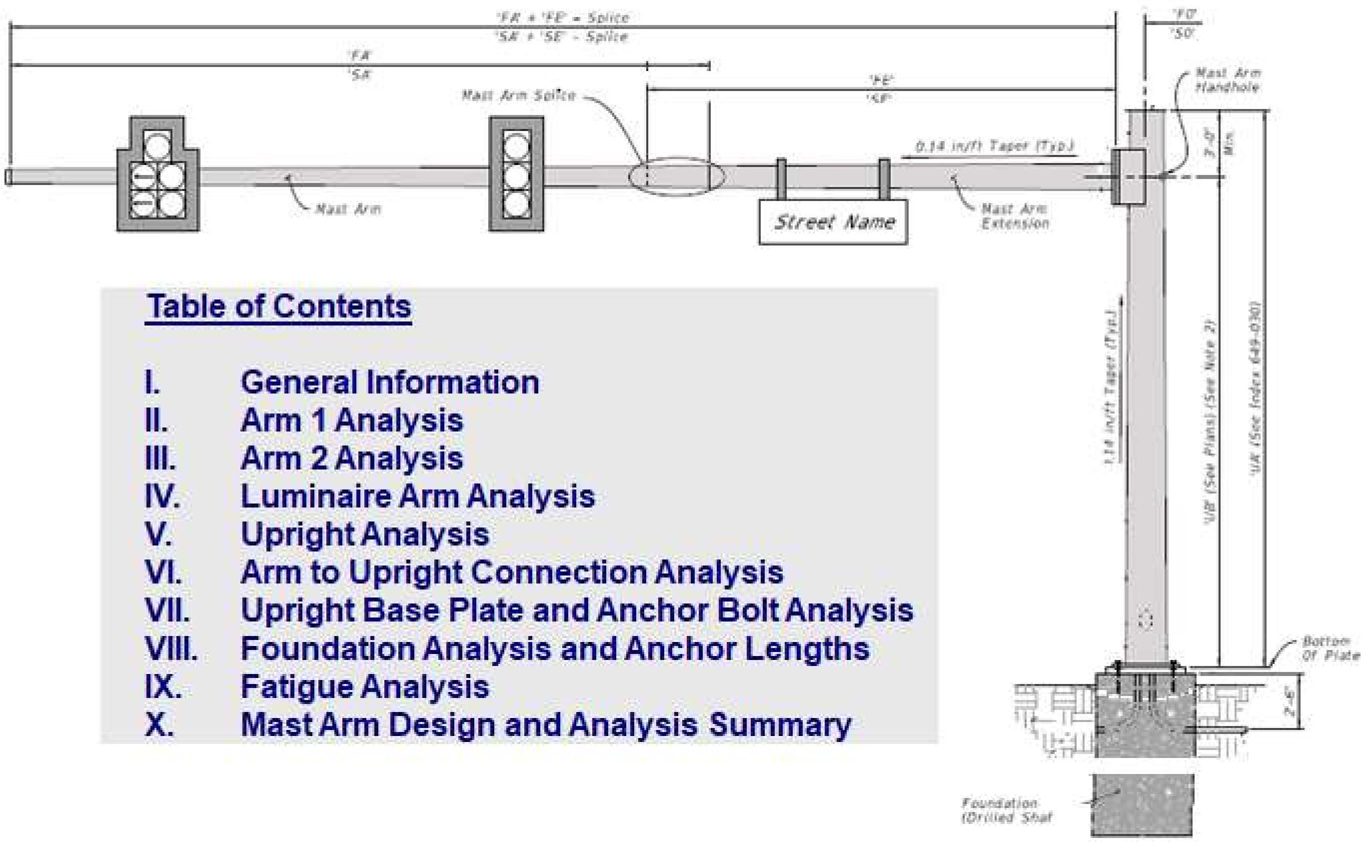
*This program works in conjunction with FDOT Mast Arm Standard Plans 649-030 & 649-031.*

*References:*
*AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (LRFDLTS).*
*FDOT Structures Manual Volume 3 (SM V3).*
*AISC Steel Construction Manual*

*Reference*



*For more information see Reference.xmcd and Changes.xmcd.*




## Table of Contents



## Data Folder and Files

***Data Files Folder***

Change Folder

C:\PWWORKING\east01\d2113436\MastArmV1.2\Data\

***Required** - Open Existing Data File. To save New Data Files, enter data variables at the end of Section IX.*

Pole 4.dat
Pole 4_Existing.dat

Refresh List

Open File

## I. General Information and Sign & Signal Data

### Enter Project Information

| | |
|---|---|
| *Project Name* | 43rd St. at Cortez |
| *Project No.* | 10226260 |
| *Designed by* | CMH |
| *Date* | 06/30/2021 |
| *Checked by* | XXX |
| *Date* | XX/XX/XXXX |
| *Signal Name* | Pole 4 |
| *Station/Offset* | 301+62.6 / 67.18' LT |

### Enter Wind Speed

*Design Wind Speed* 148 *mph*

*Extreme Event Wind Speed*

***SDG Wind Speeds by County***

### Enter Arm Lengths, Signal and Sign Data

***Arm 1***

*Arm 1 Length* 60

Reset Arm 1 Data

| *Arm1 Signal Number* | *Distance to Signal (ft)* | *Number of Heads* |
|---|---|---|
| 1 | 33.5 | 3 |
| 2 | 45.5 | 3 |
| 3 | 57 | 4 |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

***Arm 2*** *Set Arm 2 Length = 0 for single arm Mast Arms*

*Arm 2 Length* 0

Reset Arm 2 Data

| *Arm2 Signal Number* | *Distance to Signal (ft)* | *Number of Heads* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

***Arm 1 Sign Panels***

| *Arm1 Sign Panel Number* | *Distance to Panel (ft)* | *Panel Area (sf)* |
|---|---|---|
| 1 | 15.5 | 20 |
| 2 | 51 | 1 |
| 3 | 59 | 7.5 |
| 4 | | |
| 5 | | |

*Note: The VVDS is assumed to be a 1 ft x 1 ft sign for analysis purposes.*

***Arm 2 Sign Panels***

| *Arm2 Sign Panel Number* | *Distance to Panel (ft)* | *Panel Area (sf)* |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

Save Data for Signs and Signals

## II. Arm 1 Analysis

InputDataFile = "Pole 4_Existing.dat"  $V_{extreme} = 148 \cdot mph$

*Values for* $Dist_{splice.from.base.arm}$ *that give a base diameter in even inches*

| "Wall Thickness" | "dia-1in" | "dia-2in" | "dia-3in" | "dia-4in" | "dia-5in" | "d-6in" |
|---|---|---|---|---|---|---|
| $t_{wall.arm}$ = 0.179·in | **9.9**·ft | **17.0**·ft | **24.2**·ft | **31.3**·ft | **38.5**·ft | **45.6**·ft |
| $t_{wall.arm}$ = 0.25·in | **10.9**·ft | **18.0**·ft | **25.2**·ft | **32.3**·ft | **39.4**·ft | **46.6**·ft |

Help - Base Diameters | Help - Arm Tip Diameter | Help - Tube Wall Thickness | Help - Arm Lengths | Recommended Distance to Splice

Reference:C:\PWWORKING\east01\d2113436\MastArmV1.2\LRFD Equation Module.xmcd(R)

### Enter Arm 1 Data

| Arm Length (ft) | Base Diameter (in) | Wall Thickness 1 (in) | Wall Thickness 2 (in) | Distance to Splice (ft) |
|---|---|---|---|---|
| $L_{total.arm1} = 60\,ft$ | 14 | 0.375 | 0.5 | 24 |
| *feet, 40 ft. max. for 1 piece arms* | *Measured flat to flat* 'FG' | *for 1 & 2 piece arms* 'FD' | *for 2 piece arms only* 'FH' | *for 2 piece arms only* ('Larm' - 'FA') |

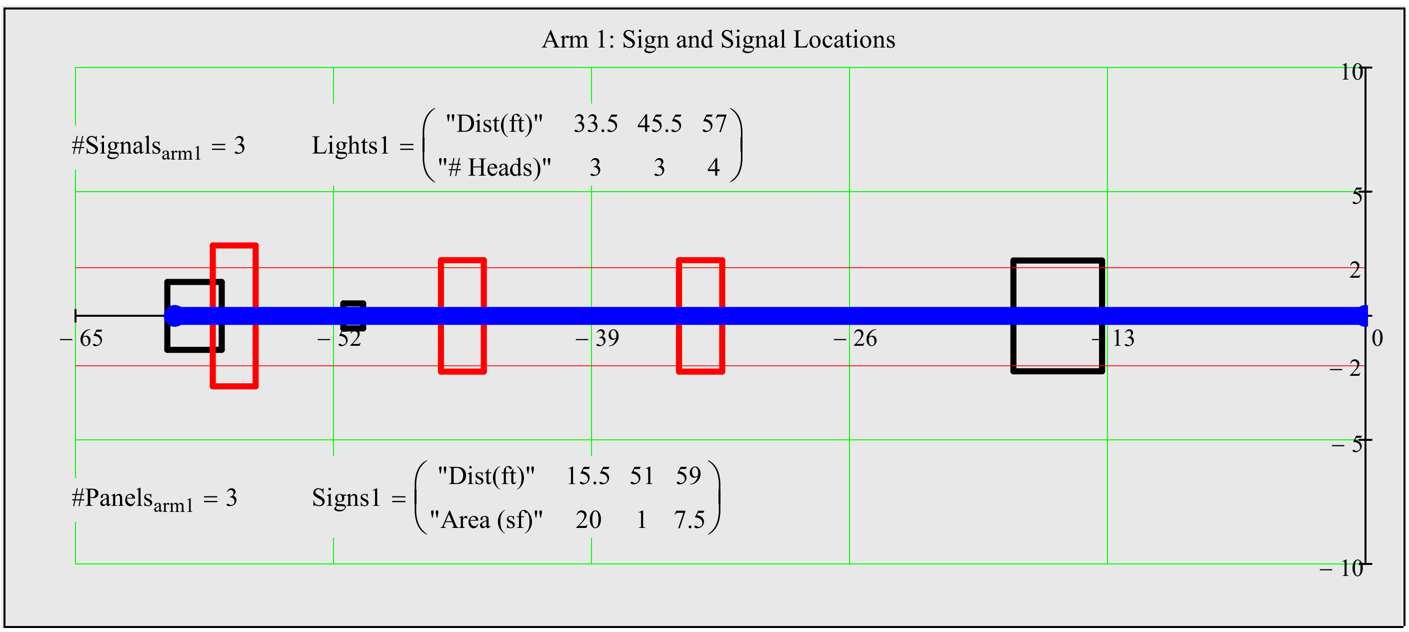
Arm 1 Analysis including Existing Mast Arm Analysis (Additional Variables Required)

