FLORIDA DEPARTMENT OF TRANSPORTATION

FDOT MODIFICATIONS TO LRFD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS (LRFDLTS-1)

STRUCTURES MANUAL
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1 INTRODUCTION

1.1 Scope

Add the following:

Conform to the date specific AASHTO Publications listed in ***Structures Manual Introduction*** I.6 References.

For evaluation of existing support structures, including the addition of attachments, use the ***LFRD*** Specification for Structural Supports for Highway Signs, Luminaires and Traffic Signals. See ***FDOT Design Manual (FDM)*** and Section 18 of this Manual for requirements.

C 1.1

Add the following:

Structures Manual Introduction I.6 is updated annually to reflect the specific specifications editions and interims adopted by the FDOT.

For existing supports, ***FDM*** 261.7 defines when structural evaluation is necessary and lists FDOT Design Exception and Variation requirements.

2 GENERAL FEATURES OF DESIGN

2.1 Scope

Add the following:

See ***FDM*** regarding the use of FDOT ***Standard Plans*** and other design requirements.

C 2.1

Add the following:

FDM contains additional FDOT requirements for sign, signal and lighting structures. The ***Standard Plans*** contains drawings for all typical sign, signal and lighting structures.

2.4 Functional Requirements

2.4.2 Structural Supports for Signs and Traffic Signals

2.4.2.2 Size, Height and Location of Signs

Add the following:

Span type overhead sign structures in urban locations shall be designed for the actual signs shown on the signing plans and a minimum sign area of 120 sq. ft. (12 ft. W x 10 ft. H) per lane. The minimum sign area applies to lanes without signs and lanes with sign sizes smaller than the minimum. A lane is considered to be without signs when 8 feet or more of the lane is not under a sign. Adjust the sign width when necessary while maintaining a minimum sign area of 120 sq. ft. (e.g. 8 ft. W x 15 ft. H). 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 in urban locations shall be designed either for the actual signs shown on the signing plans or for a minimum sign area of 80 sq. ft. (8 ft. W x 10 ft. H) located at the end of the cantilever, whichever provides the larger load or stress at the location under consideration.

Figures 1 and 2 show how to apply the above minimum sign areas for span type overhead sign structures in urban locations.

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

C 2.4.2.2

Add the following:

Minimum sign areas provide additional capacity for future sign panel installations.

See ***FDM*** 102 for a link to the Urban Boundary Maps. See ***FDM*** for cantilever and span overhead sign support location criteria.

Figure 1 Example: Actual Signs

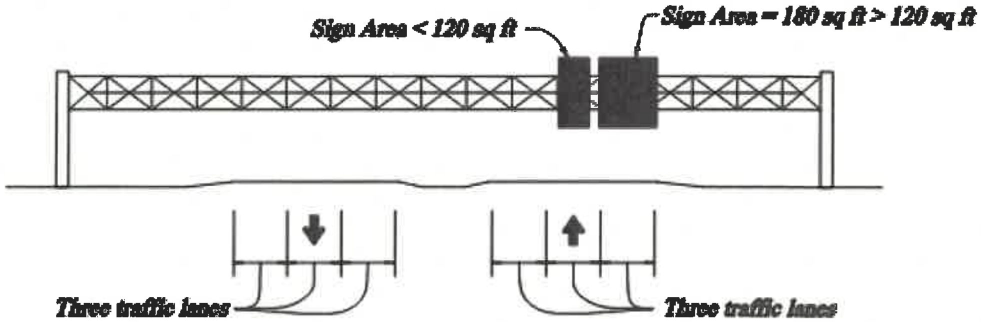
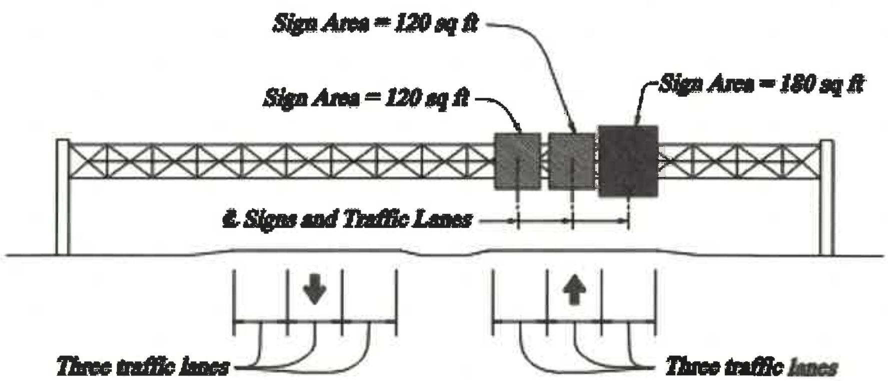


Figure 2 Example: Signs Used in Design



2.4.2.4 Changeable (Dynamic) Message Signs

Add the following:

For all walk-in overhead Dynamic Message Sign (DMS) structures, the horizontal member shall consist of a truss with a minimum of two chords with a minimum center-to-center distance between the chords of 3'- 0". See FDOT LTS Section 11.8 for maximum span-to-depth ratios.

