Truss or Cantilever Sign Foundation Design

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Division of Bridges - INDOT

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Overview

- Design Criteria
- Current Design Policy, Codes, IDM, Specifications, Standard Drawings.
- Geotechnical Requirements.
- Foundation Types, Selection, Location, Constraint
- Practice Pointers

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Sign Support Structures

- Types, IDM:

1. box truss;
2. sign cantilever structure;
3. tri-chord truss structure;
4. butterfly sign cantilever structure;
5. dynamic message sign structure;
6. monotube bridge sign structure;
7. bridge-attached sign structure for large panel signs;
8. bridge bracket for crossroad signing; and
9. cable span sign structure.

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Box Truss Structures

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Cantilever Structures

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AASHTO Specifications

- Current Design Code – ASD Design

ABBREVIATED TABLE OF CONTENTS

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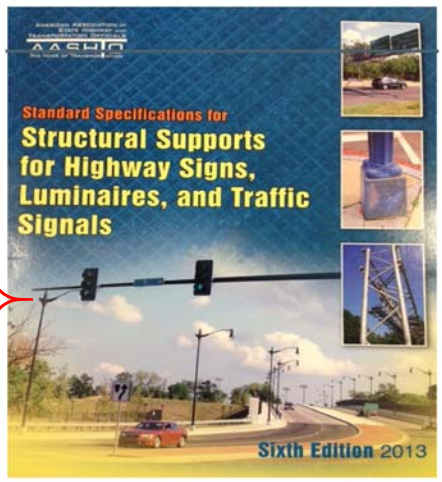

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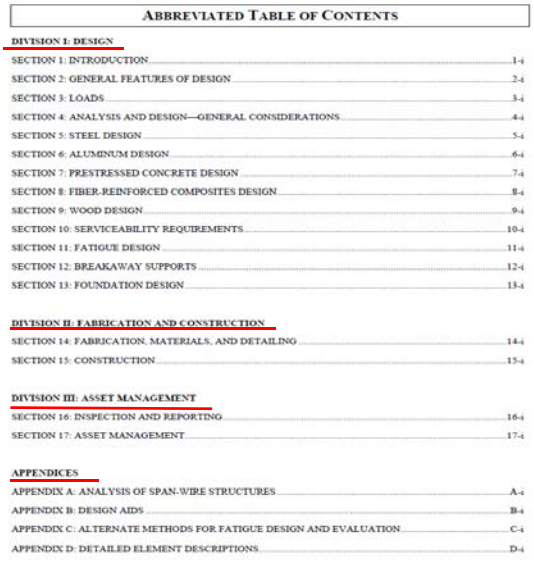
AASHTO Specifications

- Future Design Code



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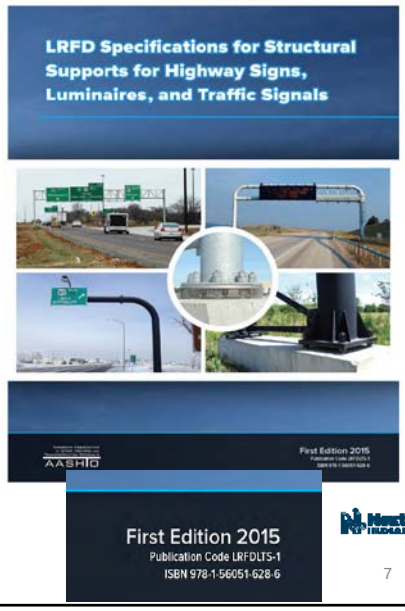

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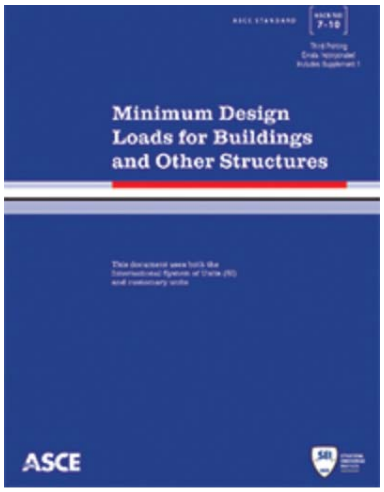
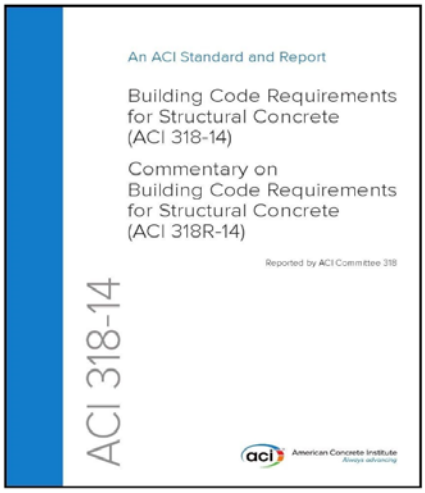
ASCE/ SEI & ACI Codes

ASCE/SEI 7-10



ACI Building Code



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Current Policy

- Sign Structure Supports: Shall be designed Per AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals 2013 Edition. IDM 502-1.01(11)
- Sign Foundation: Should be Designed per LRFD Bridge Design Specifications IDM 502-1.01(12)
- Standard Drawings for Foundations are designed per LRFD Bridge Design Specifications.

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Current Policy

- Shop Drawings for signs in the standard drawings should be submitted to Traffic Division for review and approval.
- Design calculations and shop drawings should be submitted for approval: for signs that require design and are not detailed in the standard drawings in geometry
- Geotechnical Investigation is required for overhead sign structures

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Design Criteria - Loads

AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

Table 3.4-1—Group Load Combinations

Group Load	Load Combination[a]	Percentage of Allowable Stress[b]
I	DL	100
II	$DL + W$	133
III	$DL + Ice + {}^1/_2(W)$[c]	133
IV	Fatigue	[d]

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Design Criteria - Loads

AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

- Dead Load: IDM 502-1.01(11)

  Dead Load:

  Aluminum: 169 lb/ft^3

  Steel: 490 lb/ft^3

  Traffic message panel sign: 2.48 lb/ft^2, aluminum extruded panels 12-in. height.

