Chapter 29

Miscellaneous Structures

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Chapter 29

Miscellaneous Structures

29.1 General

All sign, signal, and lighting structures designed for a minimum service life of 50 years (wind speed based on a 50-year mean recurrence interval) shall use a minimum of six ASTM F1554 anchor bolts at the pole to foundation connection (Dywidag bar are not permitted). Structures designed for wind speeds based on a 50-year mean recurrence interval include all overhead sign structures (span and cantilever), cantilevered signal structures (mast arms), monotube signal structures, and lighting structures over 50 feet in height (High Mast). Structures designed for 25 years recurrence interval winds include strain poles and light poles 50 feet in height or less.

On steel sign and signal structures, no circumferential welds are permitted on the uprights or arms with the exception of the base plate socket weld.

Grout pads underneath the baseplates in double-nut moment joints of miscellaneous highway structures (i.e. mast arms, overhead sign structures, high mast lights, steel strain poles and monotube structures) shall be considered optional. Each FDOT District shall establish a policy as to when and/or where these pads shall be installed.

29.2 Design of Overhead Sign Structures and Foundations

Unless otherwise directed by the Department, the design of all overhead sign structures whether ground mounted or supported on a structure (including bridge structures), shall be the responsibility of the Structures Design Engineer of Record (EOR). This responsibility is for the entire sign structure, including the supports and foundations, as well as all details necessary to fabricate and erect the sign structures. The EOR is also responsible for the shop drawing review in accordance with ***Chapter 28*** of this volume when sign structure shop drawings are required by the Contract Documents.

In general, the design criteria for the structural design of overhead sign structures and foundations shall be based upon this manual and ***AASHTO's 1994 Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals***, with current addenda. However, the wind loads shall be based on the wind

speeds shown on ***Table 29.1*** (50 year recurrence).

The designer may refer to the ***Design Standards, Index Nos. 11310 and 11320***.

FDOT assigns identification numbers to overhead sign structures. See ***Chapter 2*** of the ***Structures Detailing Manual*** for instructions.

29.2.1 Overhead Signs in Urban Locations

Span type overhead sign structures in urban locations shall be designed either for the actual signs shown on the signing plans or for a minimum sign area of 120 sq. ft. (12 ft. W x 10 ft. H) per lane, whichever is the greater. If the signing plans require signs for only one traffic direction, the minimum sign area per lane requirement applies to the traffic lanes in this direction only.

Cantilever type overhead sign structures shall be designed either for the actual signs shown on the signing plans or for a minimum sign 8 ft. wide by 10 ft. high located at the end of the cantilever, whichever provides the more stringent load or stress at the location under consideration.

Figures 29.1 and ***29.2*** show how to apply the above minimum sign areas for span type overhead sign structures in urban locations.

For additional design information, refer to ***Chapter 7*** of this volume.

Figure 29.1 (Showing Actual Signs)