*Arm 1 Combined Force Interaction Ratio and Deflection*

BackPlate = "Rigid, 6 inches wide"

$\max(CFI_{arm1}) = 0.58$  $\max(\Delta_{arm1}) = 14.6 \cdot in$  $2 \cdot deg \cdot L_{total.arm1} = 25.1 \cdot in$

*Summary - Arm 1 Geometry and Loading*




$\max(CFI_{arm1}) = 0.58$

'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 6.37 \\ 10.36 \end{pmatrix} \cdot in$

$Classification_{arm1} = \begin{pmatrix} \text{"Compact"} \\ \text{"Compact"} \end{pmatrix}$

$\max(\Delta_{arm1}) = 14.6 \cdot in$

$L_{total.arm1} = 60\,ft$

'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 11.41 \\ 14.00 \end{pmatrix} \cdot in$

$L_{splice.provided.arm1} = 2 \cdot ft$

'FA'= 'FE'= $L_{fabricated.arm1} = \begin{pmatrix} 36.0 \\ 26.0 \end{pmatrix} \cdot ft$

'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.375 \\ 0.500 \end{pmatrix} \cdot in$

## III. Arm 2 Analysis

InputDataFile = "Pole 4_Existing.dat"  $V_{extreme} = 148 \cdot mph$

$Dist_{splice.from.base.arm}$ *values that give a base diameter in even inches*

$$\begin{pmatrix} \text{"Wall Thickness"} & \Delta dia = 1 \cdot in & \Delta dia = 2 \cdot in & \Delta dia = 3 \cdot in & \Delta dia = 4 \cdot in & \Delta dia = 5 \cdot in & \Delta dia = 6 \cdot in \\ t_{wall.arm} = 0.179 \cdot in & 9.9 \cdot ft & 17.0 \cdot ft & 24.2 \cdot ft & 31.3 \cdot ft & 38.5 \cdot ft & 45.6 \cdot ft \\ t_{wall.arm} = 0.25 \cdot in & 10.9 \cdot ft & 18.0 \cdot ft & 25.2 \cdot ft & 32.3 \cdot ft & 39.4 \cdot ft & 46.6 \cdot ft \end{pmatrix}$$

Help - Base Diameters | Help - Arm Tip Diameter | Help - Tube Wall Thickness | Help - Arm Lengths | Recommended Distance to Splice

**Enter Arm 2 Data**

| *Arm Length (ft)* | *Base Diameter (in)* | *Wall Thickness 1 (in)* | *Wall Thickness 2 (in)* | *Distance to Splice (ft)* |
|---|---|---|---|---|
| $L_{total.arm2} = 0$ ft | | | | |
| *feet, 40 ft. max. for 1 piece arms* | *Measured flat to flat* 'SG' | *for 1 & 2 piece arms* 'SD' | *for 2 piece arms only* 'SH' | *for 2 piece arms only* ('Larm' - 'SA') |

Arm 2 Analysis including Existing Mast Arm Analysis

*Arm 2 Combined Force Interaction Ratio and Deflection*

$\max(CFI_{arm2}) = 0.00$  BackPlate = "Rigid, 6 inches wide"

*Summary - Arm 2 Geometry and Loading*  $\max(\Delta_{arm2}) = 0.0 \cdot in$  $2 \cdot deg \cdot L_{total.arm2} = 0 \cdot in$

Arm 2: Sign and Signal Locations

10

$\#Signals_{arm2} = 0$  $Lights2 = \begin{pmatrix} \text{"Dist(ft)"} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \text{"\# Heads)"} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

$\#Panels_{arm2} = 0$  $Signs2 = \begin{pmatrix} \text{"Dist(ft)"} & 0 & 0 & 0 & 0 & 0 \\ \text{"Area (sf)"} & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

−10

$-(L_{total.arm2} + 5 \cdot ft)$  0

$\max(CFI_{arm2}) = 0.00$

'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix} \cdot in$

$Classification_{arm2} = \begin{pmatrix} \text{"Compact"} \\ \text{"N/A"} \end{pmatrix}$

$\max(\Delta_{arm2}) = 0.0 \cdot in$

$L_{total.arm2} = 0$ ft

'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix} \cdot in$

$L_{splice.provided.arm2} = 0 \cdot ft$

'SA'= 'SE'= $L_{fabricated.arm2} = \begin{pmatrix} 0.0 \\ 0.0 \end{pmatrix} \cdot ft$

'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0.000 \\ 0.000 \end{pmatrix} \cdot in$

## IV. Luminaire Arm Analysis

InputDataFile = "Pole 4_Existing.dat"  $V_{extreme} = 148 \cdot mph$

### Enter Luminaire Data

*Set Lum. Ht. = 0 for no Luminaire*

*See Design Standards 649-030 and 649-031 for input values.*

| Luminaire Height (ft) | Lum Horiz Length (ft) | Lum Arm Base Dia (in) | Lum Wall Thickness (in) | Slope | Lum Arm Radius (ft) | Lum Bolt Dia (in) | Lum Base Plate Thickness (in) |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | |
| *Std = 40 feet* | *10 feet* | *3 inches* | *0.125 inches* | *0.5* | *8 feet* | *0.5 inches* | *0.75 inches* |

Analyze Luminaire

*Summary - Luminaire Arm Geometry*

$$\begin{pmatrix} CFI_{base.lumarm} \\ CSR_{bolt.lum} \\ D/C_{baseplate.lum} \\ D/C_{conn.plate.lum} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

'LA'= $Y_{luminaire} = 0\,ft$

'LB'= $X_{luminaire} = 0\,ft$

'LC'= $Diameter_{base.lumarm} = 0 \cdot in$

'LD'= $t_{wall.lumarm} = 0 \cdot in$

'LE'= $Slope_{lumarm} = 0$

'LF'= $r_{lumarm} = 0\,ft$

'LG'= $d_{bolt.lum} = 0 \cdot in$

'LH'= $t_{baseplate.lum} = 0 \cdot in$

'LJ'= $w_{base.lum} = 0 \cdot in$

'LK'= $w_{channel.lum} = 0 \cdot in$

## V. Upright Analysis

InputDataFile = "Pole 4_Existing.dat"  $V_{extreme} = 148 \cdot mph$

Help - Upright Base Diameter and Wall Thickness

Help - Gap Distance

### Enter Upright Data

| Total Height (ft) | Height to Arm Connection (ft) | Base Diameter (in) | Wall Thickness (in) | Gap (in) | |
|---|---|---|---|---|---|
| 21.5 | 20 | 19 | 0.375 | 11.34 | ***arm 1 gap*** |
| | | | | | ***arm 2 gap*** |
| 'UA' | 'UB' | 'UD' *measured flat to flat* | 'UE' | | |

Analyze Upright

*Upright Combined Force Interaction Ratio and Deflections*

$Classification_{pole} = \text{"Compact"}$

$\max(CFI_{pole}) = 0.59$

$Check_{slope} = \text{"OK"}$

$Check_{deflection} = \text{"OK"}$

$\max(\Delta_{x.dl}) = 1.35 \cdot in$

$\max(\Delta_{z.dl}) = 0 \cdot in$

$Slope_z = 0 \cdot deg$

$Slope_x = 0.7 \cdot deg$

$Diameter_{conn.pole} = 16.2 \cdot in$

$$\max\left(\begin{pmatrix} Diameter_{base.arm1_0} \\ Diameter_{base.arm2_0} \end{pmatrix}\right) = 11.4 \cdot in$$

'UA'= $Y_{pole} = 21.5\,ft$

'UB'= $Y_{arm.conn} = 20\,ft$

'UC'= $Diameter_{tip.pole} = 16 \cdot in$

'UD'= $Diameter_{base.pole} = 19 \cdot in$

'UE'= $t_{wall.pole} = 0.375\,in$

'UF'= $\alpha = 0 \cdot deg$

'UG'= $Y_{lum.conn} = 0\,ft$

## VI. Arm to Upright Connection Analysis

InputDataFile = "Pole 4_Existing.dat"

*for double arms, both connection plate heights must be equal*

Help - Arm Connection Dimensions

**Enter Connection Data**

| Connection Plate Height(in) | Connection Plate Width (in) | Vertical Plate Thickness (in) | Bolt Diameter (in) | Arm Base Plate Thickness (in) |
|---|---|---|---|---|
| 30 | 32 | 0.75 | 1.25 | 2.75 |
| | | | | |
| 'HT' | 'FJ', 'SJ' | 'FL', 'SL' | 'FP', 'SP' | 'FK', 'SK' |

Analyze Connection

*Connection Summary*

'HT'= $h_{conn.plate} = 30 \cdot in$   $D/C_{ht.conn.plate} = 0.68$   $CheckHt_{conn.plate} = \text{"OK"}$

$D/C_{width.conn.plate_0} = 0.88$

$CheckWidth_{conn.plate_0} = \text{"OK"}$

$$\begin{pmatrix} D/C_{t.baseplate.arm_0} \\ CFI_{t.vert.plate_0} \\ CSR_{bolt.conn_0} \end{pmatrix} = \begin{pmatrix} 0.73 \\ 0.40 \\ 0.34 \end{pmatrix}$$

$\#Bolts_{conn_0} = 6$

'FJ'= $b_{conn.plate_0} = 32 \cdot in$

'FK'= $t_{baseplate.arm_0} = 2.75 \cdot in$

'FL'= $t_{vertical.plate_0} = 0.75 \cdot in$

'FN'= $w_{vertical.plate_0} = \frac{3}{8} \cdot in$

'FO'= $Offset_{conn_0} = 19.5 \cdot in$

'FP'= $d_{bolt.conn_0} = 1.25 \cdot in$

'FR'= $t_{conn.plate_0} = 2.00 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 12.5 \cdot in$

'FT'= $w_{conn.plate_0} = \frac{3}{8} \cdot in$

$D/C_{width.conn.plate_1} = 0.00$

$CheckWidth_{conn.plate_1} = \text{"OK"}$

$$\begin{pmatrix} D/C_{t.baseplate.arm_1} \\ CFI_{t.vert.plate_1} \\ CSR_{bolt.conn_1} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