  Traffic message sheet sign: 2 lb/ft^2

- Live Load: Standard Specification Section 3.6 → Live Load of 550 lb distributed over 2ft for walkway design only.
- Ice Load: Shall Be 3 lb/sft (~ 0.65") around all elements, one face of sign panel.

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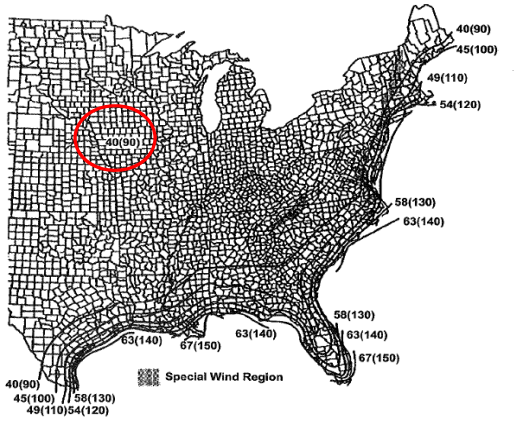
Design Criteria - Loads

AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

- Wind Load: Basic Wind Speed 90 mph, 50 Year Service Life.
- Seismic Design : NOT Required
- Fatigue: Not required for Foundation.



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Design Criteria - Loads

AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

3.8.1—Wind Pressure Equation

The design wind pressure shall be computed using the following equation:

$$P_z = 0.613 K_z G V^2 I_r C_d \text{ (Pa)} \qquad (3.8.3\text{-}1)$$

$$P_z = 0.00256 K_z G V^2 I_r C_d \text{ (psf)}$$

- Ir = Importance factor Table 3.8.3-1
- Kz = Height Exposure Factor Table 3.8.4-1
- G = Gust Effect Factor = 1.14
- Cd = Drag Coefficient Table 3.8.6-1

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Design Criteria - Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

- Limit States
  - Service Limit State → Stress Limits, Cracking, & deformations (Wind)
  - Strength Limit State → Strength & Stability (No Wind)
  - Extreme Limit State → Survival of the structure under extreme (Wind)

- Seismic Design: NOT Required LRFD 1.1

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Design Criteria - Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

Table 3.4-1—Load Combinations and Load Factors

500 lbs/sft on walkways only

Load Combination Limit State	Description	Reference Articles	Permanent		Transient		Fatigue				
			Dead Components (DC)		Live Load (LL)	Wind (W)	Truck Gust (TrG)	Natural Wind Gust Vibration (NWG)	Vortex-Induced Vibration (VVW)	Combined Wind on High-level Towers	Galloping-Induced Vibration (GVW)
			Max/Min	Mean			Apply separately				
Strength I	Gravity	3.5, 3.6, and 3.7	1.25		1.6						
Extreme I	Wind	3.5, 3.8, 3.9	1.1/0.9			1.0[a]					
Service I	Translation	10.4		1.0		1.0[b]					
Service III	Crack control for Prestressed Concrete			1.0		1.00					
Fatigue I	Infinite-life	11.7		1.0			1.0	1.0	1.0	1.0	1.0
Fatigue II	Evaluation	17.5		1.0			1.0	1.0	1.0	1.0	1.0

a. Use Figures 3.8-1, 3.8-2, or 3.8-3 (for appropriate return period)
b. Use Figure 3.8-4 (service)

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Design Criteria _ Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

Ice Load:

- LRFD: Ice Load due freezing rain and in-cloud icing May be applied:
  - Around the surfaces except one face of sign panels.
  - Owner shall specify special icing conditions.
  - LRFD Commentary: For extreme cases specified by the owner use ASCE/ SEI 7-10.

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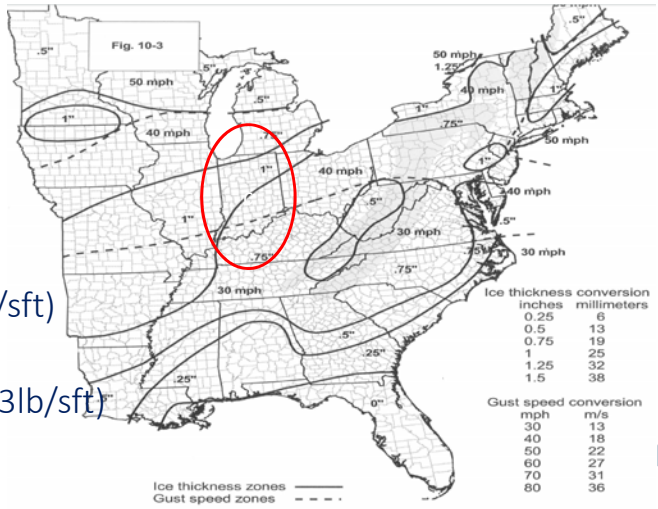
Design Criteria - Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

Ice Load:

- ASCE/ SEI 7-10
  → 1" Glazed ice (~4.6 lb/sft)
  → 0.75" Glazed ice (~3.46 lb/sft)

→ > Standard Specification (3lb/sft)



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Design Criteria - Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

- Wind Load:

3.8.1—Wind Pressure Equation

The design wind pressure shall be computed using:

$$P_z = 0.00256 K_z K_d G V^2 C_d \text{ (psf)} \qquad (3.8.1\text{-}1)$$

where

V is the basic wind speed (mph),

K_z is the height and exposure factor defined in Article 3.8.4,

K_d is the directionality factor defined in Article 3.8.5,

G is the gust effect factor defined in Article 3.8.6, and

C_d is the drag coefficient defined in Article 3.8.7.

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Design Criteria - Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

- Wind Load

New

Table 3.8-1—Mean Recurrence Interval

	Risk Category		
Traffic Volume	Typical	High	Low
ADT≤100	300	1700	300
100<ADT≤1000	700	1700	300
1000<ADT≤10000	700	1700	300
ADT>10000	1700	1700	300
Typical: Failure could cross travelway			
High: Support failure could stop a lifeline travelway			
Low: Support failure could not cross travelway			
Roadside sign supports: use 10-yr MRI, see Figure 3.8-4.			