FDOT vertical clearance requirements for walk-in DMS structures are found in ***FDM*** 210.

For vertical clearance and structural design of walk-in DMS support structures, use a DMS size of 8ft. H x 30ft. W x 5ft. D with a weight of 5500 lbs.

C 2.4.2.4

Add the following:

The minimum requirements given provide additional measures to limit the possibility of galloping.

Since cantilever walk-in overhead DMS structures are more susceptible to fatigue than span overhead DMS structures, span structures should be used whenever possible.

The DMS design size and weight are the maximum values of the system listed on the FDOT Approved Products List at the time of publication.

2.4.2.5 Horizontal Span and Cantilever Limits

New Section, add the following:

See ***FDM*** 261.1 for sign and signal support structure limits.

2.6 Integration of Structural Supports With Roadway and Bridge Design

2.6.1 Signs (Rev. 01/23)

Add the following:

On Bridges, installation of all permanent signs and associated sign supports other than ***Standard Plans*** Indexes 700-012 and 700-013 must be approved by the District Structures Design Engineer.

For permanent signs directed towards traffic on the bridge and that are attached to bridge superstructures, limit the total sign area to 25 square feet per support.

When signs directed towards the lower roadway are approved to be attached to substructures or superstructures, limit the height of the signs and associated sign supports to between the top of the adjacent traffic/pedestrian railing and 6" above the bottom of the adjacent beam/ girder.

See ***SDG*** 1.9.D for additional requirements. See Chapter 18 for existing bridge mounted support structures and signs.

C 2.6.1

Add the following:

See ***FDM*** 215 and FDOT ***SDG*** Section 1.9 for criteria for making attachments to traffic railings.

Signs directed towards the lower roadway that are attached to bridges are not permitted to extend above a traffic railing because they are not crashworthy designs. In addition, wind forces induced on the bridge could cause unforeseen stresses, hinder future bridge widenings and create aesthetic concerns for the bridge travelers.

See ***FDM*** 210.10.3 for vertical clearance requirements.

Modification for Non-Conventional Projects:
Delete the first paragraph of ***LRFDLTS-1*** 2.6.1 and insert the following: Installation of all permanent signs and associated sign supports other than ***Standard Plans*** Indexes 700-012 and 700-013 on bridges is not permitted unless otherwise written in the RFP.

3 LOADS

3.8 Wind Load

Delete Table 3.8.1 and replace it with the following:

Structure Support Type	Interval (years)
• Overhead sign structures • Luminaire support structures >50' in height. • Mast Arm Signal Structures • Monotubes • High Mast Light Poles • ITS Camera Poles >50' in height • Bridge Aesthetic Lighting Structures	700
• Luminaire supports and other structures ≤ 50' in height. • Concrete and Steel Strain Poles	300
• Roadside sign structures	10

C 3.8

FDOT continues the past practice of determining wind speeds based on structure type.
Luminaire support structures shall include all support elements including all poles, arms, connections and anchorages for all high-mast lighting, roadway lighting, sign lighting, underdeck lighting, landscape lighting, and bridge aesthetic lighting.

Based on the ASD-LTS Specifications, the design life is:
- 10 years for ground signs.
- 25 years for conventional light poles and strain poles.
- 50 years for mast arms, high mast light poles and overhead sign structures.

3.8.2 Basic Wind Speed

Delete the entire paragraph including Figures 3.8-1, 3.8-2, 3.8-3 and 3.8-4 and add the following:

For the 700 year Extreme Event Limit State, use the wind speeds (mph) shown in FDOT ***SDG*** Table 2.4.1-1

For the 300 year Extreme Event Limit State, use the wind speeds (mph) shown in FDOT ***SDG*** Table 2.4.1-1 minus 10 mph.

For the 10 year Extreme Event Limit State, use a design wind speed of 110 mph for the entire state.

For the Service Limit State, use a design wind speed of 90 mph for the entire state.

For temporary ground signs, luminaires and span wire traffic signals, for both the Extreme Event and Service Limit States,

C 3.8.2

Add the following:
FDOT ***SDG*** Table 2.4.1-1 was derived from the ASCE 7-10 wind speed map.

To simplify the design process, FDOT has designated one wind speed per county for the 700 year and 300 year Extreme Event Limit States. To maintain consistency with past practice, a 110 mph design wind speed was chosen for the 10 year Extreme Event Limit State, and an 80 mph design wind speed was chosen for temporary ground sign supports.

use a design wind speed of 80 mph for the entire state.

