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# Engineering Policy Ballot

Effective: July 1, 2026

## Level 2

Level two revisions require the approval of the **Assistant Chief Engineer** and the **Federal Highway Administration** only. The Senior Management Team is encouraged to review the content and provide comment to the appropriate director. For all other parties, these revisions are posted for information only.

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# ENGINEERING POLICY BALLOT

**Effective:** July 1, 2026

## **Issue 1: Simplify ground mounted signposts**

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** Tom Honich – TS

**Summary:** Streamlining ground mounted signposts in accordance with the engineering study by Horner and Shifrin.

**Fiscal Impact:** Long term positive as simplifies selection, installation, inventory and maintenance.

**Publication:** Missouri Standard Specifications: 903  
Missouri Standard Plans: 903.02, 903.03, D-29  
Engineering Policy Guide: 903.16.3, 903.16.4

## **Issue 2: Changes regarding Galvanized Bolt Specifications**

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** Darren Kemna – BR

**Summary:** Updating various EPG articles and specification sections regarding galvanized bolts. Fabricators, inspectors and consultants recommended galvanizing bolts, nuts and washers in accordance with ASTM F2329 instead of ASTM A153. AASHTO material specification dropped AASHTO M 298 and recommended use of ASTM B695 for a mechanically galvanized option. In some areas, AASHTO M232 or ASTM A153 remains until internal processes are updated to coincide with ASTM F2329. Clarifications to galvanization process for structural steel and usage of galvanized bolts were added.

**Fiscal Impact:** N/A

**Publication:** Missouri Standard Specifications: 614, 901, 902, 903, 1023,1040, 1052, 1080, 1081  
Engineering Policy Guide: 614.2.1, 712, 751.36, 751.50, 901.18, 902.28, 903.22, 1023.2, 1040.2.2

## **Issue 3: Laminated bearing pad material requirements**

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** Suresh Patel – BR

**Summary:** Sec 1038 updated to clarify laminated bearing pad material requirements.

**Fiscal Impact:** N/A

**Publication:** Missouri Standard Specifications: 1038

#### **Issue 4: 2025 AWS Bridge Welding Code Updates**

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** Debbie Butchart – BR

**Summary:** Revisions to update procedures to 2025 Bridge Welding Code and MoDOT’s adaptations to code.

**Fiscal Impact:** N/A

**Publication:** Missouri Standard Specifications: 712.6, 1080  
Engineering Policy Guide: 136.7.3.1.21.8.2, 712.1.4.1.3, 751.5.9.3.3

#### **Issue 5: Digital printing for highway signs**

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** Robert Marshall – CM

**Summary:** Revises specifications to address digital printing of highway signing which has been allowed for years.

**Fiscal Impact:** Digitally printed signs are highly durable and minimize work for quick, efficient production.

**Publication:** Missouri Standard Specifications: 1042

#### **Issue 6: Guidance for coring overlays on bridge decks as part of the project scoping phase**

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** Bill Dunn – BR

**Summary:** This revision provides process guidance to the districts regarding coring bridge deck overlays for roadway design work.

**Fiscal Impact:** N/A

**Publication:** Engineering Policy Guide: 104.2, 751.1.3.2

## **Issue 7: Updating EPG 109.7 Partial Payments**

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** Jen Haller – CM

**Summary:** Removes references requiring changes to pay periods at state and federal fiscal year ends. Removes procedures included in AWP Quick Reference Guides regarding the contractor payment processes through AWP from the EPG article.

**Fiscal Impact:** N/A

**Publication:** Engineering Policy Guide: 109.7

## **Issue 8: Update of distances needed to stop work**

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** Rachel Campbell – ENV

**Summary:** Updates for consistent buffer distance in regard to archaeological sites and human remains.

**Fiscal Impact:** N/A

**Publication:** Engineering Policy Guide: 127.2.3.3.1, 127.2.9.1, 127.2.9.2

## **Issue 9: EPG 616.19.7 Traffic Pacing – Changes parties allowed to perform rolling roadblocks**

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** Dan Smith – TS

**Summary:** Re-titling to Traffic Pacing/Rolling Roadblock and makes modifications to allow rolling roadblocks by MoDOT and contractor vehicles rather than restricting to law enforcement. All protective vehicles in the lane will require TMAs on their vehicles. Currently, MoDOT only allows law enforcement. Revisions are based on difficulty in getting enough law enforcement due to lack of personnel, and the potential of law enforcement being called away at any time.

**Fiscal Impact:** N/A

**Publication:** Engineering Policy Guide: 616.19.7

## **Issue 10: Friction Pile Policy**

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** Darren Kemna – BR

**Summary:** Revises policy for pile length estimates and driving verification methods to increase accuracy of length estimates requiring fewer construction changes. Shifts pile analyses from consultants hired by the contractor to MoDOT staff.

**Fiscal Impact:** New policy may lead to more accurate pile length estimates which lead to less construction changes. New policy will also shift pile analyses from consultants hired by the contractor to in-house MoDOT staff. Both changes tend to lead to cost savings for MoDOT.

**Publication:** Engineering Policy Guide: 751.36.5, 751.50

## **Issue 11: 909 TSMO Updates**

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** Raymond Shank – TS

**Summary:** Expand EPG 909 section to add information, add resources and clear guidelines.

**Fiscal Impact:** N/A

**Publication:** Engineering Policy Guide: 909



## SECTION 903

### HIGHWAY SIGNING

**903.1 Description.** This work shall consist of furnishing and installing highway signs as shown on the plans. All signs shall be in accordance with the MUTCD. Any signs not detailed on the plans shall be in accordance with *Standard Highway Signs* by the U.S. Department of Transportation, Federal Highway Administration.

**903.2 Material.** All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section/Specification
Reinforcing Steel for Concrete	1036
Highway Sign Material	1042
Delineators, Mile and Marker Posts	1044
Paints for Structural Steel	1045
Electrical Conduit	1060
Expansive Mortars	1066
Carbon Steel Bolts, Nuts and Washers	1080
Structural Carbon Steel	1080
Structural Low Alloy Steel	1080
Low-Carbon Steel Anchor Bolts	ASTM F1554, Grade 36
High-Strength Anchor Bolts and Nuts	ASTM F1554, Grade 55
High-Strength Bolts, Nuts and Washers	1080
Galvanized Coating of Structural Steel, <del>Tubular Steel Sign Supports, Sign Trusses</del> and Appurtenances	1081

#### 903.2.1 Sign Posts and Tubular Steel Sign Supports.

Item	Section/Specification
Perforated Square Steel Tube Posts	1044
<del>4" Square Steel Tube Posts</del> <del>Wood Posts</del>	<del>MoDOT Approved Products List</del> 1050
Steel Pipe Posts	ASTM A53, Grade B, or ASTM A500, Grade B
Galvanizing of Steel Pipe Posts	ASTM A53
Structural Steel Welding Electrodes	AWS A5.1 or AWS A5.5
<del>I-Beam</del> <del>Structural Steel</del> Posts	AASHTO M270 Grade 50 or 50w
U-Channel Posts	ASTM A499, Grade 60

UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

**903.3.1.2 Embedded Installations.** Embedded installations are defined as footings for pipe posts and ~~structural steel~~**I-beam** posts only. Class B or B-1 concrete, or concrete of a commercial mixture meeting the requirements of [Sec 501](#), or prepackaged dry commercial concrete mixture meeting the requirements of [Sec 903.3.1.2.1](#) shall be used for the footings for embedded-type sign posts. Posts shall be supported in proper position until the concrete or other approved material has set. Excavation and backfill shall be in accordance with [Sec 903.3.1.1](#), except forming will not be required unless soil conditions warrant forming. Tops of footings shall be finished flush with the slope of the ground. Footings shall be visually inspected for acceptance by the engineer.

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**

**903.3.1.3 Perforated Square Steel Tube Post Anchor Installations.** Construction requirements and concrete material requirements for perforated square steel tube (PSST) anchor installations shall be in accordance with [Sec 903.3.1.2](#). ~~In lieu of concrete, polyurethane foam meeting the requirements of [Sec 903.3.1.3.1](#) may be used, except that, concrete shall be used for post anchor installations for Emergency Reference Markers.~~

~~**903.3.1.3.1** Polyurethane foam shall be a quick-setting hydrophobic, closed-cell, high-density polyurethane foam with a minimum compressive strength of 80 psi (550 kPa), in the direction of rise, when tested in accordance with ASTM D1621, and shall have a minimum density of 4 pounds per cubic foot (65 kg/m<sup>3</sup>) when tested in accordance with ASTM D1622. Foam shall not be placed in standing water. Polyurethane foam shall be mixed in accordance with manufacturer's recommendations. Polyurethane foam will not be permitted if soil conditions are such that forming is necessary. Material shall be tested in the presence of the engineer in accordance with [Sec 625.10.2.1.4](#).~~

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**

**903.3.2.2.1 ~~I-Beam~~Structural Steel Posts.** ~~I-beam~~**Structural steel** sign posts for ground mounting of signs shall be fabricated and erected as shown on the plans. Welds shall be of full section and sound throughout. Posts with dimensional defects and structural discontinuities will be rejected. Posts built up by welding two lengths together will be permitted, provided the welds are ground smooth and flush with the base metal. Posts and appurtenances shall be hot-dip galvanized after fabrication. Posts with breakaway assemblies shall be cut at the hinge prior to galvanizing, except for field cutting. Hinge plates shall not be attached to the posts at the time of galvanizing. All welds shall be cleaned before galvanizing. All exposed steel areas and damaged galvanizing shall be repaired in accordance with [Sec 1081](#).

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**

~~**903.3.2.2.5 Wood Posts.** Wood posts shall be installed at locations shown on the plans.~~

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**

**903.5 Method of Measurement.** Final measurement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity. Where required, measurements will be made in the following manner.

Measurement of concrete for bolt-down footings and embedded footings will be made separately to the nearest 0.01 cubic yard for each footing and to the nearest 0.1 cubic yard for

the total, as shown on the plans. No measurement will be made for concrete ~~or polyurethane foam~~ used in footings for perforated square steel tube posts (PSST).

**903.5.1** Measurement of the weight of ~~I-beam~~ structural steel and pipe posts will be made to the nearest pound for each post and to the nearest 10 pounds for the total, as shown on the plans. Weights will be computed using the theoretical weight of the various sections.

**903.5.2** Measurement of sign areas will be made to the nearest 1/10 square foot for each sign and to the nearest square foot for the total. The area of each sign will be that of the smallest rectangular, triangular or trapezoidal shape that will encompass the sign panel.

**903.5.3** Measurement of perforated square steel tube, ~~and~~ u-channel ~~and wood~~ posts will be made to the nearest linear foot for each post, as shown on the plans.

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**

### **903.6 Basis of Payment.**

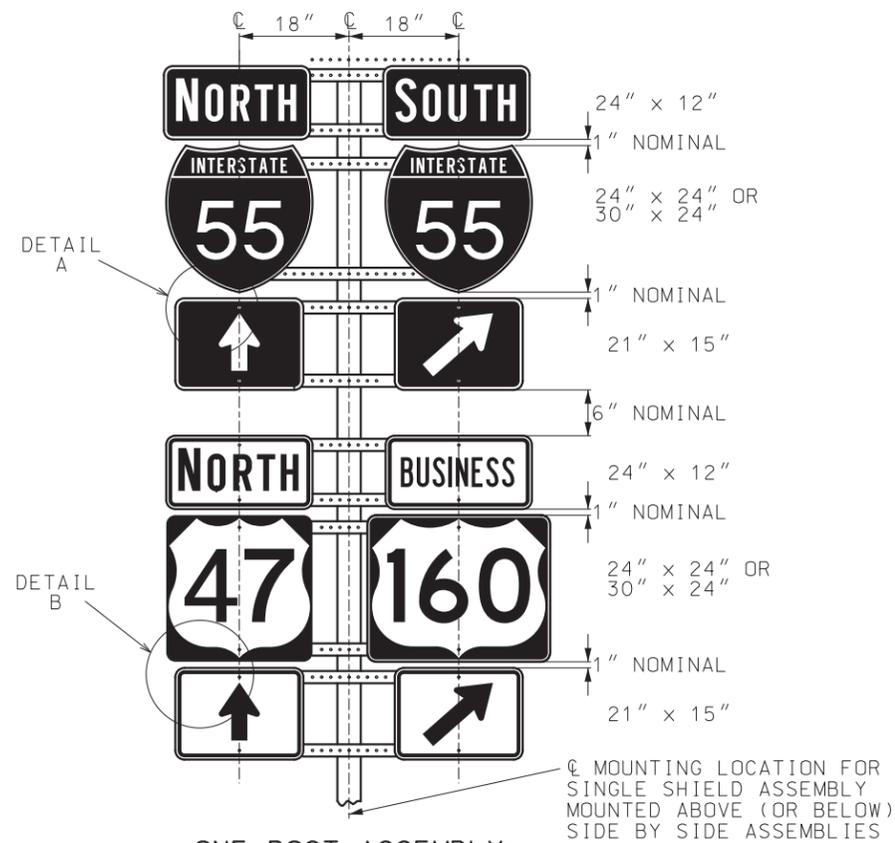
**903.6.1** Breakaway assemblies for pipe posts and ~~structural steel~~ I-beam posts, including the base connection, hinge plate, fuse plate, structural bolts and all other fabrication, complete in place, are incidental, regardless of the post size or shape. Breakaway assemblies for perforated square steel tube posts, complete in place, will be paid for at the contract unit price each, regardless of the post size.

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**

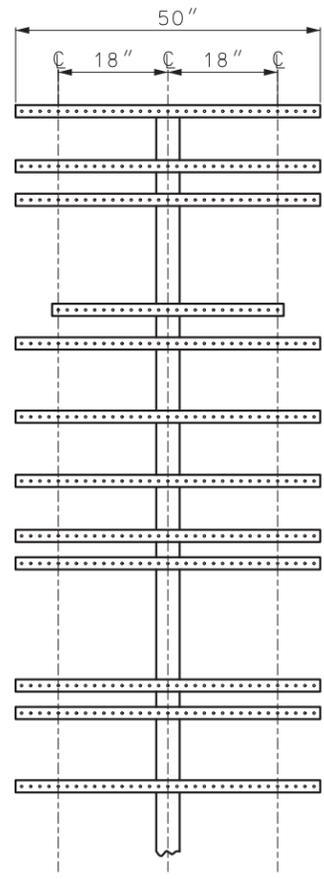
**903.6.4** Perforated square steel tube (PSST), ~~4" square steel tube and and~~ u-channel ~~and wood~~ posts will be paid for at the contract unit price for each of the items included in the contract. PSST post anchor installations will be paid for separately for each anchor type. All costs for PSST footing installations shall be considered included in the cost of the post anchor.

**903.6.5** Concrete footings for bolt-down and embedded installations will be paid for separately at the contract unit price. Excavation, backfilling, reinforcing steel, anchor bolts and nuts, grout and other items shown on the plans will be considered included in payment for concrete footings. No payment will be made for concrete ~~or polyurethane foam~~ used for the installation of PSST footings.

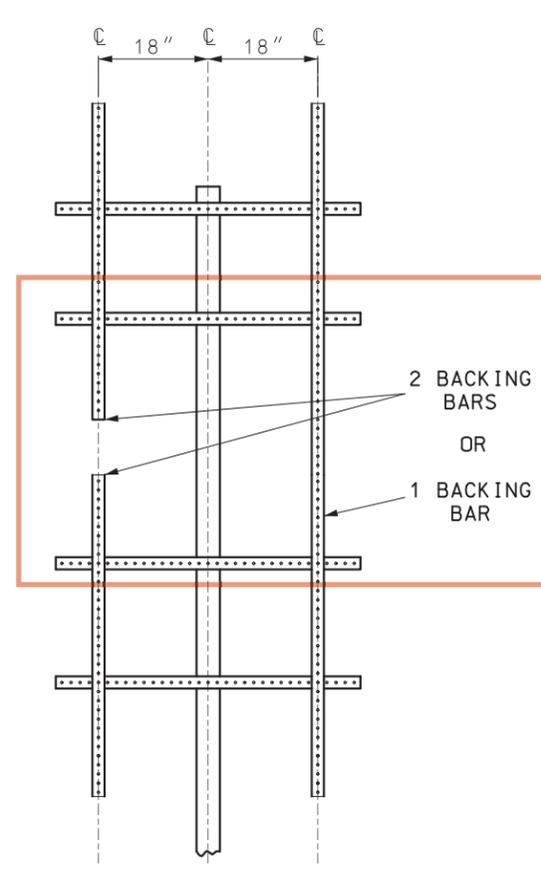
**903.6.6** ~~I-beam~~ Structural steel and pipe posts will be paid for at the contract unit price for each of the items included in the contract.



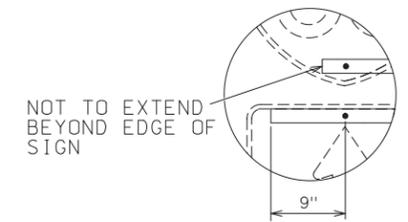
**ONE POST ASSEMBLY**  
USE TO SUPPORT UP TO 4 ROUTE MARKERS



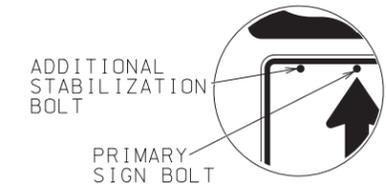
**STANDARD BACKING BAR LAYOUT**



**OPTIONAL BACKING BAR LAYOUT**



**DETAIL A**  
SEE GENERAL NOTES



**DETAIL B**  
SEE GENERAL NOTES

**GENERAL NOTES:**

DETAIL A - THE END OF THE HORIZONTAL BACKING BARS SHALL EXTEND MAXIMUM OF 9 INCHES PAST THE SIGN BOLT, BUT SHALL NOT EXTEND PAST THE EDGE OF THE SIGN.

DETAIL B - FOR SIGNS INSTALLED ON TWO PARALLEL HORIZONTAL BACKING BARS, ONE ADDITIONAL BOLT SHALL BE ADDED TO THE LEFT SIGN TO KEEP ASSEMBLY SQUARE.

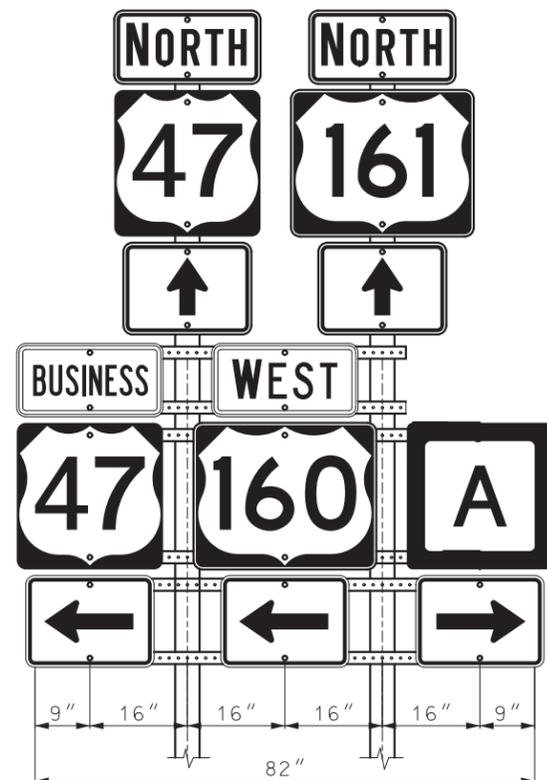
FOR ALUMINUM BACKING BAR DETAILS, SEE SHEET 7.

WHEN USING OPTIONAL BACKING BAR LAYOUT, SIGNS ARE MOUNTED ON VERTICAL BARS IN FRONT OF HORIZONTAL BARS.

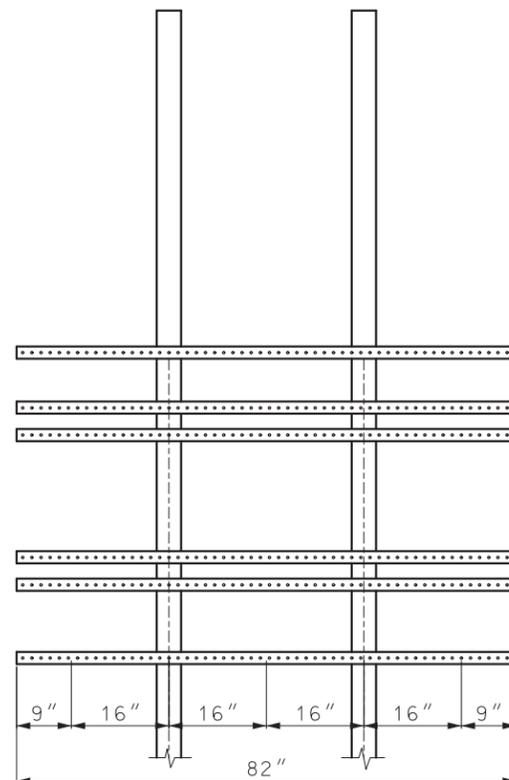
ALL SIGNS TO BE INSTALLED ALONG VERTICAL CENTERLINES.

FOR POST AND FOOTING DATA AND DETAILS OF SHIELDS AND PLAQUES, SEE OTHER DRAWINGS.

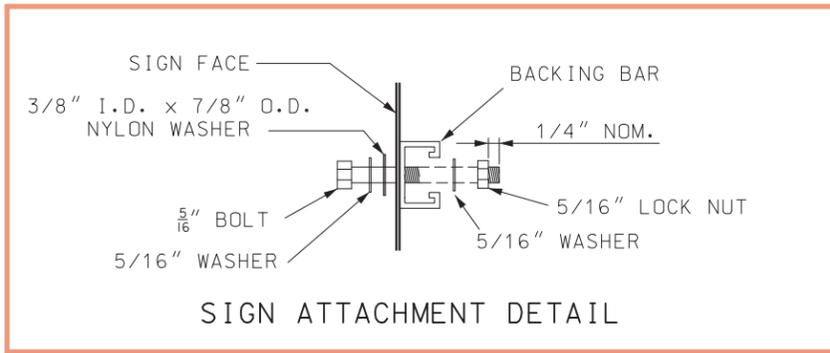
NOMINAL VERTICAL SPACING INDICATED BETWEEN SIGNS TO BE ACHIEVED BY USING THE CLOSEST AVAILABLE HOLES IN ALUMINUM BACKING BARS AND IN PSST WHEN USED.



**TWO POST ASSEMBLY**  
USE TO SUPPORT 3 TO 6 ROUTE MARKERS



**STANDARD BACKING BAR LAYOUT**



**SIGN ATTACHMENT DETAIL**

**TWO POST ASSEMBLY NOTE:**

OPTIONAL BACKING BAR LAYOUT MAY BE USED WITH TWO POST ASSEMBLY.

FOR 6 ROUTE SHIELD ASSEMBLY, ADDITIONAL BACKING BARS ARE REQUIRED.

**POST SELECTION:**

4" PIPE POST IS THE TYPICAL POST FOR THIS APPLICATION.

EPG PSST & PIPE POST QUICK REFERENCE TABLES HAS PSST POST OPTIONS.

I-BEAM POST SHALL NOT BE USED.

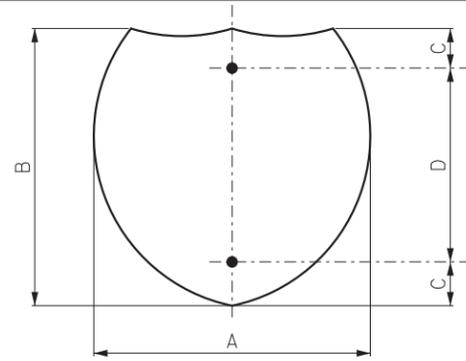
**MoDOT** MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION  
105 WEST CAPITOL JEFFERSON CITY, MO 65102  
1-888-ASK-MODOT (1-888-275-6636)

**HIGHWAY SIGNING  
BACKING BARS  
SHEET SIGN MOUNTING  
ROUTE SHIELD AND  
MARKER ASSEMBLIES**

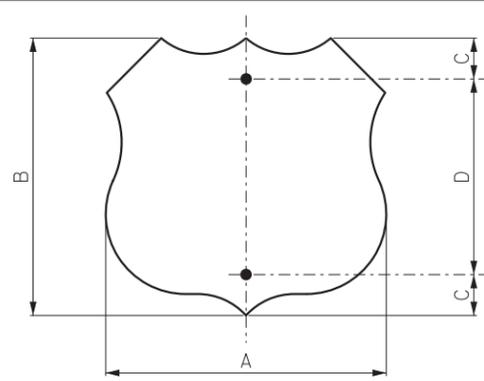
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DATE PREPARED: 3/2/2026

**903.02AR**

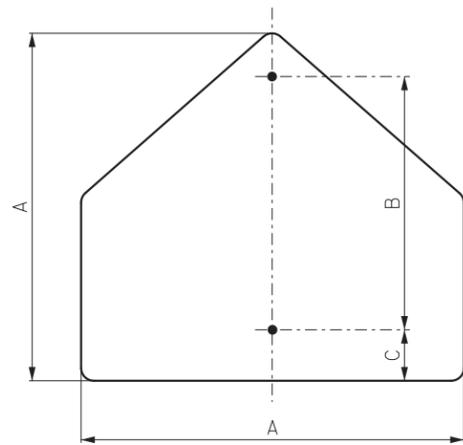
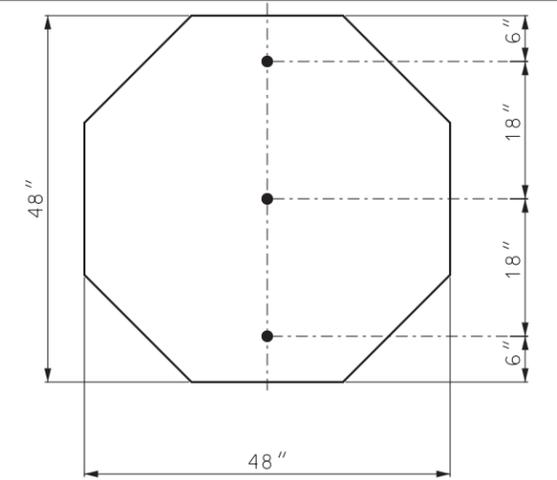
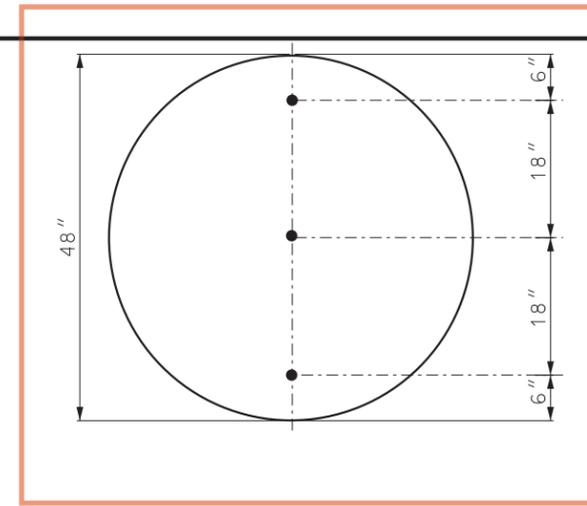
SHEET NO.  
4 OF 9



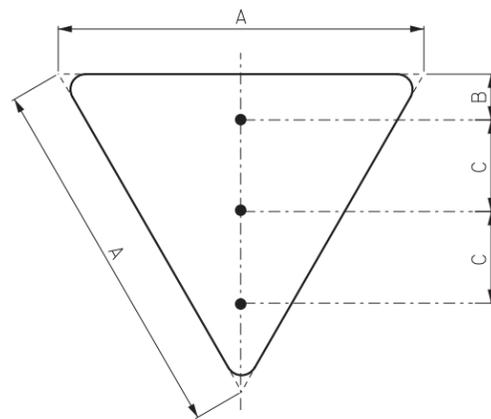
DIMENSIONS (IN.)			
A	B	C	D
24	24	3	18
30	24	3	18
36	36	6	24
45	36	6	24



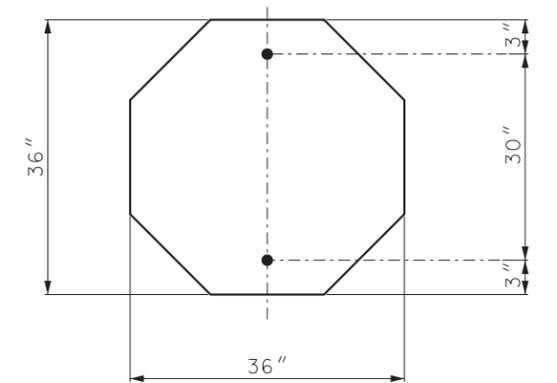
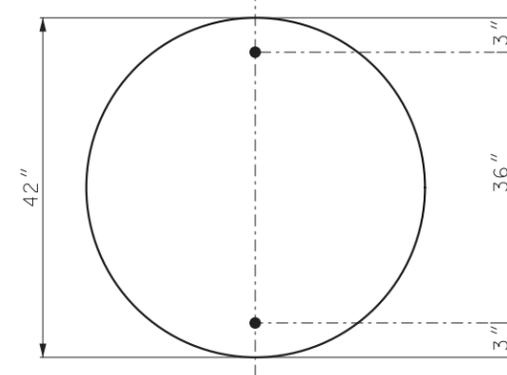
DIMENSIONS (IN.)			
A	B	C	D
24	24	3	18
30	24	3	18
36	36	6	24
45	36	6	24



DIMENSIONS (IN.)			
A	B	C	RADIUS
36	24	3	2.25



DIMENSIONS (IN.)			
A	B	C	RADIUS
48	6	12	3
60	8	15	4



**GENERAL NOTES:**

SIGNS WITH FOUR OR MORE HOLES REQUIRE BACKING BARS OR MULTIPLE POSTS.

HOLES IN SIGNS SHALL BE  $\frac{3}{8}$ " AND PUNCHED AS SHOWN ON THIS DRAWING.

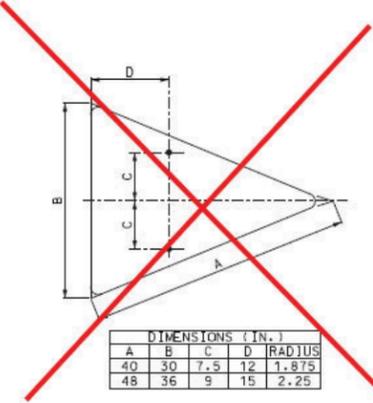
FLAT SHEET FOR SIGNS SHALL BE THE FOLLOWING THICKNESS:

9 SQUARE FEET OF LESS = 0.080 IN.

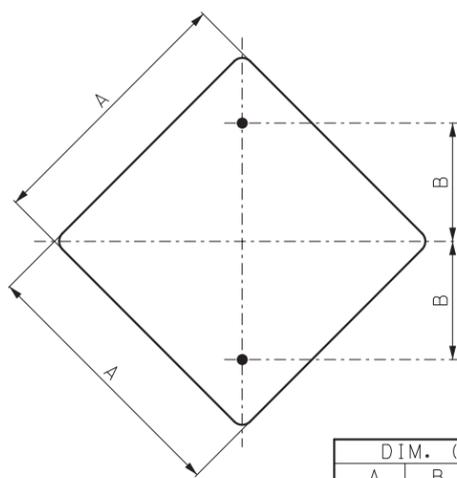
OVER 9 BUT UNDER 16 SQUARE FEET = 0.100 IN.

16 SQUARE FEET OR LARGER = 0.125 IN.

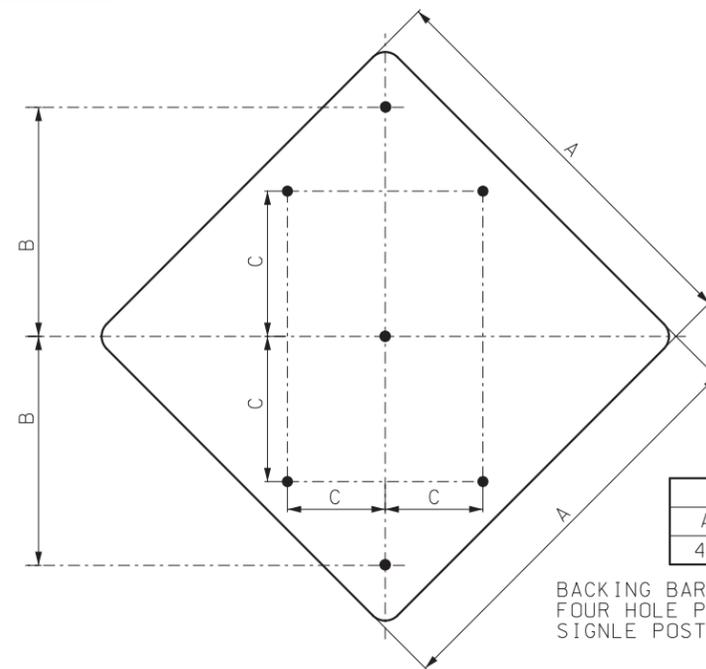
FOR MOUNTING DETAILS, SEE STANDARD PLAN 903.03.



DIMENSIONS (IN.)				
A	B	C	D	RADIUS
40	30	7.5	12	1.875
48	36	9	15	2.25



DIM. (IN.)		
A	B	RADIUS
18	9	1.5
24	12	1.5
30	15	1.875
36	18	2.25



DIMENSIONS (IN.)			
A	B	C	RADIUS
48	24	15	3

BACKING BARS ONLY REQUIRED FOR FOUR HOLE PUNCH INSTALLATION ON SINGLE POST.