Years

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Design Criteria - Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

- Wind Load

https://www.researchgate.net/figure/Failure-of-cantilever-sign-support-structure-along-I-65-in-Tennessee_275893563

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Design Criteria - Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

- Basic Wind Speed
- (Extreme Event Limit State)
  - MRI 300 Yr

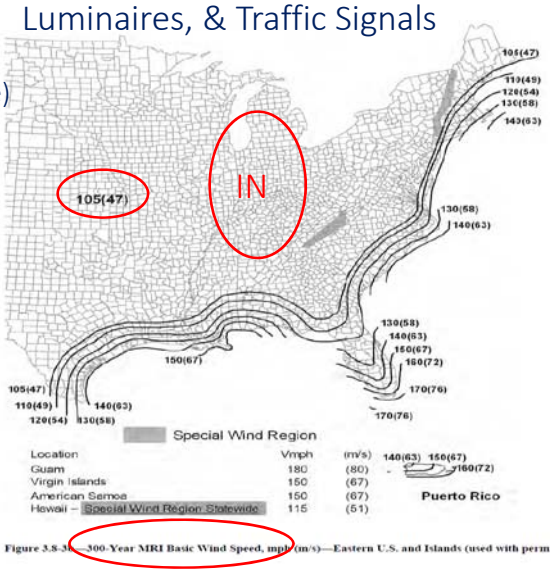

Figure 3.8-3[illegible]—300-Year MRI Basic Wind Speed, mph (m/s)—Eastern U.S. and Islands (used with permission from ASCE)

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Design Criteria - Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

- Basic Wind Speed (Extreme Event Limit State)
- MRI 700 Yr

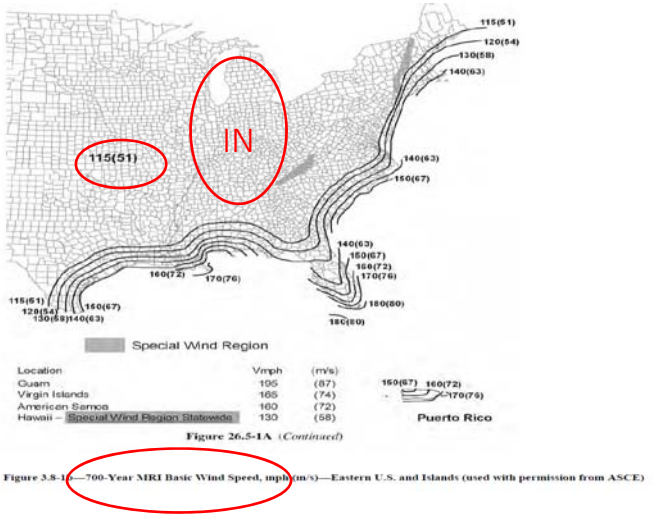

Figure 3.8-1a—700-Year MRI Basic Wind Speed, mph (m/s)—Eastern U.S. and Islands (used with permission from ASCE)

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Design Criteria - Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

- Basic Wind Speed
- (Extreme Event Limit State)
- MRI 1700 Yr

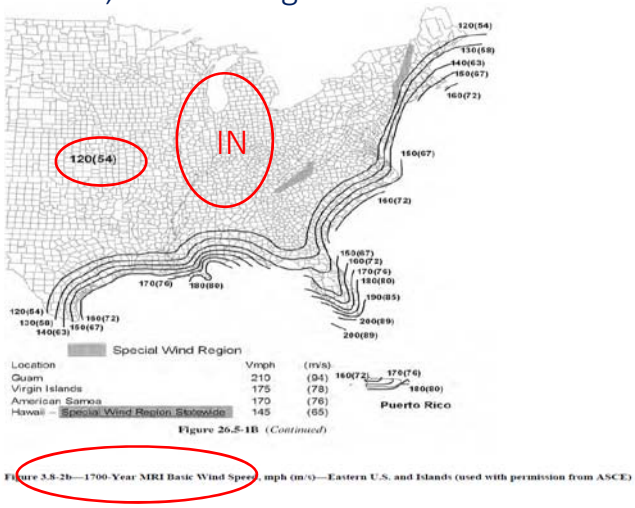

Figure 3.8-2b—1700-Year MRI Basic Wind Speed, mph (m/s)—Eastern U.S. and Islands (used with permission from ASCE)

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Design Criteria - Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

- Basic Wind Speed
- (Service Limit State)

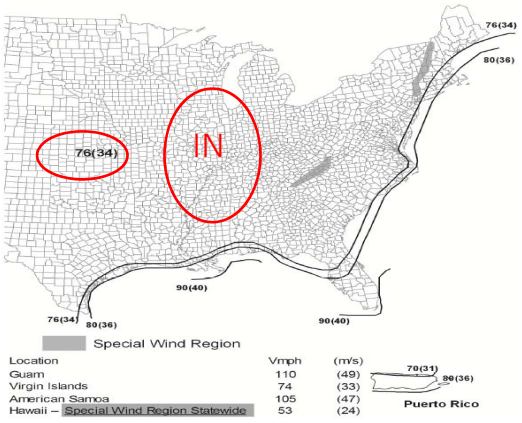

Figure 3.8-4b—10-Year MRI Gust Wind Speed, mph (m/s)—Eastern U.S. and Islands (with permission from ASCE)

- MRI 10 Yr

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Design Criteria - Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

- Height Factor, Kd
  - LRFD

Table C3.8.4-1—Height and Exposure Factors, K_z[a]

Height z, ft	K_z
≥15<15	0.84
20	0.90
30	0.98
40	1.04
50	1.09
60	1.13
70	1.17
80	1.20
90	1.23
100	1.26
110	1.28
120	1.31
130	1.33
140	1.35
150	1.37

[a] See Eq. 3.8.4-1 for calculation of K_z (Exposure C)

3.8.4—Height and Exposure Factor K_z

The height and exposure factor K_z shall be determined either from Table C3.8.4-1 or calculated using Eq. 3.8.4-1:

$$K_z = 2.0\left(\frac{z}{z_g}\right)^{\frac{2}{\alpha}} \qquad (3.8.4\text{-}1)$$

  - Standard Specs

Table 3.8.4-1—Height and Exposure Factors, K_z[a]

Height, m (ft)	K_z[a]
5.0 (16.4) or less	0.87
7.5 (24.6)	0.94
10.0 (32.8)	1.00
12.5 (41.0)	1.05
15.0 (49.2)	1.09
17.5 (57.4)	1.13
20.0 (65.6)	1.16
22.5 (73.8)	1.19
25.0 (82.0)	1.21
27.5 (90.2)	1.24
30.0 (98.4)	1.26
35.0 (114.8)	1.30
40.0 (131.2)	1.34
45.0 (147.6)	1.37
50.0 (164.0)	1.40
55.0 (180.5)	1.43
60.0 (196.9)	1.46
70.0 (229.7)	1.51
80.0 (262.5)	1.55
90.0 (295.3)	1.59
100.0 (328.1)	1.63

[a] See Eq. C3.8.4-1 for calculation of K_z.