3.8.7 Drag Coefficients C_d

Add the following to Table 3.8.7-1:

Traffic Signals - no ability to swing		1.2
Traffic Signals - installed on 2 wire, 2 point connections	Without Backplates	0.7
	With Backplates	0.6
Solar Panels - installed with a tilt angle between 15 and 30 degrees		2.1 (positive) 1.8 (negative)

C 3.8.7

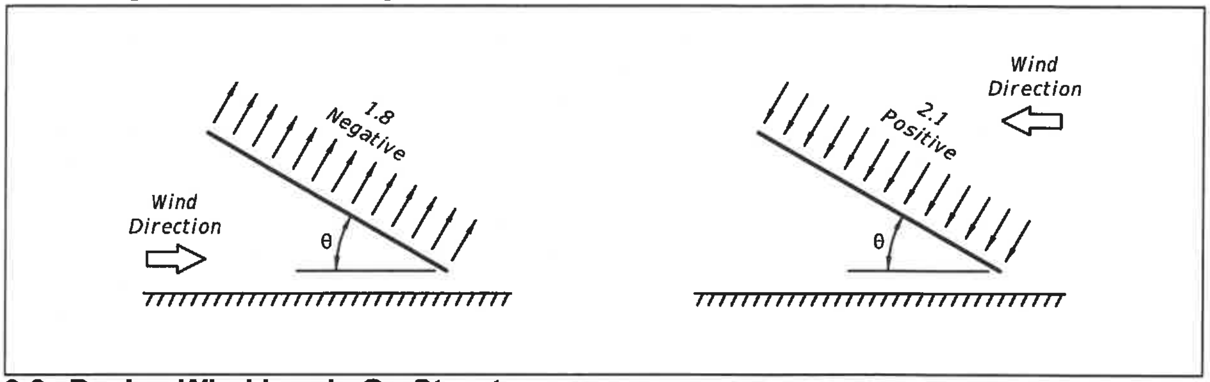
Add the following to note 2 at the bottom of Table 3.8.7-1:

On span wire systems where signals and signs are allowed to swing, varying C_d as a function of swing angle was included in the original ATLAS Program (Hoit and Cook 1997). Simplified drag coefficients for traffic signals installed with the ability to swing under controlled experimental conditions (i.e. no wind gust effects) has been suggested through research (Cook 2007). Current FDOT drag coefficients are based on parametric studies conducted in FDOT research report ***Dual Cable Supports for Wide Intersections*** (Contract C9G79, Sunna, 2015)

ATLAS is a span wire software program distributed by the University of Florida Bridge Software Institute (BSI). Do not consider uplift in the design of cable supported traffic signal systems designed using LRFD ATLAS and constructed using FDOT ***Standard Plans***. To simplify design, the drag coefficients required by the FDOT have been adjusted to account for uplift. Accordingly, ATLAS v7 no longer permits user input for uplift of cable supported traffic signal systems.

The coefficients given for solar panels are approximately the same as those given in ASCE 7-10, Figure 27.4-4 for inclined mono-sloped roofs. See simplified illustration in FDOT Figure 3.8.7-1.

FDOT Figure 3.8.7-1 Drag Coefficients for Solar Panels



3.9 Design Wind Loads On Structures

3.9.1 Load Application

Add the following:

The area of a traffic signal on new mast arms and span wires shall include a 6 inch wide backplate, use the following areas for traffic signals:

Item	Projected Area
12" Signal Section	1.36 sf
3 Section 2.5" wide Backplate	3.05 sf
4 Section 2.5" wide Backplate	3.54 sf
5 Section 2.5" wide Backplate	4.02 sf
3 Section 6" wide Backplate	5.67 sf
4 Section 6" wide Backplate	6.83 sf
5 Section 6" wide Backplate	8.00 sf

C 3.9.1

Add the following:

Areas given are for standard signals in Florida. For example, the total area for a 3 head signal with backplate is equal to: (3 x 1.36 sf) + 5.67 sf = 9.75 sf.

2.5 inch wide backplates are only used in retrofit installations.

3.10 References

Add the following:

Cook, R.A. (2007). ***Development of Hurricane Resistant Cable Supported Traffic Signals*** (FDOT Report# BD545 RPWO #57). Gainesville, Florida: University of Florida.

Hisham Sunna and David Johnson, AYRES Associates, ***Dual Cable Supports for Wide Intersections***, FDOT Contract C9G79, October 2015.

4 ANALYSIS AND DESIGN - GENERAL CONSIDERATIONS

4.7 Analysis of Span Wire Structures

Add the following:

When suspended (hanging) box span systems with FDOT two-point two-wire configurations are required, the following attachments and support structure may be used without analysis if meeting the given geometry constraints.

A. Geometry:

1. Square or rectangular suspended box with corner angles 90 degrees ±15 degrees.
2. Angle of pole cables to hanging box cables 135 degrees ± 15 degrees.
3. Maximum Pole-to-Pole distance at 220 feet.
4. Pole to hanging box cable length may not exceed 25 feet.

B. Attachments:

1. Signals: Maximum number of three-lens signals with back-plate per span:
    a. For counties with LRFD Design Wind Speed = 160 mph: 4.

C 4.7

Add the following:

When using the ATLAS program for typical box span configurations, wind directions of 0, 45 and 90 degrees are usually sufficient for design.