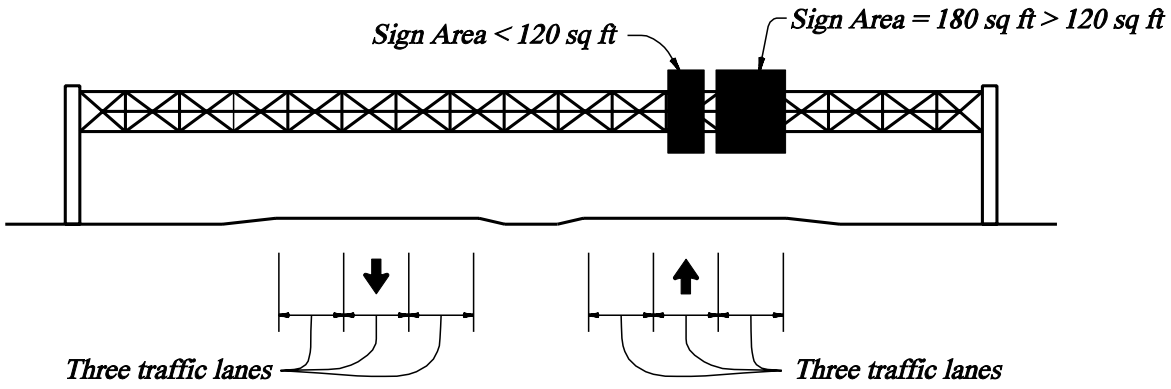
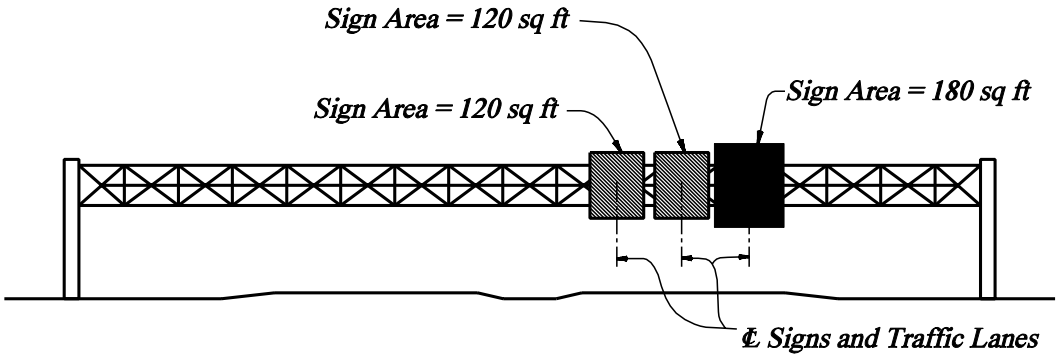


Figure 29.2 (Showing Signs for Design Purposes)



29.2.2 Overhead Signs in Rural Locations

Overhead signs in rural locations should be designed for the actual sign shown on the signing plans.

29.2.3 Overhead Signs on Bridge Structures

The design of the attachment system for signs mounted on bridge structures shall be the responsibility of the Structures Engineer of Record. The design shall be included in the structures plans if bridge work is included in the project. If bridge work is not included in the project, design details shall be included in the signing plans.

29.3 Design of High Mast Light Poles and Foundations

In general, the design criteria for the structural design of high mast light poles and foundations shall be based upon this manual and ***AASHTO's 1994 Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals***, with current addenda. However, the wind loads shall be based on the wind speeds shown on ***Table 29.1*** (50 year recurrence).

The EOR is responsible for the design and drawings of the foundations for high mast light poles and shall include the pole reactions in the drawings for the contract documents.

The Contractor is responsible for the design of the high mast light poles and will submit the design and details as shop drawings.

The design of the foundations shall consider the following:

1. Except for unusual circumstances, foundations shall be drilled shafts, 4 ft. in diameter.
2. The drilled shafts shall be designed in accordance with the ***Structures Design Guidelines***.
3. A minimum safety factor of 1.5 against overturning shall be provided.
4. Wind loading for the shafts shall be based on the wind speeds shown on ***Table 29.1*** (50 year recurrence).

For additional design information, refer to ***Chapter 7*** of this volume.

FDOT assigns identification numbers to High Mast Lighting Structures. See ***Chapter 2*** of the ***Structures Detailing Manual*** for instructions.

29.4 Design of Mast Arm Assemblies and Foundations

29.4.1 General Requirements

In general, the design criteria for the structural design of Mast Arm Assemblies and Foundations shall be in accordance with the ***AASHTO's 1994 Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals***, with current addenda, as modified by this manual.

The arm to pole connection on mast arm structures shall be “through-bolted” (tapped connections are not permitted).

Regardless of the design wind speed for the pole and arm, the torsional resistance of foundations for all Mast Arm Assemblies shall be based upon a service wind speed of 70 mph with a safety factor of 1.0.

The Designer may utilize a design wind speed of 110 mph for any site within the State or may specify the lower 90 mph wind speed in accordance with, and if permitted by, ***Table 29.2***.