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Design Criteria - Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

- Directionality Factor, Kd

Table 3.8.5-1—Directionality Factors, K_d

Support Type	Directionality Factor
High-mast and Pole	
Round	0.95
Square	0.90
Octagonal	0.95
Dodecagonal	0.95
Hexdecagonal	0.95
Traffic Signal	0.85
Dynamic Message Sign	0.85
Overhead Frame/Truss	0.85
Support with horizontal arms or members supporting sign and/or signals	0.85

New

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Design Criteria - Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

- Wind Gust Factor, G
  - LRFD

3.8.6—Gust Effect Factor G

The gust effect factor, G, shall be taken as a minimum of 1.14.

- LRFD Commentary: Follow ASCE/ SEI 7-10 if:
  - Structure is Gust Sensitive:
    - Panel Height/Length > 4
    - Fundamental Frequency < 1.0 Hz

ASCE/SEI 7-10

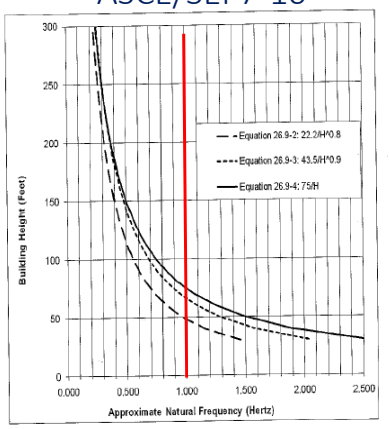

FIGURE C26.9-1 Equations for Approximate Natural Frequency n_a vs. Building Height

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Design Criteria - Loads

LRFD Specifications for Structural Supports for Highway Signs, Luminaires, & Traffic Signals

- Wind Drag Coefficient, Cd

Table 3.8.7-1—Wind Drag Coefficients, C_d [a]

Sign Panel L_{sign}/W_{sign} = 1.0	1.12	
2.0	1.19	
5.0	1.20	
10.0	1.23	
15.0	1.30	
Traffic Signals[b]	1.20	
Luminaires (with generally rounded surfaces)	0.50	
Luminaires (with rectangular flat side shapes)	1.20	
Elliptical Member ($D/d_o \le 2$)	Broadside Facing Wind $1.7\left(\frac{D}{d_o}-1\right)+C_{dD}\left(2-\frac{D}{d_o}\right)$	Narrow Side Facing Wind $C_{dd}\left[1-0.7\left(\frac{D}{d_o}-1\right)^{\frac{1}{4}}\right]$
Two Members or Trusses (one in front of other) (for widely separated trusses or trusses having small solidity ratios see note c)	1.20 (cylindrical) 2.00 (flat)	
Dynamic Message Signs (CMS)[g]	1.70	
Attachments	Drag coefficients for many attachments (cameras, luminaires, traffic signals, etc.) are often available from the manufacturer, and are typically provided in terms of effective projected area (EPA), which is the drag coefficient times the projected area. If the EPA is not provided, the drag coefficient shall be taken as 1.0.	

Table 3.8.7-1—Wind Drag Coefficients, C_d [a]—*Continued*

Single Member or Truss Member	$C_dVd \le 39$ mph-ft	39 mph-ft $< C_dVd <$ 78 mph-ft	$C_dVd \ge 78$ mph-ft
Cylindrical	1.10	$\frac{129}{(C_dVd)^{1.3}}$	0.45
Flat[d]	1.70	1.70	1.70
Hexdecagonal: 16-Sides $0 \le r_z < 0.26$	1.10	$1.37+1.08r_z-\frac{C_dVd}{145}-\frac{C_dVdr_z}{36}$	$0.83-1.08r_z$
Hexdecagonal: 16-Sides $r_z \ge 0.26$[e]	1.10	$0.55+\frac{(78.2-C_dVd)}{71}$	0.55
Dodecagonal[e]: 12-Sides	1.20	$\frac{10.8}{(C_dVd)^{0.6}}$	0.79
Octagonal[e]: 8-Sides	1.20	1.20	1.20
Square	$2.0-6r_z$ [for $r_z < 0.125$] 1.25 [for $r_z \ge 0.125$]		
Diamond[f]	1.70 [for $d = 0.33$ & 0.42] 1.90 [for $d \ge 0.50$]		

Design Criteria - Loads

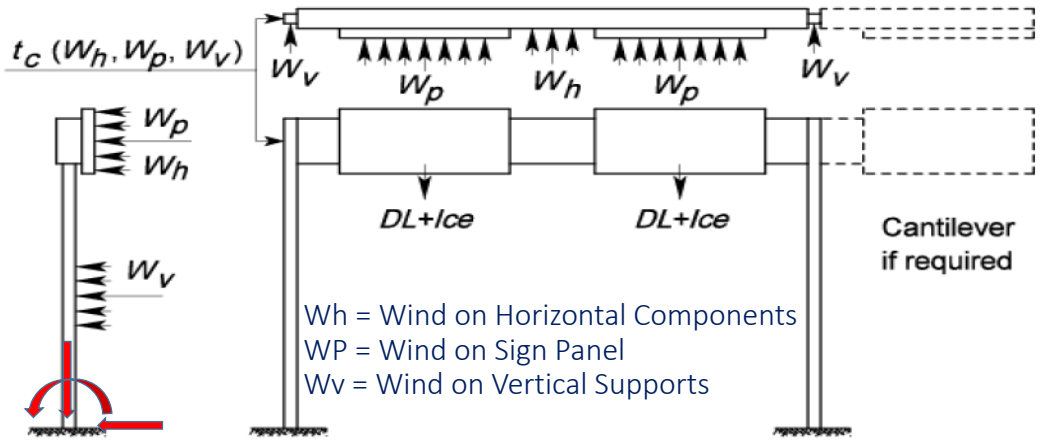
LRFD Specifications Vs Standard Specifications

$$P_z = 0.00256 K_z K_d G V^2 C_d \ \text{(psf)}$$

- Basic Wind Speed, V ↑ for Extreme ↓ For Service
- ~~Importance Factor, Ir~~ (1.0)
- Height Factor, Kz Unchanged
- Directionality Factor, kd = 0.85 for overhead signs New
- Gust Wind Factor, G, Unchanged
- Drag Coefficient, Cd, Unchanged