$\#Bolts_{conn_1} = 0$

'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SK'= $t_{baseplate.arm_1} = 0.00 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0.00 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0.00 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

## VII. Upright Base Plate & Anchor Bolt Analysis

InputDataFile = "Pole 4_Existing.dat"

**Enter Anchorage Data**

| *Anchor Bolt Diameter (in)* | *Number of Anchor Bolts* |
|---|---|
| 2 | 6 |
| 'BC' | '#Bolts' |

Help - Number of Anchor Bolts

$Diameter_{base.pole} = 19 \cdot in$

Analyze Base Plate & Anchors

*Base Plate and Anchor Summary*

'#Bolts'= #AnchorBolts = 6

'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

$CSR_{anchor} = 0.24$

$Diameter_{boltcircle.pole} = 27 \cdot in$

'BC'= $d_{anchorbolt} = 2.00 \cdot in$

$CheckCSR_{anchorbolt} =$ "OK"

'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

## VIII. Foundation Analysis & Anchor Bolt Lengths

InputDataFile = "Pole 4_Existing.dat"

**Enter Drilled Shaft Data**

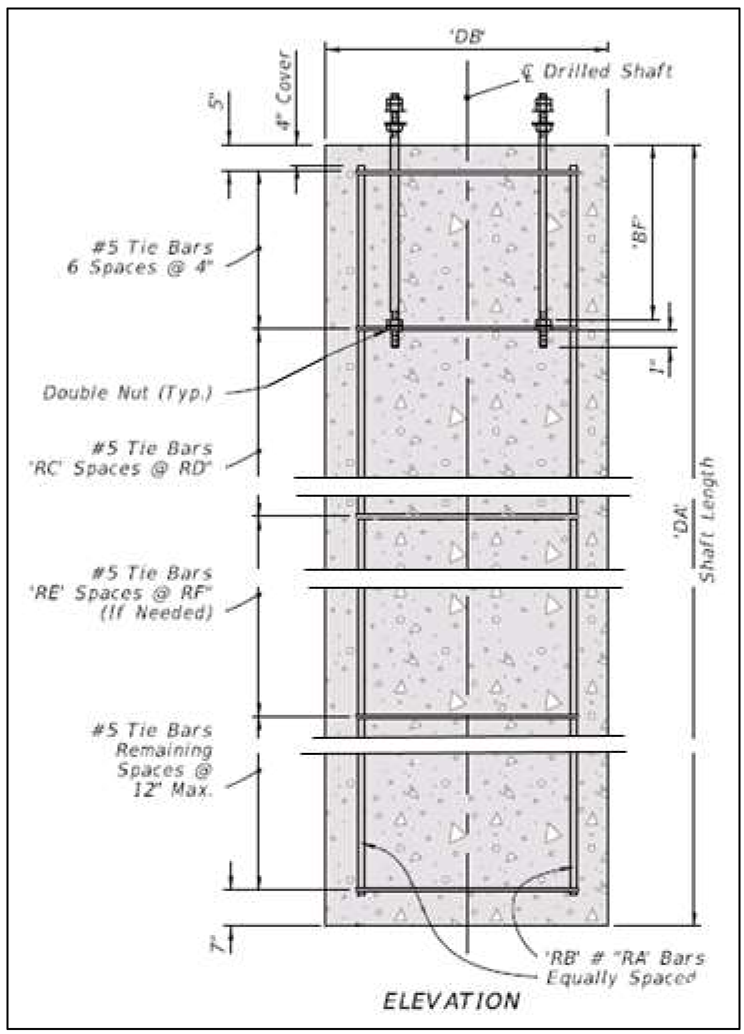
| | | |
|---|---|---|
| *Soil Type* | Sand / Clay (Sand selected) | |
| *Soil Density, $\gamma_{soil}$ (45-50 pcf typ.)* | 42.6 | pcf |
| *Friction Angle, $\phi$ (Sands)* | 30 | deg |
| *SPT Number ($N_{blows}$ 5 min. ) (Sands)* | 15 | |
| *Shear Strength, c (Clays)* | 2000 | psf |
| *Ground to Top of Shaft Offset* | 0.5 | ft |

***First Set of User Defined Stirrups:***

| | | |
|---|---|---|
| *Number of Stirrup Spaces* 'RC' | 1 | |
| *Stirrup Spacing* 'RD' | 12 | in |

***Second Set of User Defined Stirrups:***

| | | |
|---|---|---|
| *Number of Stirrup Spaces* 'RE'<br>*enter zero for 12 inch spacing* | 1 | |
| *Stirrup Spacing* 'RF'<br>*enter zero for 12 inch spacing* | 12 | in |
| *Stirrup Bar Size, use #5*<br>*for all Standard Shafts* | #5 / #6 (#5 selected) | |




Analyze Foundation

*Shaft Length* *Stirrup spacing* *Number of stirrup spaces*

$L_{shaft} = 14\,ft$ $s_v = \begin{pmatrix} 4 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot in$ $\#Spaces_{vbar} = \begin{pmatrix} 6 \\ 1 \\ 1 \\ 5 \end{pmatrix}$

*Foundation Summary*

CheckReinfClearSpacing = "OK"

$CheckLongReinf_{shr.tor}$ = "OK"

CheckMaxSpacingTransvReinf = "OK"

OverlapDesign = "Based on No Overlap of Failure Cones"

OverlapTest = "No Overlap of Failure Cones"

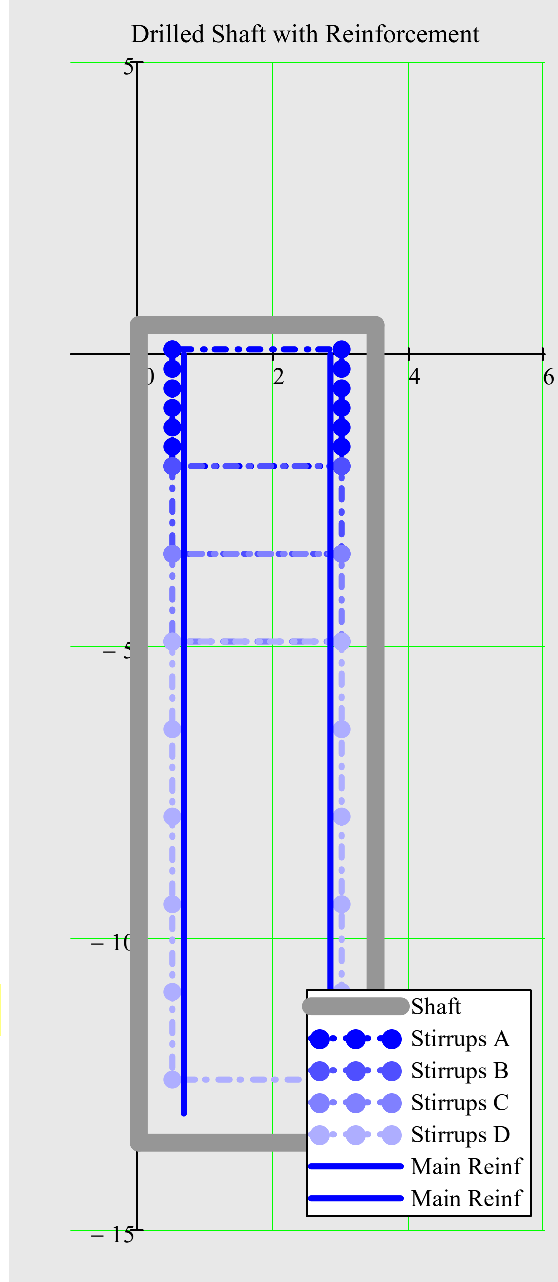
BreakoutTest = "OK"

*Stirrups* $s_{v_0} = 4 \cdot in$ @ $\#Spaces_{vbar_0} = 6$ : $D/C_{torsion_0} = 0.4$

*Stirrups* 'RC' ( $s_{v_1} = 18 \cdot in$ ) @ 'RD' ( $\#Spaces_{vbar_1} = 1$ ) : $D/C_{torsion_1} = 1.9$

*Stirrups* 'RE' ( $s_{v_2} = 18 \cdot in$ ) @ 'RF' ( $\#Spaces_{vbar_2} = 1$ ) : $D/C_{torsion_2} = 1.8$

*Stirrups* $s_{v_3} = 18 \cdot in$ @ $\#Spaces_{vbar_3} = 5$




Offset = 0.5 ft

$d_{long.bar} = 1.41 \cdot in$

$Dia_{bar.circle} = 27.3 \cdot in$

'DA'= $L_{shaft} = 14 \cdot ft$

'DB'= $Diameter_{shaft} = 3.5 \cdot ft$

'BF'= $L_{embedment.anchor} = 36 \cdot in$

$L_{anchor.bolt} = 48 \cdot in$

'RA'= $round\left(\frac{d_{long.bar}}{0.125\,in}\right) = 11$

'RB'= $\#LongBars_{prov} = 10$

$\#Spaces_{vbar_0} = 6$

$s_{v_0} = 4 \cdot in$

'RC'= $\#Spaces_{vbar_1} = 1$

'RD'= $s_{v_1} = 18 \cdot in$

'RE'= $\#Spaces_{vbar_2} = 1$

'RF'= $s_{v_2} = 18 \cdot in$

$\#Spaces_{vbar_3} = 5$

$s_{v_3} = 18 \cdot in$

## IX. Fatigue Analysis

InputDataFile = "Pole 4_Existing.dat"

$FatigueCategory_{galloping} := 2$ $FatigueCategory_{natural.wind} := 2$ **SM V3 11.6**

Analyze Structure for Fatigue

## Fatigue Summary

*Arm and Pole Welds*

*K1 values within 2% of LTS thresholds of 3.0 and 4.0 may use next higher CAFT values*

$Check_{galloping.arm1}$ = "No Good" $f_{galloping.arm1} = 5.0 \cdot ksi$ $CAFT_{fullpengroove.weld.arm1} = 4.5 \cdot ksi$

$Check_{galloping.arm2}$ = "NA" $f_{galloping.arm2} = 0.0 \cdot ksi$ $CAFT_{fullpengroove.weld.arm2}$ = "NA"·ksi

$Check_{galloping.pole}$ = "No Good" $f_{galloping.pole} = 3.5 \cdot ksi$ $CAFT_{fullpengroove.weld.pole} = 2.6 \cdot ksi$