All Mast Arm Assemblies shall be designed for signals **with backplates** unless the Maintaining Agency for a County has a written policy that prohibits the use of backplates in that County. Such a written policy must be on file with the Department's District Office in which the County is located, and the policy must be included in the Scope of Services of both the Signal and Structures Design Engineers. To date, the only Maintaining Agency with a written policy prohibiting the use of backplates is Miami-Dade County.

Mast Arm Assemblies shall be designed and detailed by one of the following three methodologies each of which has its distinct application advantages; however, Standard Mast Arm Assemblies shall be utilized whenever possible:

1. Standard Mast Arm Assemblies:

   Mast Arms that utilize all pre-approved components listed on the Department's Qualified Products List (QPL) and that have been pre-designed for the selected Load Trees shown in ***Figure 29.3***.

2. Standard Mast Arm Assemblies for Site Specific Loadings:

Mast Arms for unique loadings but which utilize all pre-approved QPL components.

3. Special Mast Arm Assemblies:

   Mast Arms for unique loadings and/or geometric constraints that contain any component (arm or pole) that is outside the range of those listed on the QPL.

For additional design information, see ***Chapter 7*** of this volume.

29.4.2 Standard Mast Arm Assemblies

The distinct advantages of utilizing Standard Mast Arm Assemblies are that design time is limited to geometric and load tree confirmation only and Shop Drawings are not required.

Standard Mast Arm Assemblies comprise component parts that are listed on the Department's QPL by pre-approved suppliers. The Standard Mast Arm Assemblies must comply with all the requirements and design criteria shown on ***Index Nos. 17743*** and ***17745*** of the ***Design Standards***, and the “Standard Mast Arm Assemblies Data Table”. Furthermore, Standard Mast Arm Assemblies are limited to 90 or 110 mph design wind speeds with one of the load tree configurations shown in ***Figure 29.3***, and either single arm, single arm with luminaire, or double arms with arm orientations of 90° or 270° only.

Foundations and base plates for Standard Mast Arm Assemblies are pre-designed based on the following conservative soil criteria which cover the majority of soil types found in Florida.

Classification:	Cohesionless (Fine Sand)
Friction Angle:	30 Degrees
Unit Weight:	50 lbs./cu.ft. (assumed saturated)

Only in cases where the designer considers soil types at the specific site location to be of lesser strength properties should an analysis be required. Auger borings, SPT borings, or CPT soundings may be used as needed to verify the assumed soil properties, and at uniform sites, a single boring or sounding may cover several foundations. Furthermore, borings in the area that were performed for other purposes may be used to confirm the assumed soil properties. Unique site circumstances may require the foundation variables to be modified from those shown on ***Index 17743***. This shall be accomplished by completing the “Special Drilled Shaft Data” in the “Standard Mast Arm Assemblies Data Table”. In this event, the Geotechnical Engineer shall justify the differing foundation criteria to the District Structures Design Engineer during the design phase of the project.

To use Standard Mast Arm Assemblies, the designer must confirm that the information furnished by the Signal Designer in the "Mast Arm Tabulation Sheet" for any of the Mast Arm Assemblies meets the geometric and load tree limitations shown in ***Figure 29.3***. Once confirmed, the designer shall follow the procedure described in the design examples in ***Volume 2, Chapter 24*** and complete the necessary information required in the "Standard Mast Arm Assemblies Data Table" The "Standard Mast Arm Assemblies DataTable," along with its notes, shall then be included in the Traffic Plans.

29.4.3 Standard Mast Arm Assemblies for Site Specific Loadings

Standard Mast Arm Assemblies for site specific loadings that solely utilize QPL component parts shall be designed for the wind speeds shown in ***Table 29.2*** except for torsion on foundations as stipulated in ***Section 29.4.1***. The Department's Mast Arm computer program will select component parts from those shown on ***Index No. 17743*** for site specific load configurations differing from those shown in ***Figure 29.3***.