If designing box span wire configurations with FDOT two-point two-wire connections, and ATLAS is having difficulty converging on a solution, the following approximate methodology may be used unless otherwise directed by the DSDE: design each of the four spans as an individual span using wind loads acting perpendicular to the span. For the pole design, multiply the maximum pole moment from the individual span analysis by 1.3 to account for wind from variable directions and the cable forces from the adjacent span. For the foundation design, multiply the maximum single span pole moment and shear by 1.3.

When using the approximate method for unusual box span configurations with two-wire two-point connections, the DSDE may require a higher multiplier than 1.3.

    b. For counties with LRFD Design Wind Speed = 140 mph: 6.
    c. For counties with LRFD Design Wind Speed = 120 mph: 6.
    d. For Allowable Stress Design, subtract 10 mph.

2. Signs per box span: for each 3'x 2' sign, subtract two signals from the maximum given in item 1) above.

C. Support Structure:

1. Pole Type: PS-X as shown in FDOT ***Standard Plans*** Index 649-010
2. Cables: All cables ½" diameter meeting the requirements of FDOT Specification 634.
3. Cable Configuration: as shown in FDOT ***Standard Plans*** Index 634-001.

For intersections with geometry outside the values given above, a finite element analysis is required to determine the number of attachments allowed.

5 STEEL DESIGN

5.4 Material

Replace 5.4 with the following:

Use the materials specified in the following documents:

- FDOT Structures Manual
- FDOT Standard Specifications for Road and Bridge Construction
- FDOT Standard Plans

Do not specify ASTM A588 (rustic, Corten, "self-oxidizing", or "self-weathering") steel in sign, signal, or lighting structures.

C 5.4

Add the following:

In some environmental conditions in Florida, A588 steel has deteriorated significantly.

5.6 General Dimensions and Details

5.6.3 Transverse Plate Thickness

Add the following:

The minimum base plate thickness shall be 2½ inches for mast arm signal structures, steel ITS poles, and steel strain poles, and 3 inches for high mast light poles.

For base plate connections without stiffeners on 700 year recurrence interval structures, only use full-penetration groove welds.

C 5.6.3

Add the following:

Research has proven full-penetration groove welds combined with thicker base plates increases the pole-to-base-plate connection fatigue strength.

5.12 Combined Forces

Add the following:

When designing mast arm signal structures, replace "≤ 1.0" with "≤ 0.95" in all equations under this section.

C 5.12

Add the following:

For mast arms, designing to a maximum limit of 0.95 allows for future attachments such as cameras and other ITS equipment.

5.13 Cables And Connections (Rev. 01/23)

Add the following:

Use the cable breaking strength values specified in FDOT ***Specifications*** Section 634.

Use $\phi_{rt} = 0.6$

When designing Strain Pole/Span Wire support structures, ensure the span wire has a Demand/Capacity Ratio ≤ 0.95.

C 5.13

Add the following

Cables used in the construction of span-wire pole structures are listed in FDOT ***Specifications*** Section 634.

Designing to a maximum limit of 0.95 allows for future attachments such as cameras and other ITS equipment.

5.14 Welded Connections

Add the following:

On steel sign, lighting, and signal support structures, no circumferential welds are permitted on the uprights, arms or chords with the following exceptions:

- The upright to base plate weld
- The flange plate connection weld on tubular truss chords
- Mitered arm-to-upright angle welds on monotubes
- Uprights with lengths greater than available mill lengths.

C 5.14

Add the following:

The Department's intent is to avoid any unnecessary welds on sign, signal or lighting structures.

Typical mill lengths for pipes and tubes are typically 35 feet and greater. When upright splices are proposed by the fabricator, approved shop drawings are required (***Specifications*** 5-1.4.2) with documentation showing the required pipe is unavailable in the lengths required.

5.15 Bolted Connections

Add the following:

Design all pole to arm connections on Mast Arm structures as "through bolted" using a minimum of six bolts.

C 5.15

Add the following:

Tapped connections are not permitted. Through bolted connections allow for fully tensioned F3125 bolts.

5.16 Anchor Bolt Connections

Add the following:

All sign, signal, and lighting structures designed for a 700 year mean recurrence interval wind speed shall use a minimum of eight ASTM F1554 Grade 55 anchor bolts at the pole to foundation connection, with the exception of Mast Arm signal structures, where the minimum is six anchor bolts.

C 5.16

Add the following:

A minimum of eight anchor bolts provides redundancy and better distribution of forces through the base plate.

5.16.1 Anchor Bolt Types

Delete anchor bolts types listed in the second and third bullet and add the following:

Both Adhesive anchors and threaded post-tensioning bars are not permitted.

C 5.16.1

Add the following:

FDOT only allows straight headed anchor bolts.

Adhesive anchor and threaded post-tensioning bars have undesirable creep and non-ductile behavior respectively.