$Check_{nwg.arm1}$ = "OK" $f_{nwg.arm1} = 2.9 \cdot ksi$ $CAFT_{fullpengroove.weld.arm1} = 4.5 \cdot ksi$

$Check_{nwg.arm2}$ = "NA" $f_{nwg.arm2} = 0.0 \cdot ksi$ $CAFT_{fullpengroove.weld.arm2}$ = "NA"·ksi

$Check_{nwg.pole}$ = "OK" $f_{nwg.pole} = 1.8 \cdot ksi$ $CAFT_{fullpengroove.weld.pole} = 2.6 \cdot ksi$

$$CheckK1Values = \begin{pmatrix} \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \end{pmatrix} \quad \begin{pmatrix} K_{I.arm1} \\ K_{I.arm2} \\ K_{I.pole} \end{pmatrix} = \begin{pmatrix} 4.342 \\ 100.000 \\ 9.057 \end{pmatrix} \begin{pmatrix} \text{"Arm 1 Base Weld"} \\ \text{"Arm 2 Base Weld"} \\ \text{"Upright Base Weld"} \end{pmatrix}$$

*A325 Connection Bolts*

$$Check_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix} \quad f_{t.g.bolt} = \begin{pmatrix} 6.3 \\ 0.0 \end{pmatrix} \cdot ksi$$

$$CAFT_{conn.bolt} = 16 \cdot ksi$$

$$Check_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix} \quad f_{t.nwg.bolt} = \begin{pmatrix} 3.6 \\ 0.0 \end{pmatrix} \cdot ksi$$

*Anchor Bolts*

$Check_{g.anchor}$ = "OK" $f_{t.g.anchor} = 3 \cdot ksi$ $CAFT_{anchor.bolts} = 7 \cdot ksi$

$Check_{nwg.anchor}$ = "OK" $f_{t.nwg.anchor} = 1.5 \cdot ksi$

***Save Data File (optional)***

☑ Use current input file

*File Name* Pole 4_Existing.dat

*Note: Select an output folder by using the "Change Folder" option above.*

Save Data

*Arm Designation Example*

A70/D-A30/D/H-P5/D/L-DS/16/5

| | |
|---|---|
| A70/D - | *Arm 70 feet long, Double Arm* |
| A30/D/H - | *Arm 30 feet long, Double Arm, Heavy Duty* |
| P5/D/L - | *Pole 5 , Double Arm, with Luminaire* |
| DS/16/5 - | *Drilled Shaft 16 ft deep, 5 foot diameter* |

# X. Mast Arm Design and Analysis Summary

InputDataFile = "Pole 4_Existing.dat"

*If comparing results to Standard Index 649-030, some values in the index have been increased to reduce the number of variations.*

**Subject** = "43rd St. at Cortez" **DesignedBy** = "CMH" **PoleLocation** = "301+62.6 / 67.18' LT"

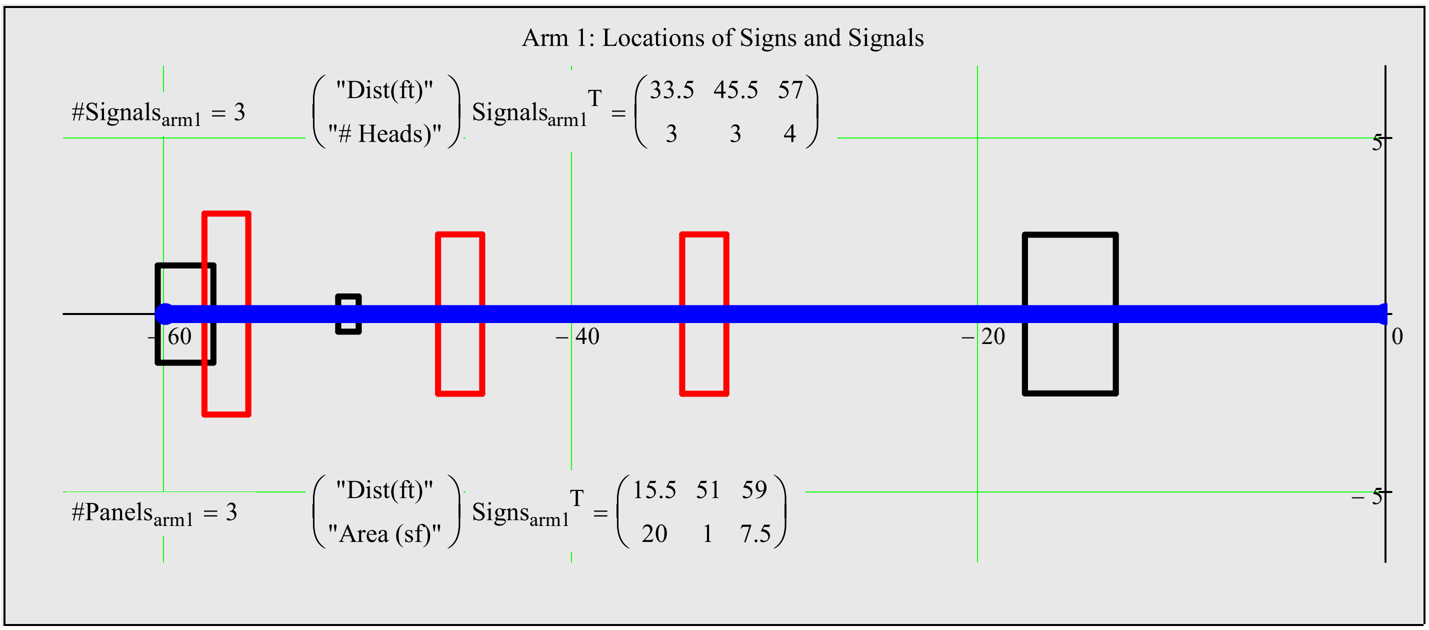
**ProjectNo** = "10226260" **CheckedBy** = "XXX" **Date** = "06/30/2021"

ExistingMastArm = "Yes"

***For FDOT Mast Arm Support Structures,*** $\max(CFI) \le 0.95$ ***(See Structures Manual Volume3)***

## 1st Mast Arm

$V_{extreme} = 148 \cdot mph$ ExistingMastArm = "Yes" BackPlate = "Rigid, 6 inches wide"




$\max(CFI_{arm1}) = 0.58$ $L_{total.arm1} = 60\,ft$ $L_{splice.provided.arm1} = 2 \cdot ft$ $\max(\Delta_{arm1}) = 14.6 \cdot in$

'FA'= 'FE'= $L_{fabricated.arm1} = \begin{pmatrix} 36 \\ 26 \end{pmatrix} \cdot ft$ 'FC'= 'FG'= $Diameter_{base.arm1} = \begin{pmatrix} 11.41 \\ 14.00 \end{pmatrix} \cdot in$

'FB'= 'FF'= $Diameter_{tip.arm1} = \begin{pmatrix} 6.37 \\ 10.36 \end{pmatrix} \cdot in$ 'FD'= 'FH'= $t_{wall.arm1} = \begin{pmatrix} 0.375 \\ 0.500 \end{pmatrix} \cdot in$

## 2nd Mast Arm

Arm 2: Locations of Signs and Signals

7

$\#Signals_{arm2} = 0$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"\# Heads)"} \end{pmatrix}$ $Signals_{arm2}{}^{T} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

$\#Panels_{arm2} = 0$ $\begin{pmatrix} \text{"Dist(ft)"} \\ \text{"Area (sf)"} \end{pmatrix}$ $Signs_{arm2}{}^{T} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

−7

$-\left(L_{total.arm2}+5\cdot ft\right)$ 0

$\max\left(CFI_{arm2}\right) = 0.00$ $L_{total.arm2} = 0\,ft$ $L_{splice.provided.arm2} = 0\cdot ft$ $\max\left(\Delta_{arm2}\right) = 0\cdot in$

'SA'= 'SE'= $L_{fabricated.arm2} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}\cdot ft$

'SC'= 'SG'= $Diameter_{base.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix}\cdot in$

'UF'= $\alpha = 0\cdot deg$ **(Angle Between Arms)**

'SB'= 'SF'= $Diameter_{tip.arm2} = \begin{pmatrix} 0.00 \\ 0.00 \end{pmatrix}\cdot in$

'SD'= 'SH'= $t_{wall.arm2} = \begin{pmatrix} 0.000 \\ 0.000 \end{pmatrix}\cdot in$

## Luminaire Arm and Connection *(use MC10x33.6 channel for connection)*

$$\begin{pmatrix} CFI_{base.lumarm} \\ CSR_{bolt.lum} \\ D/C_{baseplate.lum} \\ D/C_{conn.plate.lum} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 6.82 \times 10^{-9} \\ 0.00 \\ 0.00 \end{pmatrix}$$

'LA'= $Y_{luminaire} = 0\,ft$

'LB'= $X_{luminaire} = 0\,ft$

'LC'= $Diameter_{base.lumarm} = 0\cdot in$

'LD'= $t_{wall.lumarm} = 0\cdot in$

'LE'= $Slope_{lumarm} = 0$

'LF'= $r_{lumarm} = 0\,ft$

'LG'= $d_{bolt.lum} = 0\cdot in$

'LH'= $t_{baseplate.lum} = 0\cdot in$

'LJ'= $w_{base.lum} = 0\cdot in$

'LK'= $w_{channel.lum} = 0\cdot in$

## Upright

$\max\left(CFI_{pole}\right) = 0.59$ $Check_{deflection} = \text{"OK"}$ $Check_{slope} = \text{"OK"}$

'UA'= $Y_{pole} = 21.5\,ft$

'UB'= $Y_{arm.conn} = 20\cdot ft$

'UC'= $Diameter_{tip.pole} = 16\cdot in$

'UD'= $Diameter_{base.pole} = 19\cdot in$

'UE'= $t_{wall.pole} = 0.375\,in$

'UF'= $\alpha = 0\cdot deg$

'UG'= $Y_{lum.conn} = 0\,ft$

## 1st Arm to Upright Connection

$D/C_{ht.conn.plate} = 0.68$

'HT'= $h_{conn.plate} = 30 \cdot in$

$CheckHt_{conn.plate} = "OK"$

$\#Bolts_{conn_0} = 6$

'FO'= $Offset_{conn_0} = 19.5 \cdot in$

$D/C_{width.conn.plate_0} = 0.88$

'FJ'= $b_{conn.plate_0} = 32 \cdot in$

'FP'= $d_{bolt.conn_0} = 1.25 \cdot in$

$CheckWidth_{conn.plate_0} = "OK"$

'FK'= $t_{baseplate.arm_0} = 2.75 \cdot in$

'FR'= $t_{conn.plate_0} = 2 \cdot in$

$$\begin{pmatrix} D/C_{t.baseplate.arm_0} \\ CFI_{t.vert.plate_0} \\ CSR_{bolt.conn_0} \end{pmatrix} = \begin{pmatrix} 0.73 \\ 0.40 \\ 0.34 \end{pmatrix}$$