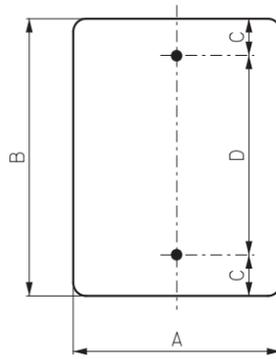
**MoDOT** MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION  
 105 WEST CAPITOL JEFFERSON CITY, MO 65102  
 1-888-ASK-MODOT (1-888-275-6636)

**HIGHWAY SIGNING**  
**HOLE PUNCHING**

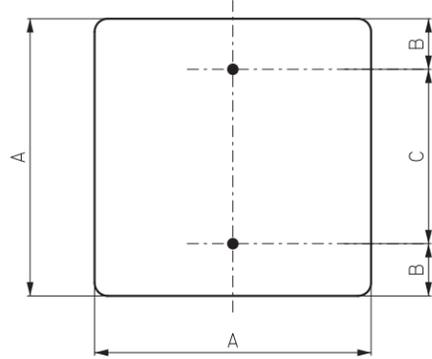
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**903.02AR**

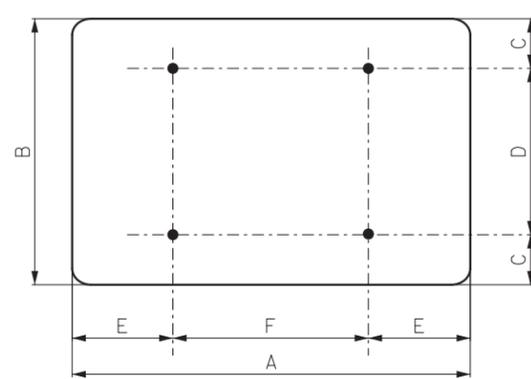
SHEET NO.  
 6 OF 9



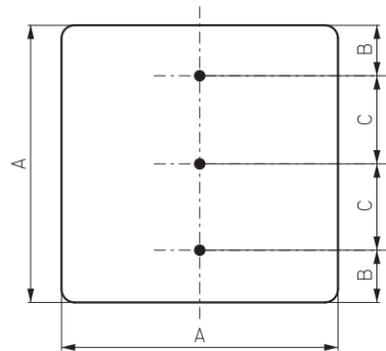
DIMENSIONS (IN.)				
A	B	C	D	RADIUS
4	16	0.75	14.5	SQ
6	12	1.5	9	1
9	12	3.5	5	1.5
9	15	3.75	7.5	1.5
12	18	3	12	1.5
12	24	3	18	1.5
12	36	3	30	1.5
12	48	3	42	1.5
15	21	3	15	1.5
18	24	3	18	1.5
24	30	3	24	1.5
24	36	3	30	1.5
30	36	3	30	1.875
30	42	3	36	1.875
36	42	3	36	1.875



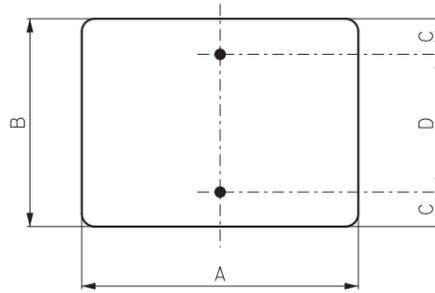
DIMENSIONS (IN.)			
A	B	C	RADIUS
12	1.5	9	1.5
18	3	12	1.5
24	3	18	1.5
30	3	24	1.875
36	6	24	2.25



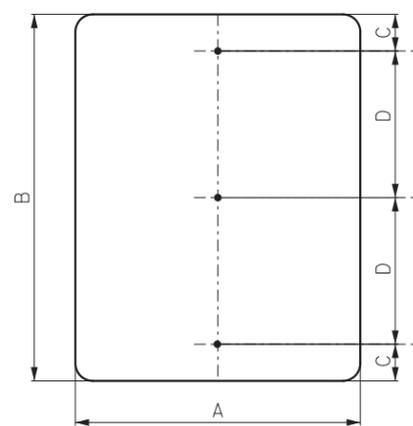
DIMENSIONS (IN.)						
A	B	C	D	E	F	RADIUS
48	12	1.5	9	9	30	1.5
48	18	1.5	15	9	30	1.5
48	24	3	18	9	30	1.5
48	30	3	24	9	30	1.875
48	36	6	24	9	30	2.25
54	18	1.5	15	9	36	1.5
60	12	1.5	9	12	36	1.5
60	18	1.5	15	12	36	1.5
60	24	3	18	12	36	1.5
60	30	3	24	12	36	1.875
60	36	6	24	12	36	2.25
60	48	6	36	12	36	3
72	36	6	24	12	48	2.25
72	48	6	36	12	48	3



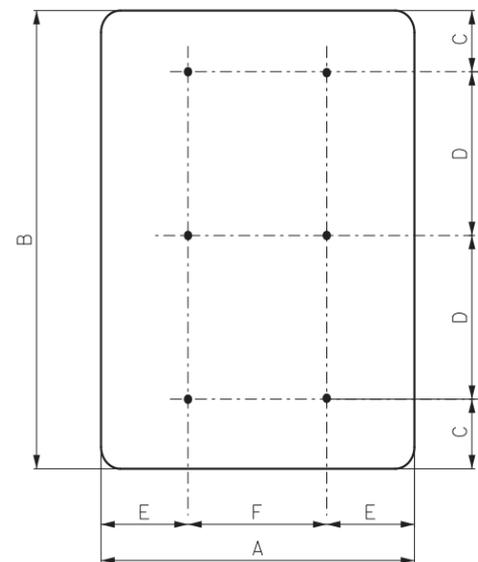
DIMENSIONS (IN.)			
A	B	C	RADIUS
48	6	18	3



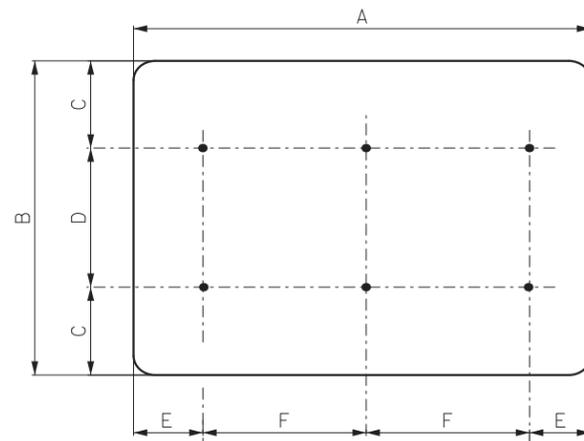
DIMENSIONS (IN.)				
A	B	C	D	RADIUS
4	5	1.5	2	1.5
12	9	1.5	6	1.5
18	9	1.5	6	1.5
18	12	1.5	9	1.5
21	15	1.5	12	1.5
24	8	1.5	5	1.5
24	12	1.5	9	1.5
24	18	3	12	1.5
30	8	1.5	5	1.5
30	12	1.5	9	1.5
30	18	3	12	1.5
30	21	3	15	1.5
30	24	3	18	1.5
36	8	1.5	5	1.5
36	12	1.5	9	1.5
36	18	3	12	1.5
36	24	3	18	1.5
36	30	3	24	1.875
42	8	1.5	5	1.5
42	18	3	12	1.5
42	24	3	18	1.5
42	30	3	24	1.875
42	36	3	30	2.25
48	8	1.5	5	1.5



DIMENSIONS (IN.)				
A	B	C	D	RADIUS
12	72	6	30	1.5
18	60	6	24	1.5
24	48	6	18	1.5
30	48	6	36	1.875
36	48	6	18	2.25
36	60	6	24	2.25
36	72	6	30	2.25

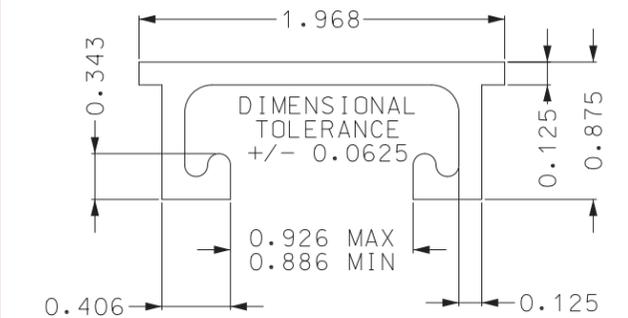
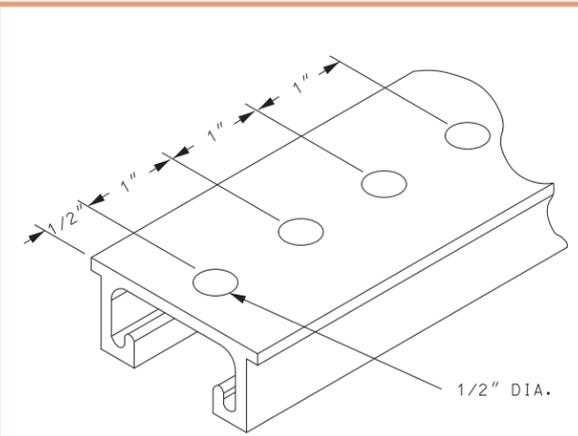
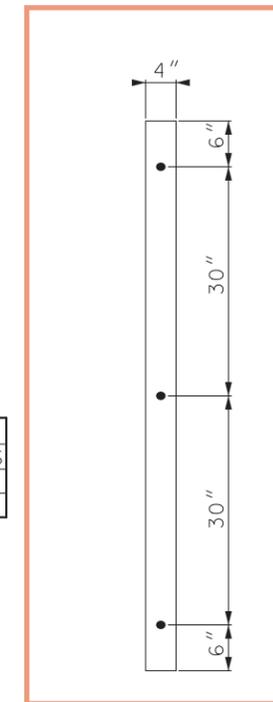


DIMENSIONS (IN.)						
A	B	C	D	E	F	RADIUS
48	60	6	24	9	30	3
48	72	6	30	9	30	3
48	84	6	36	9	30	3
48	96	6	42	9	30	3

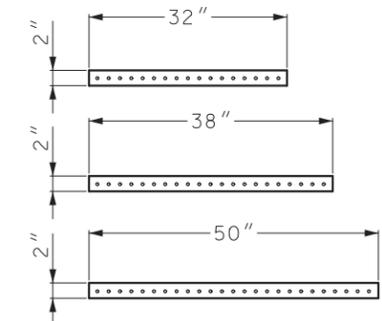


DIMENSIONS (IN.)						
A	B	C	D	E	F	RADIUS
84	24	3	18	12	30	3
96	48	6	36	16	32	3

DIMENSIONS (IN.) FOR SIGNS REQUIRING NO HOLE PUNCHING		
A	B	RADIUS
66	18	1.5
72	18	1.5
78	18	1.5
84	18	1.5
90	18	1.5
96	18	1.5
36	78	2.25



6061-T6 ALUMINUM BACKING BAR DETAIL



BACKING BARS FOR SINGLE POST SIGNS

GENERAL NOTES:

REFER TO GENERAL NOTES ON SHEET 6 OF 8.

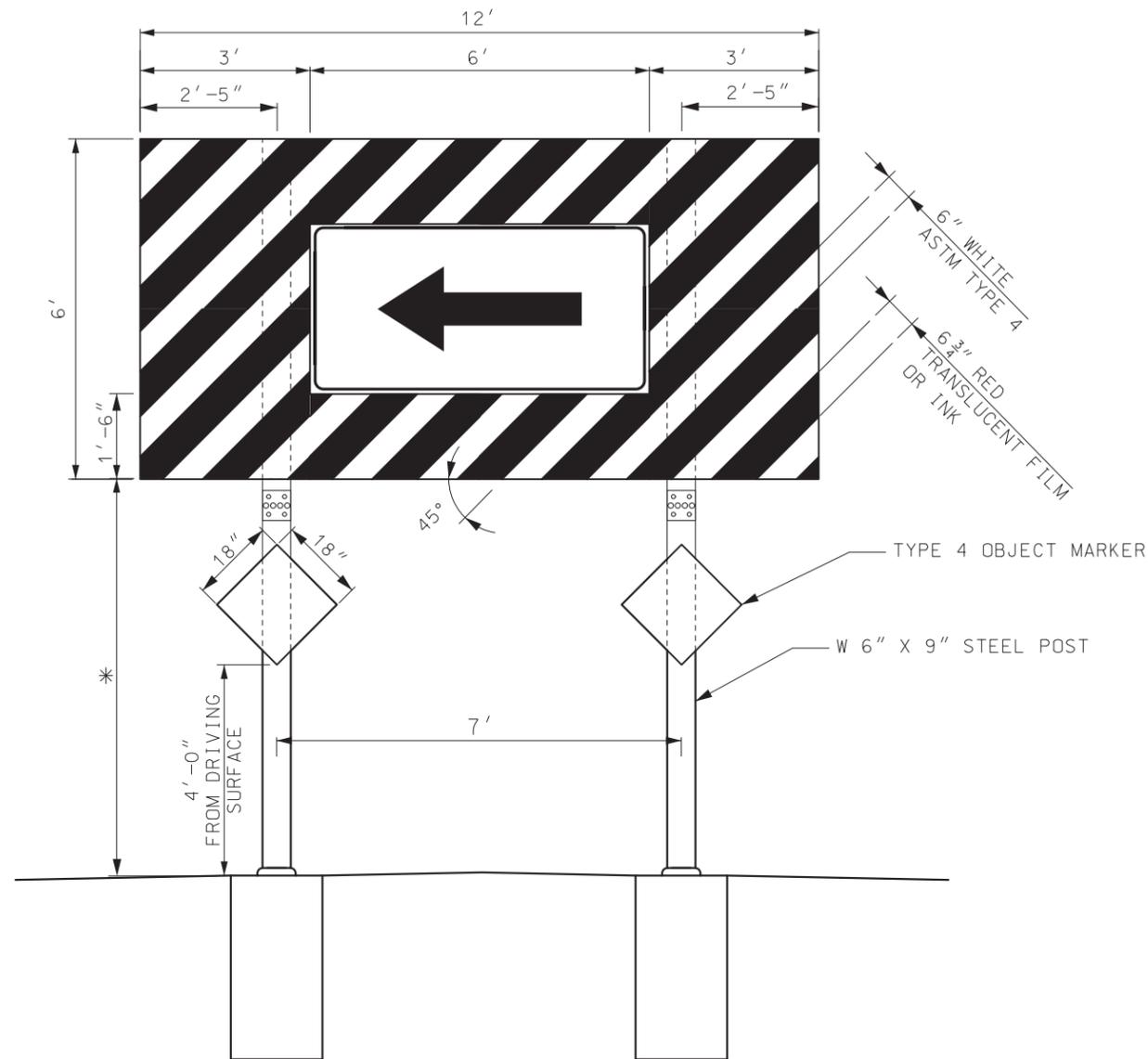
**MoDOT** MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION  
 105 WEST CAPITOL JEFFERSON CITY, MO 65102  
 1-888-ASK-MODOT (1-888-275-6636)

**HIGHWAY SIGNING**  
 HOLE PUNCHING

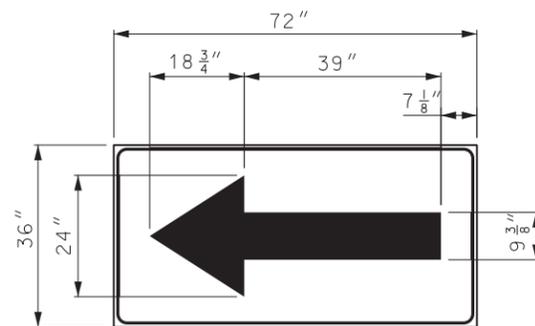
DATE EFFECTIVE: 7/1/2026  
 DATE PREPARED: 3/2/2026

**903.02AR**

SHEET NO.  
 7 OF 9



\* SEE STANDARD PLAN 903.03 FOR INSTALLATION ON I-BEAM POSTS



SIGNS SHALL HAVE SQUARE CORNERS AND BORDERS WITH THE FOLLOWING:  
 BORDER WIDTH 0.875"  
 BORDER INDENT 0.625"  
 2.250" RADIUS



DEAD END

GENERAL NOTES:

SEE STANDARD PLAN 903.03 FOR I-BEAM INSTALLATION.

SIGN BARRICADE SHALL BE CONSTRUCTED AS A STRUCTURAL (ST) SIGN.

DIRECTIONAL ARROW SHALL BE FLAT SHEET FLUORESCENT (SHF) AND CONSIDERED INCIDENTAL TO THE SIGN.

ALL REFLECTORIZED SURFACES SHALL BE RETROREFLECTIVE SHEETING IN ACCORDANCE WITH SEC 1042.

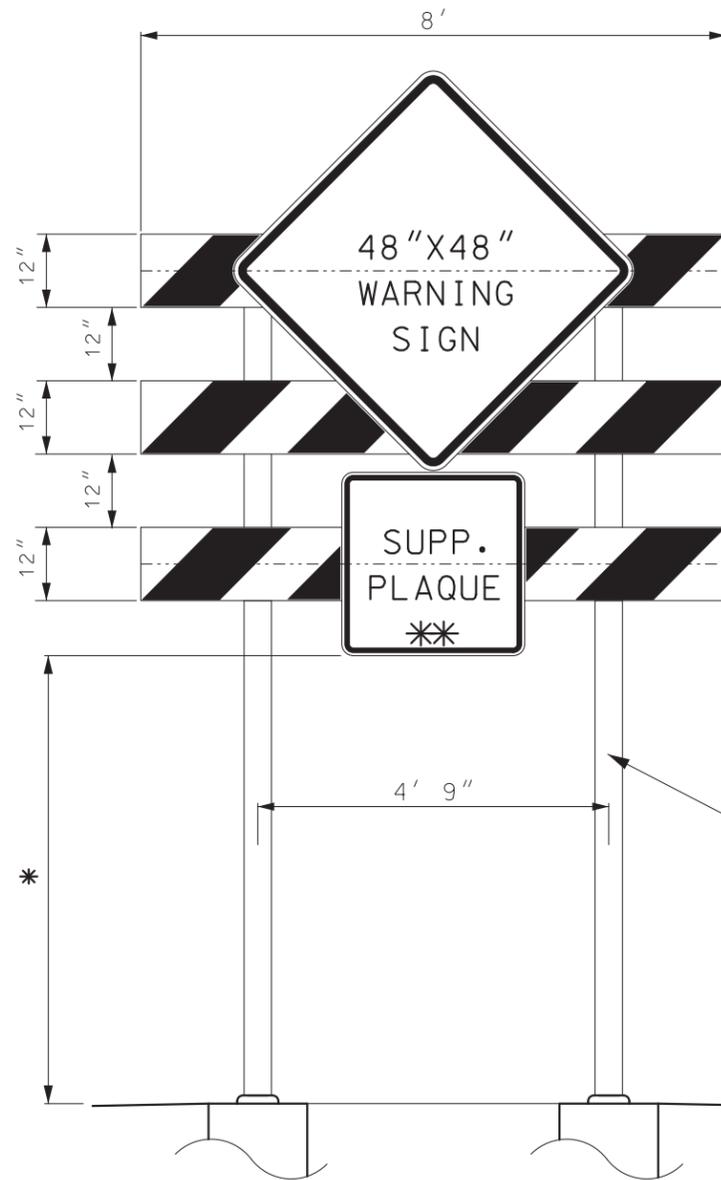
**MoDOT** MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION  
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**HIGHWAY SIGNING**  
 SIGN BARRICADE

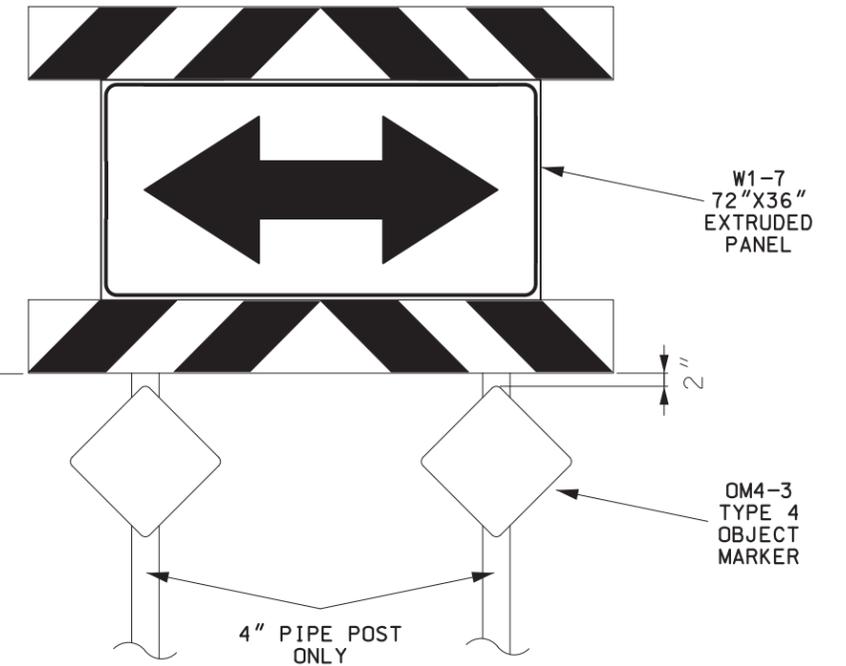
DATE EFFECTIVE: 7/1/2026  
 DATE PREPARED: 3/2/2026

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 8 OF 9



SIGNS AND PLAQUES CENTERED ON APPROPRIATE BARRICADE PANEL



T-INTERSECTION BARRICADE DETAIL

GENERAL NOTES:

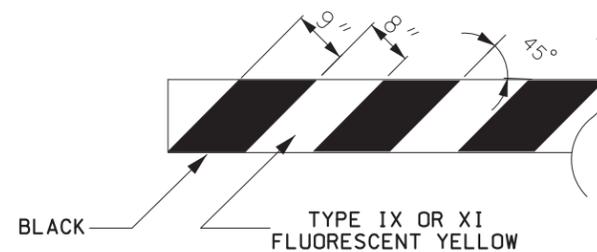
SEE STANDARD PLAN 903.03 FOR I-BEAM AND PIPE POST MOUNTING HEIGHT, OFFSET AND INSTALLATION DETAILS.

SIGN BARRICADE PANELS SHALL BE CONSTRUCTED USING EXTRUDED ALUMINUM PANELS.

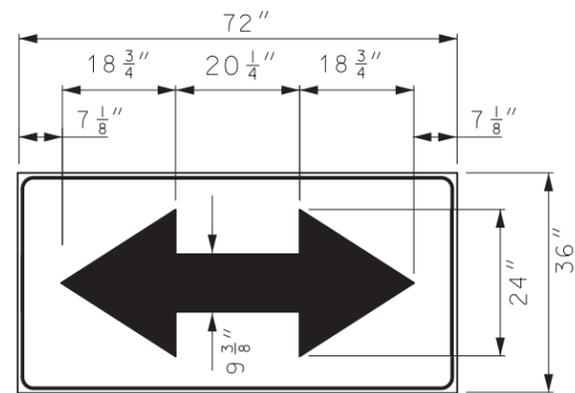
SIGN BARRICADE PANELS SHALL BE RETROREFLECTIVE SHEETING IN ACCORDANCE WITH SEC 1042.

WARNING SIGNS ATTACHED TO BARRICADE SHALL BE STANDARD SIGNS MATCHING SIZES SHOWN.

I-BEAM POST INSTALLATIONS SHALL NOT BE INSTALLED WITHIN INTERSECTION LOCATIONS.



BARRICADE PANEL DETAIL



SIGN BOARDER DETAILS:  
BOARDER WIDTH 0.875"  
BOARDER INDENT 0.625"  
2.250" RADIUS

W1-7 SIGN DETAIL

- \* SEE STANDARD PLAN 903.03 FOR SIGN MOUNTING HEIGHT AND OFFSET DETAILS
- \*\* 30"x30" W13-1P ADVISORY SPEED USED WITH HORIZONTAL ALIGNMENT WARNING SIGNS OR 30"x24" W16-2P XXX FEET USED WITH INTERSECTION WARNING SIGNS

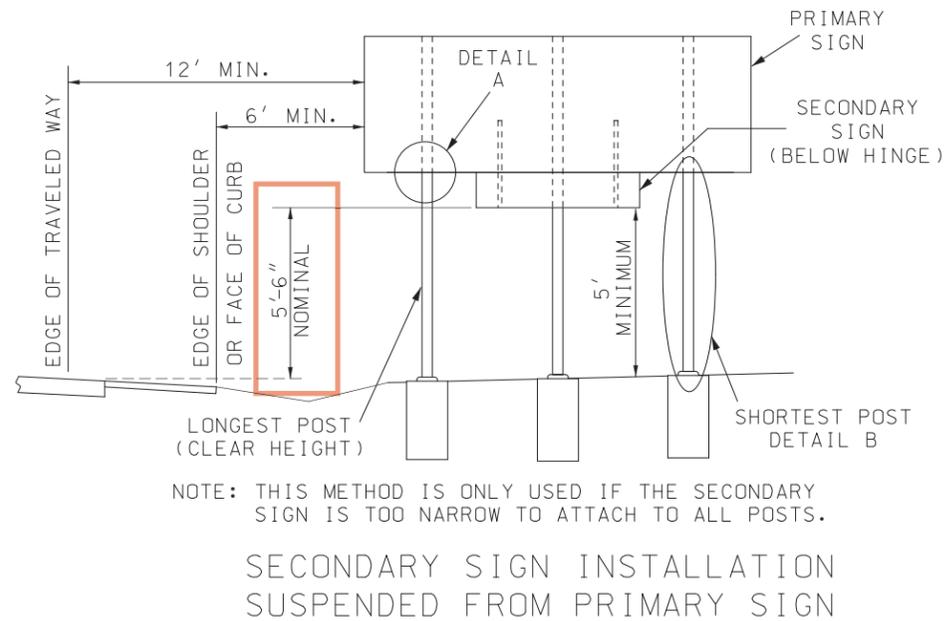
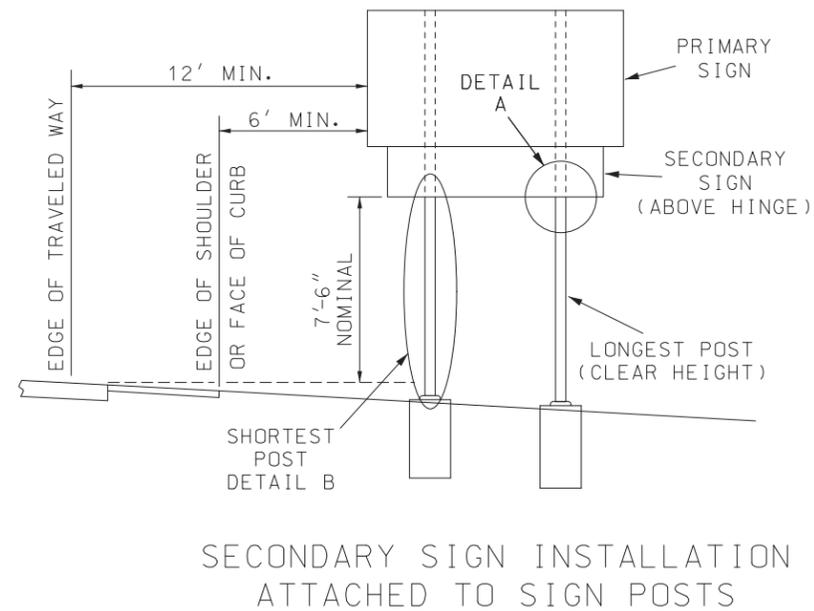
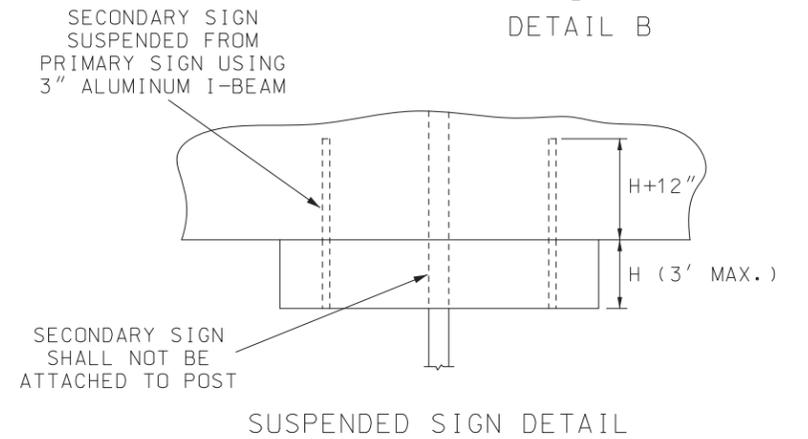
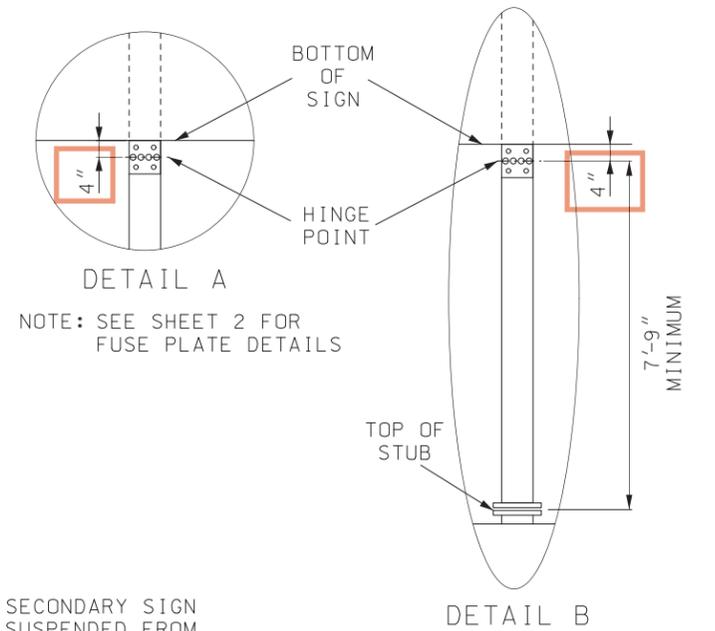
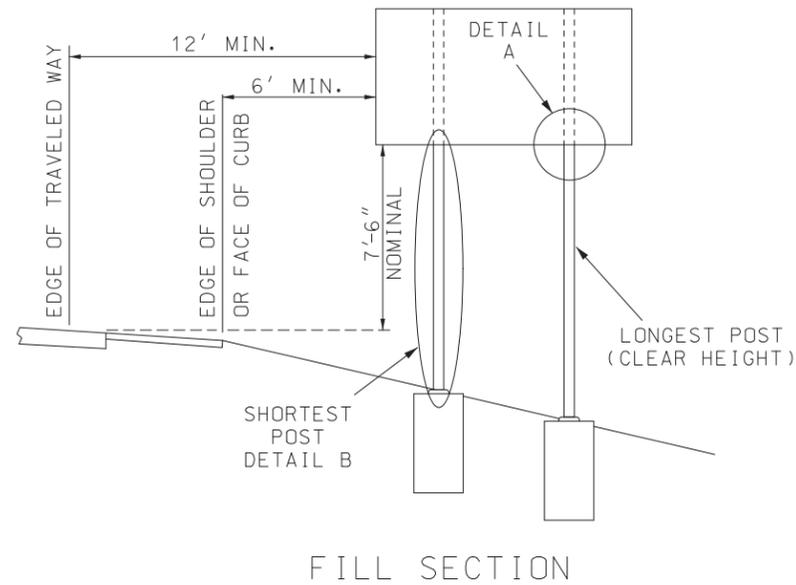
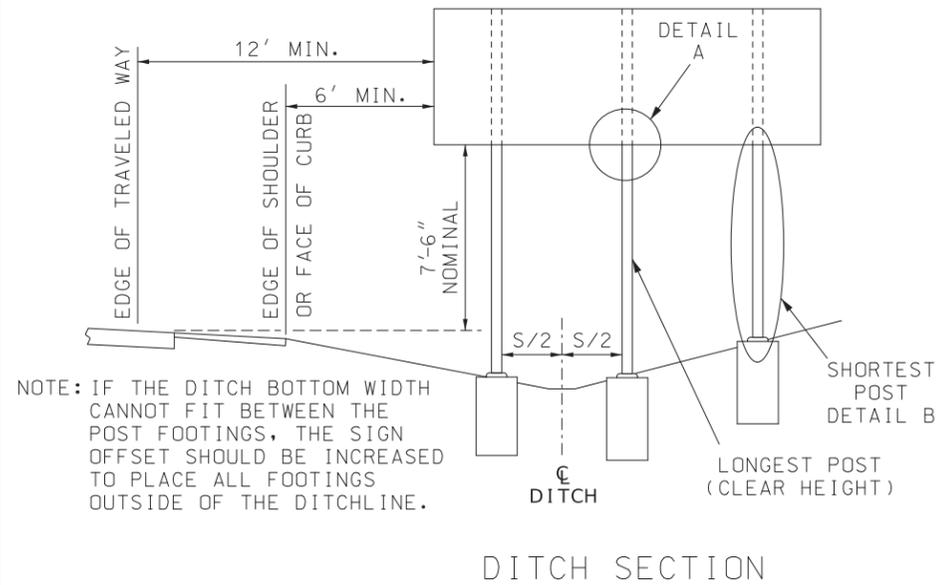
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**HIGHWAY SIGNING**  
SIGN BARRICADE

DATE EFFECTIVE: 7/1/2026  
DATE PREPARED: 3/2/2026

**903.02AR**

SHEET NO.  
9 OF 9

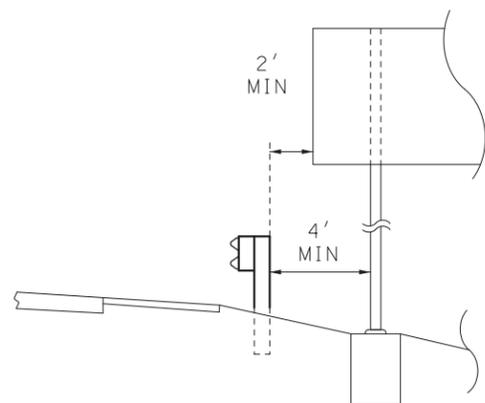
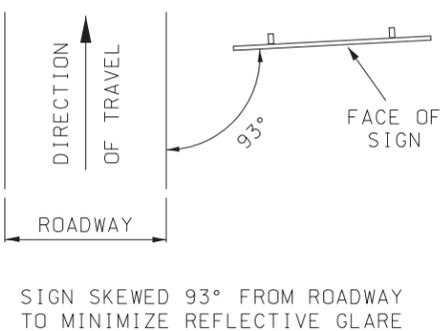


**GENERAL NOTES:**

FOR ADDITIONAL INFORMATION ON THE INSTALLATION OF I-BEAM POSTS, SEE SHEET 1 AND 2.

THE MOUNTING HEIGHT OF THE SIGN, MEASURED FROM THE ROAD SURFACE, SHALL ONLY BE INCREASED TO ENSURE THE SHORTEST POST IS A MINIMUM 7'9".

THE CORRECT NUMBER AND SIZE OF POSTS REQUIRED IS CALCULATED BASED ON THE SIGN HEIGHT, WIDTH AND THE CLEAR HEIGHT. THE CLEAR HEIGHT IS THE LENGTH OF THE LONGEST POST MEASURED FROM THE TOP OF THE STUB TO THE HINGE POINT AND DIRECTLY AFFECTS THE NUMBER AND SIZE OF POSTS REQUIRED TO SUPPORT A SIGN.

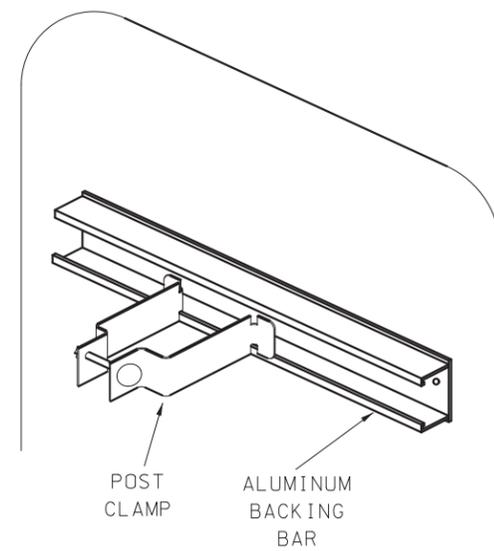


SEE SIGNPOST SELECTION TABLES IN EPG 903.16.4 FOR EXACT POST SPACING FOR EACH SPECIFIC SIGN WIDTH. POST SPACINGS GENERATED BASED ON THE FOLLOWING DESIGN REQUIREMENTS:

- POST DESIGNS 3, 4, 5 AND 6 (18 LBS/FT OR HEAVIER) - SPACE BETWEEN POSTS SHALL BE A MINIMUM OF 7'
- POST DESIGNS 1 AND 2 - SPACE BETWEEN POSTS MAY BE LESS THAN 7'
- SIGNS 6' TO 17' WIDE TYPICALLY USE TWO POSTS
- SIGNS GREATER THAN 17' TYPICALLY USE THREE POSTS

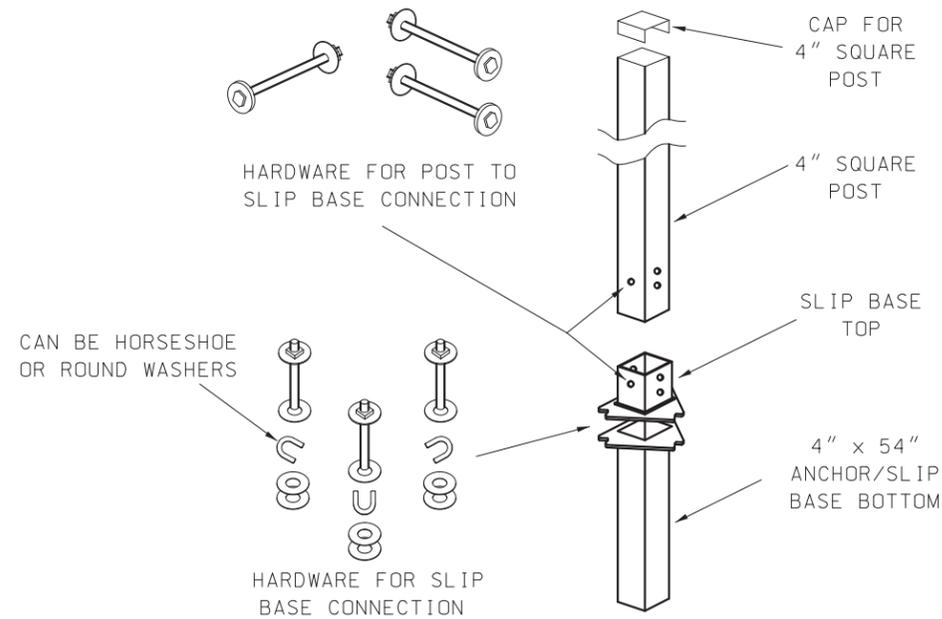
**POST SPACING**

 <p><b>MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION</b></p> <p>105 WEST CAPITOL JEFFERSON CITY, MO 65102 1-888-ASK-MODOT (1-888-275-6636)</p>	
<p><b>POST INSTALLATION DETAILS</b></p> <p>TYPICAL SECTION, MOUNTING HEIGHT AND POST SPACING I-BEAM POSTS</p>	
<p>DATE EFFECTIVE: 7/1/2026</p> <p>DATE PREPARED: 3/2/2026</p>	<p><b>903.03BV</b></p>
<p>SHEET NO. 3 OF 13</p>	

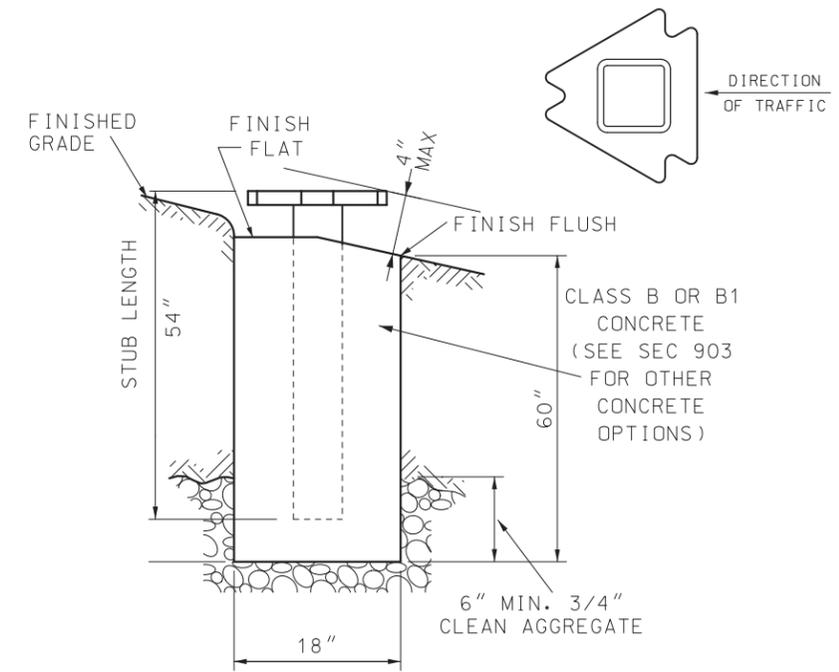


3 BACKING BARS REQUIRED FOR 48"X60" UP TO 48"X96" FLAT SHEET SIGNS

FLAT SHEET SIGN MOUNTING DETAIL



BREAKAWAY / POST ASSEMBLY DETAIL



CONCRETE FOOTING DETAIL

NOTES:

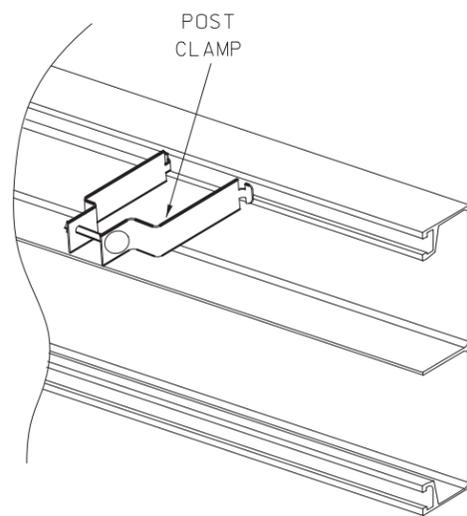
FOR MOUNTING HEIGHT AND OFFSET DETAILS, SEE SHEET 11.