5.16.2 Anchor Bolt Materials

Add the following:

Only use ASTM F 1554 anchor bolts with 55 ksi yield strength.

C 5.16.2

Add the following:

ASTM F 1554 Grade 55 anchor bolts provide sufficient ductility after yield to engage all the anchor bolts on the tension side of the base plate.

5.16.3 Design Basis (Rev. 01/23)

Add the following:

Use double-nut moment joints in all mast arm signal structures, steel strain poles, high mast light poles and overhead sign structures.

Specify a maximum clear distance of one bolt diameter between the bottom leveling nut and the top of concrete. If the clear distance is equal to or less than the nominal anchor bolt diameter, bending of the anchor bolt from shear and torsion may be ignored. If the clear distance exceeds one bolt diameter, bending in the anchor bolt shall be considered.

On mast arm signal structures and cantilever overhead sign structures, a structural grout pad is required under the base plates in double-nut moment joints.

Grout pads are not required under the base plates in double-nut moment joints of span overhead sign structures, high mast light poles, and steel strain poles.

C 5.16.3

Add the following:

A structural grout pad significantly contributes to the design load carrying capacity of anchor bolts in cantilever structures.

When significant torsion is transmitted from the base plate to the anchor bolt group, a structural grout pad permits the anchors to develop their full shear strength, Cook et al. (2013).

Inspections have shown that a poorly functioning grout pad is worse than no grout pad at all. For poles without a grout pad beneath the base plate, the double-nut moment joint requires adequate tensioning of the anchor bolts. It is critical that the nuts beneath the base plate, typically referred to as leveling nuts, are firmly tightened to prevent loosening. This tightening mechanism is accomplished through the turn of the nut method specified in FDOT Specifications Section 649 or a properly placed grout pad.

5.19 References

Add the following:

Cook, R. A., Prevatt, D. O., and McBride, K. E. 2013. *Steel Shear Strength of Anchors with Stand-Off Base Plates*. Florida Department of Transportation Research Report BDK75-49, Tallahassee, FL

6 ALUMINUM DESIGN

6.1 Scope

Add the following:

Do not specify aluminum overhead sign structure supports with the exception of the vertical sign panel hangers, which may be aluminum or steel.

C 6.1

Add the following:

Aluminum overhead sign structures have been prone to unacceptable levels of vibration and fatigue cracking.

6.4 Material and Material Properties

Add the following:

Use the materials specified in the following documents:

- FDOT Structures Manual
- FDOT Standard Specifications for Road and Bridge Construction
- FDOT Standard Plans

7 PRESTRESSED CONCRETE DESIGN

7.4 Materials

7.4.2 Normal and Lightweight Concrete

7.4.2.1 General (Rev. 01/23)

Replace 7.4.2.1 with the following:

Use the materials specified in the following documents:

- FDOT Structures Manual
- FDOT Standard Specifications for Road and Bridge Construction
- FDOT Standard Plans

For Standard Prestressed Concrete Pole Design, the minimum compressive concrete strength shall be 6.5 ksi.

C 7.4.2.1

Add the following:

FDOT uses Class V or Class VI concrete in accordance with ***Specifications*** Section 346.

7.4.3 Reinforcing Steel

7.4.3.1 General

Replace 7.4.3.1 with the following:

Use the materials specified in the following documents:

- FDOT Structures Manual
- FDOT Standard Specifications for Road and Bridge Construction
- FDOT Standard Plans

7.4.4 Prestressing Steel

7.4.4.1 General

Replace 7.4.4.1 with the following:

Use the materials specified in the following documents:

- FDOT Structures Manual
- FDOT Standard Specifications for Road and Bridge Construction
- FDOT Standard Plans

7.6 Design

Add the following:

The minimum clear concrete cover for all prestressed and non-prestressed poles is 1 inch.

C 7.6

Add the following:

FDOT requires a minimum 1 inch cover on all concrete poles in all environments.

7.6.1 General (Rev. 01/23)

Add the following:

For Standard Prestressed Concrete Pole Design, see ***Standard Plans Instructions*** Index 641-010, for the Moment Capacities for the Extreme Event Limit State.

When designing all Prestressed Concrete Pole support structures, ensure the pole has a Demand/Capacity ratio ≤ 0.95.

C 7.6.1

Add the following:

FDOT uses Standard Prestressed Concrete Poles in accordance with Index 641-010 and ***Specifications*** Section 641. After analysis of the proposed Strain Pole/Span Wire support structure, the Designer selects the appropriate pole using the design moment values given in the ***Standard Plans Instructions*** for Index 641-010.

Designing to a maximum limit of 0.95 allows for future attachments such as cameras and other ITS equipment.

10 SERVICEABILITY REQUIREMENTS

10.4.2.1 Vertical Supports

Add the following:

Under Service I load combination, limit the horizontal deflection of concrete poles supporting Closed Circuit Television (CCTV) cameras to one-inch in a 40-mph wind speed (3-second gust).