In order to be eligible for utilization of QPL component parts, the Mast Arm Assemblies must utilize only Arms and Poles from the components listed in the tables on ***Index No. 17743***. As for Standard Mast Arm Assemblies, the foundation design is included with the pole selection and needs no further information.

The design of, and details for, Standard Mast Arm Assemblies Utilizing QPL Component Parts shall be included in the plans in the same manner as for Standard Mast Arm Assemblies by use of the "Standard Mast Arm Assemblies Data Table". Similarly, because all QPL component parts are used, Shop Drawings are not required.

29.4.4 Special Mast Arm Assemblies

Special Mast Arm Assemblies shall also be designed for the wind speeds shown in ***Table 29.2*** with the exception of torsion on foundations as stipulated in ***Section 29.4.1***. The Department's Mast Arm Computer Program will provide the necessary variables to be shown in the “Special Mast Arm Assemblies Data Table”.

All designs for Special Mast Arm Assemblies shall be included in the plans including the design of the foundations. The designer may refer to applicable drawings of ***Index No. 17745***. All Special Mast Arm Assemblies require the submittal of Shop Drawings for all components.

Exhibit 29-A Flowchart for Designing and Detailing Mast Arm Assemblies

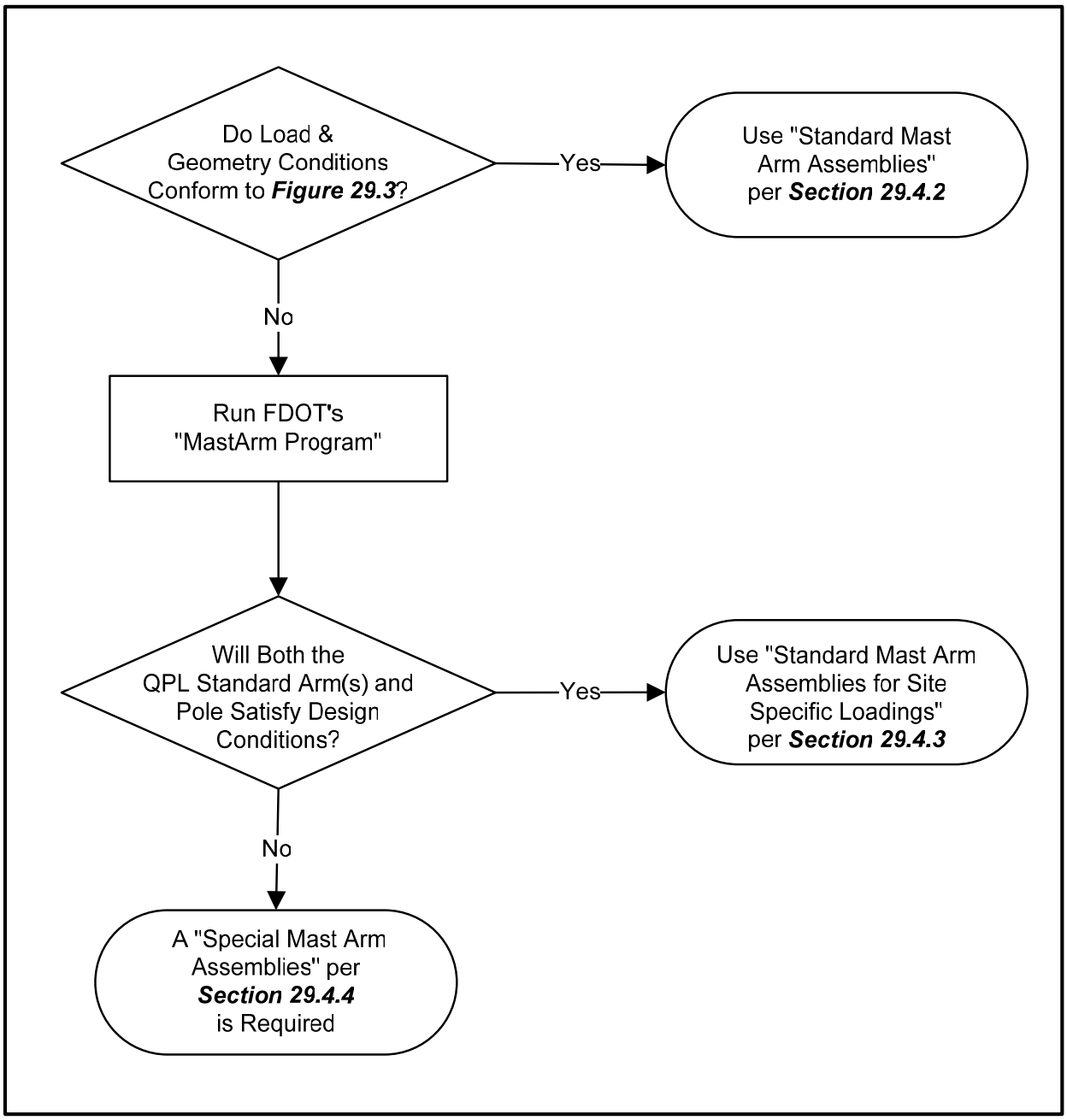
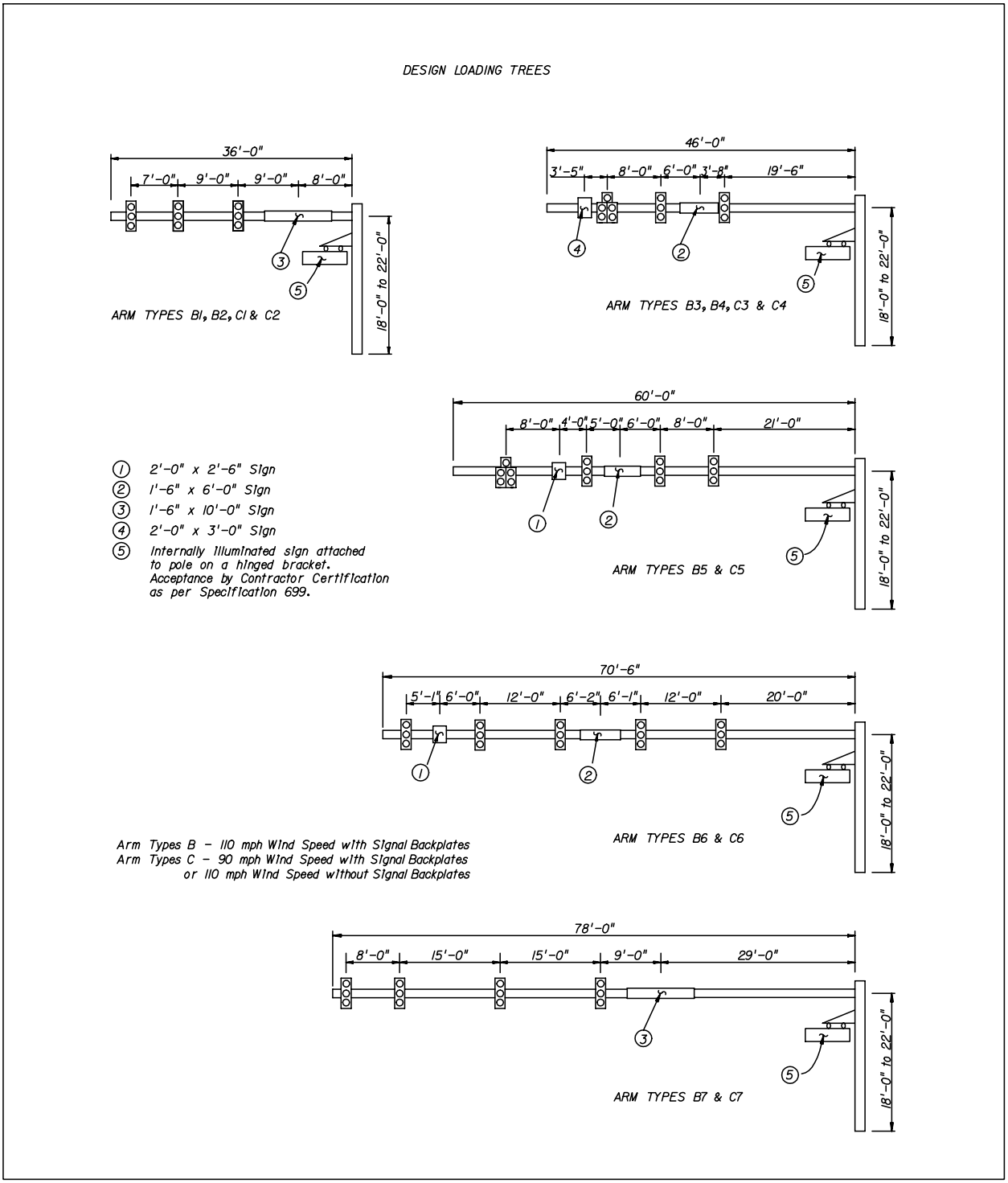