4" SQUARE STEEL TUBE POST SYSTEM SHALL BE LISTED ON THE TRAFFIC APPROVED PRODUCTS LIST.

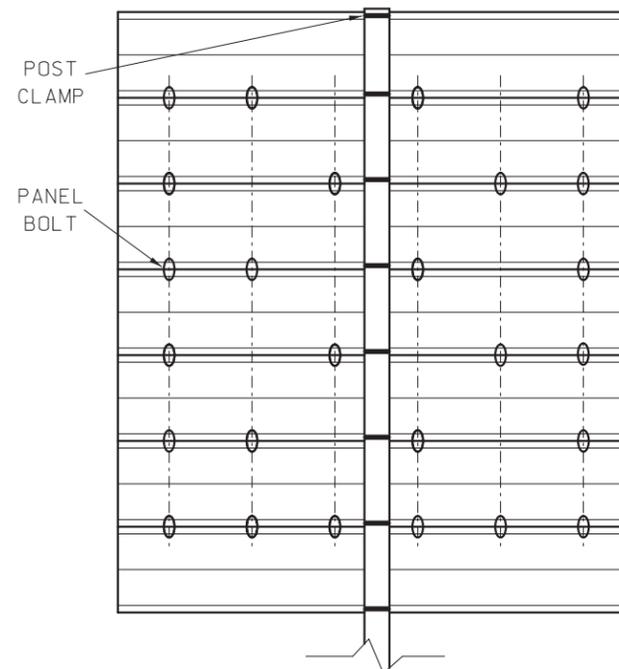
ALL HARDWARE FOR BREAKAWAY AND SIGN MOUNTING SHALL BE FROM POST MANUFACTURE.

SIGN POST / BREAKAWAY SHALL BE ASSEMBLED PER MANUFACTURE RECOMMENDATIONS.

- 4" SQUARE STEEL POST ONLY USED FOR:
- EXIT GORE SIGNS
  - FLAT SHEET SIGNS 48"X60" UP TO 48"X96"
  - 84"X96" KEEP RIGHT GORE SIGNS
  - COMMUNITY WAYFINDING SIGNS



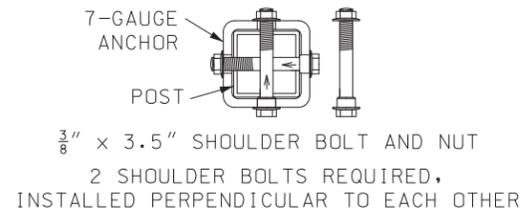
EXTRUDED PANEL MOUNTING DETAIL



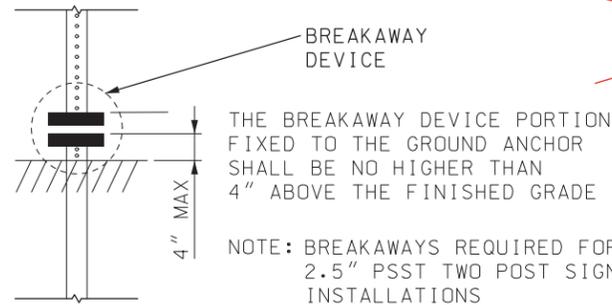
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**NEW SHEET** SIGN MOUNTING DETAILS  
 4" SQUARE STEEL TUBE POST

DATE EFFECTIVE: 7/1/2026	903.03BV	SHEET NO. 7 OF 13
DATE PREPARED: 3/2/2026		



7-GAUGE ANCHOR ANCHOR BOLT DETAIL



BREAKAWAY DETAIL

~~2.5" + 2.25" POST COMPRISED OF 2.5" PSST WITH 6-FT INSERT OF 2.25" PSST THAT RUNS UP FROM THE BREAKAWAY DEVICE~~

THE BREAKAWAY DEVICE PORTION FIXED TO THE GROUND ANCHOR SHALL BE NO HIGHER THAN 4" ABOVE THE FINISHED GRADE

NOTE: BREAKAWAYS REQUIRED FOR ALL 2.5" PSST TWO POST SIGN INSTALLATIONS

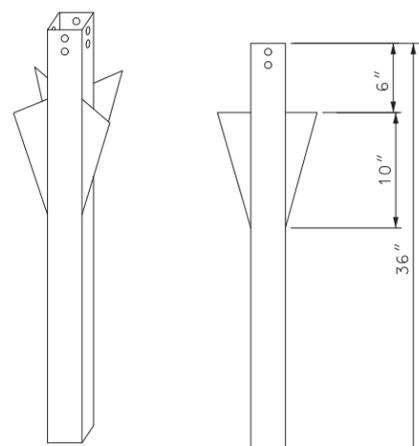
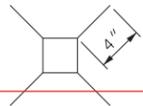
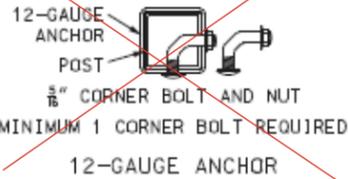
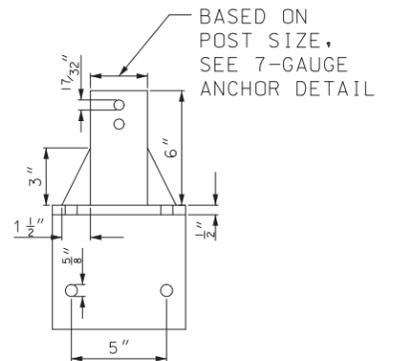
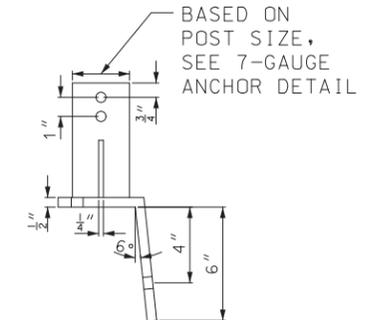
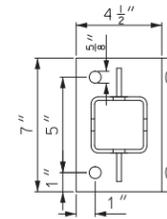
ANCHOR TUBE SHALL BE 7-GAUGE

1/2" X 4 1/2" GALVANIZED MECHANICAL FASTENERS SHALL BE USED TO ATTACH ANCHOR TO BARRIER WALL

SHOULDER BOLTS SHALL BE USED TO ATTACH PSST POST TO ANCHOR (SEE ANCHOR BOLT DETAIL)

ANCHOR SHALL BE HOT DIPPED GALVANIZED AFTER FABRICATION PER SECTION 1080

FURNISHING AND INSTALLATION OF BARRIER WALL POST ANCHOR FOR PSST SHALL BE PAID PER EACH AS CONCRETE POST ANCHOR



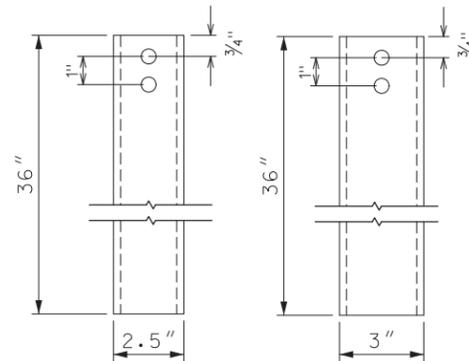
7-GAUGE

DRIVEN ANCHOR DETAIL



7-GAUGE

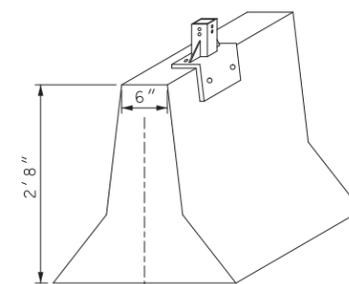
CONCRETE ANCHOR DETAIL



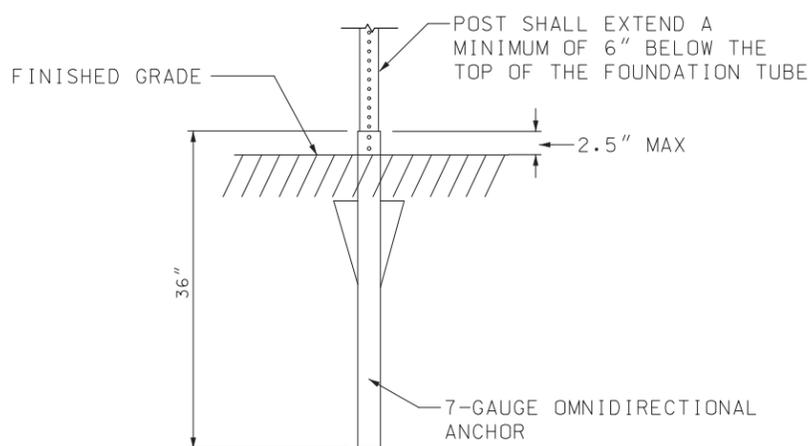
FOR 2" POST FOR 2.5" POST

BOLT HOLE DIAMETER - 17/32" 2 PER SIDE ON ALL 4 SIDES

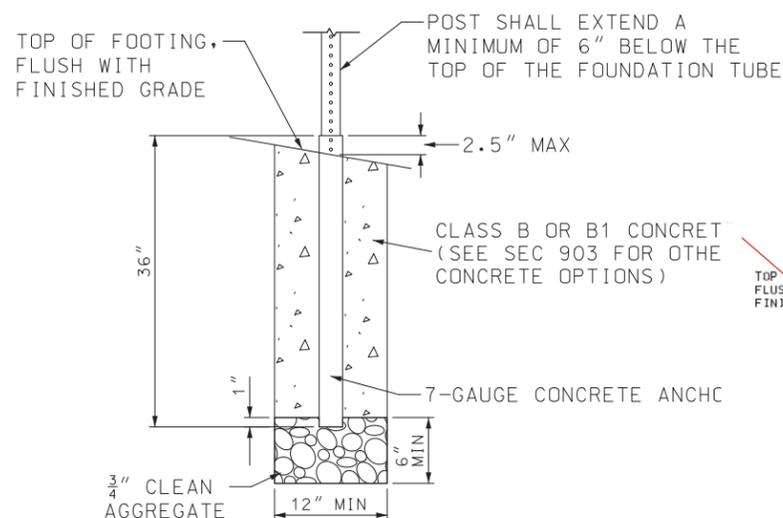
7-GAUGE ANCHOR FABRICATION DETAIL



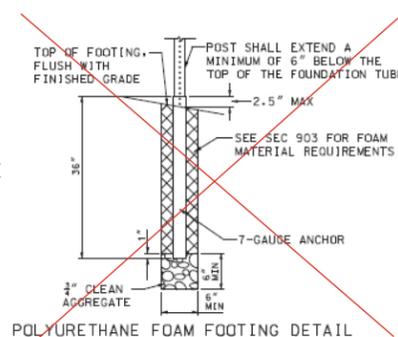
BARRIER WALL MOUNTING DETAIL



DRIVEN ANCHOR INSTALLATION DETAIL



CONCRETE FOOTING INSTALLATION DETAIL



NOTES:

FOR GENERAL NOTES, SEE SHEET 1.

FOR MOUNTING HEIGHT AND OFFSET DETAILS, SEE SHEET 11.

ANY BREAKAWAY DEVICES USED ON AN INSTALLATION SHALL BE LISTED ON THE TRAFFIC PRE-ACCEPTED PRODUCTS LIST.

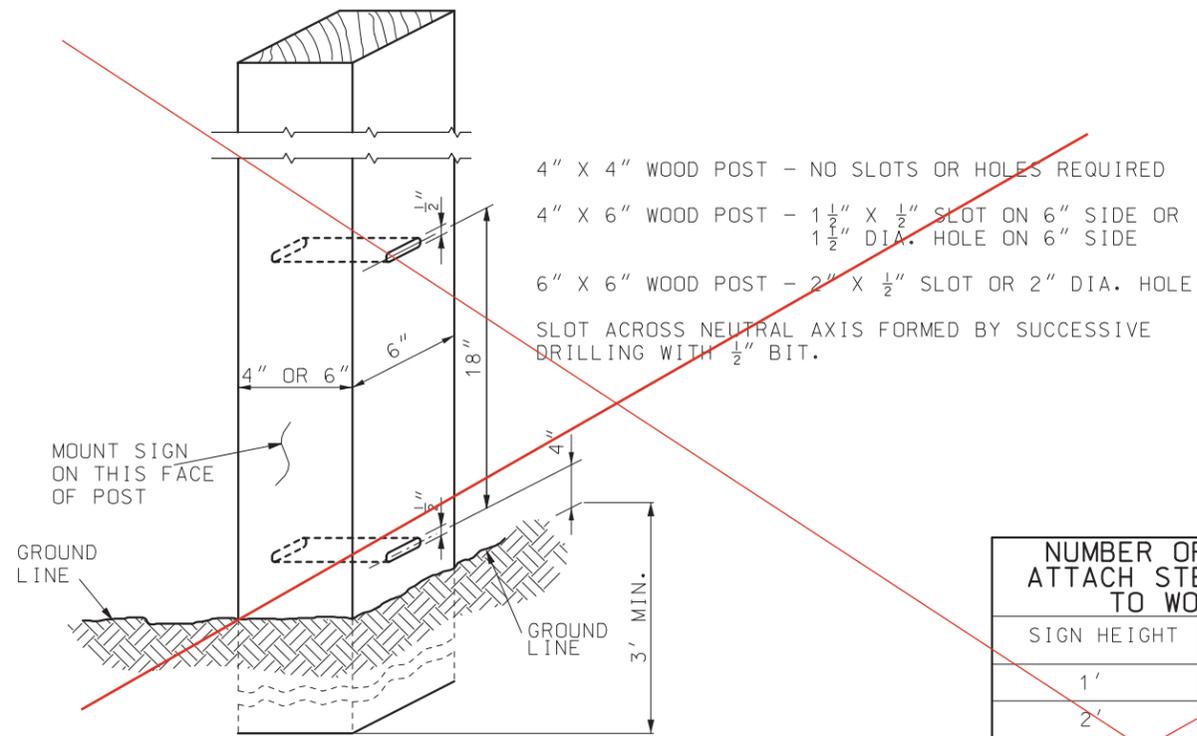
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POST INSTALLATION DETAILS PERFORATED SQUARE STEEL TUBE (PSST)

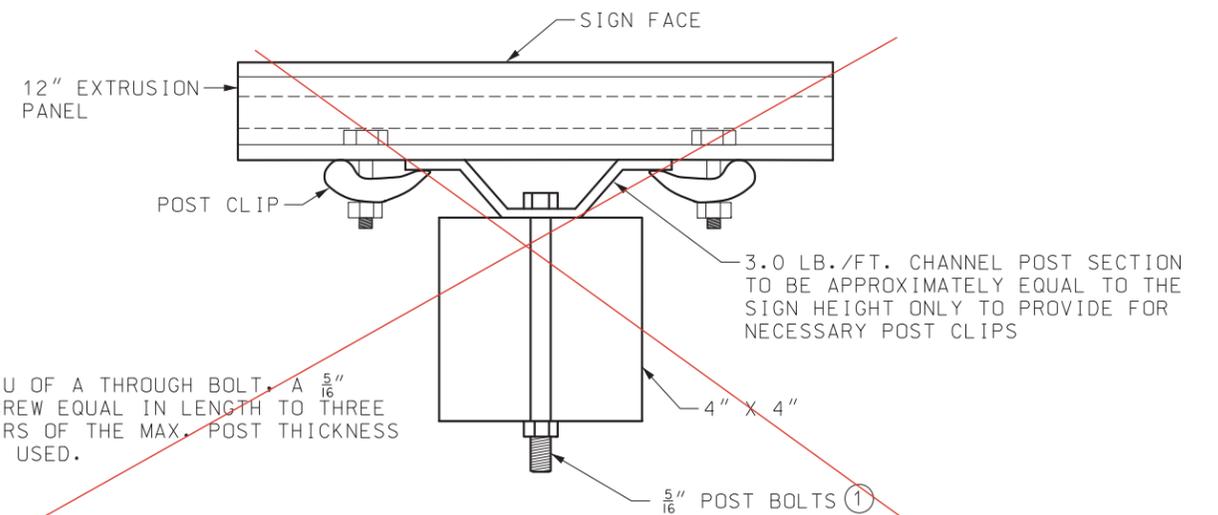
DATE EFFECTIVE: 7/1/2026  
DATE PREPARED: 3/2/2026

903.03BV

SHEET NO. 8 OF 13



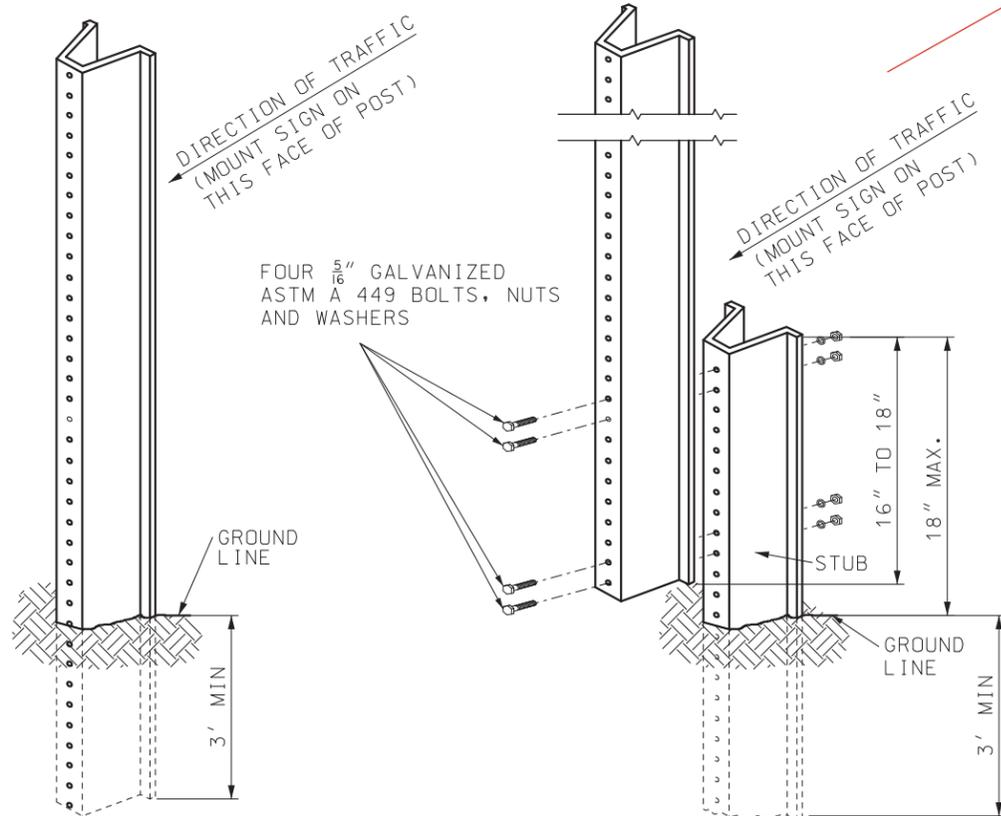
WOOD POST DETAIL



PLAN VIEW

MOUNTING DETAILS FOR EXTRUDED PANELS ON WOOD POST

NUMBER OF BOLTS TO ATTACH STEEL CHANNEL TO WOOD POST	
SIGN HEIGHT	NO. OF BOLTS PER WOOD POST USED
1'	2
2'	3
3'	4
4'	5
5'	6
6'	7
7'	8



U-CHANNEL POST DETAIL

U-CHANNEL STUB DETAIL OPTIONAL INSTALLATION

NOTES:

FOR GENERAL NOTES, SEE SHEET 1.

ALL POSTS SHALL BE EMBEDDED A MINIMUM OF 3 FEET INTO THE GROUND.

U-CHANNEL POST-STUB OVERLAP SHALL BE POSITIONED ENTIRELY BETWEEN GROUND LINE AND 18" ABOVE GROUND LINE.

~~FOR POST CLIP DETAILS, SEE STANDARD PLAN 903.02.~~

FOR MOUNTING HEIGHT AND OFFSET DETAILS, SEE SHEET 11.

SIGN AREA (SQ.FT.)	POST TYPE	
	U-CHANNEL	WOOD
≤ 10	1 - 3.0 LB./FT.*	1 - 4" X 4"*
> 10 ≤ 16	2 - 3.0 LB./FT.	2 - 4" X 4" 1 - 4" X 6"*
> 16 ≤ 24	2 - 3.0 LB./FT.	2 - 4" X 6"
> 24 ≤ 30	3 - 3.0 LB./FT.	2 - 4" X 6"
> 30 ≤ 50	N/A	2 - 6" X 6"

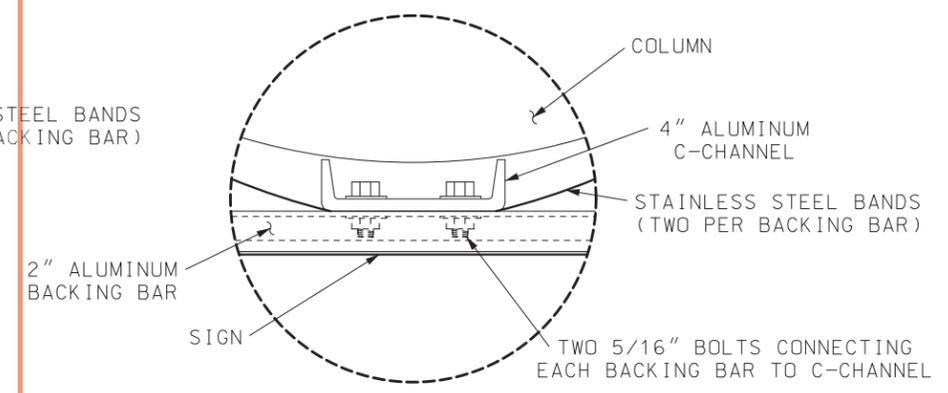
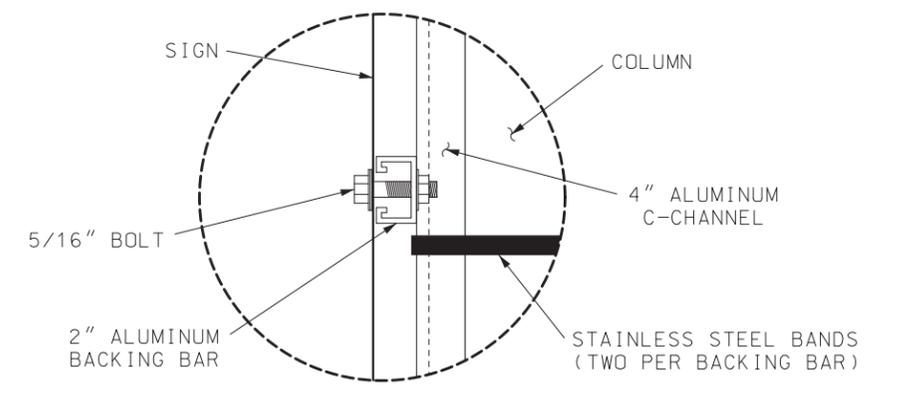
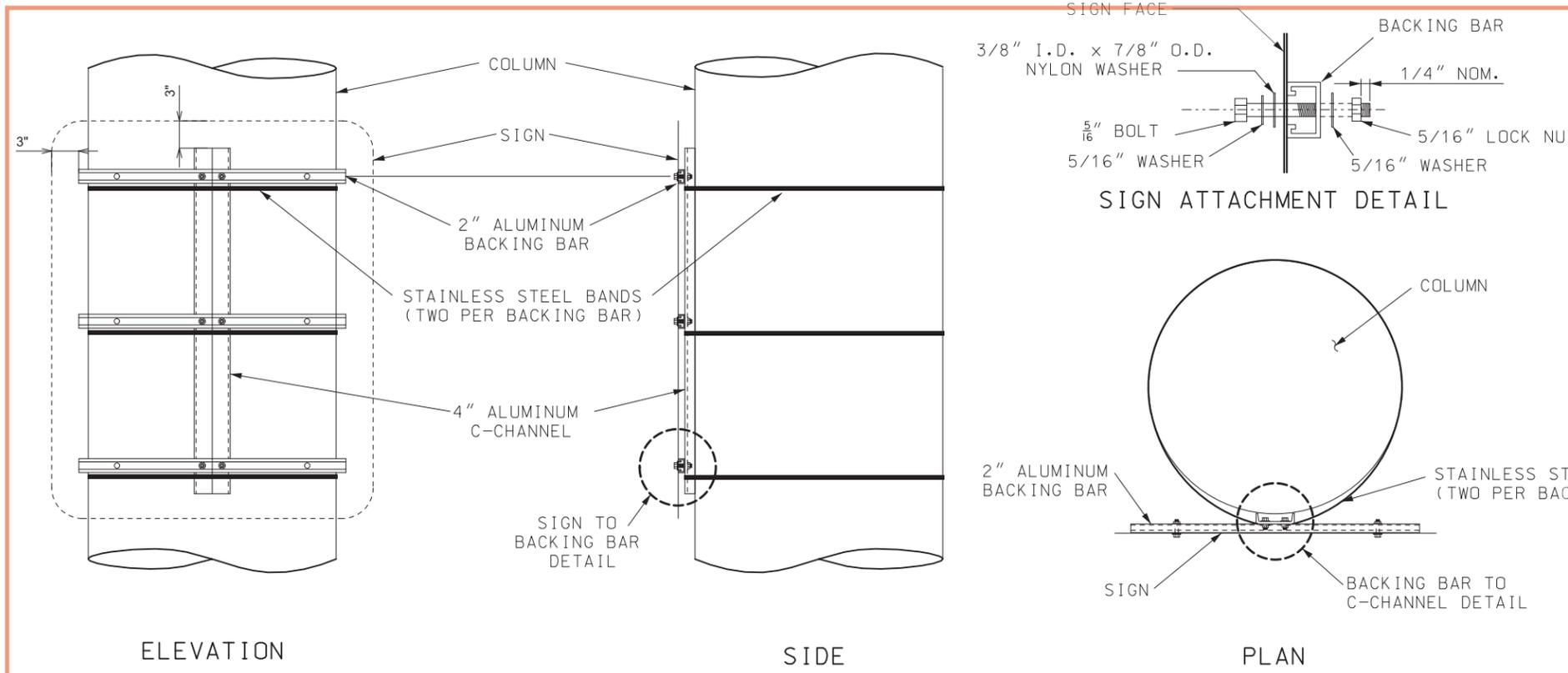
\* SIGNS GREATER THAN 4 FEET IN WIDTH REQUIRE TWO POSTS, EXCEPT DIAMOND SHAPED WARNING SIGNS, YIELD SIGNS, AND ONE WAY SIGNS.

POST SIZE REQUIREMENTS

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POST INSTALLATION DETAILS  
~~WOOD AND~~  
 U-CHANNEL POST

DATE EFFECTIVE: 7/1/2026	903.03BV	SHEET NO. 10 OF 13
DATE PREPARED: 3/2/2026		



**FLAT SHEET COLUMN MOUNTING ASSEMBLY FOR 48"X60" TO 48"X96" RECTANGLE AND 48" DIAMOND SIGNS**

**NOTES:**  
 FOR GENERAL NOTES, SEE SHEET 1.  
 FOR SIGN MOUNTING HEIGHT SEE SHEET 11.

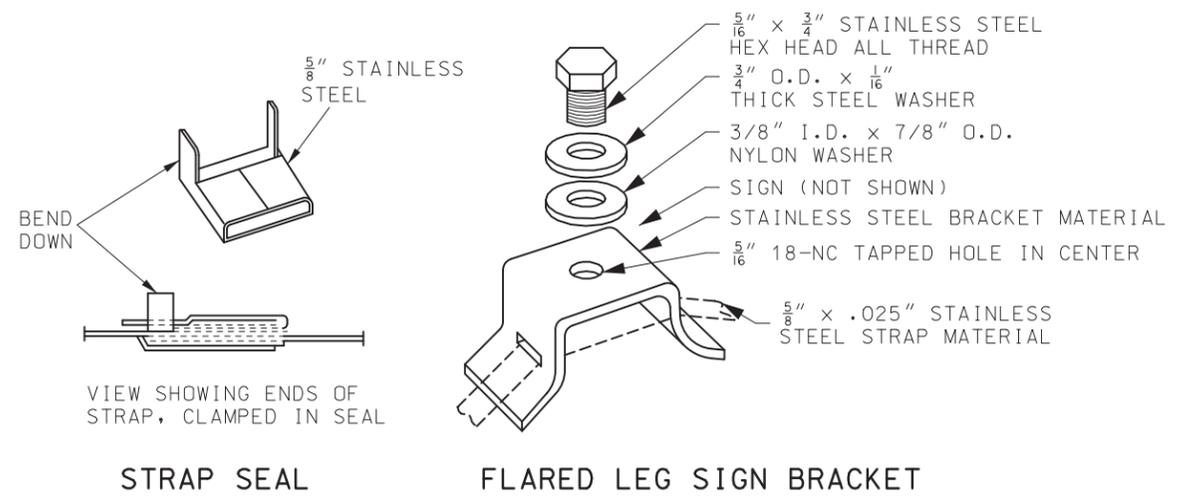
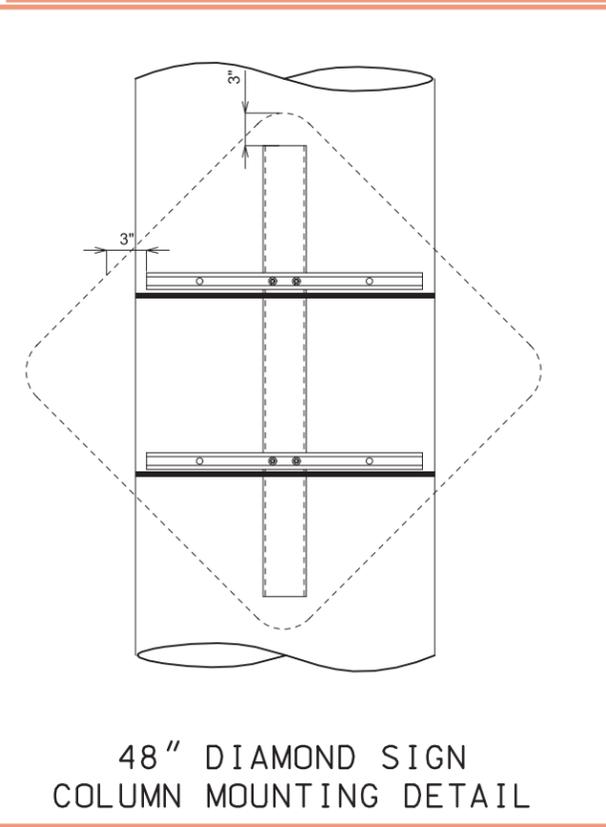
COLUMNS INCLUDE BRIDGE COLUMNS, OVERHEAD SIGN TRUSS UPRIGHTS, SIGNAL COLUMNS, ETC. SIGNS SHALL NOT BE ATTACHED TO ROADWAY LIGHTING OR UTILITY POLES.

FOR SIGNS WITH SUPPLEMENTAL PLAQUES, THE C-CHANNEL WILL NEED TO BE LENGTHENED AND ADDITIONAL BACKING BARS ADDED TO SUPPORT THE SUPPLEMENTAL SIGN.

BACKING BAR PLACEMENT ON C-CHANNEL BASED ON SIGN HOLE PUNCHING, SEE STANDARD PLAN 903.02.

SEE STD PLAN 903.02 FOR ALUMINUM BACKING BAR DETAILS.

C-CHANNEL SHALL BE STRUCTURAL 6061-T6 ALUMINUM, MINIMUM 2.50 LBS/FT.



**FLAT SHEET COLUMN MOUNTING DETAILS FOR FLAT SHEET SIGNS < 48" WIDE**

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**SIGN MOUNTING DETAILS COLUMN MOUNTING ASSEMBLY**

DATE EFFECTIVE: 7/1/2026	903.03BV	SHEET NO. 12 OF 13
DATE PREPARED: 3/2/2026		





## 903.16.3 Types of Fabricated Signs

**Support.** There are two types of sign substrate materials available used by MoDOT; – extruded aluminum panels and flat sheet aluminum. From these materials ~~there are four types of signs fabricated – structural (ST), and structural fluorescent (STF), which are made from extruded aluminum panels, and as well as flat sheet (SH) and flat sheet fluorescent (SHF).~~

Flat sheet~~Sheet~~ signs are made from single pieces of flat sheet aluminum, usually one-piece units, with the thickness of the aluminum sheet varying based on the size of the sign. and have several available thicknesses as indicated in the standard plans.

~~Structural signs are usually made fabricated using extruded aluminum panels. This sign fabrication method is used for signs of multiple extruded panels, 6 ft. wide or wider, and signs 30 sq. ft. in area and larger due to the structural strength of the extruded panels. Extruded panels are composed of a 1-ft. tall "E" shaped aluminum substrate, assembled to a desired height and cut to a uniform width for each sign. These panels are bolted together to form the larger "sign blank" substrate needed for structural signs. 6-in.- tall "C" shaped panels are also used in limited applications where the sign's vertical dimension has a 6-in. increment, such as exit number plaques on guide signs.~~

~~These signs are used primarily for guide signs on expressways and freeways, but may be found on other routes on a limited basis, and are used on all overhead-mounted signs, including "LOW CLEARANCE" and exit number panels, signs greater than 6 ft. wide, and signs greater than 30 sq. ft. in area.~~

~~Extruded panels are composed of a 1 ft. tall "E" shaped aluminum substrate, assembled to a desired height and cut to a uniform width for each sign. These panels are bolted together to form the larger "blank" substrate needed for structural signs.~~

There are two types of reflective-retroreflective sheeting available used by MoDOT:

- MoDOT Type ~~III-IV~~ High Intensity Prismatic (R2);– this sheeting is used for the background for all signs, except orange work zone, yellow warning and yellow-green school signs.
- MoDOT Type ~~VII-IX or XI~~ Prismatic (R4);– this sheeting is used for all direct applied legends used on guide signs. It is also used for the background sheeting for orange work zone, yellow warning, and yellow-green school signs as MoDOT uses the fluorescent versions of these colors that are only available in this sheeting type.

See MoDOT Standard Plans 903.02 for details on sign ~~sub-straights~~substrate and retroreflective sheeting.