'FL'= $t_{vertical.plate_0} = 0.75 \cdot in$

'FS'= $Spacing_{bolts.conn_0} = 12.5 \cdot in$

'FN'= $w_{vertical.plate_0} = \frac{3}{8} \cdot in$

'FT'= $w_{conn.plate_0} = \frac{3}{8} \cdot in$

## 2nd Arm to Upright Connection

'HT'= $h_{conn.plate} = 30 \cdot in$

$D/C_{width.conn.plate_1} = 0.00$

$\#Bolts_{conn_1} = 0$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

$CheckWidth_{conn.plate_1} = "OK"$

'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SP'= $d_{bolt.conn_1} = 0 \cdot in$

$$\begin{pmatrix} D/C_{t.baseplate.arm_1} \\ CFI_{t.vert.plate_1} \\ CSR_{bolt.conn_1} \end{pmatrix} = \begin{pmatrix} 0.00 \\ 0.00 \\ 0.00 \end{pmatrix}$$

'SK'= $t_{baseplate.arm_1} = 0 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SS'= $Spacing_{bolts.conn_1} = 0 \cdot in$

'SN'= $w_{vertical.plate_1} = 0 \cdot in$

'ST'= $w_{conn.plate_1} = 0 \cdot in$

## Pole Base Plate

$CSR_{anchor} = 0.24$

'#Bolts'= $\#AnchorBolts = 6$

'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

$CheckCSR_{anchorbolt} = "OK"$

$Diameter_{boltcircle.pole} = 27 \cdot in$

'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

'BC'= $d_{anchorbolt} = 2.00 \cdot in$

'BF'= $L_{embedment.anchor} = 36 \cdot in$

$L_{anchor.bolt} = 48 \cdot in$

## Foundation

$D/C_{torsion.max} = 1.85$

$CheckD/C_{shear.and.torsion}$ = "No Good"

CheckReinfClearSpacing = "OK"

$CheckLongReinf_{shr.tor}$ = "OK"

CheckMaxSpacingTransvReinf = "OK"

OverlapDesign = "Based on No Overlap of Failure Cones"

OverlapTest = "No Overlap of Failure Cones"

BreakoutTest = "OK"

$Clearance_{csl.to.nut} = -3 \cdot in$

$Offset = 0.5\,ft$

$d_{long.bar} = 1.41 \cdot in$

$Dia_{bar.circle} = 27.3 \cdot in$

'DA'= $L_{shaft} = 14 \cdot ft$

'DB'= $Diameter_{shaft} = 3.5 \cdot ft$

'RA'= $round\left(\frac{d_{long.bar}}{0.125in}\right) = 11$

'RB'= $\#LongBars_{prov} = 10$

'RC'= $\#Spaces_{vbar_1} = 1$

'RD'= $s_{v_1} = 18 \cdot in$

'RE'= $\#Spaces_{vbar_2} = 1$

'RF'= $s_{v_2} = 18 \cdot in$

## Fatigue

$Check_{galloping.arm1}$ = "No Good"

$Check_{galloping.arm2}$ = "NA"

$Check_{galloping.pole}$ = "No Good"

$Check_{nwg.arm1}$ = "OK"

$Check_{nwg.arm2}$ = "NA"

$Check_{nwg.pole}$ = "OK"

$Check_{g.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$Check_{nwg.conn.bolt} = \begin{pmatrix} \text{"OK"} \\ \text{"OK"} \end{pmatrix}$

$Check_{g.anchor}$ = "OK"

$Check_{nwg.anchor}$ = "OK"

*K1 values within 2% of LTS thresholds may use next higher CAFT values*

$CheckK1Values = \begin{pmatrix} \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \\ \text{"K1 is outside of 2\% of K1 thresholds"} \end{pmatrix}$

$\begin{pmatrix} K_{I.arm1} \\ K_{I.arm2} \\ K_{I.pole} \end{pmatrix} = \begin{pmatrix} 4.342 \\ 100.000 \\ 9.057 \end{pmatrix} \begin{pmatrix} \text{"Arm 1 Base Weld"} \\ \text{"Arm 2 Base Weld"} \\ \text{"Upright Base Weld"} \end{pmatrix}$

WRITEPRN to Line 1-2-3 for Mast Arm Data Table

## Mast Arm Tip Deflection

*Compare Mast Arm deflection of each arm to a proposed camber*

$Camber_{arm1} := \mathbf{2} \cdot deg$ $\quad$ $Camber_{arm2} := \mathbf{2} \cdot deg$

$Deflection_{arm1} := Slope_x \cdot L_{total.arm1} + max(\Delta_{arm1}) = 23.4 \cdot in$

$CamberArm1_{upward} := sin(Camber_{arm1}) \cdot L_{total.arm1} = 25.1 \cdot in$

$Deflection_{arm2} := [Slope_z \cdot L_{total.arm2} \cdot (sin(\alpha))] + Slope_x \cdot L_{total.arm2} \cdot cos(\alpha) + max(\Delta_{arm2}) = 0 \cdot in$

$CamberArm2_{upward} := sin(Camber_{arm2}) \cdot L_{total.arm2} = 0 \cdot in$

## Check Clearance Between Connection Plates *(for Two Arm Structures only)*

$\alpha = 0 \cdot deg$ $\qquad \alpha := if[(\alpha > 180 \cdot deg), (360 \cdot deg - \alpha), \alpha]$

$Offset_{conn_0} = 19.5 \cdot in$ $\qquad b_{conn.plate_0} = 32 \cdot in$ $\qquad h_{conn.plate} = 30 \cdot in$ $\qquad \alpha = 0 \cdot deg$

$Offset_{conn_1} = 0 \cdot in$ $\qquad b_{conn.plate_1} = 0 \cdot in$

$$x1 := Offset_{conn_0} - t_{conn.plate_0} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm1})}{2} = 16.9 \cdot in \qquad y1 := \frac{b_{conn.plate_0}}{2} = 16 \cdot in$$

$$x2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \cos(\alpha) + \frac{b_{conn.plate_1}}{2} \cdot \sin(\alpha) = -0.5 \cdot in$$

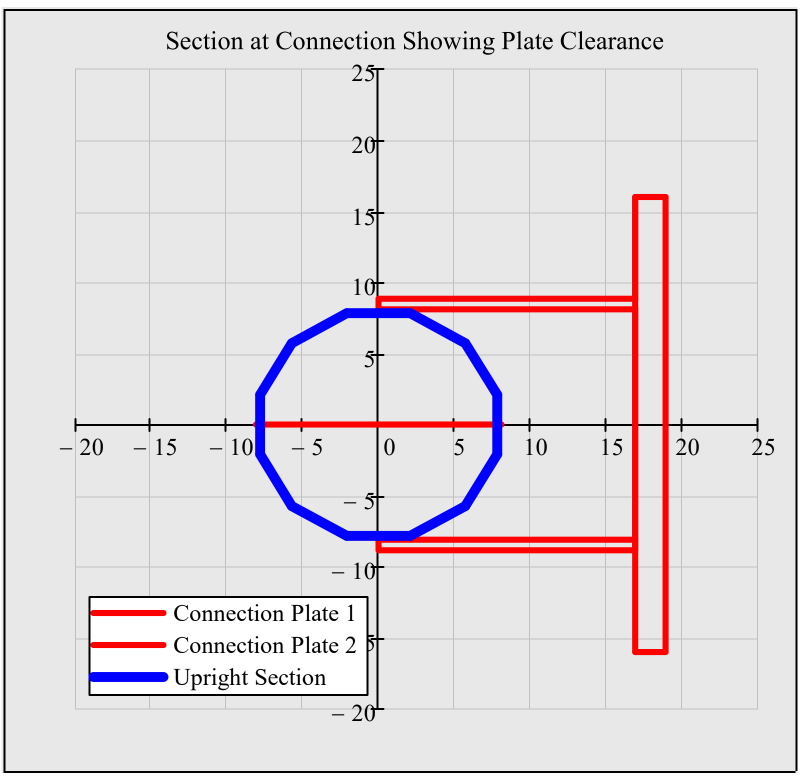
$$y2 := \left(Offset_{conn_1} - t_{conn.plate_1} - h_{conn.plate} \cdot \frac{\sin(Camber_{arm2})}{2}\right) \cdot \sin(\alpha) - \frac{b_{conn.plate_1}}{2} \cdot \cos(\alpha) = 0 \cdot in$$

$$Clearance_{plate.to.plate} := if\left[(x1 > x2) \cdot (y2 > y1), \sqrt{(x1 - x2)^2 + (y1 - y2)^2}, 0 \cdot in\right] = 0 \cdot in$$