Figure 29.3 Standard Mast Arm Design Loading Trees



29.4.5 Anchor Bolt Installation on Existing Foundations

Anchors used in the installation of a Traffic Signal Mast Arm on an existing Foundation shall conform to ***Structures Design Guidelines 1.6 – Adhesive Anchor Systems*** and ***Sections 416 & 937*** of the ***Standard Specifications***.

The Engineer shall verify that the Foundation and strength of the Anchors are adequate for Mast Arm applied loads. Anchors may be offset from center but must be placed such that all Anchors are within the Foundation reinforcing cage. A note shall be added to the plan sheet indicating the desired offset.

The Engineer shall field verify the existing condition of the drilled shaft.

29.4.6 Design of Monotube Signal Structures and Foundations

In general, the design criteria for the structural design of Monotube Signal Structures and Foundations shall be in accordance with ***AASHTO's 1994 Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals***, with current addenda, as modified by this manual.

Monotube Signal Structure arms, poles, and foundations are designed for a design wind speed of 110 mph.

Unique site circumstances may require the foundation variables to be modified from the minimum foundations shown on ***Index No. 17746*** of the ***Design Standards***. If special designs are required, the Geotechnical Engineer shall provide the soil information to be used by the District Structures Design Engineer during the design phase of the project.

For additional design information, see ***Chapter 7*** of this volume.

The distinct advantages of utilizing Standard Monotube Signal Structures are that design time is limited to geometric and load tree confirmation only and Shop Drawings are not required.

Standard Monotube Signal Structures comprise component parts that are listed on the Department's QPL by a pre-approved supplier. Standard Monotube Signal Structures must

comply with all of the requirements and design criteria shown on ***Index No. 17746***. Furthermore, Standard Monotube Signal Structures are limited to the single service design wind speed of 110 mph and the load tree configuration shown on ***Index No. 17746***.

Foundation and base plates for Standard Monotube Signal Structures are pre-designed and require no further input from the designer. Foundations and base plates are mated to monotube configuration type and are shown on ***Index No. 17746***.

To use Standard Monotube Signal Structures, the designer must confirm that the information furnished by the signal designer on the "Monotube Tabulation Sheet" for any of the Standard Monotube Signal Structures meets the geometric and load tree limitations shown on ***Index No. 17746***. Once confirmed, the designer shall select a monotube configuration and complete the necessary information required in the "Standard Monotube Signal Structures Data Table". The "Standard Monotube Signal Structures Data Table," along with its notes, shall then be included in the traffic plans.

When a Standard Monotube Signal Structure is used, the payment for the structure will be coded as "Standard" with appropriate Standard Components defined by the remaining coding of the payment item.