**Guidance.** ~~Generally, R2 sheeting should be used on all sign backgrounds. R3 sheeting should be used on all legend and symbols on guide signs.~~

## 903.16.4.4 Ground-Mounted Sign Support Selection

### Forms/Signpost Selection Tables

- PSST & Pipe Quick Reference
- PSST
- Pipe
- U-Channel & Wood
- 4" Square Steel Tube
- I-Beam

- Signpost Selection Guide
- Printable Signpost Selection Guide for use in the field

**Support.** The majority of MoDOT signs are installed and supported on one of 5 types of ground-mounted sign supports or signposts. The selection of signpost is based on many factors, but primarily on the size of sign being installed and the type of roadway the sign is being installed along. There is some overlap in signpost applications; more than one signpost may be applicable to a given installation. The final selection of the post type is based on the attributes needed for a support as discussed in each classification of signpost below.

The number of posts needed to support a sign is primarily based on the width of a sign. Typically, signs 48 inches wide and wider are installed on two ~~or more~~ posts. This requirement is based on two factors, the capacity of the post and the long-term stability of the assembly. A wide sign installed on one post will place a torsional force onto a post and in windy conditions can result in an assembly not staying plumb and, in some cases, an actual failure of the post itself.

**Standard.** The selection of the proper size of signpost shall be based on the Signpost Selection Guide Tables listed above. These ~~tools tables~~ will specify if a post type has the capability to support the sign in question and then specify what size post is required based on the requirements of the installation. Before the correct size of ~~PSST or Wide Flange I-Beam~~ post can be selected, the length of the longest post must first be determined. To determine this, the offset and mounting height must first be determined.

### 903.16.4.4.1 U-Channel Posts

**Support.** MoDOT utilizes two primary sizes of U-Channel Posts, a 3 lb/ft high carbon, rerolled rail steel post for sign installations and a low carbon steel 1 lb/ft post for ~~road side~~roadside delineation.

U-channel posts can be used to support MoDOT's small signs, such as no parking signs, object markers and chevrons on two lane roadways. U-channel posts are typically not suited to support larger permanent signs as they have limited torsional rigidity and have less ability to hold a larger sign steady in windy conditions. These are typically the most economical posts to use to support smaller signs and given these types of signs tend to be installed closer to the roadway their ability to yield more easily to impacts means they pose less of a damage risk to vehicles. U-channel posts are typically installed by driving the post into the ground without a stub or anchor, however, there is a stub / post installation option available which is detailed in the standard plans.

U-Channel posts are considered breakaway with no additional breakaway devices needing to be added. While there are breakaway devices available for U-channel posts, MoDOT's use of this type of post for smaller signs typically doesn't justify their use. A U-channel post's breakaway is typically a yielding function, meaning as a vehicle impacts the assembly, the post yields and lies down in front of the vehicle so it can pass over the assembly.

**Standard.** U-channel posts shall be installed in accordance with the details found in [Standard Plans 903](#). Signpost selection ~~tools tables~~ shall be used to determine sign sizes U-channel posts can support and the number of posts needed.

### 903.16.4.4.2 Wood Posts

**Support.** MoDOT's ~~specs specifications~~ permit ~~three two~~ sizes of wood posts to be used: 4 in. x 4 in., ~~or~~ 4 in. x 6 in., ~~or 6 in. x 6 in.~~ MoDOT's wood posts are pressure treated to promote longer life

and resist rot and insect damage. Wood posts were once MoDOT's primary post to support signs on two lane roadways; however, due to issues with material stability PSST posts have become MoDOT's standard post. Wood post installations are only an option for MoDOT operations, they are no longer an option for contractor installed signs.

When used, wood posts are capable of supporting most sign assemblies on two lane roadways, from route marker assemblies, speed limit signs, warning signs and distance and destination signs. The use of a ~~high quality~~high-quality wood post and proper installation is the key to a successful installation.

**Guidance.** The continued use of wood posts should take into consideration the special characteristics listed in [EPG 903.16.4](#).

Proper installation is also critical for the stability of the sign assembly. The wood post should be placed a minimum of 36 inches into the ground, deeper for larger signs or in areas where the soil is weak or sandy, to keep the signpost plumb. When backfilling the hole, material should be added in lifts, or levels, in order to properly compact the backfill. Loose or fine materials, such as sand, sandy soil or dry concrete mix typically will not provide a ~~long term~~long-term solid backfill and can result in the post falling out of plumb over time.

MoDOT's specifications should be followed when purchasing wood signposts. These specifications address a posts load capacity, breakaway attributes and the compatibility between the pressure treatment chemicals and our aluminum signs and sign hardware.

**Option.** While the soil originally removed from the hole can be used to back fill around the post other alternatives may be used, such as smaller quarry rock with the crushing fines mixed in, concreted mix or expanding polyurethane foam.

**Support.** Wood posts are considered breakaway without an add-on breakaway device; however, some sizes of post do need special preparation. 4 in. x 4 in. wood post are considered breakaway without any special modifications; however, 4 in. x 6 in. ~~and 6 in. x 6 in.~~ posts must be cross drilled at the base to weaken them so they will break away. The size of the holes and where they are drilled is critical to these posts meeting breakaway requirements. ~~The details for these holes are found in the Standard Plans 903~~See figure 903.16.4.4 for details for cross drilling wood posts. It is important to note these breakaway holes are drilled in the sides of the post, not in the front of the post where the sign is mounted.

**Standard.** If wood posts are used, the proper size and number of posts shall be determined by using the post selection ~~tool~~tables.

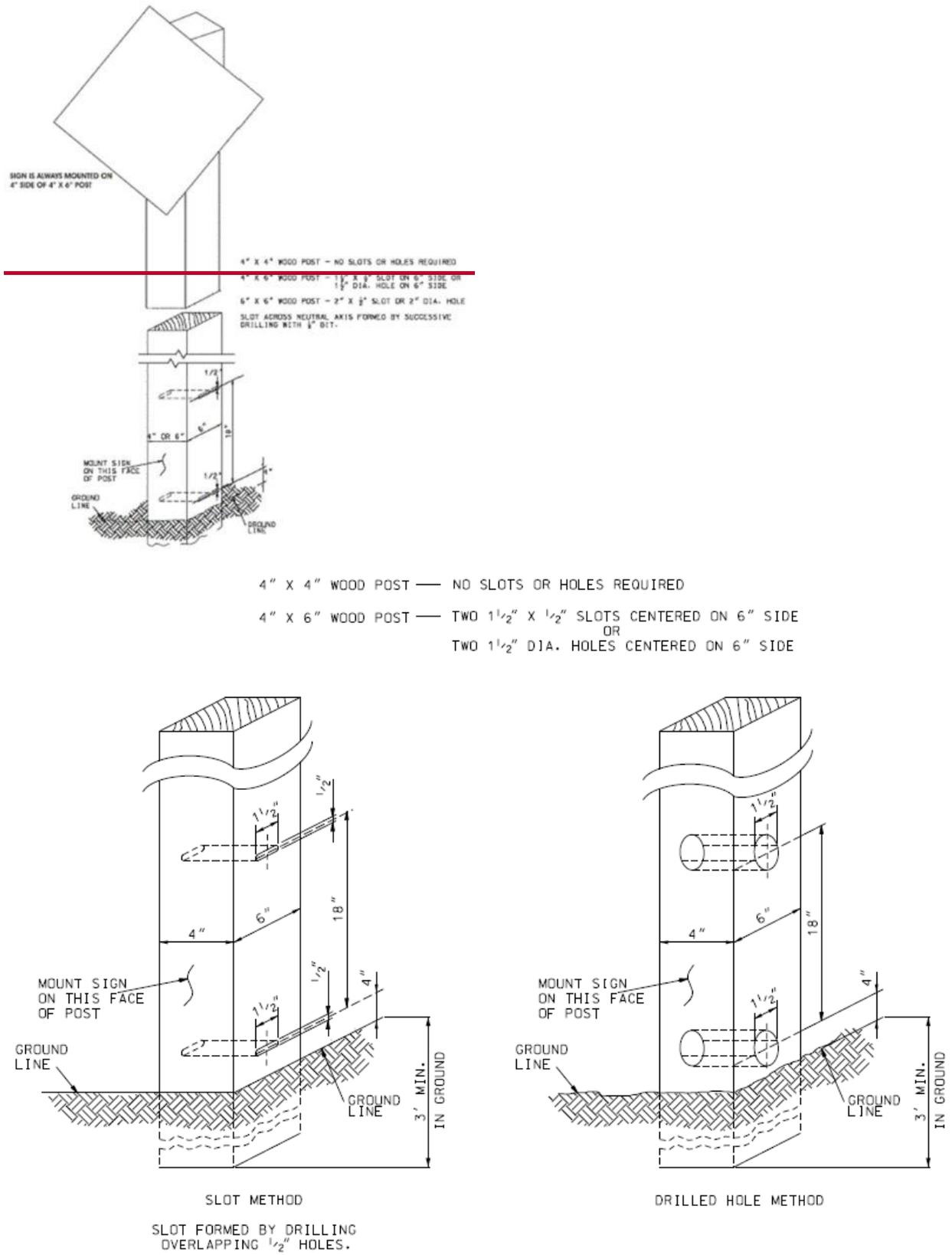


Figure 903.16.4.4-2-Details for Wood Posts Requiring Breakaway Design

**History.** One of the earliest issues experienced with wood posts is their tendency to warp and twist, both before and after installation. Keeping a sign plumb and appropriately oriented to the roadway is critical to maintain the sign's legibility and ~~night time~~retroreflectivity performance. This aspect of wood posts resulted in significant waste of inventory when the posts warped and twisted before being used and increased ~~work load~~workload on signing crews who had to correct warped and twisted posts after installations. Another concern with the use of wood posts was the installation required a hole to be dug, the posts set and property back filled so the sign would remain upright. If soil conditions prohibited a hole being dug deep enough or the back fill not capable for being compacted sufficiently the assembly would fall out of plumb. Along with these installation aspects, a wood post sign assembly can be very heavy, especially when the pressure treated wood is still wet with the pressure treating fluids and this can result in the need for additional people to set the post and/or increased risk of injury setting the post by hand.

Towards the end of MoDOT's reliance on wood posts a new issue was identified relating to the more environmentally friendly treatment process called ACQ (Ammoniacal Copper Quaternary). ACQ replaced CCA (Chromated Copper Arsenate) for residential applications as CCA had chemical component which were not recommended for routine contact with skin. However, unlike CCA, ACQ (especially early versions) turned out to be very corrosive to metals, especially to aluminum. This corrosive nature requires special fasteners to resist this corrosive effect. Early applications of ACQ in other states realized serious sign corrosion to the point the sign would fall off the post in a matter of a few years. While it appears this has improved, special fasteners with special protective coatings are still recommended for use with ACQ posts. As a result, ACQ posts do not meet MoDOT's specifications and should not be used to support signs. CCA treated posts are still MoDOT's standard for wood posts, however, it is not commonly available at local home improvement centers and at many lumber yards. Due to MoDOT's limited use of this product contract purchasing typically is not economical or possible.

#### **903.16.4.4.3 Perforated Square Steel Tube Posts (PSST)**

**Support.** MoDOT utilizes two sizes of PSST posts, 2 in. and 2.5 in., both being made from 12-gauge steel. PSST became MoDOT's standard post for most sign installation applications on two lane roadways in the early 2000's, replacing wood posts. PSST usage has since expanded to some applications on freeways and expressways.

Unlike U-channel or Wood posts, PSST utilizes a ground anchor, or footing, within which the post is then placed. MoDOT has several options in its specifications with respect to ground anchor/foundation systems, the use of each option is heavily based on the soil condition.

The anchor/footing types for PSST are:

- ~~• 12-Gauge PSST Anchor – this is the basic direct driven anchor for 2 in. PSST posts. A 12-gauge anchor does not exist for 2.5 in. PSST posts.~~
- ~~• 7-Gauge Anchor – this is a heavy wall box tube anchor which is the basic direct driven anchor for 2.5 in. PSST posts. It is also an optional heavy anchor for 2 in. PSST posts in rocky ground where a 12-gauge anchor may deform when driven. The 7-gauge anchor is also the anchor that must be used when installing a concrete or polyurethane footing.~~
- Omnidirectional, or stabilization, Direct Drive Anchor – this is the anchor that is driven directly into the soil without drilling a foundation hole. It is the appropriate 12-gauge or a 7-gauge direct driven anchor with 4 soil stabilization plates added to the anchor to increase soil surface area to help keep signs plumb in weaker soils and/or in windy areas. A JSP will be needed to specify this anchor type on a project. This is the standard anchor used for PSST signs installed on conventional two-lane roadways.
- Concrete Anchor – This is an anchor used in concrete footings, a 7-gauge anchor with no soil stabilization plates added.

- Concrete Footings – Concrete footings provide a more secure foundation to support PSST signposts. Concrete footings keep PSST sign installations straighter for longer due to the mass of the concrete and increased contact areas between the concrete and the soil, especially for the large signs used on freeway and expressway routes. Contractors must install PSST with concrete footings on all routes other than conventional two-lane roadways, and it is highly recommended MoDOT operations do the same. Concrete footings can be used on conventional two-lane roadways if the direct drive anchor is insufficient for the location.
- ~~In some applications it may be desired to install a concrete footing for PSST, similar to the footings for Pipe Post or Wide Flange Post. Concrete footings provide a stronger foundation compared to the directly-driven anchors listed above. A concrete footing may also be required in cases where the ground is too hard or rocky to direct drive the anchor and a hole may need to be dug in order to install the anchor. All concrete footing installations use a 7-gauge anchor (that only has holes at the top of the tube) because concrete would flow through the holes of a normal 12-gauge PSST anchor.~~
- Polyurethane Foam Footings – This is an alternate to a concrete footing for PSST post installations, but only for MoDOT operations. The advantage of the foam footing is it allows ~~This permits~~ the footing and the sign to be installed in one trip compared to concrete, which requires a second trip to allow the concrete to cure. The installation requirements for an expanding foam footing are the same as a concrete footing except for the diameter of the footing, which is smaller. It is important to make sure the expanding foam used meets MoDOT specifications as not all foam products are acceptable to support a breakaway sign. The downside to polyurethane foam footings is they must be replaced after the signpost is hit as the foam compresses and will no longer support the signpost properly.

The connection between the PSST posts and ~~the 7-gauge anchors varies based on the anchor gauge;~~ is accomplished using two shoulder bolts, one bolt installed through each side of the anchor. ~~Traditional PSST corner bolts cannot be used to connect a 12 gauge PSST to a 7 gauge anchor. The 12-gauge post does not nest tightly into a 7-gauge so corner bolts will not make a tight connection. The shoulder of the shoulder bolt passes through the holes in the 7-gauge anchor, but not through the holes in the post. These shoulders push and lock the post in two directions inside the anchor making a solid connection.~~

- ~~12-gauge anchor – The connection between a 12-gauge anchor and the PSST post is accomplished using a corner bolt. The corner bolt pulls the post into a corner of the anchor and eliminates any slack or play between the post and the anchor.~~
- ~~7-gauge anchor – The fit between a 7-gauge anchor and the PSST post is much looser and the radii of each do not match so a corner bolt will not eliminate the slack or play between these two devices. Shoulder bolts installed at 90-degree angles corrects this issue; the shoulder of the bolt will pass through the holes in the 7-gauge anchor, but not through the holes in the post. As a result, the two bolts push and lock the post in two directions making a solid connection.~~

Add-on breakaway devices – when breakaways are required/used, the manufacture's recommendations and hardware (if supplied) need to be used to connect the anchor, breakaway and post together. Breakaway devices are only required when installing a sign

on two 2.5" PSST posts. When surface mounting PSST to a concrete island, a surface mount breakaway device must be used.

<b>POST AND ANCHOR DATA TABLE</b>					
<b>POST</b>		<b>ANCHOR</b>		<b>BREAKAWAY REQUIRED</b>	
<b>GAUGE</b>	<b>SIZE</b>	<b>GAUGE</b>	<b>DIMENSIONS</b>	<b>1 POST</b>	<b>2 POSTS</b>
<u>12</u>	<u>2" x 2"</u>	<u>7</u>	<u>2.5" x 2.5" x 36"</u>	<u>NO</u>	<u>NO</u>
<u>12</u>	<u>2.5" x 2.5"</u>	<u>7</u>	<u>3 x 3 x 36"</u>	<u>NO</u>	<u>YES</u>

**\* TO BE USED WITH CONCRETE FOOTINGS OR IS AN OPTION IN ROCKY SOIL CONDITIONS**

<b>POST AND ANCHOR DATA TABLE</b>						
<b>POST</b>		<b>ANCHOR</b>		<b>BREAKAWAY REQUIRED</b>		
<b>GAUGE</b>	<b>SIZE</b>	<b>GAUGE</b>	<b>DIMENSIONS</b>	<b>NUMBER OF POSTS</b>		
				<b>4</b>	<b>2</b>	<b>3</b>
<u>12</u>	<u>2" x 2"</u>	<u>12</u>	<u>2.25" x 2.25" x 36"</u>	<u>NO</u>	<u>NO</u>	<u>YES</u>
		<u>7*</u>	<u>2.5" x 2.5" x 36"</u>	<u>NO</u>	<u>NO</u>	<u>YES</u>
<u>12</u>	<u>2.5" x 2.5"</u>	<u>7</u>	<u>3 x 3 x 36"</u>	<u>NO</u>	<u>YES</u>	<u>YES</u>
<u>12</u>	<u>(2.5"x2.5")+(2.25"x2.25")</u>	<u>7</u>	<u>3 x 3 x 36"</u>	<u>YES</u>	<u>YES</u>	<u>YES</u>

Breakaway aspects of PSST are a little more complicated compared to other MoDOT posts, the requirement for an add-on breakaway device heavily depends on the size and number of posts needed to support the sign. It is important to follow the guidance found in the signpost selection tools and MoDOT's standard plans to determine when an add-on breakaway device is required and when it is not. In applications where add-on breakaway devices are not required/used, PSST breaks away like a U-channel post in a yielding fashion, typically staying attached to the ground and lying down in front of the vehicle so the vehicle can pass over the assembly. However, when an add-on breakaway device is used the breakaway function changes and the assembly is designed to break away from the ground and permit the vehicle to pass under the airborne assembly.

**Standard.** If PSST posts are used, they shall be either 2 in. or 2.5 in. 12-gauge posts. The size and number of posts, as well as the requirement for add-on breakaway devices, shall be determined using the post selection ~~tools~~ tables. PSST posts shall be installed in accordance with Standard Plans 903. **PSST posts installed on freeways, expressways, and ramps any route other than a conventional two-lane road, shall be installed using concrete footings.**

**Guidance.** District operations should be consulted to determine the most appropriate footing for PSST posts alongside other roadways as footing requirements vary based on soil conditions.

#### **903.16.4.4.4 4-Inch Square Steel Tube Posts**

**Support.** 4-inch square steel tube posts, like PSST, are not a MoDOT design, but an industry standard post. MoDOT has adopted this post design for very specific applications where MoDOT standard posts are lacking. These applications include large flat sheet signs ranging in size from 48' x 60" to 48" by 96", exit gore signs, large keep right signs where divided roadways transition to

undivided roadways and community wayfinding signs. These posts were the first MASH tested and approved signposts and they have a greater capacity to support these larger signs on a single post compared to other MoDOT signposts.

**Standard.** If 4-Inch Square Steel Tube Posts are used, only those post designs and manufactures listed on the MoDOT Traffic Approved Products list shall be used. Only the signs listed previously shall ~~only~~ be installed on the 4-Inch Square Steel Tube post and shall only be installed as a single-post installation. The posts shall be assembled, and signs mounted, using the vendor specific hardware following the manufacture's recommendations and in accordance with MoDOT standard plans 903.03.

#### **903.16.4.4.5 Pipe Posts**

**History.** In 2022, a pipe post capacity evaluation was conducted that resulted in a change to the pipe post load capacity and pipe post inventory. Historically it was believed that pipe posts could support a sign size of up to 30 sq. ft. but the evaluation determined pipe posts could support a sign of up to 58.5 sq. ft. The evaluation also determined that the 3 sizes of pipe post being utilized were redundant. MoDOT historically used 2 ½ in., 3 in., and 4 in. pipe posts, however, the evaluation determined that the sign capacity of a post is determined by the breakaway assembly. The 2 ½ in. and 3 in. pipe posts used the same breakaway design and therefore the 3 in. pipe posts did not have any additional capacity over the 2 ½ in. post. As a result, the 3 in. post is redundant and was discontinued. This decision allows for a simplified inventory and eliminates confusion on pipe size. Maintenance can continue to utilize 3 in. pipe posts until the inventory is depleted but shall not order new 3 in. pipe posts. All existing 3 in. pipe posts shall be treated as 2 ½ in. posts for purposes of choosing posts using the post selection tables. 2 ½ in. pipe posts can be installed on existing 3 in. stubs.

**Support.** MoDOT utilizes two sizes of pipe post, 2 ½ in. and 4 in. An important fact to understand is pipe post sizes are based on the inside diameter (I.D.) of the pipe post and not the outside diameter, this is the industry standard for pipe measurement. This is critical in selecting the correct pipe from inventory as well as charging out the correct post to keep your inventory levels correct.

Pipe posts have a similar sign capacity as PSST, even though they would appear to be able to carry a larger sign load due to size and thickness of the steel pipe. While the post themselves are far stronger than PSST, it is the breakaway of the pipe post which controls the sign load capacity of the post. The heavy-duty construction of a pipe post is not specifically related to sign load capacity but is more directly related to the durability of the post. Unlike PSST, which must be replaced after each vehicular impact, pipe posts are constructed with much thicker steel so the signpost can be impacted by a vehicle without being damaged and reinstalled for continued use. There are many pipe posts on our right of way that have been there for two or three generations of signs and are still functional, so while they are heavier and more expensive initially, they are a ~~long-term~~long-term investment and are far more durable.

Pipe posts are used for single and double signpost assemblies to support signs up to 58.5 sq. ft. These posts are typically used on freeways and expressways where signs are larger, wind speeds can be higher due to more open right of way and the sign may see larger snow load impact from plows pushing more snow from across multiple lanes to the right side of the roadway.

Pipe posts are also the preferred post to support large route assemblies, especially on freeways and expressways. In the past, Wide-Flange-Beam posts were once used to support these assemblies (and many remain in place) as the design of the post was well suited to attaching a series of backing bars needed to support the assemblies. However, the multi-direction breakaway and high resistance

to torsional or twisting forces makes pipe posts the preferred post over the ~~Wide Flange I-Beam~~ design.

Pipe posts are designed and fabricated with the breakaway device as part of the post / stub combination; as long as the post and stub breakaway is assembled correctly the post is capable of being impacted from any direction. Details for the assembly of this post system are found in [Standard Plans 903](#), special attention must be paid to the placement of three breakaway bolts, the required and proper placement of all washers within the breakaway and most critically to the proper tightening and torque of the breakaway bolts.

**Standard.** If Pipe posts are used, they shall be either 2 ½ in. or 4 in. in size. The size and number of posts shall be determined using the post selection ~~tool~~[tables](#). Pipe posts shall be installed in accordance with [Standard Plans 903](#).

#### **903.16.4.4.5-6 ~~Wide Flange (I-Beam) Posts~~**

**Support.** MoDOT uses 6 sizes of ~~Wide Flange I-Beam~~ posts, commonly referred to as Design #1, #2, #3, #4, #5 and #6, increasing in size and capacity respectively. ~~I-Beam Wide Flange~~ posts are typically used to support signs ~~30-59 ft<sup>2</sup>-sq. ft.~~ and larger and are MoDOT's highest capacity ground-mount sign support. As with Pipe Posts, ~~I-Beam Wide Flange~~ post are designed to be a more durable post intended to last multiple generations of signs and designed to be able to be impacted by vehicle and then reassembled and reused.

~~I-Beam Wide Flange~~ posts are designed and used to support large structural signs, signs made using extruded aluminum panels instead of flat sheet aluminum. The cross section of an ~~I-Beam wide flange~~ post ~~being that of an I-beam~~ permits structure signs to be easily attached to the post using post clips or “dog clamps” instead of using traditional sign bolts. These posts are traditionally used on freeways and expressways only; however, there may be special applications where they may be used on two lane roadways if the size of the sign is too large for other post options.

~~I-Beam Wide Flange~~ posts were once the standard to support large route assemblies on freeways and expressways, however, over time two weaknesses were identified that changed this direction, making Pipe posts the better option. The two weaknesses of ~~I-Beam Wide Flange~~ posts used to support route assemblies are:

- Safety – Route assemblies ~~many times~~ are installed in and around intersections and in these locations ~~it is theoretically possible some assemblies they can be~~ could be impacted from any direction of travel. ~~Single I-Beam Wide Flange~~ posts are only breakaway ~~when hit from the front or the back in two directions~~ and are not ~~designed to be~~ breakaway if impacted on either side, ~~just the front and back of the sign~~. Pipe posts are designed as a multi-~~directional~~ breakaway post and can be impacted from any direction making them the better option for these installations.
- Torsional / Twisting Force Resistance – Although ~~I-Beam Wide Flange~~ posts are very strong, they do have a limited resistance to twisting moments when installed as a single post installation. In wind prone locations, sign assemblies on a single ~~Wide Flange I-Beam~~ post can begin to twist in the wind, and if this continues long enough, ~~it can cause~~ the post ~~to can~~ fatigue and break off at the base. Pipe posts ~~have an extreme~~ are very ~~resistant~~ resistance to twisting and can resist much larger torsional forces compared to ~~I-Beam wide flange~~ posts.

As with Pipe Posts, ~~I-Beam Wide Flange~~ posts are fabricated with the breakaway system as part of the post / stub assembly. While ~~I-Beam Wide Flange~~ posts have a breakaway assembly at ground level like Pipe posts, they also require a hinge system located directly below the sign. The hinge system permits the ~~I-Beam wide flange~~ post (the portion from the ground to the bottom of the sign) to swing up out of the way of a vehicle when impacted without the upper portion of the post and the

sign needing to move. This reduces the mass that a vehicle must move when it impacts the post and in return reduces the impact energy to the car.

Unlike all other MoDOT posts, there are minimum post spacing which must be taken into consideration when selecting the correct number and size of post. ~~I-Beam Wide Flange~~ Posts are much heavier than any other MoDOT post and hitting two of these posts at the same time in most cases would impart too much energy to the vehicle and would not meet minimum breakaway standards. These special considerations are included in [Standard Plans 903](#) which contains all of the fabrication and installation details for ~~I-Beam Wide Flange~~ Posts, however, due to their critical nature they are also listed here:

- ~~I-Beam Wide Flange~~ Post Designs #1 and #2 have no minimum post spacing requirements.
- ~~I-Beam Wide Flange~~ Post Designs #1 or #2 shall not be installed in three post configurations supporting signs less than 11 feet width.
- ~~I-Beam Wide Flange~~ Post Designs #3, #4, #5 and #6 shall be spaced at least 7 ft. apart.

The post selection ~~tool tables is~~are designed to utilize two post installations over three post installations to help address minimum post spacing; ~~it this~~ also reduces the number of footings which need to be constructed. However, there are some general rules based on sign size used to judge the number post for different size ranges of signs:

- Signs between 6 ft. and 17 ft. wide will typically be supported on two posts
- Signs wider than 17 ft. will typically be supported by three posts
- Signs of any size are not recommended to be installed on one ~~I-Beam Wide Flange~~ post

**Standard.** If ~~I-Beam Wide Flange~~ posts are used, they shall be either a structural #1, #2, #3, #4, #5 or #6 in design. The size and number of posts shall be determined using the post selection ~~tool tables~~. ~~I-Beam Wide Flange~~ posts shall be installed in accordance with [Standard Plans 903](#).

### 903.16.4.5 Secondary Sign Supports – Post Extensions

**Support.** ~~Post extensions These supports~~ are 3 in. aluminum I-Beams used to attach exit number panels to the top of, or to hang a secondary sign below, structural signs on new installations. Details of these posts are shown in the [Standard Plans 903](#).

**Option.** There are occasions where modifications and/or additions must be made to existing sign installations where the existing posts are not long enough to support the new sign assembly. In these cases, it is permissible to utilize secondary sign supports to effectively extend the primary signposts to support signs a maximum of 3 feet taller than the existing primary signposts.

Secondary sign supports may only be used to allow taller signs to be installed on existing signposts ~~and only~~ if the ~~existing~~ signposts ~~meet installation standards and~~ have the capacity to carry the larger sign based on signpost selection ~~tool tables~~.

If a new sign assembly is more than 3 ft taller than the existing primary signposts, new signposts shall be installed.

### 903.16.4.6 Backing Bars

**Support.** Backing bars are typically used to support and stiffen wide flat sheet signs mounted on single signpost or to help support the individual signs which make up sign assemblies to form one unified sign assembly. Details for backing bars can be found in [Standard Plans 903.02](#).

### **903.16.4.7 Flat Sheet Column Mounting Assembly**

**Support.** Flat sheet column mounting assemblies were developed as a method to securely fasten large flat sheet signs to bridge columns or overhead sign truss columns commonly found on freeways and expressways. Traditional banding methods typically are not sufficient to adequately attach large flat sheet signs to columns without the signs sliding down or spinning around the column in the wind. The column mounting assembly is made up of an aluminum C-channel which is banded to the column with a series of stainless-steel banding straps, providing a stronger point of contact with the structure. The sign is attached to the C-channel with aluminum backing bars. This sign attachment method is used for flat sheet signs 48" x 60" up to 48" x 96", and any additional supplemental plaques associated with these signs, as well as 48" x 48" diamond warning signs. Smaller flat sheet signs are mounted to these column structures using traditional banding methods.

**Guidance.** The flat sheet column mounting assembly should be used when attaching flat sheet signs of the sizes previously listed to bridge columns or sign truss columns to provide a secure sign attachment.

**Standard.** If used, the flat sheet column mounting assembly shall be constructed and installed according to standard plans 903.03. Signs installed using this method shall also meet sign mounting height standards found in standard plans 903.03. Signs shall not be attached to lighting structures or utility poles as these structures are not designed to support highway signs.

### **903.16.4.7-8 Breakaway Assemblies**

**Standard.** All signposts installed on right of way shall meet federal breakaway standards and MoDOT design standards. Signposts which do not meet current breakaway standards, but which did meet the breakaway standards at the time of their installation, may remain in place until the end of their service life.

Sign trusses and other large sign support structures that are not breakaway shall be protected by acceptable shielding, such as guard rail or barrier wall.

**Support.** 4 in. x 4 in. wood posts do not need any modification to be breakaway, however 4 in. x 6 in. ~~and 6 in. x 6 in.~~ wood posts will need to be cross drilled to meet breakaway standards. U-Channel posts do not require breakaway modifications if they are direct driven into the ground, however, if the ground stub and splice installation method is used the installation will need to be installed according to the Standard Plans 903 to meet breakaway requirements. PSST will require the addition of breakaway devices ~~added~~ in certain applications based on the post size sign and number of posts used for an installation. The signpost selection ~~tools tables~~ will indicate when a breakaway is required for PSST posts. 4" Square Steel, Pipe and Wide Flange Beam posts have the breakaway devices integrated into the post design.

Revised July 2026

# Non-Rectangular Sign and Sign Assembly Quick Reference Tables - PSST and Pipe Posts

Sign Image	Sign Assembly Description	Size	PSST	Pipe
	STOP	36 x 36	1 - 2"	1 - 2.5"
	STOP	48 x 48	1 - 2.5"	1 - 4"
	STOP ALL WAY	36 x 36 30 x 12	1 - 2"	1 - 2.5"
	STOP ALL WAY	48 x 48 30 x 12	2 - 2"	1 - 4"
	STOP CROSS TRAFFIC	36 x 36 24 X12	1 - 2"	1 - 2.5"
	STOP CROSS TRAFFIC	48 x 48 36 X 18	2 - 2"	1 - 4"
	ONE WAY	36 x 12	1 - 2"	1 - 2.5"
	STOP	36 x 36	1 - 2"	1 - 2.5"
	ONE WAY	48 x 18	2 - 2"	1 - 4"
	STOP	48 x 48	2 - 2"	1 - 4"
	STOP DIVIDED HIGHWAY	36 x 36 36 x 30	1 - 2.5"	1 - 4"
	STOP DIVIDED HIGHWAY	48 x 48 36 x 30	2 - 2.5"	1 - 4"
	ONE WAY	36 x 12	2 - 2"	1 - 4"
	STOP DIVIDED HIGHWAY	36 x 36 36 x 30	2 - 2"	1 - 4"
	ONE WAY	48 x 18	2 - 2.5"	1 - 4"
	STOP DIVIDED HIGHWAY	48 x 48 36 x 30	2 - 2.5"	1 - 4"

Sign Image	Sign Assembly Description	Size	PSST	Pipe
	ONE WAY	36 x 12	1 - 2"	1 - 2.5"
	ONE WAY	48 x 18	1 - 2"	1 - 2.5"
	YIELD	48 x 48	1 - 2"	1 - 2.5"
	YIELD	60 x 60	1 - 2.5"	1 - 4"
	ONE WAY	36 x 12	1 - 2.5"	1 - 4"
	YIELD	48 x 48	1 - 2.5"	1 - 4"
	ONE WAY	48 x 18	2 - 2.5"	1 - 4"
	YIELD	60 x 60	2 - 2.5"	1 - 4"
	YIELD	48 x 48	1 - 2.5"	1 - 4"
	TO ONCOMING TRAFFIC	36 x 30	1 - 2.5"	1 - 4"
	YIELD	60 x 60	2 - 2.5"	1 - 4"
	TO ONCOMING TRAFFIC	36 x 30	2 - 2.5"	1 - 4"
	Do Not Enter	36 x 36	1 - 2"	1 - 2.5"
	Do Not Enter	48 x 48	2 - 2"	1 - 4"
	Wrong Way	42 x 30	1 - 2.5"	1 - 2.5"
	Keep Right/Left	36 x 48	1 - 2"	1 - 2.5"
	Keep Right/Left	48 x 60	2 - 2"	1 - 4"
	Speed Limit	36 x 48	1 - 2.5"	1 - 2.5"
	Speed Limit	48 x 60	2 - 2.5"	1 - 4"
	Speed Limit / MIN	48 x 96	N/A*	1 - 4"
	All Bridge Posting Signs	36 x 48 / 36 x 42 36 x 42 / 36 x 60	1 - 2.5"	1 - 2.5"

Sign Image	Sign Assembly Description	Size	PSST	Pipe
	Warning (diamond)	36 x 36	1 - 2"	1 - 2.5"
	Warning (diamond)	48 x 48	2 - 2"	1 - 4"
	Warning (diamond)	36 x 36	1 - 2.5"	1 - 4"
	Supplemental Plaque	24 x 24	1 - 2.5"	1 - 4"
	Warning (diamond)	48 x 48	2 - 2.5"	1 - 4"
	Supplemental Plaque	30 x 30	2 - 2.5"	1 - 4"
	CROSS ROAD Warning	36 x 36	1 - 2.5"	1 - 2.5"
	Street Name	48 x 15	1 - 2.5"	1 - 2.5"
	CROSS ROAD Warning	48 x 48	2 - 2.5"	1 - 4"
	Street Name	60 x 24	2 - 2.5"	1 - 4"
	Chevron	18 x 24	1 - 2"	1 - 2.5"
	Chevron	30 x 36	1 - 2"	1 - 2.5"
	Arrow Board	48 x 24	1 - 2.5"	1 - 2.5"
	Arrow Board	72 x 36	2 - 2"	2 - 2.5"
	Arrow Board	48 x 24	1 - 2.5"	2 - 4"
	Advisory Speed	48 x 15	1 - 2.5"	2 - 4"
	Arrow Board	72 x 36	2 - 2.5"	2 - 4"
	Advisory Speed	72 x 24	2 - 2.5"	2 - 4"
	School	36 x 36	1 - 2"	1 - 2.5"
	School	36 x 36	1 - 2"	1 - 2.5"
	SCHOOL Plaque or AHEAD Plaque	36 x 12	1 - 2"	1 - 2.5"
	School	36 x 36	1 - 2"	1 - 2.5"
	45 Down Arrow	30 x 21	1 - 2"	1 - 2.5"
	Type 3 Object Marker	12 x 36	1 - 2"	N/A
	Double Down Arrow	30 x 30	1 - 2"	1 - 2.5"