C 10.4.2.1

Add the following:

The deflection check for CCTV poles is a FDOT requirement to prevent excessive shaking of the camera under typical operating conditions.

10.5 Camber

Replace this section with the following:

Provide a design camber equal to 2.5 times the dead load deflection for overhead sign structures. For span overhead sign structures, arch the horizontal member upwards and for cantilever overhead sign structures rake the vertical support backwards. For mast arm signal structures, provide a two degree upward angle at the arm/upright connection.

C 10.5

Add the following:

Design camber = Permanent camber + dead load deflection. Permanent camber equal to 1.5 times the dead load deflection provides for a better appearance than the relatively small L/1000 given in AASHTO. For mast arms, a two degree upward angle at the arm/upright connection is standard industry practice.

11 FATIGUE DESIGN

11.6 Fatigue Importance Factors

Add the following:

Use Fatigue Category I for all sign, traffic signal, and lighting support structures (including all DMS support structures) with the following exceptions:

A. For Galloping, use Fatigue Category II for all FDOT Standard flat panel sign, traffic signal, and lighting support structures meeting the limits in FDOT 2.4.2.5.

B. For Natural Wind Gusts, use Fatigue Category II for all FDOT Standard traffic signal and lighting support structures meeting the limits in FDOT 2.4.2.5.

C 11.6

Add the following:

Sign, signal and lighting structures built using FDOT ***Standard Plans*** have historically performed well.

11.7 Fatigue Design Loads

11.7.1 Sign and Traffic Signal Structures

11.7.1.1 Galloping

Replace the 2nd, 3rd and 4th paragraphs with the following:

Vibration Mitigation devices are not allowed in lieu of designing for galloping.

Mast arm designed only for flat panel signs and/or DMS panels require the installation of FDOT ***Developmental Standard Plans*** D659-049 for Damping Device for Miscellaneous Structures.

Exclude galloping loads for the fatigue design of overhead cantilevered sign and DMS support structures with three or four chord horizontal trusses with bolted web to chord connections.

C 11.7.1.1

Add the following:

Vibration mitigation devices are seldom necessary and installed only after excessive vibration has been observed and the device is approved by the Department.

Mast arms with signs only have a higher tendency to vibrate.

Cantilevered sign support structures with horizontal three or four chord trusses have never been reported to vibrate from vortex shedding or galloping. (ref. FHWA Guidelines for the Installation, Inspection, Maintenance and Repair of Structural Supports for Highway Signs, Luminaries, and Traffic Signals).

11.8 Deflection

Add the following:

In addition, walk-in DMS structures shall also meet the following maximum span-to-depth ratios:

Walk-In DMS Structure Type	Max. Span-to-Depth Ratio
Overhead Span Structure	25
Overhead Cantilever Structure	9

C 11.8

Add the following:

The minimum requirements given provide additional measures to limit the possibility of galloping

13 FOUNDATION DESIGN

13.6 Drilled Shafts (Rev. 01/23)

Add the following:

Drilled shafts are the standard foundation type on high mast light poles, overhead signs, mast arms and steel strain poles.

See *SDG* 1.4.4 for designating drilled shafts as mass concrete in the Plans.

C 13.6

Add the following:

For standard drilled shaft details, see *Standard Plans* Indexes 700-040, 700-041, 715-010, 649-010 and 649-031 for overhead sign structures, high mast light poles, steel strain poles, and mast arms.

13.6.1 Geotechnical Design

13.6.1.1 Embedment

Add the following:

For overturning resistance, use the following ϕ factors:

MRI Winds (yrs)	ϕ
700	0.6
300	0.6
10	0.8

For torsion resistance of cylindrical foundations in cohesionless soils supporting Mast Arm signal cantilever overhead sign structures and cantilever ground sign structures, use the following equations:

$$T_u \leq \phi_{tor} \cdot T_n$$

Where

$$T_n = \pi D L F_s \left(\frac{D}{2}\right)$$

$$F_s = \sigma_v \omega_{fdot}$$

$$\sigma_v = \gamma_{soil} \left(\frac{L}{2}\right)$$

T_u = Torsion force on the drilled shaft

T_n = Nominal torsion resistance of the drilled shaft

ϕ_{tor} = Resistance Factor for torsion
= 1.0 for Mast Arm signal structures
= 0.9 for overhead cantilever sign structures
= 1.3 for cantilever ground sign structures

C 13.6.1.1

Add the following:

Since sign, lighting and signal foundations have performed well in Florida, ***LRFD*** ϕ factors have been calibrated to allowable stress design.

The torsion resistance equation is based on the theory for the Beta Method (O'Neill and Reese, 1999). The torsional resistance from the bottom face of the shaft is omitted to increase the conservatism in this approximate calculation. A single ω_{fdot} factor of 1.5 is used to adjust for the concurrent overturning and torsional forces and to compare with past FDOT practice. Since the consequence of a torsion soil-structure failure is usually small, some rotation may occur from the design wind.