***(if Clearance < 2 inches, a redesign is required.***

Coordinates for Drawings

## Plan View - Connection Plate Clearance for Two Arm Connections




$Clearance_{plate.to.plate} = 0 \cdot in$

$Diameter_{conn.pole} = 16.2 \cdot in$

'FR'= $t_{conn.plate_0} = 2 \cdot in$

'FJ'= $b_{conn.plate_0} = 32 \cdot in$

'FL'= $t_{vertical.plate_0} = 0.75 \cdot in$

'FO'= $Offset_{conn_0} = 19.5 \cdot in$

$Gap_0 = 11.34 \cdot in$

'SR'= $t_{conn.plate_1} = 0 \cdot in$

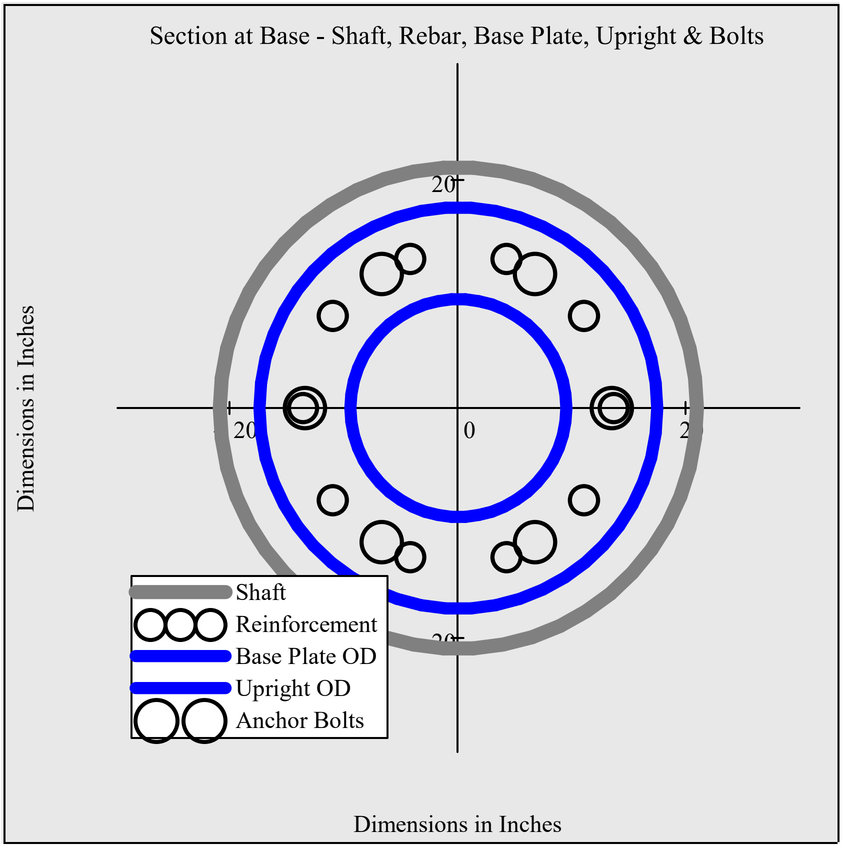
'SJ'= $b_{conn.plate_1} = 0 \cdot in$

'SL'= $t_{vertical.plate_1} = 0 \cdot in$

'SO'= $Offset_{conn_1} = 0.0 \cdot in$

$Gap_1 = 0 \cdot in$

## Plan View - Drilled Shaft, Base Plate, Upright, Anchor Bolts, & Reinforcing Steel




$Clearance_{bar.to.nut} = -2.4 \cdot in$

'UD'= $Diameter_{base.pole} = 19 \cdot in$

'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

'DB'= $Diameter_{shaft} = 42 \cdot in$

$Diameter_{boltcircle.pole} = 27 \cdot in$

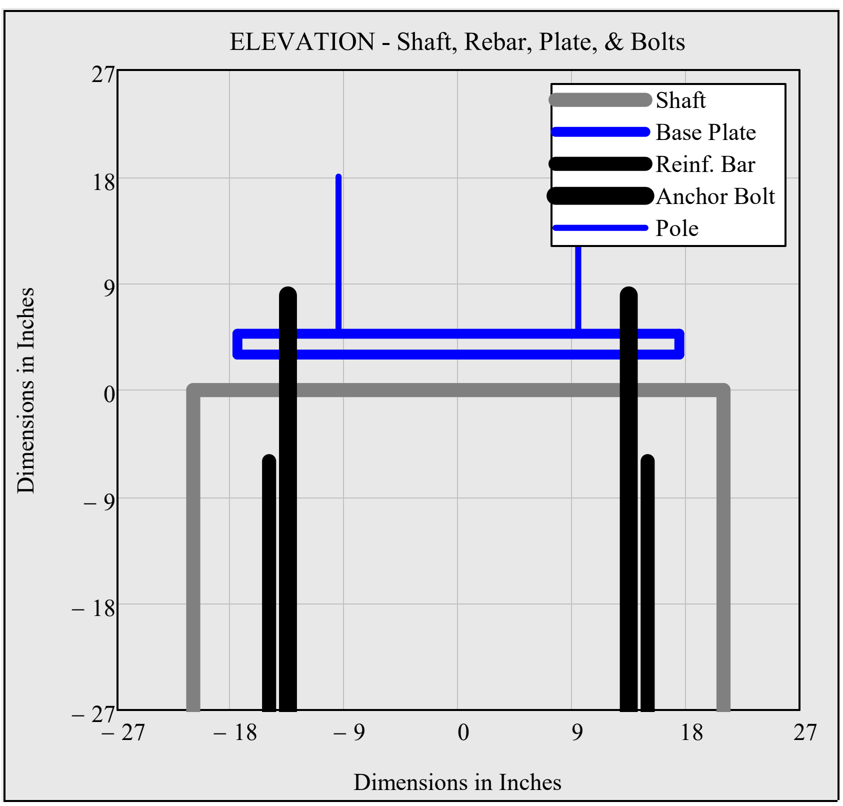
$Dia_{bar.circle} = 27.3 \cdot in$

#AnchorBolts = 6

$\#LongBars_{prov} = 10$

*Note: The Plan and Elevation Views do not show the 4 or 5 1.9" O.D. Nondestructive Integrity Testing Access Tubes that are tied to the inside of the reinforcing cage (see FDOT Spec 455-16.4).*

## Elevation View - Drilled Shaft, Base Plate, Anchor Bolts, & Reinforcing Steel




$Clearance_{bar.to.nut} = -2.4 \cdot in$

'UD'= $Diameter_{base.pole} = 19 \cdot in$

'BA'= $Diameter_{baseplate.pole} = 35 \cdot in$

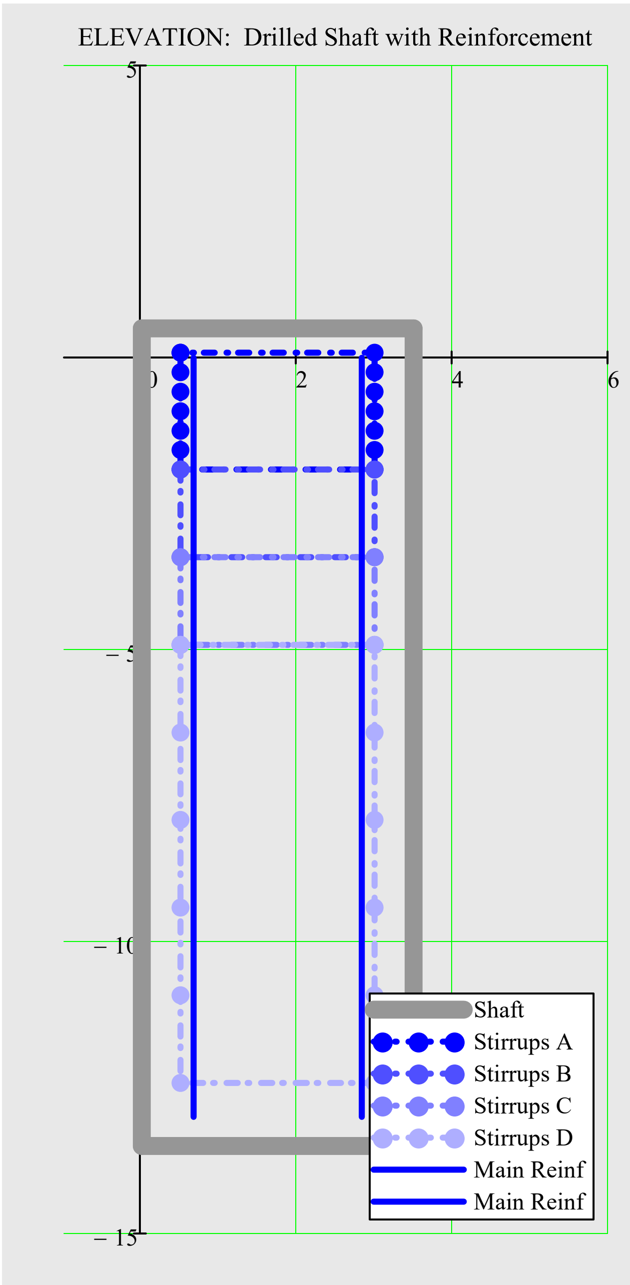
'BB'= $t_{baseplate.pole} = 1.75 \cdot in$

'DB'= $Diameter_{shaft} = 42 \cdot in$

$Diameter_{boltcircle.pole} = 27 \cdot in$

$Dia_{bar.circle} = 27.3 \cdot in$

## Elevation View - Drilled Shaft with Main Reinforcement and Stirrups




$$s_v = \begin{pmatrix} 4 \\ 18 \\ 18 \\ 18 \end{pmatrix} \cdot in$$ *stirrup spacing*

$$\#Spaces_{vbar} = \begin{pmatrix} 6 \\ 1 \\ 1 \\ 5 \end{pmatrix}$$ *number of stirrup spaces*

# Appendix F. Inspection Report

# TSMA INSPECTION REPORT

**DBi**

**PREPARED FOR:** FLORIDA DEPARTMENT OF TRANSPORTATION

**MAINTAINING AGENCY:** MANATEE COUNTY

**INSPECTED BY:**

**VOLKERT**

| TSMA NO. | 13M126 | CONTENTS OF REPORT | INSPECTION DATE: | 03/24/2021 |
|---|---|---|---|---|

| | | | |
|---|---|---|---|
| | BrM Report | * | U/W Inspection Report |
| | CIDR | * | Fracture Critical Data |
| * | Scour Elevation (Profile) | * | Load Rating Analysis Summary |
| * | Addendum (Element Notes & Photos/Sketches) | | |

*This section is not included in this report.