29.5 Structural Design of Aluminum Light Poles

29.5.1 General Requirements

In general, the design criteria for the structural design of light poles and foundations shall be in accordance with ***AASHTO's 1994 Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals***, with current addenda. However, the wind loads shall be based on the wind velocities shown on ***Table 29.1*** (25-year recurrence for poles with heights up to 50 feet, and 50-year recurrence for poles exceeding 50 feet in height). The wind design height of the pole for wind pressure determination is the distance between the fixture elevation and the ground elevation at the roadway or the original ground elevation prior to embankment construction, whichever is greater.

For additional design information, see ***Chapter 7*** of this volume.

29.5.2 Standard Aluminum Light Poles and Foundations

Standard Aluminum Light Poles that utilize the QPL must comply with all of the detail requirements shown on ***Index No. 17515*** of the ***Design Standards***. Design wind speeds for the pole selection procedure shall be based upon ***Table 29.1*** as directed in ***Section 29.5.1*** and as modified by selection procedure numbers 4, 5, and 6.

SELECTION PROCEDURE

1. Determine the height difference between the top of foundation and the top of roadway used to set the fixture mounting height, round as necessary.
2. Determine the Design Mounting Height (40, 45, or 50 feet) and Fixture Arm Length (8, 10, 12, or 15 feet) required.
3. The Wind Height At Fixture equals the design mounting height for poles not on fill. For poles on fill, determine the height of the roadway above the surrounding terrain. The Wind Height At Fixture will equal the Design Mounting Height plus the fill height, rounded up to the next highest 5-foot increment.
4. For Standard Aluminum Light Poles (Design Mounting Height ≤ 50 feet) the Recurrence Interval is 25 years.

   Using the 25 year Recurrence Interval and the County in which the pole is located, choose the Design Wind Speed from ***Table 29.1***.

5. For a 25-year Recurrence Interval and 70 or 80 mph Design Wind Speeds, use an 80 mph Design Wind Speed.
6. For a 25-year Recurrence Interval and 90 or 100 mph Design Wind Speeds, use a 100 mph Design Wind Speed.
7. Determine the pole design variables for each light pole.

Example: From design: The required Design Mounting Height is 40' and a 12' Fixture Arm Length is needed. The top of foundation is 1'-0" lower than the roadway and on a 12'-0" fill. The project is located in Miami-Dade County.

Aluminum light pole design requirements:
Design Mounting Height = 40'
Wind Height At Fixture = 55' (40+1+12)=53'; use 55'
Design Wind Speed = 100 mph
Fixture Arm Length = 12'

From ***Index 17515***, from the 12' Arm Data Table, Select Case No. 7.
From ***Index 17515***, for a 40' Mounting Height and 12' Arm, Select Case No. 7.
The Pay Item for this pole is then: 715-617-307

LIMITATIONS

1. Fixture Arm Length of 8', 10', 12' or 15'. Single arm only.
2. Design Mounting Height of 40', 45' or 50'. (May differ from Fixture Mounting Height, see Selection Procedure item 2).
3. 25' maximum height above adjoining ground surface.
4. Design weight of luminaire assumed to be 51 lbs..
5. Equivalent projected area of luminaire for design is 1.5 sq. ft..
6. No bridge or wall mounting permitted.
7. Maximum fill slope at the pole of one vertical to four horizontal. Steeper slopes can be accommodated provided the face of the slope on a horizontal projection from the foundation base is no closer than it would be if a 1:4 slope were projected from the top of the foundation.

Unique site circumstances where poorer soil conditions are encountered than shown on ***Index No. 17515*** may require the foundation variables to be modified from those shown. If special designs are required, the Geotechnical Engineer shall provide the soil information to

be used by the District Structures Design Engineer during the design phase of the project.

The distinct advantage of utilizing Standard Aluminum Light Poles is that design time is limited to the selection procedure and Shop Drawings are not required.