Sign Image	Sign Assembly Description	Size	PSST	Pipe
	JCT Route Shield	21 x 15 24 x 24 or 30 x 24	1 - 2"	1 - 2.5"
	1 Cardinal Direction Route Shield Arrow	24 x 12 24 x 24 or 30 x 24 21 x 15	1 - 2"	1 - 2.5"
	2 Cardinal Directions 2 Route Shields 2 Arrows	24 x 12 24 x 24 or 30 x 24 21 x 15	1 - 2.5"	1 - 4"
	3 Cardinal Directions 3 Route Shields 3 Arrows	24 x 12 24 x 24 or 30 x 24 21 x 15	2 - 2.5"	1 - 4"
	4 Cardinal Directions 4 Route Shields 4 Arrows	24 x 12 24 x 24 or 30 x 24 21 x 15	N/A	1 - 4"
	ONE WAY 2 Cardinal Directions 2 Route Shields 2 Arrows	48 x 18 24 x 12 24 x 24 or 30 x 24 21 x 15	2 - 2.5"	1 - 4"
	1 Route Shield 1 Arrow	24 x 24 or 30 x 24 21 x 15	1 - 2"	1 - 2.5"
	2 Route Shields 2 Arrows	24 x 24 or 30 x 24 21 x 15	1 - 2.5"	1 - 2.5"
	3 Route Shields 3 Arrows	24 x 24 or 30 x 24 21 x 15	2 - 2.5"	1 - 4"
	4 Route Shields 4 Arrows	24 x 24 or 30 x 24 21 x 15	2 - 2.5"	1 - 4"
	Speed Limit City Limit	36 x 48 42 x 24 and narrower	1 - 2.5"	1 - 4"
	Speed Limit City Limit	36 x 48 48 x 24 to 72 x 36	2 - 2.5"	2 - 4"
	Speed Limit City Limit	48 x 60 All Sizes	N/A	2 - 4"

**Notes**

- See PSST and Pipe Post selection tables when selecting the proper posts for individual rectangular signs
- All 2 - 2.5" PSST installations require the addition of breakaway devices, indicated by yellow shaded boxes
- 2 - 2" PSST installations do not require breakaway devices, however, if these installations are installed using 2 - 2.5" PSST then breakaway devices shall be added, indicated by gray shaded boxes
- Pipe Posts are fabricated with breakaway devices, no additional breakaway features need to be added



# PSST Post Selection Tables

This table is for single, rectangular signs only, for sign assemblies and/or non-rectangular signs, see PSST Quick Reference Tables

## Post Selection Instructions

- Determine Sign Width and Height
- Identify the correct Sign Width Table
- Identify the correct Sign Height Row in that table
- Post Size is indicated in the Post Size Column
- In the Double Post tables, post size is shown with a single post size, but two posts are required
- Breakaways are only required for two 2.5" PSST post installations
- If post tables indicate two 2" posts, but two 2.5' posts are used instead, breakaways are required
- See Standard Plans 903.03 for PSST post installation details

## Single Post Installations

Sign Width	Sign Height	Post Size	Sign Width	Sign Height	Post Size	Sign Width	Sign Height	Post Size	Sign Width	Sign Height	Post Size	Sign Width	Sign Height	Post Size	Sign Width	Sign Height	Post Size	Sign Width	Sign Height	Post Size
1	1 or less	2"	1.5	1 or less	2"	2	1	2"	2.5	1	2"	3	1	2"	3.5	1	2"	4	1	2"
1	1.5	2"	1.5	1.5	2"	2	1.5	2"	2.5	1.5	2"	3	1.5	2"	3.5	1.5	2"	4	1.5	2"
1	2	2"	1.5	2	2"	2	2	2"	2.5	2	2"	3	2	2"	3.5	2	2"	4	2	2"
1	2.5	2"	1.5	2.5	2"	2	2.5	2"	2.5	2.5	2"	3	2.5	2"	3.5	2.5	2.5"	4	2.5	2"
1	3	2"	1.5	3	2"	2	3	2"	2.5	3	2"	3	3	2.5"	3.5	3	2.5"	4	3	2"
1	3.5	2"	1.5	3.5	2"	2	3.5	2"	2.5	3.5	2.5"	3	3.5	2.5"	3.5	3.5	2.5"	4	3.5	
1	4	2"	1.5	4	2"	2	4	2.5"	2.5	4	2.5"	3	4	2.5"	3.5	4	2.5"	4	4	See Double Post Installation Table Below
1	4.5	2"	1.5	4.5	2"	2	4.5	2.5"	2.5	4.5	2.5"	3	4.5	2.5"	3.5	4.5	2.5"	4	4.5	
1	5	2"	1.5	5	2.5"	2	5	2.5"	2.5	5	2.5"	3	5	2.5"	3.5	5		4	5	

Pipe Post Required 

## Double Post Installations

Sign Width	Sign Height	Post Size	Sign Width	Sign Height	Post Size	Sign Width	Sign Height	Post Size	Sign Width	Sign Height	Post Size	Sign Width	Sign Height	Post Size	Sign Width	Sign Height	Post Size
4	1	See Single Post Table Above	4.5	1	2"	5	1	2"	5.5	1	2"	6	1	2"	6.5	1	2"
4	1.5		4.5	1.5	2"	5	1.5	2"	5.5	1.5	2"	6	1.5	2"	6.5	1.5	2"
4	2		4.5	2	2"	5	2	2"	5.5	2	2"	6	2	2"	6.5	2	2"
4	2.5		4.5	2.5	2"	5	2.5	2"	5.5	2.5	2"	6	2.5	2"	6.5	2.5	2.5"
4	3		4.5	3	2"	5	3	2"	5.5	3	2.5"	6	3	2.5"	6.5	3	2.5"
4	3.5	2"	4.5	3.5	2.5"	5	3.5	2.5"	5.5	3.5	2.5"	6	3.5	2.5"	6.5	3.5	2.5"
4	4	2.5"	4.5	4	2.5"	5	4	2.5"	5.5	4	2.5"	6	4	2.5"	6.5	4	
4	4.5	2.5"	4.5	4.5	2.5"	5	4.5	2.5"	5.5	4.5		6	4.5		6.5	4.5	
4	5	2.5"	4.5	5	2.5"	5	5		5.5	5		6	5		6.5	5	
4	5.5	2.5"	4.5	5.5		5	5.5		5.5	5.5		6	5.5		6.5	5.5	

width	height	Post Size	width	height	Post Size	width	height	Post Size
7	1	2"	7.5	1	2"	8	1	2"
7	1.5	2"	7.5	1.5	2"	8	1.5	2"
7	2	2"	7.5	2	2"	8	2	2"
7	2.5	2.5"	7.5	2.5	2.5"	8	2.5	2.5"
7	3	2.5"	7.5	3	2.5"	8	3	2.5"
7	3.5	2.5"	7.5	3.5		8	3.5	
7	4	2.5"	7.5	4		8	4	

Breakaways Required 

Pipe Post Required 

# Pipe Post Selection Tables

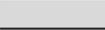
This table is for single, rectangular signs only, for sign assemblies and/or non rectangular signs see PSST Quick Reference Tables

### Post Selection Instructions

- Determine the Width and Height of Sign
- Find the appropriate table for Sign Width
- Find the appropriate row in that table for the Sign Height
- Read the Number and Size of post for that size of sign in that row

### Pipe Post Notes

- Max sign width on one pipe post = 4 ft
- Max sign width on two pipe posts = 10 ft
- Max sign sqft on pipe post = 58.5 sqft
- Pipe post size = inside pipe diameter

 For sign sizes with the number of posts and post sizes grayed out, use I-Beam Posts

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST SIZE
1	1	1	2 1/2
1	1 1/2	1	2 1/2
1	2	1	2 1/2
1	2 1/2	1	2 1/2
1	3	1	2 1/2
1	3 1/2	1	2 1/2
1	4	1	2 1/2
1	4 1/2	1	2 1/2
1	5	1	2 1/2
1	5 1/2	1	2 1/2
1	6	1	2 1/2
1	6 1/2	1	2 1/2
1	7	1	2 1/2
1	7 1/2	1	2 1/2
1	8	1	2 1/2
1	8 1/2	1	2 1/2
1	9	1	2 1/2
1	9 1/2	1	2 1/2
1	10	1	2 1/2

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST SIZE
2	1	1	2 1/2
2	1 1/2	1	2 1/2
2	2	1	2 1/2
2	2 1/2	1	2 1/2
2	3	1	2 1/2
2	3 1/2	1	2 1/2
2	4	1	2 1/2
2	4 1/2	1	2 1/2
2	5	1	2 1/2
2	5 1/2	1	2 1/2
2	6	1	2 1/2
2	6 1/2	1	2 1/2
2	7	1	2 1/2
2	7 1/2	1	4
2	8	1	4
2	8 1/2	1	4
2	9	1	4
2	9 1/2	1	4
2	10	1	4

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST SIZE
3	1	1	2 1/2
3	1 1/2	1	2 1/2
3	2	1	2 1/2
3	2 1/2	1	2 1/2
3	3	1	2 1/2
3	3 1/2	1	2 1/2
3	4	1	2 1/2
3	4 1/2	1	2 1/2
3	5	1	4
3	5 1/2	1	4
3	6	1	4
3	6 1/2	1	4
3	7	1	4
3	7 1/2	1	4
3	8	1	4
3	8 1/2	1	4
3	9	1	4
3	9 1/2	1	4
3	10		N/A

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST SIZE
4	1	1	2 1/2
4	1 1/2	1	2 1/2
4	2	1	2 1/2
4	2 1/2	1	2 1/2
4	3	1	2 1/2
4	3 1/2	1	2 1/2
4	4	1	4
4	4 1/2	1	4
4	5	1	4
4	5 1/2	1	4
4	6	1	4
4	6 1/2	1	4
4	7	1	4
4	7 1/2	1	4
4	8	1	4
4	8 1/2	2	4
4	9	2	4
4	9 1/2	2	4
4	10	2	4

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST SIZE
5	1	2	2 1/2
5	1 1/2	2	2 1/2
5	2	2	2 1/2
5	2 1/2	2	2 1/2
5	3	2	4
5	3 1/2	2	4
5	4	2	4
5	4 1/2	2	4
5	5	2	4
5	5 1/2	2	4
5	6	2	4
5	6 1/2	2	4
5	7	2	4
5	7 1/2	2	4
5	8	2	4
5	8 1/2	2	4
5	9	2	4
5	9 1/2	2	4
5	10	2	4

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST SIZE
6	1	2	2 1/2
6	1 1/2	2	2 1/2
6	2	2	2 1/2
6	2 1/2	2	4
6	3	2	4
6	3 1/2	2	4
6	4	2	4
6	4 1/2	2	4
6	5	2	4
6	5 1/2	2	4
6	6	2	4
6	6 1/2	2	4
6	7	2	4
6	7 1/2	2	4
6	8	2	4
6	8 1/2	2	4
6	9	2	4
6	9 1/2	2	4
6	10		See I-Beam Tables

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST SIZE
7	1	2	2 1/2
7	1 1/2	2	2 1/2
7	2	2	2 1/2
7	2 1/2	2	4
7	3	2	4
7	3 1/2	2	4
7	4	2	4
7	4 1/2	2	4
7	5	2	4
7	5 1/2	2	4
7	6	2	4
7	6 1/2	2	4
7	7	2	4
7	7 1/2	2	4
7	8	2	4
7	8 1/2		See I-Beam Tables
7	9		
7	9 1/2		
7	10		

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST SIZE
8	1	2	2 1/2
8	1 1/2	2	2 1/2
8	2	2	4
8	2 1/2	2	4
8	3	2	4
8	3 1/2	2	4
8	4	2	4
8	4 1/2	2	4
8	5	2	4
8	5 1/2	2	4
8	6	2	4
8	6 1/2	2	4
8	7		See I-Beam Tables
8	7 1/2		
8	8		
8	8 1/2		
8	9		
8	9 1/2		
8	10		

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST SIZE
9	1	2	2 1/2
9	1 1/2	2	2 1/2
9	2	2	4
9	2 1/2	2	4
9	3	2	4
9	3 1/2	2	4
9	4	2	4
9	4 1/2	2	4
9	5	2	4
9	5 1/2	2	4
9	6	2	4
9	6 1/2	2	4
9	7		See I-Beam Tables
9	7 1/2		
9	8		
9	8 1/2		
9	9		
9	9 1/2		
9	10		

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST SIZE
10	1	2	2 1/2
10	1 1/2	2	4
10	2	2	4
10	2 1/2	2	4
10	3	2	4
10	3 1/2	2	4
10	4	2	4
10	4 1/2	2	4
10	5	2	4
10	5 1/2	2	4
10	6		See I-Beam Tables
10	6 1/2		
10	7		
10	7 1/2		
10	8		
10	8 1/2		
10	9		
10	9 1/2		
10	10		

REVISED JULY 2026

# U-Channel / Wood Post Selection Table

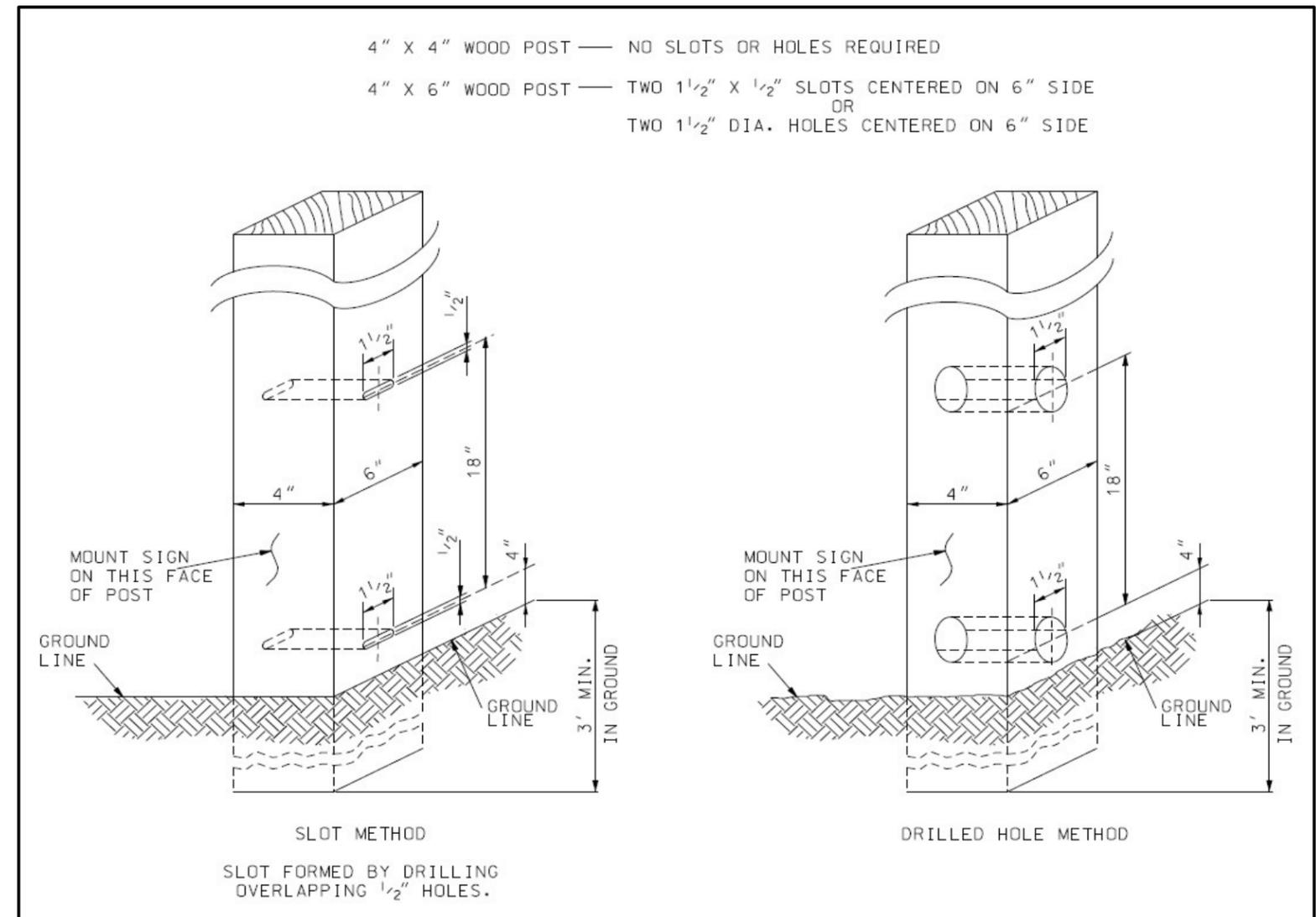
Sign Size sqft	U-Channel 3 lb / ft	Wood	
		4 x 4	4 x 6
≤ 10	1	1	
> 10 and ≤ 16	2	2	1
> 16 and ≤ 24	2		2
> 24 and ≤ 30	3		2

## Notes:

- Signs 4 feet wide or wider require 2 posts.
- Signs shall always be mounted on the 4-inch face of a 4 x 6 wood post.
- When 4 x 6 post are used they must be cross drilled per figure to the right
- See Standard Plans 903.03 for post installation details

## Use of table

- Determine Sign Height and Width
- Calculate Sign Area = Sign Height X Sign Width
- Identify the correct row under the Sign Size sqft column the calculated Sign Area falls within
- Identify the available post options in that row
- Signs 4 feet wide or wider cannot be installed on one post, in these cases choose the two post option



REVISED JULY 2026

# 4" Square Steel Tube Post

Only Used in Single Post Applications

## This post is only used to support:

- 48" x 60" up to 48" x 96" Flat Sheet Signs
- Gore Exit Signs
- 84" x 96" KEEP RIGHT Gore signs
- Community Wayfinding Signs installed by Cities on MoDOT Right of Way



# I-Beam Post Selection Tables

## Post Selection Instructions

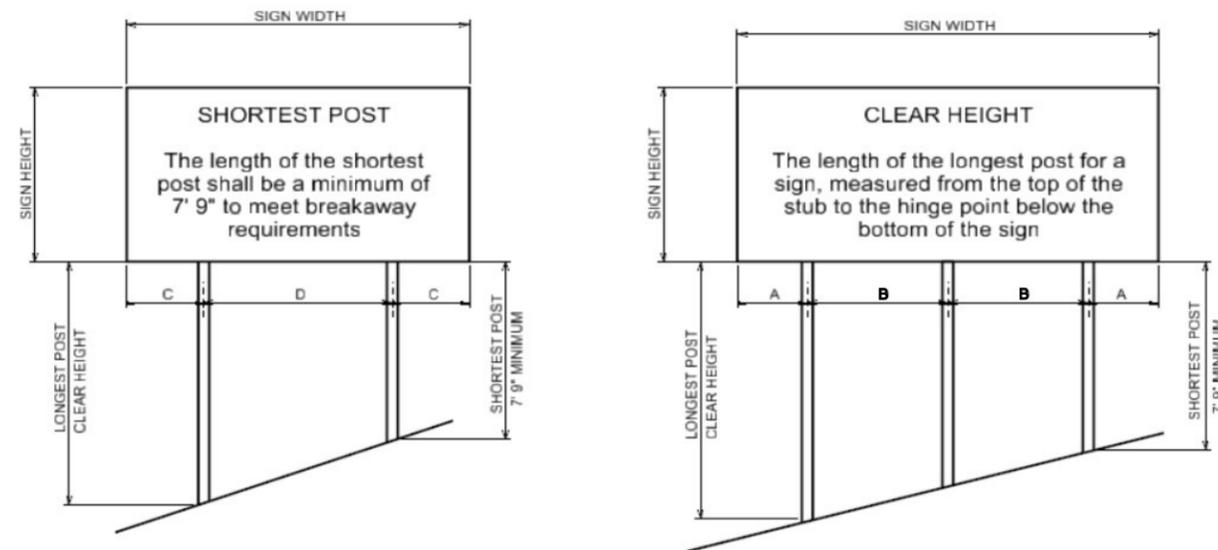
- 1- Determine Width and Height of the sign being installed
  - 2 - The sign location needs to be inspected to determine the length of the posts needed to support the sign with the proper offset and mounting height
  - 3 - Identify the length of the longest post that will support the sign, this is the CLEAR HEIGHT measurement that is required to select the appropriate set of post tables to use  
**- USING THE CORRECT CLEAR HEIGHT TABLES IS CRITICAL TO PROPER POST SELECTION -**
  - 4 - Locate the appropriate set of Clear Height Tables in this document for the installation
  - 5 - Locate the Sign Width table within the proper Clear Height table
  - 6 - Locate the Sign Height within the appropriate Sign Width table
  - 7 - Identify the Post Size and Post Spacing from the appropriate Sign Width / Sign Height row in the table
- Sign sizes with dimensions in the "C" and "D" post spacing columns are Two Post Installations

## I-Beam Post Notes:

- For multiple signs installed on one set of posts, use overall sign height and sign width of the combined sign assembly to choose the correct post size
- Include exit number panels in the sign height
- For sign heights in 6" increments, round up to the next full foot sign height in the table
- Use post spacings in table to meet MoDOT standards for I-Beam Post installations
- See Standard Plan 903.03 for I-Beam installation details and standards

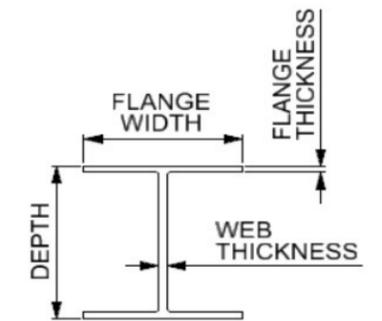
## Clear Height Ranges in these Tables

- Up to 12 feet
- Greater than 12 feet up to 16 feet
- Greater than 16 feet up to 24 feet



Two Post Installation Post Spacing  
Three Post Installation Post Spacing

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
17	3	2	#1	3' 5"	10' 2"	-	-
17	4	2	#1	3' 5"	10' 2"	-	-
17	5	2	#2	3' 5"	10' 2"	-	-
17	6	2	#2	3' 5"	10' 2"	-	-
17	7	2	#2	3' 5"	10' 2"	-	-
17	8	2	#3	3' 5"	10' 2"	-	-
17	9	2	#3	3' 5"	10' 2"	-	-
17	10	2	#4	3' 5"	10' 2"	-	-
17	11	2	#4	3' 5"	10' 2"	-	-
17	12	2	#4	3' 5"	10' 2"	-	-
17	13	2	#5	3' 5"	10' 2"	-	-
17	14	2	#5	3' 5"	10' 2"	-	-
17	15	2	#6	3' 5"	10' 2"	-	-
17	16	2	#6	3' 5"	10' 2"	-	-
17	17	2	#6	3' 5"	10' 2"	-	-
17	18	3	#6	-	-	1' 6"	7' 0"
17	19	3	#6	-	-	1' 6"	7' 0"
17	20	3	#6	-	-	1' 6"	7' 0"



POST DESIGN	NOM. SIZE (in.) (lbs/ft)	DEPTH (in.)	FLANGE		WEB THICK (in.)
			WIDTH (in.)	THICK (in.)	
#1	W6x9	5 7/8	4	3/16	3/16
#2	W6x15	6	6	1/4	1/4
#3	W8x18	8 1/8	5 1/4	5/16	1/4
#4	W10x22	10 1/8	5 3/4	3/8	1/4
#5	W10x26	10 3/8	5 3/4	7/16	1/4
#6	W12x35	12 1/4	6 1/2	3/8	1/4

# Clear Heights - Up to 12 Feet

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
7	3	2	#1	1' 5"	4' 2"	-	-
7	4	2	#1	1' 5"	4' 2"	-	-
7	5	2	#1	1' 5"	4' 2"	-	-
7	6	2	#1	1' 5"	4' 2"	-	-
7	7	2	#1	1' 5"	4' 2"	-	-
7	8	2	#2	1' 5"	4' 2"	-	-
7	9	2	#2	1' 5"	4' 2"	-	-
7	10	2	#2	1' 5"	4' 2"	-	-
7	11	2	#2	1' 5"	4' 2"	-	-
7	12	2	#2	1' 5"	4' 2"	-	-
7	13	2	#2	1' 5"	4' 2"	-	-
7	14						
7	15						
7	16						
7	17						
7	18						
7	19						
7	20						

Signs in this range are too narrow to achieve the required posts spacings necessary for #3 through #6 sign post to meet breakaway standards. The sign width needs to be increased to 10 feet.

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
8	3	2	#1	1' 7"	4' 10"	-	-
8	4	2	#1	1' 7"	4' 10"	-	-
8	5	2	#1	1' 7"	4' 10"	-	-
8	6	2	#1	1' 7"	4' 10"	-	-
8	7	2	#1	1' 7"	4' 10"	-	-
8	8	2	#2	1' 7"	4' 10"	-	-
8	9	2	#2	1' 7"	4' 10"	-	-
8	10	2	#2	1' 7"	4' 10"	-	-
8	11	2	#2	1' 7"	4' 10"	-	-
8	12	2	#2	1' 7"	4' 10"	-	-
8	13	2	#2	1' 7"	4' 10"	-	-
8	14						
8	15						
8	16						
8	17						
8	18						
8	19						
8	20						

Signs in this range are too narrow to achieve the required posts spacings necessary for #3 through #6 sign post to meet breakaway standards. The sign width needs to be increased to 10 feet.

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
9	3	2	#1	1' 10"	5' 4"	-	-
9	4	2	#1	1' 10"	5' 4"	-	-
9	5	2	#1	1' 10"	5' 4"	-	-
9	6	2	#1	1' 10"	5' 4"	-	-
9	7	2	#1	1' 10"	5' 4"	-	-
9	8	2	#2	1' 10"	5' 4"	-	-
9	9	2	#2	1' 10"	5' 4"	-	-
9	10	2	#2	1' 10"	5' 4"	-	-
9	11	2	#2	1' 10"	5' 4"	-	-
9	12	2	#2	1' 10"	5' 4"	-	-
9	13						
9	14						
9	15						
9	16						
9	17						
9	18						
9	19						
9	20						

Signs in this range are too narrow to achieve the required posts spacings necessary for #3 through #6 sign post to meet breakaway standards. The sign width needs to be increased to 10 feet.

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
10	3	2	#1	2' 0"	6' 0"	-	-
10	4	2	#1	2' 0"	6' 0"	-	-
10	5	2	#1	2' 0"	6' 0"	-	-
10	6	2	#1	2' 0"	6' 0"	-	-
10	7	2	#2	2' 0"	6' 0"	-	-
10	8	2	#2	2' 0"	6' 0"	-	-
10	9	2	#2	2' 0"	6' 0"	-	-
10	10	2	#2	2' 0"	6' 0"	-	-
10	11	2	#2	2' 0"	6' 0"	-	-
10	12	2	#3	1' 6"	7' 0"	-	-
10	13	2	#4	1' 6"	7' 0"	-	-
10	14	2	#4	1' 6"	7' 0"	-	-
10	15	2	#4	1' 6"	7' 0"	-	-
10	16	2	#4	1' 6"	7' 0"	-	-
10	17	2	#5	1' 6"	7' 0"	-	-
10	18	2	#5	1' 6"	7' 0"	-	-
10	19	2	#5	1' 6"	7' 0"	-	-
10	20	2	#6	1' 6"	7' 0"	-	-

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
11	3	2	#1	2' 2"	6' 8"	-	-
11	4	2	#1	2' 2"	6' 8"	-	-
11	5	2	#1	2' 2"	6' 8"	-	-
11	6	2	#1	2' 2"	6' 8"	-	-
11	7	2	#2	2' 2"	6' 8"	-	-
11	8	2	#2	2' 2"	6' 8"	-	-
11	9	2	#2	2' 2"	6' 8"	-	-
11	10	2	#2	2' 2"	6' 8"	-	-
11	11	2	#3	2' 0"	7' 0"	-	-
11	12	2	#3	2' 0"	7' 0"	-	-
11	13	2	#4	2' 0"	7' 0"	-	-
11	14	2	#4	2' 0"	7' 0"	-	-
11	15	2	#4	2' 0"	7' 0"	-	-
11	16	2	#4	2' 0"	7' 0"	-	-
11	17	2	#5	2' 0"	7' 0"	-	-
11	18	2	#5	2' 0"	7' 0"	-	-
11	19	2	#5	2' 0"	7' 0"	-	-
11	20	2	#6	2' 0"	7' 0"	-	-

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
12	3	2	#1	2' 5"	7' 2"	-	-
12	4	2	#1	2' 5"	7' 2"	-	-
12	5	2	#1	2' 5"	7' 2"	-	-
12	6	2	#1	2' 5"	7' 2"	-	-
12	7	2	#2	2' 5"	7' 2"	-	-
12	8	2	#2	2' 5"	7' 2"	-	-
12	9	2	#2	2' 5"	7' 2"	-	-
12	10	2	#3	2' 5"	7' 2"	-	-
12	11	2	#3	2' 5"	7' 2"	-	-
12	12	2	#3	2' 5"	7' 2"	-	-
12	13	2	#4	2' 5"	7' 2"	-	-
12	14	2	#4	2' 5"	7' 2"	-	-
12	15	2	#4	2' 5"	7' 2"	-	-
12	16	2	#4	2' 5"	7' 2"	-	-
12	17	2	#5	2' 5"	7' 2"	-	-
12	18	2	#5	2' 5"	7' 2"	-	-
12	19	2	#5	2' 5"	7' 2"	-	-
12	20	2	#6	2' 5"	7' 2"	-	-

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
13	3	2	#1	2' 7"	7' 10"	-	-
13	4	2	#1	2' 7"	7' 10"	-	-
13	5	2	#1	2' 7"	7' 10"	-	-
13	6	2	#2	2' 7"	7' 10"	-	-
13	7	2	#2	2' 7"	7' 10"	-	-
13	8	2	#2	2' 7"	7' 10"	-	-
13	9	2	#2	2' 7"	7' 10"	-	-
13	10	2	#3	2' 7"	7' 10"	-	-
13	11	2	#3	2' 7"	7' 10"	-	-
13	12	2	#4	2' 7"	7' 10"	-	-
13	13	2	#4	2' 7"	7' 10"	-	-
13	14	2	#4	2' 7"	7' 10"	-	-
13	15	2	#4	2' 7"	7' 10"	-	-
13	16	2	#5	2' 7"	7' 10"	-	-
13	17	2	#5	2' 7"	7' 10"	-	-
13	18	2	#5	2' 7"	7' 10"	-	-
13	19	2	#6	2' 7"	7' 10"	-	-
13	20	2	#6	2' 7"	7' 10"	-	-

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
14	3	2	#1	2' 10"	8' 4"	-	-
14	4	2	#1	2' 10"	8' 4"	-	-
14	5	2	#1	2' 10"	8' 4"	-	-
14	6	2	#2	2' 10"	8' 4"	-	-
14	7	2	#2	2' 10"	8' 4"	-	-
14	8	2	#2	2' 10"	8' 4"	-	-
14	9	2	#3	2' 10"	8' 4"	-	-
14	10	2	#3	2' 10"	8' 4"	-	-
14	11	2	#4	2' 10"	8' 4"	-	-
14	12	2	#4	2' 10"	8' 4"	-	-
14	13	2	#4	2' 10"	8' 4"	-	-
14	14	2	#4	2' 10"	8' 4"	-	-
14	15	2	#5	2' 10"	8' 4"	-	-
14	16	2	#5	2' 10"	8' 4"	-	-
14	17	2	#5	2' 10"	8' 4"	-	-
14	18	2	#6	2' 10"	8' 4"	-	-
14	19	2	#6	2' 10"	8' 4"	-	-
14	20	2	#6	2' 10"	8' 4"	-	-

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
15	3	2	#1	3' 0"	9' 0"	-	-
15	4	2	#1	3' 0"	9' 0"	-	-
15	5	2	#1	3' 0"	9' 0"	-	-
15	6	2	#2	3' 0"	9' 0"	-	-
15	7	2	#2	3' 0"	9' 0"	-	-
15	8	2	#2	3' 0"	9' 0"	-	-
15	9	2	#3	3' 0"	9' 0"	-	-
15	10	2	#3	3' 0"	9' 0"	-	-
15	11	2	#4	3' 0"	9' 0"	-	-
15	12	2	#4	3' 0"	9' 0"	-	-
15	13	2	#4	3' 0"	9' 0"	-	-
15	14	2	#4	3' 0"	9' 0"	-	-
15	15	2	#5	3' 0"	9' 0"	-	-
15	16	2	#5	3' 0"	9' 0"	-	-
15	17	2	#6	3' 0"	9' 0"	-	-
15	18	2	#6	3' 0"	9' 0"	-	-
15	19	2	#6	3' 0"	9' 0"	-	-
15	20	3	#6	-	-	0' 6"	7' 0"

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
16	3	2	#1	3' 2"	9' 8"	-	-
16	4	2	#1	3' 2"	9' 8"	-	-
16	5	2	#1	3' 2"	9' 8"	-	-
16	6	2	#2	3' 2"	9' 8"	-	-
16	7	2	#2	3' 2"	9' 8"	-	-
16	8	2	#3	3' 2"	9' 8"	-	-
16	9	2	#3	3' 2"	9' 8"	-	-
16	10	2	#4	3' 2"	9' 8"	-	-
16	11	2	#4	3' 2"	9' 8"	-	-
16	12	2	#4	3' 2"	9' 8"	-	-
16	13	2	#4	3' 2"	9' 8"	-	-
16	14	2	#5	3' 2"	9' 8"	-	-
16	15	2	#5	3' 2"	9' 8"	-	-
16	16	2	#6	3' 2"	9' 8"	-	-
16	17	2	#6	3' 2"	9' 8"	-	-
16	18	2	#6	3' 2"	9' 8"	-	-
16	19	3	#6	-	-	1' 0"	7' 0"
16	20	3	#6	-	-	1' 0"	7' 0"

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
17	3	2	#1	3' 5"	10' 2"	-	-
17	4	2	#1	3' 5"	10' 2"	-	-
17	5	2	#2				

# Clear Heights - Greater Than 12 Feet up to 16 Feet

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
7	3	2	#1	1' 5"	4' 2"	-	-
7	4	2	#1	1' 5"	4' 2"	-	-
7	5	2	#2	1' 5"	4' 2"	-	-
7	6	2	#2	1' 5"	4' 2"	-	-
7	7	2	#2	1' 5"	4' 2"	-	-
7	8						
7	9						
7	10						
7	11						
7	12						
7	13						
7	14						
7	15						
7	16						
7	17						
7	18						
7	19						
7	20						

Signs in this range are too narrow to achieve the required posts spacings necessary for #3 through #6 sign post to meet breakaway standards. The sign width needs to be increased to 10 feet.

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
8	3	2	#1	1' 7"	4' 10"	-	-
8	4	2	#1	1' 7"	4' 10"	-	-
8	5	2	#2	1' 7"	4' 10"	-	-
8	6	2	#2	1' 7"	4' 10"	-	-
8	7	2	#2	1' 7"	4' 10"	-	-
8	8	2					
8	9	2					
8	10	2					
8	11	2					
8	12	2					
8	13	2					
8	14	2					
8	15	2					
8	16	2					
8	17	2					
8	18	2					
8	19	2					
8	20	2					

Signs in this range are too narrow to achieve the required posts spacings necessary for #3 through #6 sign post to meet breakaway standards. The sign width needs to be increased to 10 feet.

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
9	3	2	#1	1' 10"	5' 4"	-	-
9	4	2	#1	1' 10"	5' 4"	-	-
9	5	2	#2	1' 10"	5' 4"	-	-
9	6	2	#2	1' 10"	5' 4"	-	-
9	7	2	#2	1' 10"	5' 4"	-	-
9	8	2					
9	9	2					
9	10	2					
9	11	2					
9	12	2					
9	13	2					
9	14	2					
9	15	2					
9	16	2					
9	17	2					
9	18	2					
9	19	2					
9	20	2					

Signs in this range are too narrow to achieve the required posts spacings necessary for #3 through #6 sign post to meet breakaway standards. The sign width needs to be increased to 10 feet.