Design Criteria - Loads

Wind Load Application – Box Truss Sign



Wh = Wind on Horizontal Components
WP = Wind on Sign Panel
Wv = Wind on Vertical Supports

Overhead Bridge Structures

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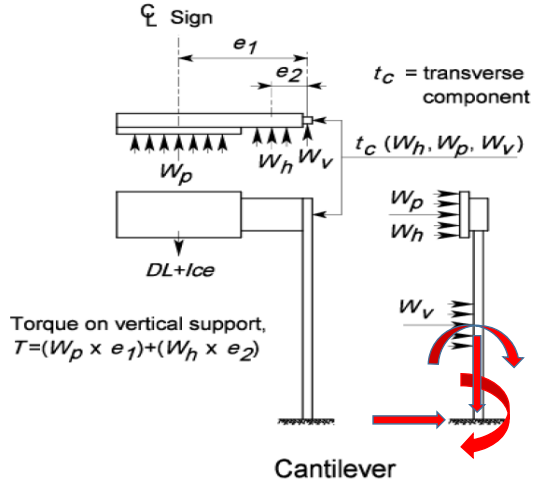
Design Criteria - Loads

Wind Load Application – Cantilever Sign



Wh = Wind on Horizontal Components
WP = Wind on Sign Panel
Wv = Wind on Vertical Supports

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Design Criteria - Geotechnical

Geotechnical Requirements - IDM CH 502

- Soil Borings Will be required for overhead structures to determine:
  - Soil Type: Sandy or Cohesive
  - Soil Bearing Capacity
  - Soil Friction Coefficient

- Foundations in Standard Drawings Reflects Minimum of:
  - Undrained Shear Strength 750 psf for Clay
  - Friction Angle of 30° for Sand

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Design Criteria _ Geotechnical

- Broms' Method for Cohesive or Cohesionless Soil for Drilled shafts

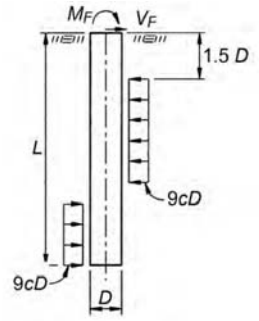

Figure C13.6.1.1-1—Foundation in Cohesive Soil

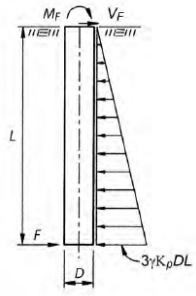

Figure C13.6.1.1-2—Foundation in Cohesionless Soil

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Design Criteria - Types

- Types in the Standard Drawings
  - Drilled Shaft or Spread Footing for Box Truss Structures
  - Drilled Shafts for Cantilever Structures

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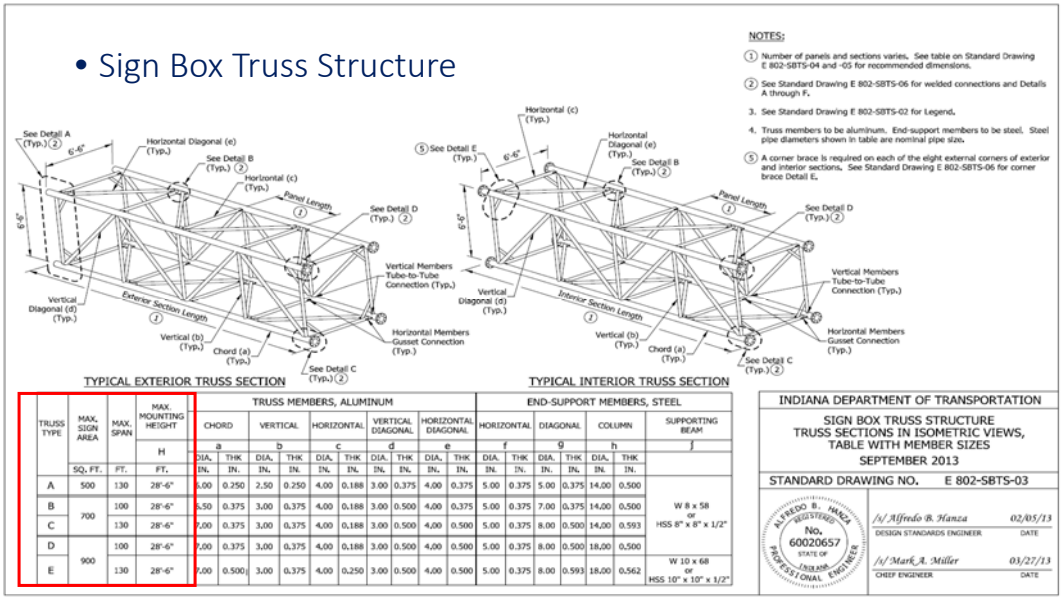
Design Criteria - Standard Drawings