For additional design information, see ***Chapter 7*** of this volume.

29.5.3 Special Aluminum Light Poles and Foundations

When Special Aluminum Light Poles are required, or otherwise specifically designated in the contract documents, the Contractor's Specialty Engineer is responsible for the structural design of the roadway light poles and foundations and the EOR is responsible for the review of the Shop Drawings.

29.6 Design of Strain Poles and Span Wire Assembly

In general, the design criteria for the structural design of these structures and foundations, including attached traffic signals and signs, shall be based upon this manual and ***AASHTO's 1994 Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals***; with current addenda. However, the wind loads shall be based on the wind velocities shown on ***Table 29.1*** (25 year recurrence).

For additional design information, refer to ***Chapter 7*** of this volume.

Table 29.1 Design Wind Speeds (mph)

County (Dist)	25-year Recurrence	50-year Recurrence
Alachua (2)	80	90
Baker (2)	80	90
Bay (3)	80	90
Bradford (2)	80	90
Brevard (5)	90	100
Broward (4)	100	110
Calhoun (3)	80	90
Charlotte (1)	90	100
Citrus (7)	80	90
Clay (2)	80	90
Collier (1)	90	100
Columbia (2)	70	80
DeSoto (1)	80	90
Dixie (2)	80	90
Duval (2)	80	90
Escambia (3)	90	100
Flagler (5)	80	90
Franklin (3)	90	100
Gadsden (3)	70	80
Gilchrist (2)	80	90
Glades (1)	80	90
Gulf (3)	90	100
Hamilton (2)	70	80
Hardee (1)	80	90
Hendry (1)	80	90
Hernando (7)	90	100
Highlands (1)	80	90
Hillsborough (7)	80	90
Holmes (3)	70	80
Indian River (4)	90	100
Jackson (3)	70	80
Jefferson (3)	70	80
Lafayette (2)	80	90
Lake (5)	80	90

County (Dist)	25-year Recurrence	50-year Recurrence
Lee (1)	90	100
Leon (3)	70	80
Levy (2)	80	90
Liberty (3)	80	90
Madison (2)	70	80
Manatee (1)	90	100
Marion (5)	80	90
Martin (4)	90	100
Miami-Dade (6)	100	110
Monroe (6)	100	110
Nassau (2)	80	90
Okaloosa (3)	90	100
Okeechobee (1)	80	90
Orange (5)	80	90
Osceola (5)	80	90
Palm Beach (4)	100	110
Pasco (7)	90	100
Pinellas (7)	90	100
Polk (1)	80	90
Putnam (2)	80	90
St. Johns (2)	80	90
St. Lucie (4)	90	100
Santa Rosa (3)	90	100
Sarasota (1)	90	100
Seminole (5)	80	90
Sumter (5)	80	90
Suwannee (2)	70	80
Taylor (2)	80	90
Union (2)	80	90
Volusia (5)	90	100
Wakulla (3)	80	90
Walton (3)	80	90
Washington (3)	80	90

Table 29.2 Design Wind Speeds for Mast Arms

110 mph Counties	90 mph Counties
Bay	Alachua
Brevard	Baker
Broward	Bradford
Charlotte	Calhoun
Citrus	Clay
Collier	Columbia
Dixie	DeSoto
Duval	Gadsden
Escambia	Gilchrist
Flagler	Glades
Franklin	Hamilton
Gulf	Hardee
Hernando	Hendry
Hillsborough	Highlands
Indian River	Holmes
Lee	Jackson
Levy	Jefferson
Manatee	Lafayette
Martin	Lake
Miami-Dade	Leon
Monroe	Liberty
Nassau	Madison
Okaloosa	Marion
Palm Beach	Okeechobee
Pasco	Orange
Pinellas	Osceola
Santa Rosa	Polk
Sarasota	Putnam
St. Johns	Seminole
St. Lucie	Sumter
Taylor	Suwannee
Volusia	Union
Wakulla	Washington
Walton	

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