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
10	3	2	#1	2' 0"	6' 0"	-	-
10	4	2	#1	2' 0"	6' 0"	-	-
10	5	2	#2	2' 0"	6' 0"	-	-
10	6	2	#2	2' 0"	6' 0"	-	-
10	7	2	#2	2' 0"	6' 0"	-	-
10	8	2	#3	1' 6"	7' 0"	-	-
10	9	2	#3	1' 6"	7' 0"	-	-
10	10	2	#3	1' 6"	7' 0"	-	-
10	11	2	#4	1' 6"	7' 0"	-	-
10	12	2	#4	1' 6"	7' 0"	-	-
10	13	2	#4	1' 6"	7' 0"	-	-
10	14	2	#4	1' 6"	7' 0"	-	-
10	15	2	#5	1' 6"	7' 0"	-	-
10	16	2	#5	1' 6"	7' 0"	-	-
10	17	2	#5	1' 6"	7' 0"	-	-
10	18	2	#6	1' 6"	7' 0"	-	-
10	19	2	#6	1' 6"	7' 0"	-	-
10	20	2	#6	1' 6"	7' 0"	-	-

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
11	3	2	#1	2' 2"	6' 8"	-	-
11	4	2	#1	2' 2"	6' 8"	-	-
11	5	2	#2	2' 2"	6' 8"	-	-
11	6	2	#2	2' 2"	6' 8"	-	-
11	7	2	#2	2' 2"	6' 8"	-	-
11	8	2	#3	2' 0"	7' 0"	-	-
11	9	2	#3	2' 0"	7' 0"	-	-
11	10	2	#3	2' 0"	7' 0"	-	-
11	11	2	#4	2' 0"	7' 0"	-	-
11	12	2	#4	2' 0"	7' 0"	-	-
11	13	2	#4	2' 0"	7' 0"	-	-
11	14	2	#4	2' 0"	7' 0"	-	-
11	15	2	#5	2' 0"	7' 0"	-	-
11	16	2	#5	2' 0"	7' 0"	-	-
11	17	2	#5	2' 0"	7' 0"	-	-
11	18	2	#6	2' 0"	7' 0"	-	-
11	19	2	#6	2' 0"	7' 0"	-	-
11	20	2	#6	2' 0"	7' 0"	-	-

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
12	3	2	#1	2' 5"	7' 2"	-	-
12	4	2	#1	2' 5"	7' 2"	-	-
12	5	2	#2	2' 5"	7' 2"	-	-
12	6	2	#2	2' 5"	7' 2"	-	-
12	7	2	#2	2' 5"	7' 2"	-	-
12	8	2	#3	2' 5"	7' 2"	-	-
12	9	2	#3	2' 5"	7' 2"	-	-
12	10	2	#3	2' 5"	7' 2"	-	-
12	11	2	#4	2' 5"	7' 2"	-	-
12	12	2	#4	2' 5"	7' 2"	-	-
12	13	2	#4	2' 5"	7' 2"	-	-
12	14	2	#4	2' 5"	7' 2"	-	-
12	15	2	#5	2' 5"	7' 2"	-	-
12	16	2	#5	2' 5"	7' 2"	-	-
12	17	2	#5	2' 5"	7' 2"	-	-
12	18	2	#6	2' 5"	7' 2"	-	-
12	19	2	#6	2' 5"	7' 2"	-	-
12	20	2	#6	2' 5"	7' 2"	-	-

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
13	3	2	#1	2' 7"	7' 10"	-	-
13	4	2	#2	2' 7"	7' 10"	-	-
13	5	2	#2	2' 7"	7' 10"	-	-
13	6	2	#2	2' 7"	7' 10"	-	-
13	7	2	#2	2' 7"	7' 10"	-	-
13	8	2	#3	2' 7"	7' 10"	-	-
13	9	2	#3	2' 7"	7' 10"	-	-
13	10	2	#4	2' 7"	7' 10"	-	-
13	11	2	#4	2' 7"	7' 10"	-	-
13	12	2	#4	2' 7"	7' 10"	-	-
13	13	2	#4	2' 7"	7' 10"	-	-
13	14	2	#5	2' 7"	7' 10"	-	-
13	15	2	#5	2' 7"	7' 10"	-	-
13	16	2	#5	2' 7"	7' 10"	-	-
13	17	2	#6	2' 7"	7' 10"	-	-
13	18	2	#6	2' 7"	7' 10"	-	-
13	19	2	#6	2' 7"	7' 10"	-	-
13	20						

Size Exceeds Capacity of I-Beam Post

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
14	3	2	#1	2' 10"	8' 4"	-	-
14	4	2	#2	2' 10"	8' 4"	-	-
14	5	2	#2	2' 10"	8' 4"	-	-
14	6	2	#2	2' 10"	8' 4"	-	-
14	7	2	#3	2' 10"	8' 4"	-	-
14	8	2	#3	2' 10"	8' 4"	-	-
14	9	2	#3	2' 10"	8' 4"	-	-
14	10	2	#4	2' 10"	8' 4"	-	-
14	11	2	#4	2' 10"	8' 4"	-	-
14	12	2	#4	2' 10"	8' 4"	-	-
14	13	2	#5	2' 10"	8' 4"	-	-
14	14	2	#5	2' 10"	8' 4"	-	-
14	15	2	#5	2' 10"	8' 4"	-	-
14	16	2	#6	2' 10"	8' 4"	-	-
14	17	2	#6	2' 10"	8' 4"	-	-
14	18	2	#6	2' 10"	8' 4"	-	-
14	19						
14	20						

Size Exceeds Capacity of I-Beam Post

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
15	3	2	#1	3' 0"	9' 0"	-	-
15	4	2	#2	3' 0"	9' 0"	-	-
15	5	2	#2	3' 0"	9' 0"	-	-
15	6	2	#2	3' 0"	9' 0"	-	-
15	7	2	#3	3' 0"	9' 0"	-	-
15	8	2	#3	3' 0"	9' 0"	-	-
15	9	2	#4	3' 0"	9' 0"	-	-
15	10	2	#4	3' 0"	9' 0"	-	-
15	11	2	#4	3' 0"	9' 0"	-	-
15	12	2	#5	3' 0"	9' 0"	-	-
15	13	2	#5	3' 0"	9' 0"	-	-
15	14	2	#5	3' 0"	9' 0"	-	-
15	15	2	#6	3' 0"	9' 0"	-	-
15	16	2	#6	3' 0"	9' 0"	-	-
15	17	2	#6	3' 0"	9' 0"	-	-
15	18	3	#6	-	-	0' 6"	7' 0"
15	19						
15	20						

Size Exceeds Capacity of I-Beam Post

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
16	3	2	#1	3' 2"	9' 8"	-	-
16	4	2	#2	3' 2"	9' 8"	-	-
16	5	2	#2	3' 2"	9' 8"	-	-
16	6	2	#2	3' 2"	9' 8"	-	-
16	7	2	#3	3' 2"	9' 8"	-	-
16	8	2	#3	3' 2"	9' 8"	-	-
16	9	2	#4	3' 2"	9' 8"	-	-
16	10	2	#4	3' 2"	9' 8"	-	-
16	11	2	#4	3' 2"	9' 8"	-	-
16	12	2	#5	3' 2"	9' 8"	-	-
16	13	2	#5	3' 2"	9' 8"	-	-
16	14	2	#6	3' 2"	9' 8"	-	-
16	15	2	#6	3' 2"	9' 8"	-	-
16	16	2	#6	3' 2"	9' 8"	-	-
16	17	3	#6	-	-	1' 0"	7' 0"
16	18	3	#6	-	-	1' 0"	7' 0"
16	19						
16	20						

Size Exceeds Capacity of I-Beam Post

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
17	3	2	#2	3' 5"	10' 2"	-	-
17	4	2	#2	3' 5"	10' 2"	-	-
17	5	2	#2	3' 5"	10' 2"	-	-
17	6	2	#3	3' 5"	10' 2"	-	-
17	7	2	#3	3' 5"	10' 2"	-	-

# Clear Heights - Greater Than 16 Feet up to 24 Feet

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
7	3	2	#1	1' 5"	4' 2"	-	-
7	4	2	#2	1' 5"	4' 2"	-	-
7	5	2	#2	1' 5"	4' 2"	-	-
7	6						
7	7						
7	8						
7	9						
7	10						
7	11						
7	12						
7	13						
7	14						
7	15						
7	16						
7	17						
7	18						
7	19						
7	20						

Signs in this range are too narrow to achieve the required posts spacings necessary for #3 through #6 sign post to meet breakaway standards. The sign width needs to be increased to 10 feet.

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
8	3	2	#1	1' 7"	4' 10"	-	-
8	4	2	#2	1' 7"	4' 10"	-	-
8	5	2	#2	1' 7"	4' 10"	-	-
8	6						
8	7						
8	8						
8	9						
8	10						
8	11						
8	12						
8	13						
8	14						
8	15						
8	16						
8	17						
8	18						
8	19						
8	20						

Signs in this range are too narrow to achieve the required posts spacings necessary for #3 through #6 sign post to meet breakaway standards. The sign width needs to be increased to 10 feet.

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
9	3	2	#1	1' 10"	5' 4"	-	-
9	4	2	#2	1' 10"	5' 4"	-	-
9	5	2	#2	1' 10"	5' 4"	-	-
9	6						
9	7						
9	8						
9	9						
9	10						
9	11						
9	12						
9	13						
9	14						
9	15						
9	16						
9	17						
9	18						
9	19						
9	20						

Signs in this range are too narrow to achieve the required posts spacings necessary for #3 through #6 sign post to meet breakaway standards. The sign width needs to be increased to 10 feet.

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
10	3	2	#1	2' 0"	6' 0"	-	-
10	4	2	#2	2' 0"	6' 0"	-	-
10	5	2	#2	2' 0"	6' 0"	-	-
10	6	2	#3	1' 6"	7' 0"	-	-
10	7	2	#3	1' 6"	7' 0"	-	-
10	8	2	#4	1' 6"	7' 0"	-	-
10	9	2	#4	1' 6"	7' 0"	-	-
10	10	2	#4	1' 6"	7' 0"	-	-
10	11	2	#4	1' 6"	7' 0"	-	-
10	12	2	#5	1' 6"	7' 0"	-	-
10	13	2	#5	1' 6"	7' 0"	-	-
10	14	2	#6	1' 6"	7' 0"	-	-
10	15	2	#6	1' 6"	7' 0"	-	-
10	16	2	#6	1' 6"	7' 0"	-	-
10	17						
10	18						
10	19						
10	20						

Size Exceeds Capacity of I-Beam Post

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
11	3	2	#1	2' 2"	6' 8"	-	-
11	4	2	#2	2' 2"	6' 8"	-	-
11	5	2	#2	2' 2"	6' 8"	-	-
11	6	2	#3	2' 0"	7' 0"	-	-
11	7	2	#3	2' 0"	7' 0"	-	-
11	8	2	#4	2' 0"	7' 0"	-	-
11	9	2	#4	2' 0"	7' 0"	-	-
11	10	2	#4	2' 0"	7' 0"	-	-
11	11	2	#4	2' 0"	7' 0"	-	-
11	12	2	#5	2' 0"	7' 0"	-	-
11	13	2	#5	2' 0"	7' 0"	-	-
11	14	2	#6	2' 0"	7' 0"	-	-
11	15	2	#6	2' 0"	7' 0"	-	-
11	16	2	#6	2' 0"	7' 0"	-	-
11	17						
11	18						
11	19						
11	20						

Size Exceeds Capacity of I-Beam Post

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
12	3	2	#1	2' 5"	7' 2"	-	-
12	4	2	#2	2' 5"	7' 2"	-	-
12	5	2	#2	2' 5"	7' 2"	-	-
12	6	2	#3	2' 5"	7' 2"	-	-
12	7	2	#3	2' 5"	7' 2"	-	-
12	8	2	#4	2' 5"	7' 2"	-	-
12	9	2	#4	2' 5"	7' 2"	-	-
12	10	2	#4	2' 5"	7' 2"	-	-
12	11	2	#4	2' 5"	7' 2"	-	-
12	12	2	#5	2' 5"	7' 2"	-	-
12	13	2	#5	2' 5"	7' 2"	-	-
12	14	2	#6	2' 5"	7' 2"	-	-
12	15	2	#6	2' 5"	7' 2"	-	-
12	16	2	#6	2' 5"	7' 2"	-	-
12	17						
12	18						
12	19						
12	20						

Size Exceeds Capacity of I-Beam Post

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
13	3	2	#1	2' 7"	7' 10"	-	-
13	4	2	#2	2' 7"	7' 10"	-	-
13	5	2	#2	2' 7"	7' 10"	-	-
13	6	2	#3	2' 7"	7' 10"	-	-
13	7	2	#3	2' 7"	7' 10"	-	-
13	8	2	#4	2' 7"	7' 10"	-	-
13	9	2	#4	2' 7"	7' 10"	-	-
13	10	2	#4	2' 7"	7' 10"	-	-
13	11	2	#5	2' 7"	7' 10"	-	-
13	12	2	#5	2' 7"	7' 10"	-	-
13	13	2	#6	2' 7"	7' 10"	-	-
13	14	2	#6	2' 7"	7' 10"	-	-
13	15	2	#6	2' 7"	7' 10"	-	-
13	16						
13	17						
13	18						
13	19						
13	20						

Size Exceeds Capacity of I-Beam Post

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
14	3	2	#2	2' 10"	8' 4"	-	-
14	4	2	#2	2' 10"	8' 4"	-	-
14	5	2	#2	2' 10"	8' 4"	-	-
14	6	2	#3	2' 10"	8' 4"	-	-
14	7	2	#4	2' 10"	8' 4"	-	-
14	8	2	#4	2' 10"	8' 4"	-	-
14	9	2	#4	2' 10"	8' 4"	-	-
14	10	2	#5	2' 10"	8' 4"	-	-
14	11	2	#5	2' 10"	8' 4"	-	-
14	12	2	#6	2' 10"	8' 4"	-	-
14	13	2	#6	2' 10"	8' 4"	-	-
14	14	2	#6	2' 10"	8' 4"	-	-
14	15						
14	16						
14	17						
14	18						
14	19						
14	20						

Size Exceeds Capacity of I-Beam Post

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
15	3	2	#2	3' 0"	9' 0"	-	-
15	4	2	#2	3' 0"	9' 0"	-	-
15	5	2	#3	3' 0"	9' 0"	-	-
15	6	2	#3	3' 0"	9' 0"	-	-
15	7	2	#4	3' 0"	9' 0"	-	-
15	8	2	#4	3' 0"	9' 0"	-	-
15	9	2	#4	3' 0"	9' 0"	-	-
15	10	2	#5	3' 0"	9' 0"	-	-
15	11	2	#5	3' 0"	9' 0"	-	-
15	12	2	#6	3' 0"	9' 0"	-	-
15	13	2	#6	3' 0"	9' 0"	-	-
15	14	3	#6	-	-	0' 6"	7' 0"
15	15						
15	16						
15	17						
15	18						
15	19						
15	20						

Size Exceeds Capacity of I-Beam Post

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
16	3	2	#2	3' 2"	9' 8"	-	-
16	4	2	#2	3' 2"	9' 8"	-	-
16	5	2	#3	3' 2"	9' 8"	-	-
16	6	2	#3	3' 2"	9' 8"	-	-
16	7	2	#4	3' 2"	9' 8"	-	-
16	8	2	#4	3' 2"	9' 8"	-	-
16	9	2	#5	3' 2"	9' 8"	-	-
16	10	2	#5	3' 2"	9' 8"	-	-
16	11	2	#6	3' 2"	9' 8"	-	-
16	12	2	#6	3' 2"	9' 8"	-	-
16	13	2	#6	3' 2"	9' 8"	-	-
16	14	3	#6	-	-	1' 0"	7' 0"
16	15						
16	16						
16	17						
16	18						
16	19						
16	20						

Size Exceeds Capacity of I-Beam Post

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS	POST DESIGN	Post Spacing			
				C	D	A	B
17	3	2	#2	3' 5"	10' 2"	-	-
17	4	2	#2	3' 5"	10' 2"	-	-
17	5	2	#3	3' 5"	10' 2"	-	-
17	6	2	#4	3' 5"	10' 2"	-	-
17	7	2	#4	3' 5"	10' 2"	-	-
17	8	2	#4	3' 5"	10' 2"	-	-
17	9	2	#5	3' 5"	10' 2"	-	-
17	10	2	#5	3' 5"	10' 2"	-	-
17	11	2	#6	3' 5"	10' 2"	-	-
17	12	2	#6	3' 5"	10' 2"	-	-
17	13	3	#6	-	-	1' 6"	7' 0"
17	14	3	#6	-	-	1' 6"	7' 0"
17	15						
17	16						
17	17						
17	18						
17	19						
17	20						

Size Exceeds Capacity of I-Beam Post

SIGN WIDTH	SIGN HEIGHT	NUMBER OF POSTS
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## SECTION 614

### DRAINAGE FITTINGS

#### SECTION 614.10 GRATES AND BEARING PLATES.

**614.10.1 Description.** This work shall consist of furnishing and installing parallel bar grates and bearing plates, and curved vane grates and frames of the size and design shown on the plans.

#### **614.10.2 Material.**

**614.10.2.1** Parallel bar grates and bearing plates, and curb inlets shall be constructed of structural steel meeting the requirements of ASTM A 36 and shall be fabricated as shown on the plans. Welds shall be of full section and sound throughout. Obvious dimensional defects and structural discontinuity of welds will be cause for rejection. All welding residue shall be removed. All tightly contacting surfaces shall be completely sealed by welding. Removal of welding beads will not be required except on bearing surfaces. Parallel bar grates and bearing plates, and curb inlets shall be hot-dip galvanized after fabrication in accordance with AASHTO M 111. Bolts, nuts and washers shall be galvanized in accordance with AASHTO M 232 or shall be mechanically galvanized. If mechanically galvanized, the coating thickness, adherence and quality requirements shall be in accordance with [ASTM B695](#)~~AASHTO M 232~~, Class ~~55C~~. Damaged spelter coating shall be repaired in accordance with [Sec 1081](#).

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**



## SECTION 901

### HIGHWAY LIGHTING

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

**901.3.1** Anchor bolts, bolts, nuts and washers specified to be galvanized shall be galvanized in accordance with ~~ASTM F2329~~AASHTO M 232 (ASTM A153), Class C, or mechanically galvanized in accordance with ASTM B695, Class 55. Except for anchor bolts, galvanizing thickness shall not exceed 6 mils. For anchor bolts and nuts and for high strength bolts and nuts, except those in accordance with ASTM F3125 Grade A325, the contractor shall furnish to the engineer a test report certified to be the last completed set of mechanical tests for each size in each shipment. For high strength bolts and nuts in accordance with ASTM F3125 Grade A325, the contractor shall furnish to the engineer a copy of the manufacturer's inspection test report for each production lot or shipping lot furnished and shall certify the bolts furnished are in accordance with the specifications. Bolts and nuts in accordance with ASTM A307 shall be accompanied by a manufacturer's statement that the bolts and nuts were manufactured in accordance with ASTM A307.

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN



## SECTION 902

### TRAFFIC SIGNALS

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

**902.4.1** Anchor bolts, bolts, nuts and washers, except stainless steel, shall be galvanized in accordance with ~~ASTM F2329-AASHTO M 232 (ASTM A153), Class C or mechanically galvanized in accordance with ASTM B695, Class 55.~~ Except for anchor bolts, galvanizing thickness shall not exceed 6 mils. For anchor bolts and nuts, and for high strength bolts and nuts, except those in accordance with ASTM F3125 Grade A325, the contractor shall furnish to the engineer a test report certified to be the last completed set of mechanical tests for each size in each shipment. For high strength bolts and nuts in accordance with ASTM F3125 Grade A325, the contractor shall furnish a copy of the manufacturer's inspection test report for each production lot or shipping lot furnished to the engineer and shall certify the bolts furnished are in accordance with the requirements specified. Bolts and nuts specified to meet ASTM A307 shall be accompanied by a manufacturer's statement that the bolts and nuts were manufactured in accordance with ASTM A307.

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

**902.17.7 External Conduit on Structure.** For existing structures, or if provisions are not made in the plans for providing a conduit raceway in new structures as described in [Sec 707](#), the conduit shall be external conduit on structure. Conduit on structure will include conduit on bridges, retaining walls or other structures, and shall be installed as shown on the plans or as directed by the engineer. The final location of all conduit and junction boxes shall be approved by the engineer before installation begins. Conduit shall not be attached to prestressed concrete girders or prestressed, precast concrete deck panels. The conduit shall be secured to the concrete with clamps at no more than 5-foot intervals. Concrete anchors for clamps shall be in accordance with Commercial Item Description (CID) A-A-1923A and shall be galvanized in accordance with ~~ASTM F2329-AASHTO M 232 (ASTM A153), Class C,~~ or mechanically galvanized in accordance with ASTM B695, Class 55, or constructed of stainless steel. The minimum embedment in concrete shall be 1 3/4 inches. The supplier shall furnish a manufacturer's certification that the concrete anchors meet the required material and galvanizing specifications. If necessary to anchor the conduit to steel bridge members, the attachment method shall not involve drilling, grinding or welding. Attachment method to steel members shall be approved by the engineer. Junction boxes shall be installed as shown on the plans or as directed by the engineer. Junction boxes shall be surface-mounted and installed such that covers are accessible. If the conduit crosses a bridge expansion joint, a conduit expansion fitting shall be used. The expansion fitting shall provide a minimum movement in either direction as shown on the plans or as specified by the engineer. Junction boxes, expansion fittings and any hardware or material required for conduit installation shall be at the contractor's expense.



## SECTION 903

### HIGHWAY SIGNING

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

**903.2.3 Hardware.** Anchor bolts, bolts, nuts and washers specified to be galvanized shall be galvanized in accordance with ~~ASTM F2329, AASHTO M 232 (ASTM A153), Class C or mechanically galvanized in accordance with ASTM B695, Class 55.~~ Except for anchor bolts, galvanizing thickness shall not exceed 6 mils. For high strength bolts, the contractor shall furnish to the engineer a copy of the manufacturer's inspection test report for each production lot or shipping lot furnished, and shall certify the bolts furnished are in accordance with [Sec 1080](#).

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN



## SECTION 1023

### STRUCTURAL PLATE PIPE AND PIPE ARCHES

UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

#### 1023.3.4 Bolts and Nuts for Connecting Plates.

**1023.3.4.1** Bolts for connecting plates shall be 3/4 inch in diameter and shall be in accordance with ASTM A 449. Nuts shall be in accordance with ASTM A 563, Grade C. Bolts, nuts and washers shall be galvanized in accordance with ~~ASTM F2329~~AASHTO M 232, or the bolts, nuts and washers may be mechanically galvanized. If mechanically galvanized, the coating thickness, adherence and quality requirements shall be in accordance with ~~ASTM B695, Class 55~~AASHTO M 232, Class C. Except as specified herein, bolts and nuts shall meet the dimension requirements of ANSI B18.2.1 for heavy hex bolts and ANSI B18.2.2 for heavy hex nuts. The bearing surface of both bolts and nuts shall be symmetrically shaped to a one-inch radius spherical surface. The maximum height of the wrench flats on bolts and thickness of nuts shall be within the limits specified in ANSI B18.2.1 and ANSI B18.2.2, respectively. Bolt lengths shall be such as to result in at least "full nuts" when tightened in place. The bolts and nuts may be sampled and tested before erection, or the bolts, nuts and washers may be accepted on certified mill tests by the manufacturer.

UNCHANGED SPECS – INTENTIONALLY NOT SHOWN



## SECTION 1040

### GUARDRAIL, END TERMINALS, ONE-STRAND ACCESS RESTRAINT CABLE AND GUARD CABLE MATERIAL

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

##### 1040.7.2 Guard Cable.

**1040.7.2.1 Cable and Connecting Hardware.** The cable and connecting hardware shall be in accordance with AASHTO M 30 and AASHTO M 269. The wire rope shall be Type 1, 3/4-inch diameter, 3 by 7 construction with a Class A coating. The rope, with connecting hardware, shall develop the breaking strength at a minimum of 25,000-pound single cable. Connecting hardware shall be galvanized in accordance with AASHTO M 232 or may be mechanically galvanized. If mechanically galvanized, the coating, thickness, adherence and quality requirements shall be in accordance with ~~AASHTO M 232, Class C~~ ASTM B695, Class 55. Cast Steel components shall be in accordance with AASHTO M 103, Grade 70-40, Class 1. Malleable iron castings shall be in accordance with ASTM A47. Compensating devices shall have a spring constant of 0.46 psi, plus or minus 0.06 pound per inch, and permit 6 inches of travel, plus or minus one inch. All threaded parts on compensating cable end assemblies shall be in accordance with ASTM F568, Class 4.6, 3/4-10 threads. Socket baskets shall be designed for use with the cable anchor wedge as shown on the plans. Guard cable anchor brackets shall be manufactured from an AASHTO M 270, Grade 250 steel plate, and zinc-coated in accordance with AASHTO M 111. Dimensional tolerances not shown on the plans shall be consistent with the proper functioning of the part, including the part's appearance and accepted manufacturing process.

**1040.7.2.2 Cable Brackets.** Steel used in the fabrication of the bracket shall be in accordance with ASTM A36. The bracket shall be galvanized after fabrication in accordance with AASHTO M 111. All fittings, including splices, shall be designed to use the wedge detail, and shall be of such section as to develop the full strength of the 3/4-inch, at a minimum of 25,000-pound round cable. Designs for a combination or single-unit compensating device and turnbuckle assembly shall be submitted for approval. Compensating devices shall have a spring rate of  $0.46 \pm 0.03$  pound per inch, and shall permit 6 inches  $\pm$  one inch of travel. All parts, except cable wedge, shall be hot-dip zinc coated in accordance with AASHTO M 232 or may be mechanically galvanized in accordance with ASTM B695, Class 55 ~~AASHTO M 298~~.

**1040.7.2.3 Hook Bolts, Hex Bolts, Nuts and Washers.** Hook bolts, hex bolts and washers shall be in accordance with ASTM A307. Cable hook nuts shall be 5/16-18 threads and in accordance with ASTM A563. Hook bolts, as installed, shall develop an ultimate pull open strength of 450 to 1,000 pounds applied in a direction normal to the axis of the post. Hooked anchor studs shall be in accordance with AASHTO M 314, except the threads and nominal diameter shall be 3/4-10 and in accordance with ASTM F568, Class 4.6. All items shall be galvanized in accordance with AASHTO M 232 or may be mechanically galvanized in accordance with ASTM B695, Class 55 ~~AASHTO M 232, Class C~~.

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

**1040.9 Repair of Galvanizing.** Galvanized material shall be handled in a manner to avoid damage to the surface. No field punching, drilling, cutting or welding will be permitted after

galvanizing. Any galvanized material on which the spelter coating has been damaged will be rejected or may be repaired in accordance with [Sec 1081](#), with approval from the engineer.

TABLE I - Certification Requirements			
Item	Galvanizing Standard	Steel Grade	Other
Wood Post and Blocks	-	-	a
Steel Posts, Plates and Brackets	AASHTO M 111	AASHTO M 270, Grade 36	b
Plastic Blocks	-	-	g
Guardrail Beam	<a href="#">Sec 1040.4</a>	<a href="#">Sec 1040.4</a>	b, c
Bolts, Nuts and Washers	AASHTO M 232	ASTM A307	
End Terminals Systems	-	-	f
End Anchors			
- Tubes	AASHTO M 111	ASTM A500/ASTM A501	b
- Transition Cap Rail	AASHTO M 111	AASHTO M 270, Grade 36	b
One-Strand Access Restraint Cable			
- Cable	AASHTO M 30	AASHTO M 30	b
- Hardware	AASHTO M 232	AASHTO M 102/ ASTM A220	b
Guard Cable			
- Cable	AASHTO M30	AASHTO M 30 & AASHTO M 269	b
- Hardware	AASHTO M 232	AASHTO M 102/ ASTM A220	d
- Cast Steel Components	AASHTO M 232	AASHTO M 103	d
- Malleable Iron Castings	AASHTO M 232	ASTM A47	e
- Anchor Brackets	AASHTO M 111	AASHTO M 270	
- Cable Brackets	AASHTO M 111	AASHTO M 270, Grade 36	d
- Hook and Hex Bolts	AASHTO M 232	ASTM A307	
- Hook Nuts	AASHTO M 232	ASTM A563	
- Hooked Anchor Studs	AASHTO M 232	AASHTO M 314	

(a) Certification shall state that the material is in accordance with [Sec 1050](#) and shall include a listing of the material supplied and a certified test report as detailed in Section 7.2 of AWP, Standard M2, attesting to complete compliance with this specification.

(b) Certification shall include, or have attached, specific results of laboratory tests for physical and chemical properties from samples representative of the material.

(c) Shall have Brand Registration and Guarantee on file, including certification indicating the coating is either Type 1 by Continuous Galvanizing Method or Type 2.

(d) All threaded parts of compensating cable end assemblies and hooked anchor studs shall be in accordance with ASTM F568.

(e) All fittings for cable bracket, except the cable wedge, shall be in accordance with AASHTO M 232 or [ASTM B695, Class 55](#)~~AASHTO M 298~~.

(f) Certification shall state the name of the manufacturer and that the units furnished are identical in material and design as those tested for performance in accordance with [Sec 606.30](#).

(g) Certification shall state that the materials furnished are identical in chemistry, mechanical properties and geometry as those that passed the NCHRP 350 or MASH 2016 crash test, and as those that were approved by the Missouri Department of Transportation.



## SECTION 1052

### MECHANICALLY STABILIZED EARTH WALL (MSE) AND SOUND WALL SYSTEM COMPONENTS

UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

**1052.10.5 Galvanizing and Aluminizing.** All soil reinforcement material shall be either galvanized or aluminized. Galvanized soil reinforcement shall be in accordance with AASHTO M 111. Aluminized soil reinforcement shall be in accordance with ASTM A 463 Aluminized Type 2-100, SS, Grade 50, Class 2. Fasteners, including bolts, nuts and washers, shall be galvanized in accordance with [ASTM F2329](#)~~AASHTO M 232~~. All connection devices shall be galvanized in accordance with either AASHTO M 111 or [AASHTO M 232 \(ASTM A153\), Class C](#).

UNCHANGED SPECS – INTENTIONALLY NOT SHOWN



## SECTION 1080

### STRUCTURAL STEEL FABRICATION

**1080.1 Scope.** This specification covers the fabrication and inspection of bridges and structures made of structural steel and miscellaneous metals.

**1080.2 Material.** Except as amended by [Sec 1080.2.4](#), all material shall be in accordance with [Division 1000](#), Material Details, and specifically as follows:

Item	Section / Specification
Shear Connectors	<a href="#">1037</a>
Paint for Structural Steel	<a href="#">1045</a>
Coating of Structural Steel	<a href="#">1081</a>
Structural Carbon Steel	AASHTO M 270, Grade 36 ASTM A709, Grade 36
Structural Low Alloy Steel	AASHTO M 270, Grade 50 ASTM A709, Grade 50 AASHTO M 270, Grade 50W ASTM A709, Grade 50W
Quenched and Tempered Alloy Steel	AASHTO M 270, Grade HPS 50W ASTM A709, Grade HPS 50W AASHTO M 270, Grade HPS 70W ASTM A709, Grade HPS 70W ASTM A709, Grade 100/100W
Carbon Steel Bolts and Nuts	ASTM A307
High Strength Bolts, Nuts and Washers	ASTM F3125 Grade A 325 Type 1 ASTM F3125 Grade A325 Type 3 ASTM F3125 Grade 144 Type 1 ASTM F3125 Grade 144 Type 3 ASTM F3125 Grade A490 Type 1 (Plain only) ASTM F3125 Grade A490 Type 3 ASTM F3148 Grade 144 Type 1 ASTM F3148 Grade 144 Type 3 ASTM F436 ASTM A563 AASHTO M 292
Cold Finished Carbon Steel Shafting	AASHTO M 169
Carbon Steel Forgings	AASHTO M 102 Class F
Alloy Steel Forgings	AASHTO M 102 Class G
Gray Iron Castings	AASHTO M 105 Class 50
Malleable Iron Castings	ASTM A47
Carbon Steel Castings	AASHTO M 103 Grade 485-275
Galvanized Coatings	AASHTO M 111 <a href="#">ASTM F2329</a> <a href="#">AASHTO M 232 Class C</a> ASTM B695 Class 55
Lead for Bearing Pads	ASTM B29
Identification of Metals	ASTM A6

**1080.2.1 Galvanized Bolts.** Bolts, nuts and washers specified to be galvanized shall be galvanized in accordance with the requirements of [AASHTO M 232 \(ASTM F2329 A153\)](#), Class C or shall be mechanically galvanized in accordance with ASTM B695, Class 55. [Mechanically galvanized bolts, nuts and washers shall not be used on galvanized structures.](#) Except for anchor bolts, galvanizing thickness shall not exceed 6 mils. Fasteners installed prior to the completion of shop blast cleaning will not require galvanizing. The thickness of the zinc coating for galvanized bolts shall be measured on the wrench flats and top of the bolt head. For mechanically galvanized bolts, the significant surfaces as referenced in ASTM B695 shall be the entire bolt surface, excluding the underside of the surface of the head and the shank surface between the threaded portion and the underside of the head. The thickness of the zinc coating on the galvanized nuts shall be measured on the wrench flats. For mechanically galvanized nuts, the significant surfaces shall be all surfaces of the nut excluding the threads. The thickness of the zinc coating on galvanized washers shall be measured on both sides. The significant surfaces on mechanically galvanized washers shall be all surfaces of the washer.

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**

**1080.2.5 High Strength Fastener Assemblies.** In addition to the requirements of [Sec 712.2](#), high strength bolts, nuts and washers shall meet the following requirements. The contractor shall furnish a manufacturer's certified test report showing the results. Identification in accordance with the appropriate AASHTO/ASTM specifications shall be maintained by container markings which shall match identifying numbers on the certifications and be traceable to the certified mill test reports. [All ASTM F3125 Grade A325 and 144 Type 1 and ASTM F3148 Grade 144 Type 1 h](#)High strength fastener assemblies shall be galvanized unless specifically indicated [“uncoated, plain or black”](#) otherwise by the contract documents. When high strength bolts are used with weathering steel, the fasteners shall be Type 3, including fasteners located in areas of the structure to be partially coated, expansion device supports, slab drain brackets and similar items. High strength fasteners in partially coated areas of weathering steel and slab drain baskets attached to weathering steel shall be coated in accordance with [Sec 1080.4.5.1](#). ASTM F3125 Grade A490 bolts shall be installed plain (also referred to as uncoated or black), tensioned and then cleaned and coated with the coating system as specified on the plans. The cleaning and the zinc coating shall not be applied by any process, which can cause hydrogen embrittlement. All certification testing requirements and mill test reports referenced in the following sections shall be in accordance with [Sec 106](#).

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**

**1080.2.5.2.1 Nut Grades.** Ungalvanized nuts shall be grades [2](#), C, D or C3 with a minimum Rockwell hardness of 89 HRB or Brinell hardness 180 HB or heat-treated grades [2H](#), DH or DH3. Nuts that are to be galvanized shall be heat-treated grades [2H](#), DH or DH3. Weathering steel nuts shall be grade C3 or DH3 for use with ASTM F3125 Grade A325 Type 3 and grade DH3 for use with ASTM F3125 Grade 144 Type 3, A490 Type 3 or ASTM F3148 Grade 144 Type 3.

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**



## SECTION 1081

### COATING OF STRUCTURAL STEEL

UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

#### 1081.20 GALVANIZING OF STRUCTURAL STEEL.

**1081.20.1 Scope.** This specification covers galvanizing new and existing bridges and structures made of structural steel and miscellaneous metals.

**1081.20.2 Material.** All material shall be in accordance with Division 1000, Material Details, and in conjunction with:

Item	Specification
Galvanizing	ASTM A123
Galvanizing Repair	ASTM A780

**1081.20.3 Galvanized Metal.** Structural steel beams or girders, bracing and diaphragms shall be galvanized as shown on the plans and in accordance with this specification. ~~Galvanizing shall be applied after fabrication.~~ After fabrication and prior to galvanizing, the steel surfaces shall be solvent cleaned in accordance with SSPC-SP1 Solvent Cleaning and then blast cleaned in accordance with SSPC-SP6 Commercial Blast Cleaning requirements. Structural steel beams and girders webs shall remain vertical while being galvanized. Galvanized material on which the galvanizing has been damaged will be rejected or may, with approval from the engineer, be repaired in the field, fabrication shop, or at the galvanizing facility by the zinc alloy stick method in accordance with this specification. Required field welds and adjacent areas on which galvanizing has been damaged shall be galvanized by this same repair method. The area to be regalvanized shall be thoroughly cleaned, including the removal of slag on welds. Touch-up of galvanizing of sheet material less than 3/16 inch may be completed by the use of an approved aluminum epoxy mastic coating if the material will not be in direct contact with concrete or with an approved non-aluminum epoxy mastic coating if the material will be in direct contact with concrete. Other protective coatings specified in ASTM A780 will not be permitted for galvanized beams, girders, bracing and diaphragms.

UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

### 614.2.1 Procedure

Grates and bearing plates shall be tested for weight (mass) of zinc coating according to AASHTO M 111. Bolts, nuts and washers shall be tested for weight (mass) ~~thickness~~ of zinc coating according to AASHTO M232. If mechanically galvanized, the coating thickness, adherence and quality requirements shall be in accordance with ASTM B695, Class 55. Refer to [Field determination of weight of coating](#) for additional information concerning the testing of bolts, nuts, and washers for weight (mass) of zinc coating. All test data and calculations shall be recorded in Laboratory workbooks. Test results shall then be recorded through AASHTOWARE Project (AWP).

**712.2.3.1.1 Manufacturer's Certification.** Bolts and nuts specified to meet the requirements of ASTM A307 shall be accompanied by a manufacturer's certification statement that the bolts and nuts were manufactured to comply with requirements of ASTM A307 and, if required, galvanized to comply with requirements of ~~AASHTO M232 (ASTM A153), Class C~~ [ASTM F2329](#) or were mechanically galvanized and meet the coating thickness, adherence, and quality requirements of ASTM B695, Class 55. Certification shall be retained by the shipper. A copy should be obtained when sampling at the shipper and submitted with the samples to the lab.