**SR-684 (CORTEZ RD) AT 43RD ST W**

# FLORIDA DEPARTMENT OF TRANSPORTATION
# BRIDGE MANAGEMENT SYSTEM
## Inspection/CIDR Report
(TRAFFIC SIGNAL MAST ARM INSPECTION REPORT)

**Structure ID: 13M126** **Inspection**

**DISTRICT: D1 - Bartow** **INSPECTION DATE: 3/24/2021 ZUSA**

| | | | |
|---|---|---|---|
| BY: | VOLKERT, INC. | STRUCTURE NAME: | SR 684 AT 43 STREET W |
| OWNER: | 1 State Highway Agency | YEAR BUILT: | 2016 |
| MAINTAINED BY: | 2 County Hwy Agency | SECTION NO.: | 13 040 000 |
| STRUCTURE TYPE: | 3 Steel - Traffic Signal Mast Arm | MP: | 5.979 |
| LOCATION: | AT 43 STREET WEST | ROUTE: | 00684 |
| SERV. TYPE ON: | Traffic Signal Mast Arm | FACILITY CARRIED: | _ |
| SERV. TYPE UNDER: | 1 Highway | FEATURE INTERSECTED: | SR 684 (CORTEZ RD) |
| MAST ARM CODE: | 2 | MAST ARM DESCRIPTION: | Mast arm is inside the mast arm boundary area |

☐ FUNCTIONALLY OBSOLETE ☐ STRUCTURALLY DEFICIENT

TYPE OF INSPECTION: Regular NBI

DATE FIELD INSPECTION WAS PERFORMED: ABOVE WATER: 3/24/2021 UNDERWATER: N/A

SUFFICIENCY RATING: -1
HEALTH INDEX: 97.65

# FLORIDA DEPARTMENT OF TRANSPORTATION
# BRIDGE MANAGEMENT SYSTEM
## Inspection/CIDR Report
(TRAFFIC SIGNAL MAST ARM INSPECTION REPORT)

**Structure ID: 13M126** **Inspection**

**DISTRICT: D1 - Bartow** **INSPECTION DATE: 3/24/2021 ZUSA**

| | | | |
|---|---|---|---|
| BY: | VOLKERT, INC. | STRUCTURE NAME: | SR 684 AT 43 STREET W |
| OWNER: | 1 State Highway Agency | YEAR BUILT: | 2016 |
| MAINTAINED BY: | 2 County Hwy Agency | SECTION NO.: | 13 040 000 |
| STRUCTURE TYPE: | 3 Steel - Traffic Signal Mast Arm | MP: | 5.979 |
| LOCATION: | AT 43 STREET WEST | ROUTE: | 00684 |
| SERV. TYPE ON: | Traffic Signal Mast Arm | FACILITY CARRIED: | _ |
| SERV. TYPE UNDER: | 1 Highway | FEATURE INTERSECTED: | SR 684 (CORTEZ RD) |
| MAST ARM CODE: | 2 | MAST ARM DESCRIPTION: | Mast arm is inside the mast arm boundary area |

☐ THIS BRIDGE CONTAINS FRACTURE CRITICAL COMPONENTS

☐ THIS BRIDGE IS SCOUR CRITICAL

☐ THIS REPORT IDENTIFIES DEFICIENCIES WHICH REQUIRE PROMPT CORRECTIVE ACTION

☐ FUNCTIONALLY OBSOLETE ☐ STRUCTURALLY DEFICIENT

TYPE OF INSPECTION: Regular NBI

DATE FIELD INSPECTION WAS PERFORMED: ABOVE WATER: 3/24/2021 UNDERWATER: N/A

**OVERALL NBI RATINGS:**

| | | | |
|---|---|---|---|
| DECK: | N N/A (NBI) | CHANNEL: | N N/A (NBI) |
| SUPERSTRUCTURE: | 7 Good | CULVERT: | N N/A (NBI) |
| SUBSTRUCTURE: | 5 Fair | SUFF. RATING: | -1 |
| PERF. RATING: | Performance Rating Not applicable or not calculable. | HEALTH INDEX: | 97.65 |

| **FIELD PERSONNEL / TITLE / NUMBER:** | **INITIALS** |
|---|---|
| McCutcheon, Thomas - Bridge Inspector (CBI #00416) (lead) | TMc |
| Massotto, Matt - Bridge Inspector (CBI#00502) | |

**REVIEWING BRIDGE INSPECTION SUPERVISOR:**

Rucks, Edward - CBI (#00273) ER

**CONFIRMING REGISTERED PROFESSIONAL ENGINEER:**

DeReus, Scott - Professional Engineer (PE #51907) Volkert, Inc.
1408 N. Westshore Blvd., Suite 600
Certificate of Authorization Number 4641
Tampa Florida 33607

Digitally signed by Scott DeReus Date: 2021.05.04 '09:45:57 -04'00

SCOTT D. DEREUS LICENSE No. 51907 STATE OF FLORIDA PROFESSIONAL ENGINEER

SIGNATURE:

DATE:

This item has been digitally signed and sealed by Scott DeReus on the date adjacent to the seal. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

# FLORIDA DEPARTMENT OF TRANSPORTATION
# BRIDGE MANAGEMENT SYSTEM
## Inspection/CIDR Report
(TRAFFIC SIGNAL MAST ARM INSPECTION REPORT)

**Structure ID: 13M126** **Inspection**

**DISTRICT: D1 - Bartow** **INSPECTION DATE: 3/24/2021 ZUSA**

### All Elements

**MISCELLANEOUS :** Other Elements

| Str Unit | Elem/Env | Description | Qty1 | %1 | Qty2 | %2 | Qty3 | %3 | Qty4 | %4 | T Qty |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Structure Unit 1 | 8480 / 4 | Mast Arm Foundation | 1 | 25 | 3 | 75 | 0 | . | 0 | . | 4 (EA) |
| Structure Unit 1 | 1020 / 4 | Connection | 0 | . | 3 | 100 | 0 | . | 0 | . | 3 (EA) |

**Element Inspection Notes:**

8480/4 V1 - Number of anchor bolts: 6; Anchor bolt diameter: 1-1/2in.; Base plate thickness: 1-3/4in.; No grout; Standoff: 3/4in.
V2 - Number of anchor bolts: 6; Anchor bolt diameter: 2in.; Base plate thickness: 1-3/4in.; No grout; Standoff: 1/4in.
V3 - Number of anchor bolts: 6; Anchor bolt diameter: 1-1/2in.; Base plate thickness: 1-1/2in.; No grout; Standoff: 1/2in.
V4 - Number of anchor bolts: 6; Anchor bolt diameter: 2in.; Base plate thickness: 1-3/4in.; No grout; Standoff: 1/2in.

CS2 1020: There are loose leveling nuts and anchor bolt nuts as follows:
V1 - three of six anchor nuts
V3 - one of six leveling nuts, two of six anchor nuts
V4 - one of six leveling nuts, one of six anchor nuts
Refer to Photo 1. REPAIR (3EA)

INCIDENTAL:
V4 foundation has one missing and one damaged anchor bolt cover.

PREVIOUS REPAIR RECOMMENDATIONS:
Tighten all leveling nuts at V2 foundation. Repair complete.
Tighten all anchor bolt nuts at all foundations. Partially completed. Repeat.

1020/4 Refer to Parent Element

**MISCELLANEOUS :** Other Elements

| Str Unit | Elem/Env | Description | Qty1 | %1 | Qty2 | %2 | Qty3 | %3 | Qty4 | %4 | T Qty |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Structure Unit 1 | 8481 / 4 | Metal Mast Arm Vertical | 0 | . | 4 | 100 | 0 | . | 0 | . | 4 (EA) |
| Structure Unit 1 | 1000 / 4 | Corrosion | 0 | . | 4 | 100 | 0 | . | 0 | . | 4 (EA) |
| Structure Unit 1 | 8518 / 4 | Galvanized Steel | 484 | 98.57 | 7 | 1.43 | 0 | . | 0 | . | 491 sq.ft |
| Structure Unit 1 | 3440 / 4 | Eff (Stl Protect Coat) | 0 | . | 7 | 100 | 0 | . | 0 | . | 7 sq.ft |

**Element Inspection Notes:**

8481/4 V1 - Ultrasonic measurement 4ft. from base plate: 0.379in.
V2 - Ultrasonic measurement 4ft. from base plate: 0.409in.
V3 - Ultrasonic measurement 4ft. from base plate: 0.381in.
V4 - Ultrasonic measurement 4ft. from base plate: 0.383in.

CS2 1000: All of the verticals have minor areas of light corrosion, primarily on the columns and moment connections. Refer to Photo 2. REPAIR (4EA)

PREVIOUS REPAIR RECOMMENDATION:
Clean and spot paint chips and scrapes in galvanizing and areas of corrosion on all columns and moment connections. Repair not evident. Repeat.

**FLORIDA DEPARTMENT OF TRANSPORTATION**
**BRIDGE MANAGEMENT SYSTEM**
**Inspection/CIDR Report**
(TRAFFIC SIGNAL MAST ARM INSPECTION REPORT)

**Structure ID: 13M126** **Inspection**

**DISTRICT: D1 - Bartow** **INSPECTION DATE: 3/24/2021 ZUSA**

1000/4 Refer to Parent Element

8518/4 NOTE: The TSMA vertical members are unpainted galvanized steel.

CS2 3440: There are scrapes and chips in the galvanizing on all verticals. Refer to Photo 2. REPAIR (7SF)

3440/4 Refer to Parent Element

**MISCELLANEOUS :** Other Elements

| Str Unit | Elem/Env | Description | Qty1 | %1 | Qty2 | %2 | Qty3 | %3 | Qty4 | %4 | T Qty |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Structure Unit 1 | 8484 / 4 | Metal Mast Arm Horizontal | 0 | . | 4 | 100 | 0 | . | 0 | . | 4 (EA) |
| Structure Unit 1 | 1000 / 4 | Corrosion | 0 | . | 4 | 100 | 0 | . | 0 | . | 4 (EA) |
| Structure Unit 1 | 8518 / 4 | Galvanized Steel | 605 | 99.18 | 5 | 0.82 | 0 | . | 0 | . | 610 sq.ft |
| Structure Unit 1 | 3440 / 4 | Eff (Stl Protect Coat) | 0 | . | 5 | 100 | 0 | . | 0 | . | 5 sq.ft |

**Element Inspection Notes:**

8484/4 H1 - Ultrasonic measurement 4ft. from connection plate: 0.378in.; Horizontal length: 44ft.
H2 - Ultrasonic measurement 4ft. from connection plate: 0.518in.; Horizontal length: 58ft.
H3 - Ultrasonic measurement 4ft. from connection plate: 0.376in.; Horizontal length: 44ft.
H4 - Ultrasonic measurement 4ft. from connection plate: 0.506in.; Horizontal length: 58ft.

CS2 1000: All of the horizontals have minor areas of light surface corrosion. Refer to Photo 3. REPAIR (4EA)

PREVIOUS REPAIR RECOMMENDATION:
Clean and spot paint areas of corrosion on all horizontals. Repair not evident. Repeat.

1000/4 Refer to Parent Element

8518/4 NOTE: The TSMA horizontal members are unpainted galvanized steel.

CS2 3440: All of the horizontals have minor scrapes in the galvanizing. Refer to Photo 3. REPAIR (5SF)

3440/4 Refer to Parent Element

**Total Number of ADE Elements*:** 3
*excluding defects/protective systems

## Structure Notes

MAINTAINING AGENCY: MANATEE COUNTY

Equipment: Bucket Truck

Structure inspected west to east.