- Sign Box Truss Structure



TRUSS TYPE	MAX. SIGN AREA	MAX. SPAN	MAX. MOUNTING HEIGHT	TRUSS MEMBERS, ALUMINUM										END-SUPPORT MEMBERS, STEEL									
				CHORD		VERTICAL		HORIZONTAL		VERTICAL DIAGONAL		HORIZONTAL DIAGONAL		HORIZONTAL		DIAGONAL		COLUMN		SUPPORTING BEAM
			H	a		b		c		d		e		f		g		h		j
	SQ. FT.	FT.	FT.	DIA. IN.	THK IN.	DIA. IN.	THK IN.	DIA. IN.	THK IN.	DIA. IN.	THK IN.	DIA. IN.	THK IN.	DIA. IN.	THK IN.	DIA. IN.	THK IN.	DIA. IN.	THK IN.	
A	500	130	28'-6"	3.00	0.250	2.50	0.250	4.00	0.188	3.00	0.375	4.00	0.375	5.00	0.375	5.00	0.375	14.00	0.500	
B	700	100	28'-6"	3.50	0.375	3.00	0.375	4.00	0.188	3.00	0.500	4.00	0.375	5.00	0.375	7.00	0.375	14.00	0.500	W 8 x 58 or HSS 8" x 8" x 1/2"
C		130	28'-6"	7.00	0.375	3.00	0.375	4.00	0.188	3.00	0.500	4.00	0.500	5.00	0.375	8.00	0.500	14.00	0.593	
D	900	100	28'-6"	7.00	0.375	3.00	0.375	4.00	0.188	3.00	0.500	4.00	0.500	5.00	0.375	8.00	0.500	18.00	0.500	
E		130	28'-6"	7.00	0.500	3.00	0.375	4.00	0.250	3.00	0.500	4.00	0.500	5.00	0.375	8.00	0.593	18.00	0.562	W 10 x 68 or HSS 10" x 10" x 1/2"

INDIANA DEPARTMENT OF TRANSPORTATION
SIGN BOX TRUSS STRUCTURE
TRUSS SECTIONS IN ISOMETRIC VIEWS, TABLE WITH MEMBER SIZES
SEPTEMBER 2013
STANDARD DRAWING NO. E 802-SBTS-03

ALFREDO B. HANZA REGISTERED No. 60020657 STATE OF INDIANA PROFESSIONAL ENGINEER

/s/ Alfredo B. Hanza 02/05/13
DESIGN STANDARDS ENGINEER DATE

/s/ Mark A. Miller 03/27/13
CHIEF ENGINEER DATE

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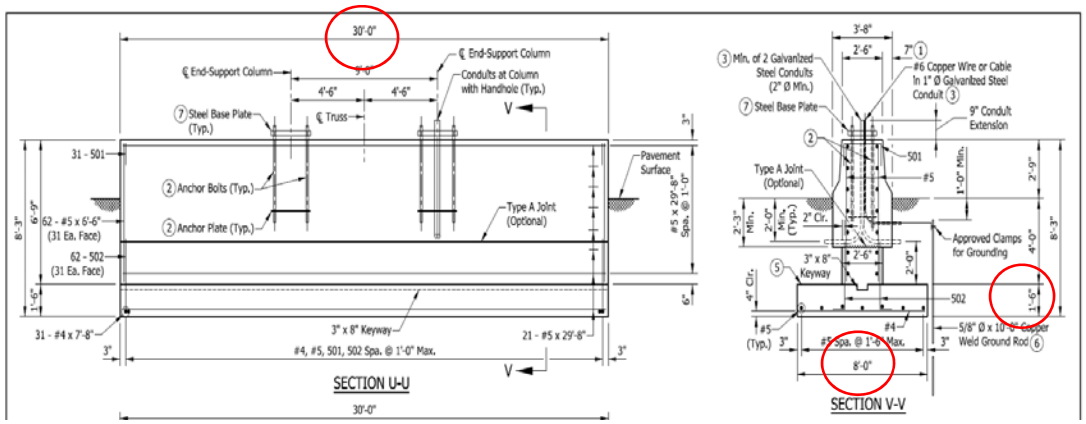
Design Criteria – Standard Drawings

- Sign Box Structure



Spread Footing

Design Criteria - Standard Drawings

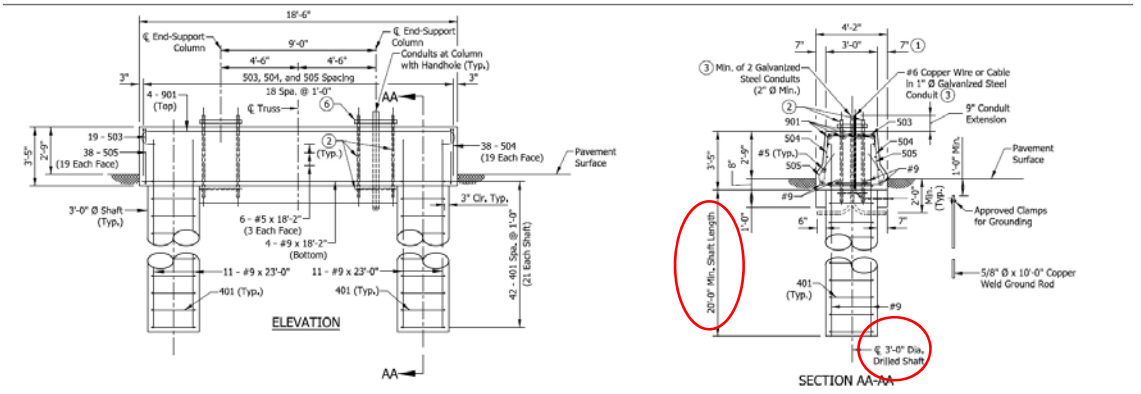
- Sign Box Structure

E 802-SBTS-20	Lighting Walkway, Handrail Hinge, and Grating Details (new 09/03/13)
E 802-SBTS-21	Lighting Walkway Fixture Mount Details (new 09/03/13)
E 802-SBTS-22	Spread Foundation at 33" Concrete Barrier Wall (new 09/03/13)
E 802-SBTS-23	Spread Foundation at 45" Concrete Barrier Wall (new 09/03/13)
E 802-SBTS-24	Spread Foundation for Median or Shoulder, 36" Height (new 09/03/13)
E 802-SBTS-25	Spread Foundations Quantities (new 09/03/13)
E 802-SBTS-26	Alternate Drilled Shaft Foundation at 33" Concrete Barrier Wall (new 09/03/13)
E 802-SBTS-27	Alternate Drilled Shaft Foundation at 45" Concrete Barrier Wall (new 09/03/13)
E 802-SBTS-28	Alternate Drilled Shaft Foundation for Median or Shoulder, 36" Height (new 09/03/13)
E 802-SBTS-29	Alternate Drilled Shaft Foundations Quantities (new 09/03/13)

Design Criteria - Standard Drawings

- Sign Box Structure

Drilled Shaft



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Design Criteria - Standard Drawings