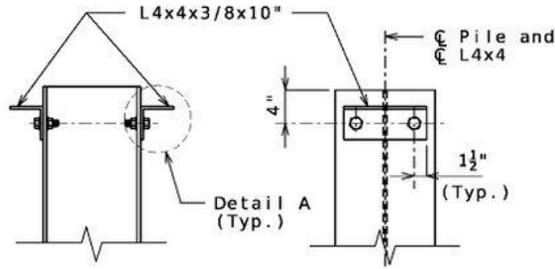
### 712.3.2.1 Chemical Tests - Bolts, Nuts, and Washers

~~Weight (mass)~~ Thickness of coating shall be determined in accordance with ~~AASHTO M232~~ [ASTM F2329](#) or where mechanically galvanized shall meet the coating thickness, adherence, and quality requirements of ASTM B695, Class 55. Chemical analysis of the base metal shall be determined, when requested, according to [Laboratory Testing Guidelines for Sec 1020](#). Original test data and calculations shall be recorded in Laboratory workbooks.

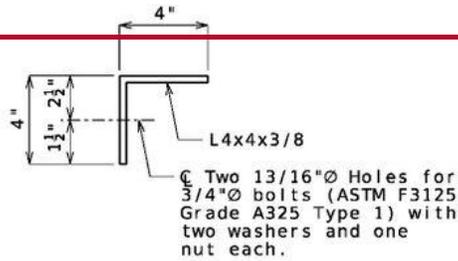
### 751.36.4.1 Structural Steel HP Pile - Details

[MS Cell]

**Use standard seismic anchorage detail for all HP pile sizes. Modify detail (bolt size, no. of bolts, angle size) if seismic and geotechnical analyses require increased uplift resistance. Follow AASHTO 17th Ed. LFD or AASHTO Guide Specifications for LRFD Seismic Bridge Design (SGS).**

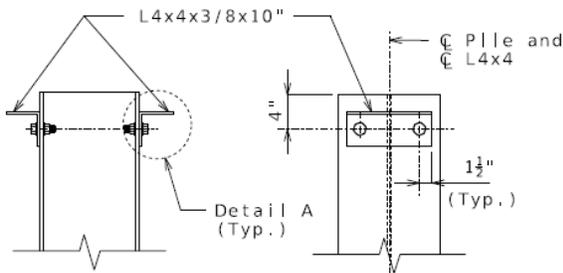


**DETAILS OF HP PILE ANCHORS**

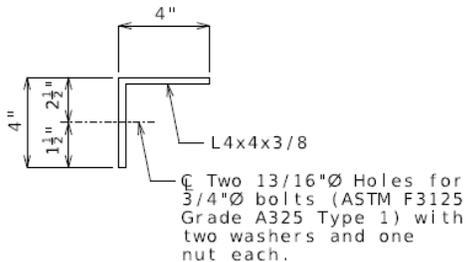


**DETAIL A**

Angles shall be coated with a minimum of two coats of non-aluminum epoxy mastic primer to provide a dry film thickness of 4 mils minimum, 8 mils maximum, or galvanized in accordance with Sec 1081. Bolts, washers and nuts shall be galvanized in accordance with AASHTO M 232 (ASTM A153), Class C.



**DETAILS OF HP PILE ANCHORS**



**DETAIL A**

Angles shall be coated with a minimum of two coats of non-aluminum epoxy mastic primer to provide a dry film thickness of 4 mils minimum, 8 mils maximum, or galvanized in accordance with Sec 1081. Bolts, washers and nuts shall be galvanized in accordance with ASTM F2329.

**751.50****(D1.2) Use for bolts and studs:**

(D1.2a) All bolts shall be ASTM F3125 Grade A325 Type 3, except as noted.

(D1.2b) All ASTM A307 bolts and their accompanying hex nuts and washers and all ASTM A449 Type 1 studs and their accompanying heavy hex nuts shall be galvanized in accordance with ~~AASHTO M 232 (ASTM A153), Class C~~ASTM F2329.

**(G7.2) [MS Cell] Use with Pile Seismic Anchor Detail.**

Angles shall be coated with a minimum of two coats of non-aluminum epoxy mastic primer to provide a dry film thickness of 4 mils minimum, 8 mils maximum, or galvanized in accordance with [Sec 1081](#). Bolts, washers and nuts shall be galvanized in accordance with ~~AASHTO M 232 (ASTM A153), Class C~~ASTM F2329.

**(H3.2)**

Anchor bolts shall be coated with a minimum of two coats of inorganic zinc primer to provide a total dry film thickness of 4 mils minimum, 6 mils maximum, or galvanized in accordance with ~~AASHTO M 232 (ASTM A153), Class C~~ASTM F2329.

**(H3.7)**

Anchor bolts, hardened washers and heavy hex nuts shall be coated with a minimum of two coats of inorganic zinc primer to provide a total dry film thickness of 4 mils minimum, 6 mils maximum, or galvanized in accordance with ~~AASHTO M 232 (ASTM A153), Class C~~ASTM F2329.

**(H3.16)**

Anchor bolts, hardened washers and heavy hex nuts shall be coated with a minimum of two coats of inorganic zinc primer to provide a total dry film thickness of 4 mils minimum, 6 mils maximum, or galvanized in accordance with ~~AASHTO M 232 (ASTM A153), Class C~~ASTM F2329.

**(H3.26) Remove underline portion when superstructure is galvanized or where weathering steel is not being coated.**

Anchor bolts and heavy hex nuts shall be coated with a minimum of two coats of inorganic zinc primer to provide a total dry film thickness of 4 mils minimum, 6 mils maximum, or galvanized in accordance with ~~AASHTO M 232 (ASTM A153), Class C~~ASTM F2329.

**(H3.46) Remove underline portion when superstructure is galvanized or where weathering steel is not being coated.**

Anchor bolts and heavy hex nuts shall be coated with a minimum of two coats of inorganic zinc primer to provide a total dry film thickness of 4 mils minimum, 6 mils maximum, or galvanized in accordance with ~~AASHTO M 232 (ASTM A153), Class ASTM F2329.~~

**(H3.92)**

Anchor bolts and hardened washers shall be coated with a minimum of two coats of inorganic zinc primer to provide a total dry film thickness of 4 mils minimum, 6 mils maximum, or galvanized in accordance with ~~AASHTO M 232 (ASTM A153), Class ASTM F 2329.~~

**(H4.2.2)**

Anchor bolts and nuts shall be ASTM F1554 Grade 55. Anchor bolts, nuts and washers shall be galvanized in accordance with ~~AASHTO M 232 (ASTM A153), Class ASTM F 2329,~~ or ASTM B695, Class 55.

**(H4.10) Use for all conduits when conduit clamps are required.**

All conduits shall be secured to concrete with nonmetallic clamps at about 5'-0" cts. Concrete anchors for clamps shall be in accordance with Commercial Item Description (CID) A-A-1923A and shall be galvanized in accordance with ~~AASHTO M 232 (ASTM A153), Class ASTM F2329,~~ ASTM B695, Class 55 or stainless steel. Minimum embedment in concrete shall be 1 3/4". The supplier shall furnish a manufacturer's certification that the concrete anchors meet the required material and galvanizing specifications.

**(H7.7) Use underlined portion with weathering steel girders and beams. Note not required for continuous concrete slab bridges.**

All bolts, hardened washers, lock washers and nuts shall be galvanized in accordance with ~~AASHTO M 232 (ASTM A153), Class ASTM F2329,~~ except as shown.

**(H9.48)**

All anchor bolts, studs, nuts, and washers shall be galvanized in accordance with ~~AASHTO M 232 (ASTM A153), Class ASTM F2329.~~

### 901.18.1 Procedure

#### Bolts, Nuts, and Washers

Chemical tests consisting of ~~mass thickness~~ of coating shall be determined according to ~~AASHTO M232~~ASTM F2329. Original test data and calculations shall be recorded in Laboratory workbooks. Test results shall then be recorded through AASHTOWARE Project (AWP).

Physical tests shall be conducted according to [EPG 712.3.2.2 Physical Tests - Bolts and Nuts](#). Test results and calculations shall be recorded through AWP.

### 902.28.1.1 Chemical Tests

~~Mass Thickness~~ of coating shall be determined according to ~~AASHTO M232~~ASTM F2329. Original test data and calculations shall be recorded in Laboratory workbooks. Test results shall then be recorded through AASHTOWare.

### 903.22.1.1 Bolts, Nuts and Washers

Chemical tests, consisting of ~~mass thickness~~ of coating, shall be determined according to ~~AASHTO M232~~ASTM F2329. Chemical analysis of the base metal shall be determined, when requested, according to [EPG 1020.8.1.1 Chemical Tests](#). Original test data and calculations shall be recorded in Laboratory workbooks. Test results shall then be recorded through AASHTOWare.

### 1023.2.4 Bolts and Nuts

Bolts and nuts are to be accepted on the basis of a certified mill test report and field inspection. Samples need to be submitted to the Central Laboratory only when field inspection indicates questionable compliance.

Bolts and nuts for use in structural plate pipe and pipe-arch are high-strength and require markings on the bolt heads and on the nuts. The required identification markings may be found in the applicable ASTM specification. The bolts and nuts are to be accompanied by a certified mill test report from the manufacturer, showing complete chemical and physical tests for the material and a statement that they were galvanized in accordance with ~~AASHTO M-232~~ASTM F2329, or were mechanically galvanized and meet the coating

thickness, adherence, and quality requirements of [ASTM B695, Class 55](#)~~AASHTO M 232, Class C.~~

### **1040.2.2 Bolts, Nuts, and Washers**

Bolts, nuts and washers intended for use in beam connections and splices may be accepted by Brand Registration Guarantee or by an acceptable certification. Regardless of the type of acceptance documentation, field inspection performed shall include an examination of certifications and testing for weight (mass) of coating and dimensions. It will only be necessary to submit samples to the Laboratory when requested by Construction and Materials or when field inspection indicates questionable compliance. When samples are taken, take them at the frequency and size shown in Table 1040.2.1.2.

Post and splice bolts, nuts and washers furnished by a fabricator listed in Table 1040.2.1.1 require no additional documentation. Those not covered by Brand Registration and Guarantee must be accompanied by a certification or mill test report. Bolts and nuts specified meeting the requirements of ASTM A307 shall be accompanied by a manufacturer's certification statement that the bolts and nuts were manufactured to comply to the requirements of ASTM A307 and galvanized to comply to the requirements of AASHTO M 232 or were mechanically galvanized and meet the coating thickness, adherence, and quality requirements of [ASTM B695, Class 55](#)~~AASHTO M 232, Class C.~~

Markings are not required on bolts and nuts meeting ASTM A307. All bolts and nuts should be identifiable as to type and manufacturer whether the information is shown on a container or on the bolts and nuts.

Field determination of weight (mass) of coating is to be made on each lot of material furnished. Test procedures and conditions of acceptance or rejection shall be as described in [Field determination of weight \(mass\) of coating](#) with the following modifications:

Due to the size and shape of the material being tested, it will only be necessary to obtain a minimum of three readings of the magnetic gauge on a bolt to determine a single-spot test result and at least five readings on a nut or washer. Since the minimum sampling frequency is three bolts or three nuts or three washers, it will always be possible to obtain at least three single-spot test results from which to calculate an average coating weight (mass) and minimum coating weight (mass) for reporting and applying the specification requirements.

Dimensions of bolts, nuts and washers are to be as shown on the Standard Drawings or as specified.



## SECTION 1038

### BEARING PADS FOR STRUCTURES

**1038.1 Scope.** These specifications cover elastomeric bearing pads of neoprene, of rubber and fabric and of rubber and fiber. Elastomeric bearing pads shall include plain bearings, consisting of elastomer only, and laminated bearings, consisting of layers of elastomer restrained at their interfaces by bonded laminates.

**1038.2 Acceptance.** All material will be accepted on the basis of the required certification and testing required by the engineer.

#### 1038.3 Elastomeric Bearing Pads.

**1038.3.1 Material.** The elastomer shall be 100 percent virgin chloroprene (neoprene) compound meeting the requirements shown below. The pads shall be of the Durometer Grade specified on the plans. If test specimens are cut from the finished product, a 10 percent variation in "Physical Properties" will be allowed.

ASTM Standard	Property	Durometer Grade		
		50	60	70
D 2240	Hardness	50 ± 5	60 ± 5	70 ± 5
D 412	Tensile Strength, psi, minimum	2500	2500	2500
D 412	Ultimate Elongation, percent, min	400	350	300
D 573 70 hrs @ 212 F	Heat Resistance Change in Durometer Hardness, points, max Change in Tensile Strength, percent, max Change in Ultimate Elongation, percent, max	+15 -15 -40	+15 -15 -40	+15 -15 -40
D 395, Method B	Compressive Set 22 hrs at 212 F, %, max	35	35	35
D 1149	Ozone 100 pphm ozone in air by volume, 20 % strain 100 ± 2 F, 100 hrs, mounting procedure ASTM D 518 Procedure A	No Cracks	No Cracks	No Cracks
D 429, Method B	Adhesion Bond made during vulcanization, lbs/inch	40	40	40
D 746, Procedure B	Low Temperature Test Brittleness at -40 F	No Failure	No Failure	No Failure

**1038.3.2 Laminates.** Laminates shall be ~~cold~~ rolled mild steel sheets that meet the requirements of AASHTO M 251 ~~in accordance with ASTM A 1008 or hot rolled steel sheets in accordance with ASTM A 1011 with a minimum grade of 36.~~

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**



## SECTION 1080

### STRUCTURAL STEEL FABRICATION

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

**1080.2.9 Identification of Metals.** The steel shall be stamped or stenciled ~~and color striped~~ with paint at the mill. Heat numbers shall be steel stamped or stenciled with paint at the mill. Separate markings ~~and color codes~~ shall be in accordance with ASTM A6. ~~The characteristic color stripes shall be placed on each part cut from the mill piece. For steels not covered by ASTM A6, the fabricator shall furnish the engineer the color coding in writing before fabrication begins.~~ Heat numbers shall be painted on all principal pieces and these pieces shall be ~~so~~ noted on the shop drawings. Principal pieces for this requirement shall include all beams, flanges, webs, splice plates, cover plates, bearings, bearing stiffener plates, load bearing members of end diaphragms, pin plates, hanger plates and others as may be directed by the engineer. Principal pieces shall include individual plates of all truss members, truss gusset plates, splice plates and floorbeam connection angles. The ~~color code and~~ heat number markings shall be placed on the material such that the markings are visible throughout the work of fabrication. Loss of identification on pieces or items will be cause for rejection of the pieces or items.

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

**1080.3.2 Shop Drawings.** Shop drawings for structural steel and miscellaneous metals shall be required and shall be prepared in strict accordance with the design details shown on the plans. If details are lacking, the details shall be supplied and shall conform to the design plans and specifications. All drawings shall be clear and complete and shall be thoroughly checked before submittal. Shop drawings shall be completely titled in accordance with the contract plans and shall pertain to only a single structure. The approved weld procedure (See Sec 1080.3.2.2) to be used on each welded joint shall be indicated on the shop drawings when submitted for approval. One set of the shop drawings for railroad structures and other structures shall be submitted electronically to the [Bridge Division](#) for approval. The prints submitted shall be legible and shall have distinct details of sufficient contrast. Prints that do not have the desired clarity and contrast will be returned for corrective action. One set of prints will be returned marked reviewed or approved subject to noted corrections. The contractor shall promptly make necessary corrections and resubmit for final approval. When shop drawings are approved, the contractor shall furnish as many additional prints as requested. Reproductions on cloth or film of the original shop drawings shall be required for railroad structures and shall be delivered to the engineer prior to completion of the work. The approval of shop drawings will cover only the general design features and in no case shall this approval be considered to cover errors or omissions in shop details. The contractor shall be responsible for the accuracy of the shop drawings, the fabrication of material and the fit of all connections. All changes in the fabrication and erection work caused by errors in shop drawings and any changes in fabrication necessary for satisfactory results shall be at the contractor's expense. After shop drawings have been approved, no changes in dimensions or substitutions of sections shall be made without written approval from the engineer. Shop drawings shall be revised to show any authorized changes and the required number of prints shall be furnished to the engineer.

**1080.3.2.1 Non-Domestic Shop Drawings.** Shop drawings from fabricators located outside the 48 contiguous States, whether marked approved or approved subject to the corrections noted,

will be returned to the contractor and the contractor shall be responsible for transmitting the drawings to the fabricator for further handling. Should such fabricator also be the contractor, all prints will be returned to the office located on the project.

**1080.3.2.2 Weld Procedures.** All welding procedures to be used shall be prepared by the manufacturer, contractor or fabricator as a written procedure specification. For new welding procedures, one copy shall be electronically submitted for approval to [Bridge Division](#) prior to submitting shop drawings. Approved weld procedures will be kept on file by Bridge and may be considered for use on multiple projects. Any changes to the parameters of an approved welding procedure shall require submittal for approval. ~~The shop drawings submitted for approval shall indicate the welding procedure to be used for each joint.~~

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

**1080.3.3.4 Applicable Codes.** All welding, oxygen cutting, shearing and clipping and dimensional tolerances shall be in accordance with the ANSI/AASHTO/AWS D1.5: ~~2025~~~~2002~~, Bridge Welding Code and as modified by Sec 1080.3.3.5. Tubular steel structures shall be governed by the current edition of the ANSI/AWS D1.1, Structural Welding Code - Steel, in effect at the time of the contract, unless specified otherwise. Aluminum structures shall be governed by the current edition of the ANSI/AWS D1.2, Structural Welding Code - Aluminum, except as amended by Sec 903, unless otherwise indicated.

**1080.3.3.5 Modifications to the Bridge Welding Code.** The following modifications to the ANSI/AASHTO/AWS D1.5 ~~2025~~~~2002~~, Bridge Welding Code (AWS), shall apply:

**1080.3.3.5.1 AWS Clause 1.5 Paragraph 1.5.3 and 1.5.4 - Paragraphs 1.5.3 and 1.5.4 shall be deleted. Electrogas (EGW) and Electoslag (ESW) shall not be allowed on any bridge components.**

**1080.3.3.5.2** ~~AWS See Clause 1.5.1.3 Paragraph 1.5.6.1.3.4~~ - Paragraph ~~1.5.6.1.3.4~~ shall be replaced with the following:

The gas metal arc welding process shall not be used on any structural components of bridges. Approved gas metal arc processes, other than short circuit arc, may be used for incidental, non-structural components as may be specifically approved by the engineer. Tack welding with an approved gas metal arc process, other than short circuit arc, will be permitted for joints that will subsequently be welded using an approved submerged arc automatic welding process.

**1080.3.3.5.3** ~~AWS See Clause 1.5.1.3 Paragraph 1.5.8.1.3.7~~ - A new Paragraph ~~1.5.8.1.3.7~~ shall be added as follows:

All primary shop welds shall be made by approved submerged arc automatic welding processes. The automatic welding process shall be one in which the wire or electrode feed, speed of travel and guidance are all mechanically controlled. Noncompliance with this requirement will be cause for rejection of the welded material unless prior approval is granted by the engineer for welding the specified joints by the use of other processes. The automatic welding process requirement for primary shop welds shall be shown on the shop drawings for each joint. Primary shop welds will be defined as flange and web butt welded splices in I-beams, box members and plate girders, plate girder or box flange to web fillet welds and cover plate to flange fillet welds.

**1080.3.3.5.4** ~~AWS See Clause 4.8.2.8 Paragraph 4.8.1 and Table 4.12.8.1.1~~ - Paragraph ~~4.8.12.8.1.1~~ and Table 4.1 shall be replaced with the following:

The minimum fillet weld size, except for fillet welds used to reinforce groove welds, shall be as shown in the following table or as calculated using procedures established to prevent cracking in accordance with AWS Paragraph ~~6.2.1.2~~~~4.2.2~~. In both cases, the minimum size shall apply if the size is sufficient to satisfy design requirements.

<b>Table 4.1 Minimum Fillet Weld Size</b>	
<b>Material Thickness of Thicker Part Joined, in.</b>	<b>Minimum Size of Fillet Weld<sup>a</sup>, in.</b>
To 3/4	1/4 <sup>b</sup>
Over 3/4 to 2 1/2	5/16 <sup>b</sup>
Over 2 1/2	1/2

<sup>a</sup>Except that the weld size need not exceed the thickness of the thinner part joined.

<sup>b</sup>Single pass welds must be used.

**1080.3.3.5.5** ~~AWS Clause 4.17 Paragraph 4.17.3 - Paragraph 4.17.3 shall be deleted. Paragraph 4.17.2 shall be used.~~

**1080.3.3.5.6.4.** AWS ~~See Clause 5.23.2 Paragraph 5.2.5.23.2.2.2~~ (4) - A new Paragraph ~~5.2.5.23.2.2.2~~ (4) shall be added as follows:

Quenched and tempered steel plate may be thermally cut provided sufficient preheating is applied according to the steel producer's written recommendations. Procedures for thermal cutting of quenched and tempered steel plate, along with the steel producer's written report, shall be submitted to the engineer for approval prior to the start of such work.

**1080.3.3.5.7.5** AWS ~~See Clause 5.23.2 Paragraph 5.2.6.43.2.3.4~~ - Paragraph ~~5.2.6.43.2.3.4~~ shall be replaced with the following:

The corrective procedures described in Table 3.1 shall not apply to discontinuities in rolled base-metal surfaces. Such discontinuities may be corrected by the fabricator in accordance with ASTM A6, except that repair by welding will be permitted only when approved by the engineer. Approval will be limited to areas where there will be less than the maximum design stress in the finished structure. When surface imperfections in alloy, low alloy and carbon steel plates are repaired by grinding, the surfaces shall have edges faired to the plate surface with a maximum slope of 1 in 10.

**1080.3.3.5.8** ~~AWS Clause 5.2 Paragraph 5.2.9.1 - A new paragraph 5.2.9.1 shall be added as follows:~~

~~All corners of rolled or thermal cut edges not being welded shall have a 1/16-inch radius or equivalent flat surface at a suitable angle.~~

**1080.3.3.5.6.9** AWS ~~See Clause 5.23.2 Paragraph 5.2.133.2.11~~ - A new paragraph ~~5.2.133.2.11~~ shall be added as follows:

Edges of principal pieces as identified in Sec 1080.2.9 shall not be produced by mechanical shearing. For other than principal pieces, sheared edges of plates not to be welded that are more than 5/8 inch thick and carrying calculated stress shall be planed to a depth of 1/4 inch.

**1080.3.3.5.10** ~~AWS Clause 5.3 Paragraph 5.3.7.5 (1) and (2) - Paragraph 5.3.7.5 (1) and (2) shall be replaced with the following:~~

If a tack weld breaks or cracks before or during welding, the broken or cracked tack weld shall be ground smooth and base metal magnetic particle tested (MT) to ensure no cracks are present before welding. Tack weld may be replaced if necessary.

**1080.3.3.5.117** AWS ~~See Clause 5.3.3.3~~ Paragraph ~~5.3.83.3.8~~ - Paragraph ~~5.3.83.3.8~~ shall be replaced with the following:

Unless previously approved in writing by the engineer, there shall be no temporary welds for fabrication, transportation, erection or other purposes on primary members except at locations more than 1/6 the depth of the web from the flanges of beams and girders. Temporary welds shall be subject to the same WPS requirements as final welds. Temporary welds shall be removed unless otherwise permitted by the engineer and the surface shall be made flush with the original surface. ~~Unless previously approved in writing by the engineer, there shall be no temporary welds for fabrication, transportation, erection or other purposes on main members except at locations more than 1/6 the depth of the web from the flanges of beams and girders.~~ There shall be no temporary welds in tension zones of members of quenched and tempered steels. Temporary welds at other locations shall be shown on shop drawings and shall be made with approved consumables. Removal of temporary welds shall conform to Paragraphs ~~3.5.3.7.3~~ and ~~3.5.3.7.4~~.

**1080.3.3.5.128** AWS ~~See Clause 5.4.3.4~~ Paragraph ~~5.4.63.4.6~~ - Paragraph ~~5.4.63.4.6~~ shall be replaced with the following:

All shop splices in each component part of a cover-plated beam or built-up member shall be made and all required nondestructive testing completed and approved by the engineer before the component part is welded to other component parts of the member. Long members or member sections may be made by shop-splicing subsections, each made in accordance with this AWS subclause 4.17.6 ~~section (See 2.17.6)~~. All shop splices shall be made using full penetration welds that fully develop the capacity of the original member. Additional shop splices required due to length limits of available material may be used if detailed on the shop drawings and placed at locations approved by the engineer. No additional payment will be made for any additional shop splices placed in the members at the option of the contractor, including shop splices that may be required as a result of material limitations.

**1080.3.3.5.139** AWS ~~See Clause 5.53.5~~ Paragraph ~~5.5.8.13.5.1.8.1~~ - A new Paragraph ~~5.5.8.13.5.1.8.1~~ shall be added as follows:

The maximum permissible variation from specified width for rolled or burned flange plates shall be -1/8 inch to +3/8 inch.

**1080.3.3.5.1410** AWS ~~See Clause 5.53.5~~ Paragraph ~~5.5.93.5.1.9~~ - Paragraph ~~5.5.93.5.1.9~~ shall be replaced with the following:

The bearing ends of bearing stiffeners shall be flush and square with the web and shall have at least 75 percent of this area in contact with the inner surface of the flanges. The remaining 25 percent of the area of the bearing stiffener shall be within 0.010 inch of the inner surface of the flanges. When bearing against a steel base or seat, all steel components shall fit within 0.010 inch for 75 percent of the projected area of web and stiffeners and not more than 1/32 inch for the remaining 25 percent of the projected area. Girders without stiffeners shall bear on the projected area of the web on the outer flange surface within 0.010 inch. The included angle between web and flange shall not exceed 90 degrees in the bearing length. The top surface of a flange or shelf plate supporting a steel bearing rocker shall be considered a flat surface with a tolerance of 0.003 inch per inch in any direction over the projected area of the rocker. The top

surface of a flange or shelf plate in direct contact with elastomeric bearings shall not deviate from a true plane surface by more than 1/16 inch.

**1080.3.3.5.1514** AWS ~~See Clause 5.53.5 Paragraph 5.5.173.5.1.16~~ - A new Paragraph ~~5.5.173.5.1.16~~ shall be added as follows:

Permissible variation in length of assembled beams or girders between the centerline of bearing devices shall not exceed plus or minus 1/4 inch for any one span or plus or minus 1/2 inch for any two or more spans within the assembled unit. The actual centerline of any bearing device shall lie within the thickness of the bearing stiffener.

**1080.3.3.5.1612** AWS ~~See Clause 5.73.7 Paragraph 5.7.2.63.7.2.5~~ - A new Paragraph ~~5.7.2.63.7.2.5~~ shall be added as follows:

If, after three repairs to the same area of a weld requiring radiographic or ultrasonic quality, there is any part of the original defect remaining or there is a new rejectable indication, the total joint shall be cut apart, all deposited weld metal removed, joint preparation made and the total joint rewelded.

**1080.3.3.5.1713** AWS ~~See Clause 5.73.7 Paragraph 5.7.2.73.7.2.6~~ - A new Paragraph ~~5.7.2.73.7.2.6~~ shall be added as follows:

The gas metal arc welding process shall not be used for the repair of welds except when repairing welds made with the GMAW process.

**1080.3.3.5.18** AWS ~~Clause 7.12 Paragraph 7.12.5~~ - Paragraph 7.12.5 shall be replaced with the following:

**Production Procedure Qualification.** The Production Procedure WPS qualification method shall be used to qualify the following:

- (1) SAW WPSs utilizing active fluxes for other than single and two pass applications.
- (2) All groove WPSs not using the standard joint details shown in Figures 4.4 and 4.5.
- (3) WPSs using matching strength filler metals for Grade HPS 100W steel.
- (4) WPSs for welding on unlisted base metals (see 7.4.2).
- (5) WPSs that include PWHT.

Production Welding Limitations in accordance with 7.12.4 shall be used when qualification is in accordance with 7.12.2 or 7.12.3.

**1080.3.3.5.19** AWS ~~Clause 7.13 and 7.14~~ - Clause 7.13 and 7.14 shall be deleted. Electrogas (EGW) and Electoslag (ESW) shall not be allowed on any bridge components.

**1080.3.3.5.2014** AWS ~~See Clause 7.215.21 Paragraph 57.21.6.2~~ - A new Paragraph ~~57.21.6.2~~ shall be added as follows:

Any cost involved in qualifying welders, welding operators and tackers, including all material costs, finishing of test specimens, the physical testing of finished specimens and any radiography required shall be borne by the contractor. Required radiography and physical testing of finished specimens shall be performed at test facilities approved by the engineer.

**1080.3.3.5.21 AWS Clause 8 Table 8.1** - Table 8.1 shall be replaced with the following:

<b>Table 8.1 – NDT Methods and Frequency</b>				
<b>Weld Type</b>	<b>Joint Type</b>	<b>Member Design Stress Type</b>	<b>NDT Method</b>	<b>Frequency</b>
<b>CJP Groove Welds</b>	<u>Butt joints other than in webs of flexural members</u>	<u>Tension, compression or shear</u>	<u>RT<sup>a</sup></u>	<u>100% of each joint</u>
	<u>Butt joints in webs of flexural members, transverse to the direction of bending stress</u>	<u>Tension or compression</u>	<u>RT<sup>a</sup></u>	<u>1/6 of the web depth beginning at each flange joint for each joint</u>
			<u>RT<sup>a</sup></u>	<u>25% of the remainder of the web depth for each joint</u>
	<u>Butt joints in webs of flexural members, parallel to the direction of bending stress</u>	<u>Shear</u>	<u>RT<sup>a</sup></u>	<u>1/3 of length at even intervals throughout length of joint for each joint (See Sec 1080.3.3.5.24)</u>
	<u>T- or corner joints</u>	<u>Main member in tension, compression or shear</u>	<u>UT<sup>b</sup></u>	<u>100% for each joint</u>
		<u>Secondary member in tension</u>	<u>UT<sup>b</sup></u>	<u>100% for each joint<sup>d</sup></u>
		<u>Secondary member in compression or shear</u>	<u>UT<sup>c, d</sup></u>	<u>25% for each joint (See Sec 1080.3.3.5.24)</u>
<u>PJP groove welds and fillets welds, Grade HPS 100W</u>	<u>Any</u>	<u>Any</u>	<u>RT<sup>a</sup> or UT<sup>b</sup></u>	<u>100% of each joint</u>
<u>PJP groove welds and fillets welds, all other grades</u>				<u>10% of each joint (See 8.7.4)</u>

<sup>a</sup> RT acceptance-rejection criteria shall be based on Figure 8.8, Weld Quality Requirements for Discontinuities Occurring in Tension Welds

<sup>b</sup> UT acceptance-rejection criteria shall be based on Table 8.4, UT Acceptance-Rejection Criteria – Tension Stress

<sup>c</sup> UT acceptance-rejection criteria shall be based on Table 8.5, UT Acceptance-Rejection Criteria – Compressive Stress

<sup>d</sup> Not required on L shaped plate connections brackets on Strip Seal, Compression Seal, Open Cell Foam, Silicone, Preformed Silicone or EPDM Expansion Joint Systems.

~~1080.3.3.5.2215~~ AWS See ~~Clause 8.16.1 Paragraph 8.1.66.1.6~~ - A new Paragraph ~~8.1.66.1.6~~ shall be added as follows:-

~~-~~  
**Nondestructive Testing (NDT) Qualifications Submittal.** The contractor shall submit to Bridge Division the following documentation for each individual performing nondestructive testing ~~(NDT)~~; their certifications, current eye exam, and the NDT company written practice, including the Level III individual certification used for the written practice.

~~1080.3.3.5.2316~~ AWS See ~~Clause 8.66.6 Paragraph 6.6.58.6.5~~ - Paragraph ~~8.6.56.6.5~~ shall be replaced with the following:

If the engineer subsequently requests nondestructive testing, not specified in the original contract agreement, the contractor shall perform any requested testing or shall permit any requested testing to be performed. Handling, surface preparation, repair welds and any nondestructive testing requested by the engineer, as a result of weld repair, shall be at the contractor's expense. Payment for any non-destructive testing that does not indicate the need for repair to the tested weld will be in accordance with Sec 109.4.

~~1080.3.3.5.24~~ AWS Clause 8.7 Paragraph 8.7.1 - Paragraph 8.7.1 shall be replaced with the following:

~~CJP Groove Welds.~~ In main members, CJP groove welds shall be tested by NDT. Unless otherwise provided, RT shall be used for examination of CJP groove welds in butt joints subject to calculated tension, compression or reversal of stresses. All CJP groove welds in T- and corner joints shall be tested by UT.

~~1080.3.3.5.25~~ AWS Clause 8.7 Paragraphs 8.7.3, 8.7.3.1, 8.7.3.2 and 8.7.3.3 – Paragraphs 8.7.3.1, 8.7.3.2 and 8.7.3.3 shall be deleted and Paragraph 8.7.3 shall be replaced with the following:

~~CJP Groove Welds Subject to Partial Testing.~~ If a defect is found in any test length of a weld, the entire length shall be tested by UT or RT.

~~1080.3.3.5.26~~ AWS Clause 8.10 Paragraph 8.10.12.1 – A new Paragraph 8.10.12.1 shall be added as follows:

~~Location marks shall include a 3rd location identification mark which is a “floating” mark. This floating location mark shall be randomly placed within each exposure at the same distance from the edge of the weld.~~

~~1080.3.3.5.17~~ AWS Sec 6.7 Paragraphs 6.7.1, 6.7.1.1 and 6.7.1.2 – Paragraphs 6.7.1, 6.7.1.1 and 6.7.1.2 shall be replaced with the following:

~~Radiographic inspection (RT) shall be required for areas of both shop and field butt welds as specified herein with RT acceptance or rejection criteria based on 2002 AWS D1.5 Table 6.8, Tension Welds.~~

- ~~a. One hundred (100) percent inspection shall be required for flanges of rolled beams and girders~~

- b. ~~One hundred (100) percent of transverse butt welds in webs for a distance of no less than one sixth of the web depth from each flange~~
- c. ~~Twenty five (25) percent of the remainder of the web depth~~
- d. ~~At least one third of the length of all longitudinal web splices shall be radiographed at even intervals throughout the length of the splice.~~

~~When a rejectable defect is found by radiography in any partially tested joint, either initially or in a later additional radiograph, tests shall be conducted on either side of and adjacent to the rejectable test area. If a rejectable defect is found in any additional areas, then 100 percent of vertical web splices and an additional 10 percent of total weld length in longitudinal web splices shall be tested. The location of these additional test areas shall be as directed by the engineer. All complete joint penetration groove welds in T and corner joints shall be 100 percent tested by ultrasonic testing (UT) with UT acceptance or rejection criteria based on 2002 AWS D1.5 Table 6.3, Tension Stress, except as follows: L shaped plate connection brackets on expansion devices with complete joint penetration welds at the corner, are not required to be ultrasonically tested. On fabricating expansion joints only (does not apply to finger, flat and modular expansion devices), 25 percent of each joint subject to compression or shear, or, at the contractor's option, 25 percent of the total joints subject to compression or shear. When the latter is selected, the tested joints shall be distributed throughout the work and shall total at least 25 percent of the compression or shear weld length.~~

- a. ~~If unacceptable discontinuities are found in spot testing, the entire length shall be tested.~~
- b. ~~If unacceptable discontinuities are found in 20 percent or more of the compression or shear joints in that "lot", all compression and shear joints in that "lot" shall be tested for their full length. A "lot" is defined as those tension or compression/shear joints, or both, which were welded in accordance with the same approved WPS and non-destructively tested as a group.~~
- c. ~~Ultrasonic testing acceptance or rejection criteria will be in accordance with 2002 AWS D1.5 Table 6.4 Compressive Stress.~~
- d. ~~Shop complete joint penetration splicing of flat bar, beam, or support angle under the expansion joint is only by approval and shown on the shop drawings, this type of splicing will require 25 percent ultrasonic testing as stated.~~

~~**1080.3.3.5.18 AWS Sec 6.10 Paragraph 6.10.3.4** A new Paragraph 6.10.3.4 shall be added as follows:~~

~~Edge blocks shall be used when radiographing butt welds greater than 1/2 inch in thickness. The edge blocks shall have a length sufficient to extend beyond each side of the weld centerline for a minimum distance of 2 inches and shall have a thickness equal to the thickness of the weld, plus or minus 1/16 inch. The minimum width of the edge blocks shall be no less than 1 inch. The edge blocks shall be centered on the weld with a snug fit against the plate being radiographed, allowing no more than 1/16 inch gap. Edge blocks shall be made of radiographically clean steel and the surface shall have a finish of ANSI 125µin. or smoother (refer to ANSI/AWS D1.1-98 Structural Welding Code Steel, Sec 6.17, Paragraph 6.17.13 and Figure 6.15).~~

~~**1080.3.3.5.19 AWS Sec 6.10 Paragraph 6.10.11.2** Paragraph 6.10.11.2 shall be replaced with the following:~~

~~If the greatest and least thickness of a weld connecting parts of different thickness cannot be rendered with adequate contrast on a single film with a single exposure, a dual film or dual~~

~~exposure technique shall be used to obtain suitable density for both the greatest and the least thickness of the weld.~~

**1080.3.3.5.2720** AWS ~~See Clause 8.126.42~~ Paragraph ~~8.12.3.16-12.4~~ - A new Paragraph ~~8.12.3.16-12.4~~ shall be added as follows:

After completion of all radiographic inspection, the contractor shall submit to the engineer one set of drawing details showing the location and identification numbers of all radiographs taken.