# FLORIDA DEPARTMENT OF TRANSPORTATION
# BRIDGE MANAGEMENT SYSTEM
## Inspection/CIDR Report
(TRAFFIC SIGNAL MAST ARM INSPECTION REPORT)

**Structure ID: 13M126** **Inspection**

**DISTRICT: D1 - Bartow** **INSPECTION DATE: 3/24/2021 ZUSA**

**INSPECTION NOTES:** **ZUSA** **3/24/2021**

The NBI rating for SIA Item 60, Substructure, is 5 because of loose leveling nuts at V3 and V4 foundations.

Item 092, Routine Inspection Frequency, has been updated to 60 months.

**FLORIDA DEPARTMENT OF TRANSPORTATION**
**BRIDGE MANAGEMENT SYSTEM**
**Inspection/CIDR Report**
(TRAFFIC SIGNAL MAST ARM INSPECTION REPORT)

**Structure ID: 13M126** **Inspection**
**DISTRICT: D1 - Bartow** **INSPECTION DATE: 3/24/2021 ZUSA**


**Photo 1: 8480 Mast Arm Foundation**

Typical loose leveling nut at V4 foundation.

REPAIR RECOMMENDATIONS:
Tighten all leveling nuts at V3 and V4 foundations.
Tighten all anchor nuts at V1, V3, and V4 foundations.

# FLORIDA DEPARTMENT OF TRANSPORTATION
## BRIDGE MANAGEMENT SYSTEM
### Inspection/CIDR Report
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**Structure ID: 13M126** **Inspection**

**DISTRICT: D1 - Bartow** **INSPECTION DATE: 3/24/2021 ZUSA**


**Photo 2: 8481 Metal Mast Arm Vertical / 8518 Galvanized Steel**

Typical scrapes in galvanizing with corrosion at V3/H3 moment connection.

REPAIR RECOMMENDATION:
Clean and spot paint chips and scrapes in galvanizing and areas of corrosion on all verticals.

# FLORIDA DEPARTMENT OF TRANSPORTATION
## BRIDGE MANAGEMENT SYSTEM
### Inspection/CIDR Report
(TRAFFIC SIGNAL MAST ARM INSPECTION REPORT)

**Structure ID: 13M126** **Inspection**

**DISTRICT: D1 - Bartow** **INSPECTION DATE: 3/24/2021 ZUSA**


**Photo 3: 8484 Metal Mast Arm Horizontal / 8518 Galvanized Steel**

Typical scrapes and corrosion on H1.

REPAIR RECOMMENDATION:
Clean and spot paint areas of corrosion on all horizontals.

# FLORIDA DEPARTMENT OF TRANSPORTATION
# BRIDGE MANAGEMENT SYSTEM

REPORT ID: INSP005
Structure ID: 13M126

## Inspection/CIDR Report
## TRAFFIC SIGNAL MAST ARM

DATE PRINTED: 5/3/2021

## Description

### Structure Unit Identification

Bridge/Unit Key: 13M126 1
Structure Name: SR 684 AT 43 STREET W
Description: TSMA
Type: M - Main

### Structure Identification

Admin Area: Sarasota/Manatee
District (2): D1 - Bartow
County (3): (13)Manatee
Location (9): AT 43 STREET WEST
FIPS State/Region (1): 12 Florida Region 4-Atlanta
NBIS Bridge Len (112): N - Does not meet NBI Length
Maint. Resp. (21): 2 County Hwy Agency
Owner (22): 1 State Highway Agency
Previous Structure:
2nd Previous Structure:
Replacement Structure:

### Age and Service

Year Built (27): 2016
Year Reconstructed (106): 0
Type of Service On (42a): Traffic Signal Mast Arm
Under (42b): 1 Highway

### Structure Type and Material

Main Span Material (43A): 3 Steel
Main Span Design (43B): Traffic Signal Mast Arm

### NBI Rating

Superstructure (59): 7 Good
Substructure (60): 5 Fair

### General Structure Information

Electrical Devices: Other type electric srvc
Maintenance Yard: Not FDOT Maintained (0)

Mast Arm Managing Agency ID:
Mast Arm Code: 2
Mast Arm Description: Mast arm is inside the mast arm boundary area

## Appraisal

### Minimum Vertical Clearance

Over Structure (53): 99.99 ft
Under (reference) (54a): H Hwy beneath struct
Under (54b): 0 ft

### Minimum Lateral Underclearance

Reference (55a): H Hwy beneath struct
Right Side (55b): 0 ft
Left Side (56): 0 ft

## Schedule

### Current Inspection

Inspection Date: 03/24/2021
Inspector: KNVOLTM - Thomas McCutcheon
Bridge Group: E1N92
Alt. Bridge Group:
Primary Type: Regular NBI
Review Required: [X]

### Next Inspection Date / Scheduled

NBI: 03/24/2026
Element: 03/24/2026
Other/Special:
Inventory Photo Update Due: 03/24/2026

### Inspection Types Performed

NBI [X] Element [X] Other Special [ ]

| Inspection Intervals | Required (92) | Frequency (92) | Last Date (93) |
|---|---|---|---|
| Other Special | [ ] | mos | |
| NBI | | 60 mos (91) | 03/24/2021 (90) |

### Inspection Resources

Crew Hours: 6
Flagger Hours: 0
Helper Hours: 0
Snooper Hours: 0

# FLORIDA DEPARTMENT OF TRANSPORTATION
# BRIDGE MANAGEMENT SYSTEM

**REPORT ID: INSP005**

## Inspection/CIDR Report

**Structure ID: 13M126**

## TRAFFIC SIGNAL MAST ARM

**DATE PRINTED: 5/3/2021**

## Elements

**Inspection Date: 03/24/2021** **ZUSA**

### MISCELLANEOUS : Other Elements

| Str Unit | Elem/Env | Description | Qty1 | %1 | Qty2 | %2 | Qty3 | %3 | Qty4 | %4 | T Qty |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Structure Unit 1 | 8480 / 4 | Mast Arm Foundation | 1 | 25 | 3 | 75 | 0 | . | 0 | . | 4 (EA) |
| Structure Unit 1 | 1020 / 4 | Connection | 0 | . | 3 | 100 | 0 | . | 0 | . | 3 (EA) |

### MISCELLANEOUS : Other Elements

| Str Unit | Elem/Env | Description | Qty1 | %1 | Qty2 | %2 | Qty3 | %3 | Qty4 | %4 | T Qty |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Structure Unit 1 | 8481 / 4 | Metal Mast Arm Vertical | 0 | . | 4 | 100 | 0 | . | 0 | . | 4 (EA) |
| Structure Unit 1 | 1000 / 4 | Corrosion | 0 | . | 4 | 100 | 0 | . | 0 | . | 4 (EA) |
| Structure Unit 1 | 8518 / 4 | Galvanized Steel | 484 | 98.57 | 7 | 1.43 | 0 | . | 0 | . | 491 sq.ft |
| Structure Unit 1 | 3440 / 4 | Eff (Stl Protect Coat) | 0 | . | 7 | 100 | 0 | . | 0 | . | 7 sq.ft |

### MISCELLANEOUS : Other Elements

| Str Unit | Elem/Env | Description | Qty1 | %1 | Qty2 | %2 | Qty3 | %3 | Qty4 | %4 | T Qty |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Structure Unit 1 | 8484 / 4 | Metal Mast Arm Horizontal | 0 | . | 4 | 100 | 0 | . | 0 | . | 4 (EA) |
| Structure Unit 1 | 1000 / 4 | Corrosion | 0 | . | 4 | 100 | 0 | . | 0 | . | 4 (EA) |
| Structure Unit 1 | 8518 / 4 | Galvanized Steel | 605 | 99.18 | 5 | 0.82 | 0 | . | 0 | . | 610 sq.ft |
| Structure Unit 1 | 3440 / 4 | Eff (Stl Protect Coat) | 0 | . | 5 | 100 | 0 | . | 0 | . | 5 sq.ft |

**Total Number of ADE Elements*:** 3
*excluding defects/protective systems

## Inspection Information

**Inspection Date:** 03/24/2021 **Type:** Regular NBI

**Inspector:** KNVOLTM - Thomas McCutcheon

**Inspection Notes:** The NBI rating for SIA Item 60, Substructure, is 5 because of loose leveling nuts at V3 and V4 foundations.

Item 092, Routine Inspection Frequency, has been updated to 60 months.

## Structure Notes

MAINTAINING AGENCY: MANATEE COUNTY

Equipment: Bucket Truck

Structure inspected west to east.

## Schedule Notes

# FLORIDA DEPARTMENT OF TRANSPORTATION
# BRIDGE MANAGEMENT SYSTEM

**REPORT ID: INSP005**

**Structure ID: 13M126**

## Inspection/CIDR Report
## TRAFFIC SIGNAL MAST ARM

**DATE PRINTED: 5/3/2021**

## Under Route Information

### Roadway Identification

NBI Structure No (8): 13M126
Position/Prefix (5): 2 - One Route Under
Kind Hwy (Rte Prefix): 3 State Hwy
Design Level of Service: 1 Mainline
Route Number/Suffix: 00684 / 0 N/A (NBI)
District (2): D1 - Bartow
County (3): (13)Manatee
Place Code (4): Bradenton
Feature Intersect (6): SR 684 (CORTEZ RD)
Roadway Name: SR 684 (CORTEZ RD)
Mile Point (11): 5.979
Latitude (16): 027d27'44.1"    Long (17): 082d36'15.4"

### Roadway Traffic and Accidents

Lanes (28): 4    Medians: 1    Speed: 45 mph

### Roadway Classification

Nat. Hwy Sys (104): 1 On the NHS
National base Net (12): 1 - On Base Network
LRS Inventory Rte (13a): 13 040 000    Sub Rte (13b): 00
Functional Class (26): 14 Urban Other Princ
Federal Aid System: ON
Defense Hwy (100): 0 Not a STRAHNET hwy
Direction of Traffic (102): 2 2-way traffic
Emergency: X

### Roadway Clearances

Vertical (10): 0 ft
Horiz. (47): 0 ft    Roadway (51): 0 ft
Truck Network (110): 0 Not part of natl netwo
Toll Facility (20): 3 On free road
Fed. Lands Hwy (105): 0 N/A (NBI)