Since cantilever overhead sign structures can have significantly more torsion than a Mast Arm, a lower resistance ϕ factor = 0.90 is appropriate. Cantilevered Ground Signs have a higher resistance factor greater than 1 due to a lower consequence of failure.

For soils with SPT N-values less than 5, consult the Geotechnical Engineer for additional recommendations.

D = diameter of the drilled shaft
L = length of the drilled shaft
F_s = unit skin friction
σ_v = effective vertical stress at mid-layer
γ_{soil} = unit weight of soil
N_{60} = the equivalent safety hammer SPT blow count uncorrected for overburden
ω_{fdot} = load transfer ratio where the allowable shaft rotation may exceed 10 degrees
= 1.5 for granular soils where SPT N_{60}-values are 15 or greater
= **$1.5(N_{60}/15)$** for N_{60}-values greater than or equal to 5 and less than 15.

13.6.2 Structural Design

Add the following:

Longitudinally reinforce drilled shaft foundations with a minimum of 1% steel. At a minimum, place #5 stirrups at 4 inch spacing in the top two feet of shaft. In cantilever structures, design for shear resulting from the torsion loading on the anchor bolt group.

C 13.6.2

Add the following:

Using 1% steel is conservative for flexural design in most cases. Additional stirrups in the top of the shaft provides resistance against shear failure in the top of the shaft. Due to torsion, additional stirrups may be required in cantilever structures.

13.6.2.1 Details

Replace the second sentence with the following:

A minimum concrete cover of six inches over steel reinforcement is required.

Add the following:

The minimum design diameter for drilled shafts is 3 feet and the maximum design diameter is 6 feet. A minimum main reinforcement clear spacing of six inches is required for proper concrete consolidation. The top five feet of stirrups in drilled shafts

C 13.6.2.1

Add the following:

FDOT requires six inches of cover to ensure durability in drilled shafts.

Drilled shafts with design diameters greater than 6 feet should be avoided. Concrete consolidation below the anchor bolts becomes more difficult with reinforcement clear spacing less than six inches. Larger shaft diameters should be considered to increase reinforcement spacing.

for sign, signal and lighting structures are exempt from this spacing requirement.

Modification for Non-Conventional Projects:
Delete FDOT 13.6.2.1 and insert the following: *Replace the second sentence with the following:* A minimum concrete cover of six inches over steel reinforcement is required. *Add the following:* A minimum reinforcement clear spacing of six inches is required for proper concrete consolidation. The top five feet of stirrups in drilled shafts for sign, signal and lighting structures are exempt from this spacing requirement.

13.7 Spread Footings

13.7.1 Geotechnical Design

Replace 13.7.1 with the following:

The bearing capacity and settlement of spread footings in various types of soils may be estimated according to methods prescribed in ***LRFD***. Eccentric load limitations shall be as given in ***LRFD*** 10.6.3.3.

C 13.7.1

Replace C13.7.1 with the following:

FDOT is using the ***LRFD*** Bridge Design Specifications for Geotechnical Design.

13.8 Piles

Add the following:

The minimum sizes of cased micropiles used to support miscellaneous structures are:

- For structures with a 300-year wind recurrence interval design
  5 inches OD
- For structures with a 700-year wind recurrence interval design
  7 inches OD.

Miscellaneous Structures may be founded on Auger Cast Piles (ACP).

13.10 References

Add the following:

Cook, R.A. (2007). ***Anchor Embedment Requirements for Signal/Sign Structures*** (FDOT Report# BD545 RPWO #54). Gainesville, Florida: University of Florida.

14 FABRICATION, MATERIALS, AND DETAILING

Replace this section with the following:

- See the FDOT Standard Specifications for Road and Bridge Construction and FDOT Materials Manual.

15 CONSTRUCTION

Replace this section with the following:

- See the FDOT Standard Specifications for Road and Bridge Construction and FDOT Materials Manual.

18 EVALUATION OF EXISTING STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES, TRAFFIC SIGNALS, ITS AND TOLLING (Rev. 01/23)

Add new Section 18 as titled above and include the following:

C 18
This section is added to provide guidance for the evaluation of existing support structures.

18.1 General (Rev. 01/23)

See *FDM* 261.8 for requirements for evaluating existing highway signs, luminaires, traffic signals, ITS and tolling structures.

The minimum sign areas for overhead sign structures per FDOT 2.4.2.2 are not required when analyzing an existing structure.

C 18.1
Field verified K_z and wind speeds derived from the wind speed map are consistent with the LTS Specification.

The details listed have been constructed in Florida and have performed well.

Foundation failures in Florida on LTS support structures are rare.

The following values may be used in the analysis of existing support structures:

- A height and exposure factor K_Z confirmed by field evaluation.
- A wind speed for the specific location using the 700-year MRI Florida wind speed map (See ***Figure*** 18.1-1). Liner interpolation between contours is permitted. For the 300-year MRI wind speed, use the wind speed given by the 700-year MRI map minus 10 mph. For ground signs, use 110 mph for the entire state.