- Sign Box Structure – Spread Footing

Advantages	Disadvantages
• Better for new roadway construction • Can be installed outside travelway limits	• Requires bigger area of roadway disturbance. • Requires longer construction time (excavation, forms, backfill, paving, forms, MOT…)

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Design Criteria - Standard Drawings

- Sign Box Structure – Drilled Shafts

Advantages	Disadvantages
• Less roadway disturbance – Space Limitation • Better for existing roadway/ median or tight locations • Shorter construction time	• Require Casing if water table or caving soil encountered • More Expensive: Mob & Demob for drilling equipment

If Both can be used, Use cost to determine Foundation Type

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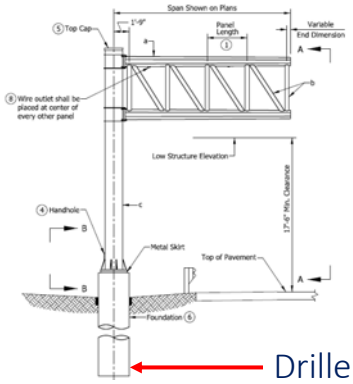
Design Criteria - Standard Drawings

- Cantilever Structure – Double Arm



Drilled Shaft

DOUBLE ARM MEMBER SIZES

STR. TYPE	MAX SPAN (FT.)	MAX SIGN AREA (FT.)	MAX MOUNTING HEIGHT (FT.)	⑥ CHORD a		VERTICAL/VI
				DIAMETER (IN.)	WALL THICK. (IN.)	DIAMETEF (IN.)
A	10	180	24	7 5/8	0.500	4 1/2
B	15	280	24	10 3/4	0.593	5 9/16
C	20	380	24	14	0.593	6 5/8

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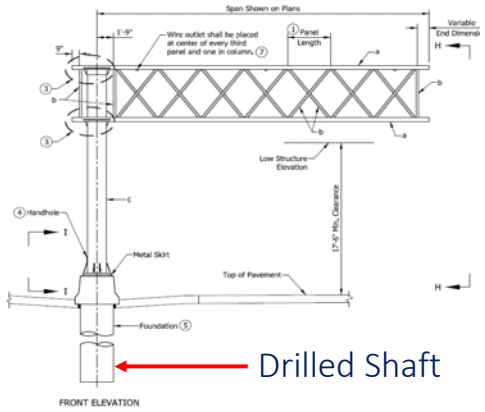
Design Criteria - Standard Drawings

- Cantilever Structure – Quadri Chord



Drilled Shaft

QUADRI-CHORD MEMBER SIZES						
STR. TYPE	MAX SPAN (FT.)	MAX SIGN AREA (FT.)	MAX MOUNTING HEIGHT (FT.)	(5) CHORD a		VERT./HO
				DIAMETER (IN.)	WALL THICK. (IN.)	DIAMETER (IN.)
D	25	300	24	5 9/16	0.258	2 7/8
E	30	300	24	5 9/16	0.258	2 7/8
F	35	300	24	5 9/16	0.375	2 7/8
G	25	400	24	5 9/16	0.375	2 7/8
H	30	400	24	5 9/16	0.375	2 7/8
I	35	400	24	5 9/16	0.375	2 7/8

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Design Criteria - Standard Drawings

- Cantilever Structure – Foundation

E 802-SCLS-12	Double Arm and Quadri-Chord Base Plate, Anchor Bolt, and Metal Skirt Details (rev. 09/02/14
E 802-SCLS-13	Double Arm and Quadri-Chord Column Handhole and I.D. Tag Details (new 09/03/13)
E 802-SCLS-14	Structure Type A or B Foundation at 33" Concrete Barrier (new 09/03/13)
E 802-SCLS-15	Structure Type C, D, E, or F Foundation at 33" Concrete Barrier (new 09/03/13)
E 802-SCLS-16	Structure Type G, H, or I Foundation at 33" Concrete Barrier (new 09/03/13)
E 802-SCLS-17	Structure Type A or B Foundation at 45" Concrete Barrier (new 09/03/13)
E 802-SCLS-18	Structure Type C, D, E, or F Foundation at 45" Concrete Barrier (new 09/03/13)
E 802-SCLS-19	Structure Type G, H, or I Foundation at 45" Concrete Barrier (new 09/03/13)
E 802-SCLS-20	Structure Type A or B Foundation, 36" Height (new 09/03/13)
E 802-SCLS-21	Structure Type C, D, E, or F Foundation, 36" Height (new 09/03/13)
E 802-SCLS-22	Structure Type G, H, or I Foundation, 36" Height (new 09/03/13)

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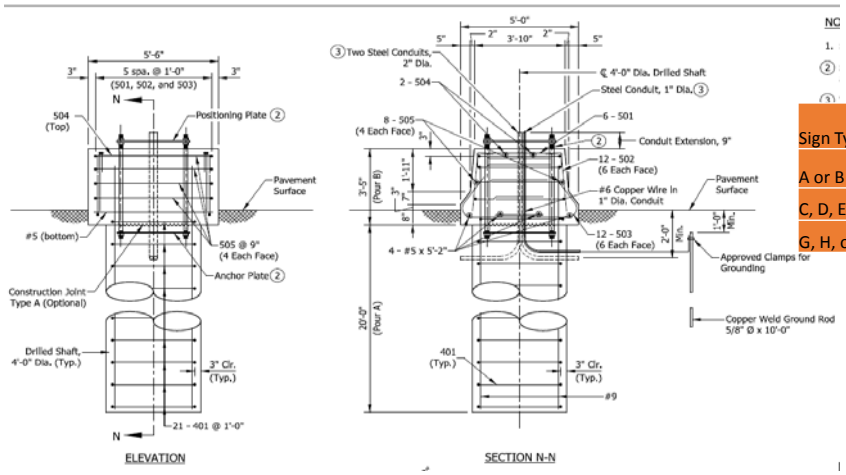
Design Criteria - Standard Drawings

- Cantilever Structure – Median Installation



Sign Type	Drilled Shaft Dia, Ft	Drilled Shaft Length, Ft
A or B	4	20
C, D, E, or F	4	24
G, H, or I	4	30