FDOT approval is not required for any of the following existing details or conditions:

- mast arm to upright connections with 4 bolts (FDOT 5.15)
- tapped mast arm connections (FDOT 5.15)
- fillet welded tube-to-transverse plate connections (FDOT 5.14)
- mast arm upright anchorages with 4 bolts (FDOT 5.16)
- transverse plate thickness (FDOT 5.6.3)

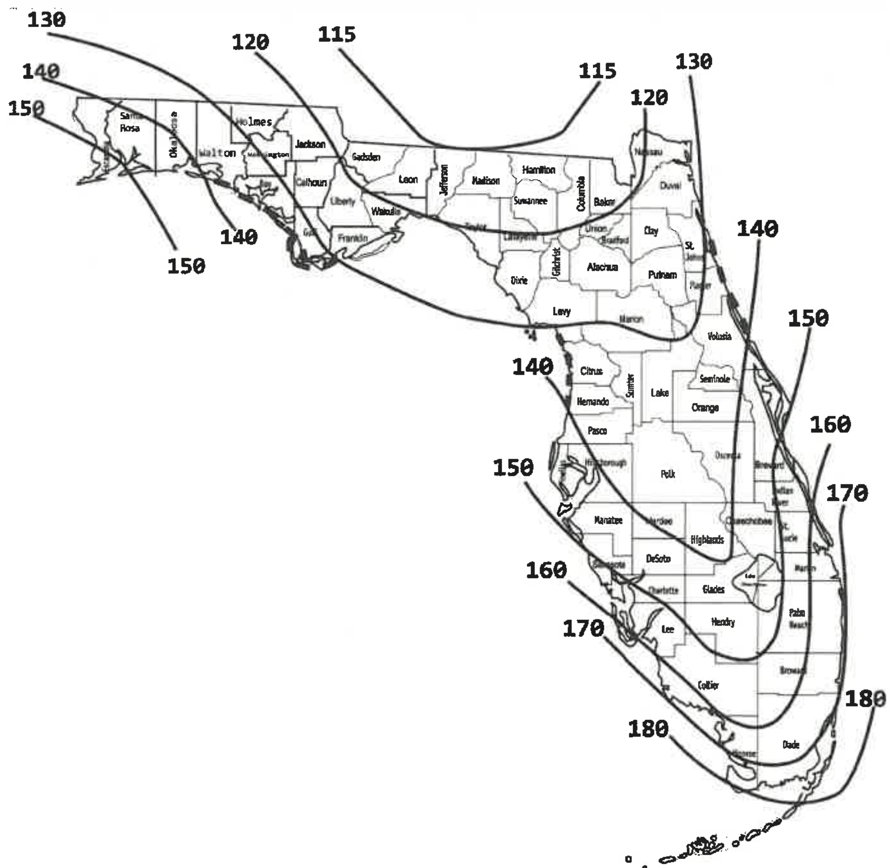
  - mast arm horizontal and upright base plate 1.25 inches and greater

  - high mast light pole and steel strain pole base plates 2.0 inches and greater
- mast arm foundations with stirrups spaced at 1'-0" centers.
- a CSR or CFI ≤ 1.10.
- Fatigue evaluation (LRFD-LTS Section 11 is not required).
- Foundation evaluation (LRFD-LTS Section 13, structural and geotechnical, is not required).

All items listed above should be checked when there is evidence of distress or instability, or when the Engineer has reason to believe the structural capacity is in doubt.

When retrofitting with "flexible" backplates to an existing mast arm or span wire, see the ***Traffic Engineering Manual, TEM,*** Section 3.9.

FDOT Figure 18.1-1 700-year MRI Florida Wind Speed Map



18.2 Existing Bridge Mounted Support Structures and Signs (Rev. 01/23)

Evaluate existing bridge mounted support structures and signs per *FDM* 261.8. Existing bridge mounted signs that extend above the bridge traffic railing are allowed to remain provided that the sign panel dimensions do not increase. In all cases, remove existing bridge mounted signs that extend above the bridge traffic railing when the sign does not meet the setback distance for discontinuous elements per *FDM* Figure 215.4.7. For a bridge widened on one side, these requirements also apply to the non-widened side of the bridge.

VOLUME 3 - REVISION HISTORY

2.6.1 ....Added policy for treatment of existing bridge mounted support structures and signs.

5.13 ....Added maximum demand/capacity ratio consistent with existing policy for mast arms.

5.16.3 ....Correction in commentary.

7.4.2.1 ....Eliminated Class V Special concrete. See Volume 1 SDG for explanation.

7.6.1 ....Added maximum demand/capacity ratio consistent with existing policy for mast arms.

13.6 ....Added cross-reference. Updated commentary for consistency with Specifications.

18 ....Companion changes with FDM 261.

18.1 ....Added support structures for traffic signals, ITS and tolling. Moved last bullet item to main paragraph of section for clarity.

18.2 ....Added new section to address policy on existing bridge mounted support structures and signs.