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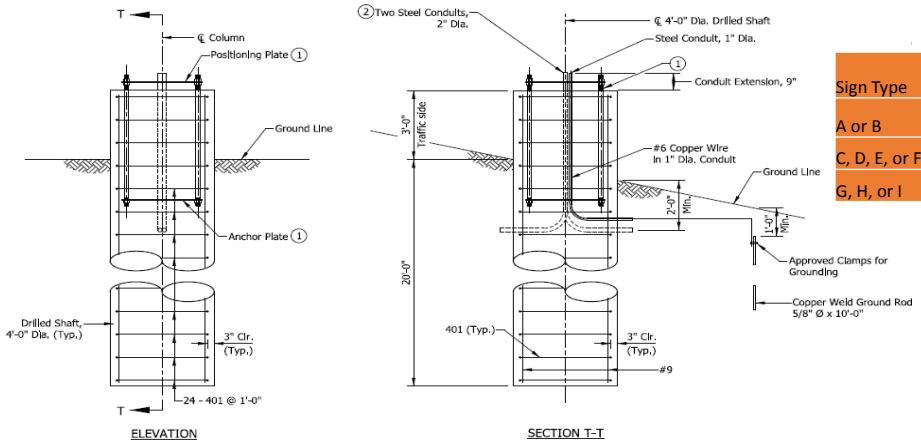
Design Criteria - Standard Drawings

- Cantilever Sign – Outside Shoulder Installation



Sign Type	Drilled Shaft Dia, Ft	Drilled Shaft Length, Ft
A or B	4	20
C, D, E, or F	4	24
G, H, or I	4	30

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Design Criteria

- Anchorage Design/ Code Check – ACI Appendix D
  - Steel Strength of Anchor in tension
  - Concrete Breakout Strength in tension
  - Pullout Strength of Anchor in concrete
  - For headed Anchor: Concrete Side-Face blockout Strength of Anchor In tension
  - Steel Strength of Anchor in Shear
  - Concrete Breakout Strength in shear
  - Concrete Pryout Strength of Anchor in shear
  - Interaction of Tensile and Shear Forces

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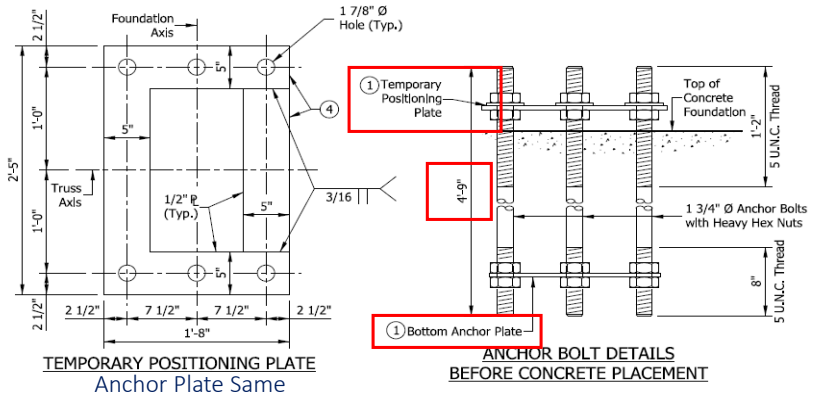
Design Criteria – Standard Drawings

- Anchorage – Sign Box Truss Strutcures



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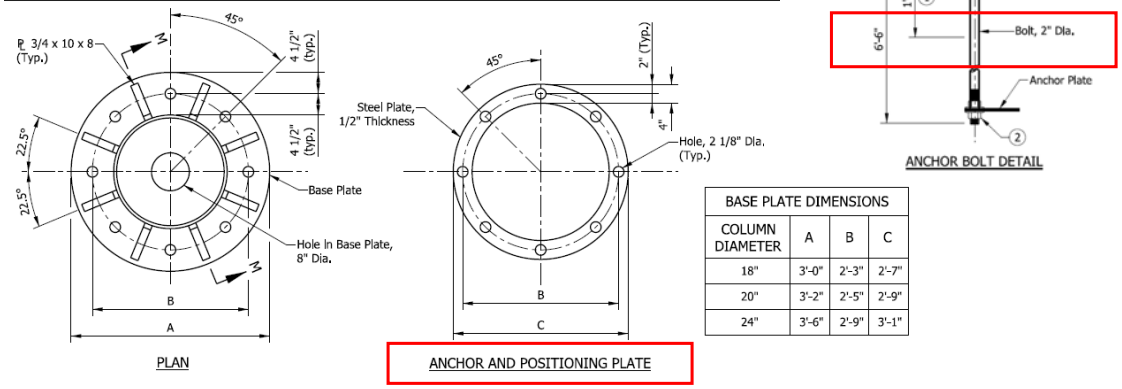
Design Criteria – Standard Drawings

- Anchorage – Cantilever Sign



BASE PLATE DIMENSIONS			
COLUMN DIAMETER	A	B	C
18"	3'-0"	2'-3"	2'-7"
20"	3'-2"	2'-5"	2'-9"
24"	3'-6"	2'-9"	3'-1"

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Design Criteria

- Specifications/ Material Properties Section 700, 800, 900
  - Concrete: Class A for Spread Footing & Drilled Shaft Foundation
  - Reinforcing Steel: Grade 60 Epoxy Coated
  - Anchor bolts, Nuts, and washers: ASTM F1554 Grade 36
  - Top End of Anchor bolts: Coated or Galvanized
  - Surface Seal Top Surface and Sides of foundation above the ground

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Practice Pointers

- General Requirements IDM 502-1.01(10)
  - On Barrier Wall: Transition Taper = 30:1 to connect to adjacent barrier wall.
  - Provide expansion Joints at the at transitions and pavement joint locations within the transition area.
  - Drainage shall be accounted for in the vicinity of the structure. IDM 502-1.01(10).

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Practice Pointers

Summary/ Recommendations

- Coordinate with other roadside safety elements
- Pay attention to tight location in urban areas.
- Properly quantify Wind & Ice loads,
- Pay attention to anchorage design and details.
- Proper load path and proper load analysis.
- Try not to use soil borings from another location
- Pay attention to excavation limits adjacent to travelway, mainly for spread foundation
- Structural elements do not fit/ Anchor bolts or positioning plate not oriented properly.

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Truss or Cantilever Sign Foundation Design

QUESTIONS

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