**1080.3.3.5.28** AWS Clause 8.26 Paragraph 8.26.2 - Paragraph 8.26.2, shall be replaced with the following:

**Radiographic (RT) and Magnetic Particle (MT) Inspection.** Welds that are subject to RT or MT in addition to visual inspection shall have no cracks and shall be unacceptable if the RT or MT shows any of the types of discontinuities described in the 8.26.2.1 as modified below, 8.26.2.3 and 8.26.2.4.

**1080.3.3.5.2924** AWS ~~See Clause 8.266.26~~ Paragraph ~~68.26.2.1~~ - Paragraph ~~68.26.2.1~~ shall be replaced with the following:

**Welds Carrying Tensile or Compressive Stress.** For any welds, the greatest dimension of any porosity or fusion type discontinuity that is 1/16 inch or larger in greatest dimension shall not exceed the size, B, indicated in Figure ~~8.86-8~~ for the effective throat or weld size involved. The distance from any porosity or fusion type discontinuity described above to another such discontinuity, to an edge or to the toe or root of any intersecting flange-to-web weld shall not be less than the minimum clearance allowed, C, indicated in Figure ~~8.86-8~~ for the size of discontinuity under examination.

**1080.3.3.5.3022** AWS ~~See Clause 8.266.26~~ Paragraph ~~68.26.2.2~~ and Figure ~~8.96-9~~ - ~~Delete~~ Paragraph ~~68.26.2.2~~ and Figure ~~8.96-9~~ shall be deleted.

**1080.3.3.5.3123** AWS ~~See Clause 8.266.26~~ Paragraph ~~68.26.3.1 (1) and (2)~~ - Paragraph ~~68.26.3.1 (1) and (2)~~ shall be replaced with the following:

(1) Welds subjected to ultrasonic testing **tension stress criteria per modified Table 8.1 (Sec 1080.3.3.5.20)** in addition to visual inspection shall conform to the requirements of Table ~~8.46-3~~ **UT Acceptance-Rejection Criteria-Tensile Stress.**

(2) Welds subjected to ultrasonic testing **compressive stress criteria per modified Table 8.1 (Sec 1080.3.3.5.20)** in addition to visual inspection shall conform to the requirements of Table ~~8.5,~~ **UT Acceptance-Rejection Criteria-Compressive Stress.**

**1080.3.3.5.32** AWS Clause 12.17 Paragraph 12.17.6 (11) - Paragraph 12.17.6 (11) shall be replaced with the following:

(11) Hydrogen Diffusion Post Heat listed in Clause 12.15 shall be required for all critical repair groove welds and shall be described on the WPS for approval.

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**

**1080.3.3.8 Longitudinal Stiffeners.** Longitudinal girder web stiffeners shall be a single length if possible. If more than a single length is necessary, such lengths shall be joined by a full penetration butt weld. The location of these butt welds shall be shown on the shop drawings for each joint and shall be subject to approval by the engineer. Runoff plates in accordance with

AWS [D1.5: 2025, Clause 5.12](#)~~Section 3.12~~ shall be used. The welds shall be radiographically tested and accepted in accordance with AWS [D1.5: 2025, Clause 8.10](#)~~Sec 6.10~~ prior to being attached to the web.

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**

**1080.4.2.2 Fabrication Requirements.** All fabrication shall be in accordance with the latest edition of the *AASHTO Guide Specifications for Highway Bridge Fabrication with HPS70W Steel*, an addendum to be used in conjunction with ANSI / AASHTO / AWS D1.5: [2025](#)~~2002~~, except as modified by this section. Only fabricators meeting the requirements of the AISC Certification Program for Steel Bridge Fabricator Advanced Bridge (ABr) classification or approved equal may be used to fabricate HPS 50W and HPS 70W steel. Whenever magnetic particle testing is conducted, only the yoke technique will be permitted as described in [AWS D1.5: 2025, Paragraph 8.7.8.2](#),~~Sec 6.7.6.2 of AWS D1.5: 2002~~,which shall be modified to test using alternating current only.

**1080.4.2.3 Welding Requirements for HPS.** All welding for high performance steel shall be in accordance with ~~ANSI/AASHTO / ANSI~~ / AWS D1.5: [2025](#)~~2002~~ Bridge Welding Code, except as modified herein and by the latest edition of the *AASHTO Guide Specifications for Highway Bridge Fabrication with HPS70W Steel*. Only submerged arc and shielded metal arc welding processes shall be permitted when welding Grade HPS 70W steel. The matching submerged arc consumables using the ESAB electrode and Lincoln flux combinations, recommended in Appendix A of the guide specification shall not be allowed. Filler metals used for single pass fillet welds or for complete joint penetration groove welds connecting Grade HPS 70W plate to ASTM A709 Grade HPS 50W or Grade 50W may conform to the matching or undermatching requirements from AWS D1.5: [2025](#)~~2002~~ as indicated in the guide specification. Moisture resistant coating shall be required for all shielded metal arc welding. The contractor may request approval of alternate consumables in lieu of the filler metals listed in the guide specification for submerged arc welding in accordance with AWS D1.5: [2025](#), Table [6.14.4](#). The request for approval shall include documentation of successful welding and shall include diffusible hydrogen tests indicating the levels of diffusible hydrogen to meet the requirements of the guide specifications. Grade HPS 50W may be welded under the same requirements as ASTM A709 Grade 50W.

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**

**1080.4.6 Welding.** All welds shall utilize welding processes and electrodes as required that will provide corrosion resistance and weathering characteristics for the welds comparable to the base metal, in accordance with the [AWS D1.5: 2025, Clause 6](#)~~Section 4 of AWS D1.5: 2002~~ or as modified in [Sec 1080.4.2.3](#).

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**

### 136.7.3.1.2.1.8.2 Acceptance of Structural Steel

The following procedures have been established for the acceptance of structural steel. Shop drawings [in accordance with Sec 1080.3.2](#) shall be submitted for review and approval to the engineer of record for the ~~Local~~ ~~Public~~ Agency (LPA). The approval is expected to cover only the general design features, and in no case shall this approval be considered to cover errors or omissions in the shop drawings. It is recommended that the contract documents contain provisions that the contractor shall utilize a fabricator that meets the appropriate American Institute of Steel Construction (AISC) certification provisions as outlined in [Sec 1080.3.1.6](#). Additional information regarding the AISC certification program can be found on [the AISC website](#).

All welding operations, including material and personnel, shall meet the American Welding Society (AWS) specifications [as specified in Sec 1080.3.3.4](#). ~~Primary welds shall meet the provisions of Sec 1080.3.3.5.2.~~ The LPA or their engineer of record has the option of inspecting the steel units during fabrication or requiring the fabricator to furnish a certification of contract compliance and substantiating test reports. In addition, the reports shown below shall be required.

- Certified mill test reports, including results of chemical and physical tests on all structural steel as furnished.
- Non-destructive testing reports.
- Verification of the girder camber, sweep, and other blocking data.
- Verification of coating operations.

The LPA or their engineer of record shall verify and document that the dimensions of the structural steel units were checked at the jobsite and found to be in compliance with the shop drawings.

### 712.1.4.1.3 Shear Connector Welding

Current practices by the contractor may utilize the installation of shear connectors by field personnel. Most shear connector welding is completed by an automated welding process. AWS does not have a qualification procedure established in QC7. Instead, welders shall be qualified in accordance with ~~2002~~ [AWS D1.5: 2025](#), Bridge Welding Code, ~~D1.5~~ Clause ~~79~~.7 by MoDOT field personnel. Shear connector welders shall be qualified by conducting a preproduction test. This test involves the welder welding two shear connectors to a test plate or to the production plate. The test specimens shall be visually inspected to ensure a full 360° weld. After the welds have cooled, the shear connectors shall then be bent to an angle of approximately 30° from the original axis by either striking with a hammer or placing a pipe over the shear connector and then bending. If the shear connector does not exhibit a complete weld or a failure occurs in the weld of either shear connector, the welder shall adjust the automatic welding machine and retest on a separate weld test plate. The welder may not retest on the actual production plate.

Before shear connector production welding in the field begins with a particular welder set-up, a specific shear connector size or type, and at the beginning of production for a particular shift or day, a preproduction test shall be conducted. The preproduction test shall be conducted on the first two shear connectors welded

to the production plate or may be conducted on a separate test plate of the same thickness (+/- 25%). The acceptance method is the same as given earlier for the welder test.

Once shear connector production welding has commenced, any welds that do not exhibit the full 360° weld may be repaired using a 5/16 in. fillet weld for shear connector diameters up to one inch and 3/8 in. for diameters greater than one inch. The repair weld shall extend 3/8 in. beyond the end of the area to be repaired.

Additional verification of shear connector welds in the field will be performed by sounding a random 25% of the shear connectors on the girder/beam with a sledge hammer. The field inspector will also sound 25 percent of the shear connectors used on expansion device(s) whether shop or field installed. A sharp ping sound is heard on a good weld. A thud sound will occur if the weld is possibly not sufficient and a bent test needs to be performed on this shear connector. A random 5% of all shear connectors will be bent to an approximately 30° from the original axes to verify the integrity and welding of the shear connector. If a failed weld is discovered, all adjacent connectors shall be tested. Particular emphasis on testing shall be at the start-up of the welding operation. Once an acceptable welding process is established, any weld failures should be rare. For a large bridge with many shear connectors, the 5% testing rate may be decreased at the engineer's discretion. Any failed welds shall be ground off, base metal pull outs repaired by approved weld procedures, weld surface ground flush and a replacement shear stud installed.

On a re-deck project, some shear connectors may be bent from the deck removal or from the original construction testing. These shear connectors do not have to be replaced or straightened. Shear connectors on new or re-deck projects may also need to be field bent to accommodate expansion joints, rebar conflicts or other construction needs. If a shear connector is severely bent where concrete coverage is compromised, the shear connector shall be removed and replaced.

### **751.5.9.3.3 Fracture Control Plan (FCP)**

Fracture Control Plan (FCP), Section 12 of ANSI/AASHTO/AWS D1.5: 2025-95, Bridge Welding Code, Clause 12, Fracture Control Plan (FCP) for Nonredundant Members shall apply to fracture critical non-redundant members.

Main elements and components whose failure is expected to cause the collapse of the bridge shall be designated as failure-critical, and the associated structural system as non-redundant. Examples of non-redundant members are flange and web plates in one or two girder bridges, main one-element truss members and hanger plates.

For non-redundant steel structures or members, the designer shall determine which, if any, component is a Fracture Critical Member (FCM). The location of all FCMs shall be clearly delineated on the design plans.

FCMs are defined as tension members or tension components of bending members (including those subject to reversal of stress), the failure of which would be expected to result in collapse of the bridge. The designation "FCM" shall mean fracture critical member or member component. Members and components that are not subject to tension stress under any condition of live load are not fracture critical.

Any attachment welded to a tension zone of an FCM shall be considered an FCM when any dimension of the attachment exceeds 4 inches in the direction parallel to the calculated tensile stress in the FCM.

Attachments designated FCM shall meet all requirements of FCP. All welds to FCMs shall be considered

fracture critical and shall conform to the requirements of FCP. Welds to compression members or the compression area of bending members are not fracture critical.

FCMs shall be fabricated in accordance with FCP. Material for FCM shall be tested in accordance with AASHTO T243 (ASTM A673), Frequency P. Material for components not designed as fracture critical shall be tested in conformance with AASHTO T243 (ASTM A673), Frequency H. [Sec 712](#) and FCM Special Provisions will include additional requirement for material, welding, inspection and manufacturing.

Notes EPG 751.50 Miscellaneous A5.1 and H1.23b Structural Steel for Wide Flange Beams and Plate Girder Structures shall be placed on contract plans as required.



## SECTION 1042

### HIGHWAY SIGN MATERIAL

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

**1042.2.7 Retroreflective Sheeting.** Retroreflective sheeting shall be in accordance with latest versions or ASTM D 4956 and AASHTO M 268, except as noted herein. Retroreflective sheeting shall have sufficient adhesion, strength and flexibility such that the sheeting can be handled, processed and applied according to the manufacturer's recommendations without appreciable stretching, tearing, cracking or other damage. Adhesive performance for retroreflective sheeting shall be in accordance with ASTM D 4956. The sheeting surface shall be in condition to be readily screen processed and compatible with transparent overlay films, plus recommended transparent and opaque screen process colors. The retroreflective sheeting manufacturer shall furnish information as to the type of solvent or solvents that may be used to clean the surface of the sheeting without detrimental loss of performance and durability. Retroreflective sheeting having a datum mark on the surface shall be oriented vertically. ASTM D 4956 Type IX, XI or AASHTO M 268 Type ~~C or~~ D retroreflective sheeting applied as legend and border for specific signing applications, without a datum mark on the surface of the sheeting, shall be evaluated for rotational sensitivity per AASHTO M 268, Section 3.3. Retroreflective sheeting products that do not meet the rotational sensitivity requirements of Section 3.3 shall follow guidelines detailed in AASHTO M 268 Section 3.3.1 and fabricated per AASHTO M 268 Section 3.3.2.

~~1042.2.7.1 ASTM D 4956 Type I, Class 1 retroreflective sheeting shall be enclosed lens glass bead or prismatic sheeting.~~

**1042.2.7.12 Sign Sheeting.** ~~ASTM D4956 Type I, Class 1 retroreflective sheeting shall be enclosed lens glass bead or prismatic.~~ Background sheeting applied to flat sheet and extruded panel signs shall be in accordance with ASTM D 4956 Type IV, Class 1, ~~except A~~ all yellow, orange and yellow-green sheeted signs shall be fabricated with fluorescent sheeting in accordance with ASTM D 4956 Type IX, XI or AASHTO M 268 Type ~~C or~~ D.

**1042.2.7.23 Channelizers.** All reflective sheeting for trim-line and drum-like channelizers shall be in accordance with ASTM D 4956 Type IV for fluorescent orange and white sheeting. All retroreflective marking on channelizers shall be in accordance with ASTM D 4956, Supplemental Requirements, and Section S2. Reflective sheeting applied to channelizers shall be reboundable in accordance with ASTM D 4956. Retroreflective marking on cones will not be required.

**1042.2.7.34 Barricades.** All reflective sheeting for barricades shall be in accordance with ASTM D 4956 Type IV.

**1042.2.7.45 Delineators.** All retroreflective sheeting for delineators shall be in accordance with ASTM D 4956 Type IX or XI requirements, except permanent and temporary tubular delineators, which shall be ASTM D 4956 Type IV requirements. All permanent and temporary tubular delineators' reflective sheeting shall be reboundable in accordance with ASTM D 4956.

**1042.2.7.56 Structural Signs** Retroreflective sheeting applied as legend and border shall be in accordance with ASTM D 4956, Type IX, XI or AASHTO Type C or D, Class 1. All structural signs shall be built using extruded panels per Sec 903.

**1042.2.7.67 Screen Print, Digital Print and Translucent Overlay Films.** For screen printed ~~translucent~~ ~~transparent~~ colored areas, ~~translucent~~ ~~or transparent~~ colored overlay films or digital printed areas on white sheeting, the coefficient of retroreflection ( $R_A$ ) shall be no less than 70 percent of the original values for the corresponding color.

**1042.2.8 Outdoor Exposure.** Retroreflective sheeting, except for work zone signs, shall be submitted by the manufacturer to AASHTO Product Evaluation and Audit Solutions program for ~~three~~ ~~two~~ years of 45-degree south-facing outdoor exposure. Retroreflective sheeting for rigid work zone signs and devices shall be submitted by the manufacturer to AASHTO Product Evaluation and Audit Solutions for an exposure time of one year. Results shall be published by AASHTO Product Evaluation and Audit Solutions program and available for MoDOT review. For all AASHTO Product Evaluation and Audit Solutions test decks, retroreflective sheeting shall have a coefficient of retroreflection at least 50 percent of the specified value for ASTM D 4956 Type I or 80 percent of the specified values ~~original reading~~ for ASTM D 4956 Type IV, IX or XI.

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

**1042.2.10.1 Screen Print, Digital Print, Translucent~~Transparent~~ Overlay Films and Opaque Black Film.**

**1042.2.10.1.1** The letters, numerals, arrows, symbols and borders shall be applied to the background of the sign by the direct or reverse screen process. Messages and borders of a color darker than the sign field shall be applied to the retroreflective sheeting by the direct process. Messages and borders of a color lighter than the sign field shall be produced by the reverse screen process. Inks used in the silkscreen process shall be of the type to produce the desired color and durability when applied on retroreflective sheeting. Silkscreen inks shall be used in accordance with the manufacturer's recommendations. The ink shall produce the desired color when applied on retroreflective sheeting background and shall dry to a good film without running, streaking or sagging. The screening shall be done in a manner that results in a uniform color and tone, with sharply defined edges of legend and border without blemishes on the sign field that will affect the intended use. Signs after screening shall be dried in accordance with the manufacturer's recommendations to provide a smooth hard finish. Any signs on which blisters appear during the drying process will be rejected. Permanent traffic signs using digital print must be produced using matched components and processes that comply with retroreflective sheeting manufacturer's recommendations. All fabrication processes on retroreflective sheeting specified herein shall conform to all requirements of the current version of ASTM D4956 and its classification.

**1042.2.10.1.2** ~~Translucent~~ ~~Transparent~~ overlay films may be used as a replacement for the reverse screen process, as recommended by the sheeting manufacturer. Digital print on permanent traffic signs will be fabricated with a full protective clear overlay film over the sign designed to provide a smooth surface needed for retroreflectivity, and to protect the sign from fading and UV degradation. The overlamine shall be part of the manufacturer's matched component system. Refer to the ATSSA Digitally Printed Traffic Sign Guide Specification section 2.3 subsection 2.3.1 Table 1 for reflective film durability requirements.

**1042.2.10.1.3 Certified Digital Sign Fabricator.** Sign fabricators using digital imaging methods to produce permanent traffic signs must be certified by the reflective sheeting manufacturer whose matched component systems are to be used to produce the signs. The

sheeting manufacturer's warranty obligations must be validated by an audit process through the sheeting manufacturer. Sign fabricators must undergo a training and certification process by the sheeting manufacturer to ensure this audit process. Sign fabricators must re-certify annually with the reflective sheeting manufacturers or utilize a 3<sup>rd</sup> party certifier approved by the reflective sheeting manufacturer. Purchasing agency shall require proof of Sign Fabricator Certification with the execution of a purchase order (P.O) or construction contract for signs. Refer to ATSSA Digitally Printed Traffic Sign Specification section 6 per <https://www.atssa/resourcece/digitally-traffic-sign-guide/>.

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

**1042.3 Sign Fabrication.** A sign shall consist of aluminum flat sheets or extruded panels retroreflectorized on the face side with all letters, numerals, symbols, borders, corners and route shields mounted on the face, and shall include all necessary mounting devices shown on the plans. Signs equal to or greater in width than six feet are considered structural (ST) and shall be fabricated on extruded panels. Signs less than six feet in width will be considered sheet (SH) signs and shall be fabricated with flat sheet aluminum. Any exceptions to these fabrication standards will be indicated on the plans.

**1042.3.1** All signs must meet and comply with daytime and nighttime chromaticity as recognized in ASTM D4956~~shall be of the highest quality with consistent daytime and nighttime color and retroreflectivity throughout the sign and produced as follows.~~

**1042.3.1.1** Except as otherwise allowed for extruded aluminum panels in Sec 1042.3.1.2, all aluminum substrate shall be given a chromate conversion coating in accordance with ASTM B 449, Class 2 or ASTM B 921, Class 2, and shall be prepared by one of the Treatment Sequence Options described in ASTM B 449, Appendix X2 or ASTM B 921. The chemicals and solvents shall be applied in strict accordance with the manufacturer's recommendations. Sufficient laboratory facilities to test and control the concentration of the solutions used shall be maintained at the ~~treating~~treatment plant. A data log of the concentration of treating solutions shall be maintained. Treated panels ~~shall~~should be handled in such a manner as to prevent contamination. Panels shall be stored in a dry, clean area free from dust, acid fumes or vapors. When aluminum is shipped to a secondary location for retroreflectorizing, adequate precautions shall be taken to ensure that the material arrives at the destination uncontaminated.

#### UNCHANGED SPECS – INTENTIONALLY NOT SHOWN

**1042.3.1.4** Retroreflective sheeting splices on structural signs shall be kept to a minimum. Rolled overlap or butt splices in accordance with the sheeting manufacturer's recommendations may be used, with no more than one allowed per panel. Retroreflective sheeting shall be placed on the individual extruded panels in accordance with the manufacturer's recommendations. The sign panels may be clear coated, or edge sealed after application of the retroreflective sheeting, if recommended by the sheeting manufacturer. If edge sealer is used, the sealer shall be applied to all splices and edges. The completed sign shall have good color matching of retroreflective sheeting and shall be free from air bubbles, wrinkles or other blemishes.

**1042.3.1.5** Retroreflective sheeting applied to standard flat sheet signs shall not have splices on signs where the smallest dimension is less than 4 feet. One vertical overlap or butt splice approximately 1/4-inch wide will be allowed on standard flat sheet signs where the smallest dimension is greater than 4 feet. Any special flat sheet signs requiring splicing other than noted for the standard flat sheet signs shall be approved by the engineer. The sign panels may be clear coated, or edge sealed after application of the retroreflective sheeting if recommended by the sheeting manufacturer. If clear finish is used, the finish shall be applied after screening of

messages and borders. If edge sealer is used, the sealer shall be applied to all splices and edges. The completed sign face shall be free from air bubbles, wrinkles or other blemishes.

**1042.3.2** Nuts on panel bolts used to connect extruded panels together to form a structural sign shall be torqued to 220 - 230 inch-pounds.

**1042.3.3** Signs will be accepted on certification from the manufacture assuring all fabrication and sheeting specifications ~~follow are in compliance with~~ all applicable requirements specified herein. Periodic shop inspections of sign fabrication will be made at the discretion of MoDOT, to include contractor furnished signs for MoDOT projects. Routine shop inspections will include inspection and sampling of materials, inspection of treatment and fabrication processes, and of any signs completed at time of inspection. Inspections on delivered signs for maintenance operations will be conducted for quality assurance purposes by the appropriate district inspectors. Signs may be rejected at the fabrication shop and/or upon delivery based on unsatisfactory workmanship and/or material applications or based on any aspect of the product that is not in accordance with the specifications.

**UNCHANGED SPECS – INTENTIONALLY NOT SHOWN**

## 104.2 Project Scoping



Project Scoping is a process that is used to clearly define transportation needs and to determine the appropriate means to address them. This involves determining the root causes of the need, developing a range of possible solutions to address the need, choosing the best solution, setting the physical limits of the project, accurately estimating the cost of the project, and forecasting the delivery schedule of the project.

The purpose of project scoping is to develop the most complete, cost effective solutions, as is practical, early in the project development process. This is foundational to avoiding major design changes, large estimate adjustments, and last minute project changes later in the project development process. With proper project scoping, such changes will be minimized and will have reduced impacts on the overall project. Proper project scoping of all needs leads to a more balanced, consistent construction program.

After the elements and limits of a project become clearly defined by the project scoping process, it becomes necessary to develop a [project agreement](#) if elements of the project are to be shared between the Commission and other public agencies or private interests.

Project scoping should not be thought of as a separate, stand-alone process from the [project development process](#). It is, instead, the initial stage of the project development process where the details of appropriate solutions are developed. Project scoping begins with the delivery of the need to the project manager and continues until the elements and limits of a project become so well-defined that accurate costs and project delivery schedules can be forecast. A [project scoping process flowchart](#) depicting the project scoping process is available. [Guidance for Coring and Overlays on Bridge Decks as Part of the Project Scoping Phase provides information to be used when scoping bridge rehab and resurfacing projects to obtain accurate representations of overlay thicknesses across bridges.](#)

### 751.1.3.2 Documentation

A [structural rehabilitation checklist](#) shall be required for determining the current condition and documenting all needed improvements regardless of budget restraints. It is critical to control future growth in project scope or cost overruns during construction that is checklist captures all needed repairs using accurate quantities corresponding to contract bid items. Staff responsible for filling out checklist should contact the Bridge Division if assistance is needing in correlating deterioration with appropriate contract bid items.

A deck test is not required but may be useful in determining the most appropriate wearing surface for bridges with deck ratings of 5 or 6.

A pull off test is not required but may be useful in determining the viability of polymer wearing surface.

Both deck tests and pull off tests are performed by the Preliminary and Review Section.

A [Bridge Memorandum](#) shall be required for documenting proposed construction work and estimated construction costs for district concurrence.

A [Design Layout](#) shall be required only for widening projects where there is proposed foundation construction.

**Follow [Guidance for Coring and Overlays on Bridge Decks as Part of the Project Scoping Phase](#) to obtain accurate representations of overlay thicknesses across bridges, to be used in scoping and plan development.**

There will also be links to the **Guidance for Coring Overlays on Bridge Decks as Part of the Project Scoping Phase** Document in EPG 104.6 in the Forms box under Other Documentation and EPG 751.1.1 in the Forms box.

## Guidance for Coring Overlays on Bridge Decks as Part of the Project Scoping Phase

It is important to get an accurate representation of the asphalt overlay thickness across bridges. Some asphalt overlays taper down over the width of the shoulder. Cores should be taken along the inside edge of pavement when lane drops are possible. When lane drops are not possible, cores should be taken from the shoulder, as close to the edge of pavement as safely possible. One core per bridge span, located approximately mid span, will provide the most accurate measurements. Bridges with concrete barriers have saw cuts over the bridge piers. Midspan can be approximated by coring at the midpoint between the barrier saw cuts. Bridges with three beam rails may require more effort to find the pier locations. The exact midspan point is not necessary. A distance of 5 feet either side of midspan is acceptable for coring locations. Contact Bridge Division, if necessary, to determine mid-span points. Bridges with three or more lanes of traffic may require lane drops to obtain cores near the crown of the roadway. These situations should be coordinated with the Bridge Division contact for final coring locations.

Bridges with an asphalt overlay should have the depth of the asphalt determined by coring. The core should not advance into the concrete. If the concrete is not significantly damaged, the core hole may be backfilled with cold mix. If the concrete is penetrated more than half inch, the core hole should be patched with Polymer Modified Structural Repair. Initial set should be completed to prevent tracking by traffic.

Bridges with a dense concrete overlay should have the core advance deep enough to find the interface between the dense overlay and the original bridge deck. This may require coring to the rebar level. It is unnecessary to advance the core deeper than the rebar level. Pictures of the cores should be taken to aid in determining the beginning point of the overlay. The core hole should be patched with Polymer Modified Structural Repair. Initial set should be completed to prevent tracking by traffic.

[Polymer Modified Structural Repair | QUIKRETE: Cement and Concrete Products](#)

**TABLE 2 TYPICAL PHYSICAL PROPERTIES**

Setting Time, ASTM C191	
Initial	Approx. 20 minutes
Final	20 to 40 minutes
Compressive Strength, ASTM C109 (Modified)	
Age	PSI (MPa)
3 hours	2500 (17.2)
24 hours	4000 (27.5)
7 days	5500 (37.9)
28 days	6500 (44.8)



## Guidance for Department/Division Roles in Coring Overlays on Bridge Decks as Part of the Project Scoping Phase

District Transportation Project Designer (District Planning Manager as needed) and District Bridge Engineer role:

- District will work through asset management to develop list of prospective bridges (Completed yearly)
- District will identify potential bridges where asphalt or concrete overlays play a role in scoping and final grading (Completed yearly)
- District will provide Bridge Liaison with list of potential bridges for next two fiscal years (Completed yearly)
- District secures coring information at least 9 months ahead of projects' PS&E (PCD) and no later than rehab checklist submission (District Pavement Specialist to mark locations and arrange for coring)

Bridge Division role:

- Bridge Liaisons and Bridge Project Managers will work with Bridge Division to provide feedback to Districts on identified bridges

## 109.7 Partial Payments (for Sec 109.7)

Partial payments are payments made over the course of the contract each estimate period, and payments made for material allowance.

### 109.7.1 Payment Estimates

Payment estimates  are generated by the district construction staff throughwith the AASHTOWare Project (AWP) computer software application.

#### 109.7.1.1

Estimates will be generated for all active contracts, ~~regardless of the amount of payment ifwhen there was work encountered-performed~~ during the estimate period. This includes all estimates for contracts which will ~~produce payment, "no pay" estimates (zero dollar value) and estimates which~~ result in a negative payment.

~~Should the contract be inactive and a series of estimates will be no pay estimates, a letter or e-mail shall be sent to the contractor with a copy to the controller's office stating estimates will not be generated during the following time periods because there is no work conducted on the contract. The controller's office will record this information and will not contact the Resident Engineer because estimates haven't been generated for a specific time period.~~

#### 109.7.1.2

The first level of estimate generation will be designated by the Resident Engineer at the time of ~~contract activationnotice to proceed, in accordance with Sec 618. The Resident Engineer will notify the AWP Administrator who this person shall be. This person must have project manager access to the system.~~

When work has been performed, Pprogress estimates will be generated for estimate end dates of, generally, the 1st and 15th of each month as posted on the website. The controller's Central Office Financial Services office will issue a the schedule ~~chart~~ of estimate due dates annually. AWP estimates must-should be approved by Level 2 (Resident Engineer) no later than 4:00 PM on the day listed on the chart as "Due in Controller's Office." by the estimate due date posted on the schedule.

#### 109.7.1.3

~~Estimates may be generated repeatedly prior to the estimate ending date, in order to resolve discrepancies or check quantities.~~ Two payment estimates shall be made per month for active contracts. The official pay estimates shall be generated with the period ending dates as indicated on the contractor payment schedule. ~~of the 1st and the 15th, making the estimate periods typically the 2nd day of the month to the 15th day, and the 16th day to the 1st of the following month.~~ There may be exceptions to the estimate periods depending upon the financial systems ~~such as the end of the state fiscal year. Other exceptions may be made to the estimate period depending on the status of the contract or~~ as notified ~~otherwise~~ by the AWP Administrator and in the first paragraph of EPG 109.7.1.4, below.

All indexes based upon a monthly index value shall use the same index value for the entire estimate period even though the index value may be reestablished on the 1st of the month. For example, the asphalt and fuel index values change on the 1st of the month, but any work

completed on the 1st shall use the same index value as the previous month so that the entire 16th to 1st estimate period uses the same index value.

~~Estimates can be re-generated without deleting the existing estimate from the Estimate History window. Do not use the "delete" option to delete an estimate. To re-generate an estimate for a pay period, just generate that estimate. The system will indicate that an estimate already exists for the period, and will prompt "Would you like to delete?" (meaning to overwrite the existing estimate.) Select "Yes", which will reset the tables and the estimate will be generated containing any new information that has been added.~~

#### 109.7.1.4

~~The progress estimate for the period ending July 1 of each year shall be changed by the user to the period ending date of June 30th, prior to estimate generation. This change shall be made to coincide with the MoDOT Fiscal Year End cycle.~~

Supplemental estimates will not be generated unless specifically instructed to do so by the AWP administrator.

Final Estimates shall be generated by the Resident Engineer prior to submission of the final plans to the District for checking. ~~When logged into the system as a Resident Engineer, only final estimates can be generated. For a Resident Engineer to generate a progress estimate, they must log in as a project manager.~~

#### 109.7.1.5

Payment estimates must be supported by documentary evidence that work items allowed have actually been done. Evidence may be in the form of scale tickets, ~~diary entries~~daily work reports, material receipts, etc. Earthwork quantities may, for example, be supported by load count entries in the inspector's remarks, or by noting the station limits completed within a balance (or the portion thereof). ~~Another way is by remarks entries giving limiting stations of completed balances.~~ Weight or volume tickets are a sound basis for allowing payment on items measured in this manner. The payment estimate is intended to provide payment to the contractor for all work performed during the estimate period. In no case should payment for specification compliant and accepted work be delayed beyond the estimate period following the period in which the work was performed.

Check all items against inspection records to be sure they are properly approved.

#### 109.7.1.6

The Division Final Plans Reviewer shall notify the Resident Engineer when the final estimate is approved and ~~the final plans are passed~~sent to Central Office- Financial Services for project closeout for payment. Once the Resident Engineer receives the notification, the Resident Engineer will send the prime contractor the Estimate Summary Report(s) for the final estimate as outlined below:

**General:** ~~The Cognos report "Estimate Summary for Contract, By Estimate Number" is the official estimate report to send to the prime contractor on all MoDOT contracts administered through AWP. This will establish the policy and procedure related to this function of AWP.~~

~~Prior to producing this report, it shall be the responsibility of the Resident Engineer to verify the accuracy of the estimate and to approve the estimate in AWP. The Resident Engineer will make this verification by confirming the Last Approver ID is the User ID of the Resident Engineer in the Estimate Summary of each contract.~~

~~After the RE has verified the estimate has been approved at the Resident Engineer level, the Estimate Summary for Contract, By Estimate Number shall be electronically saved as a .pdf file in eProjects. Refer to EPG 137 Construction Inspection Guidance for Records to be Maintained for more information on saving reports produced from AWP or information retrieved from AWP.~~

### 109.7.2 Material Allowance

~~Under The Quick Reference Guide (QRG) for stockpile materials details how a should appear those items for which~~ a payment may be made in accordance with the general requirements within AWP. Check the specification for the minimum acceptable material allowance. Non-perishable items to be incorporated in the finished product may, in general, be included on the estimate for stockpile materials provided satisfactory inspection reports, certifications or mill test reports and required invoices are in the project file. When the item first appears on the estimate, the resident engineer must have on file a copy of an invoice to substantiate the unit prices allowed. Receipted bills for all materials allowed on the estimate must be furnished to the resident engineer within the time established by specifications, or the item must be eliminated from future estimates. Missouri state sales tax may be included in material allowances if shown on invoices or receipted bills. Each receipted bill must be marked or stamped paid with date of payment shown, as well as the name of the firm and signature of the person who received payment. All invoices and receipted bills obtained to substantiate material allowances during progress of the project are to be filed in ~~the district ase~~ Projects as part of the permanent project record.

Some aggregates are accepted for "quality only" at the point of production. Total acceptance is not made at the time of production because additional processing and/or screening are required before incorporation into the final product. If gradation tests, which are run for information purposes only, indicated it is reasonably possible to produce an acceptable finished product, this material may be included in the stockpile material payment.

If test reports or visual inspection on the above material or other material that might be produced and accepted indicate that it will be unsatisfactory at a later date due to gradation, excess P.I., segregation, contamination, etc., these materials should not be included on the stockpile materials payment.

The price per unit for material produced by the contractor or by a producer other than an established commercial producer should reflect the actual cost of production. The units shown under material estimate should be the same unit of measure used in the bid item where possible, such as pound for steel, linear foot for piles, etc. Where this is not possible, a convenient unit such as ton for aggregate should be used. Quantities in excess of contract requirements should not be allowed. Hauling costs should not normally be included in the unit cost of any material unless it has been hauled to a site where it can immediately be incorporated in the finished product or work. If hauling cost is allowed, it must be considered with relation to the value of the material in case it is necessary for the state to take it over. Stockpiling costs are not to be included as part of the unit cost.

Items that are to be accepted by project personnel must be inspected and found satisfactory prior to being included on a stockpile materials payment. Quantities for materials included on a stockpile materials payment should never exceed approved quantities.

Before an allowance will be approved for payment on material stockpiled or stored on private property, or for aggregates stored on property operated as a commercial business, a lease agreement from the contractor or subcontractor showing compliance with the following points must be submitted to the district office for approval.

1. A complete land description covered in the lease form and the haul distance from the lease area to the project.

2. The following statement included in the lease agreement:

"It is understood and agreed by the parties hereto that the land herein involved is to be used as a materials storage site and that the prime contractor, whether or not the lessee herein, may obtain payment from the Missouri Highway and Transportation Commission for material stored thereon".

"It is further understood and agreed by the parties hereto that the prime contractor or contractor having a written agreement with the Missouri Highway and Transportation Commission for the construction of highway work involving this lease and the materials stored thereon, whether or not the lessee, and the employees of the Missouri Highway and Transportation Commission shall have the right of access to the property covered by this lease at all times during its existence and that in the event of default on the part of the lessee or the prime contractor, if other than lessee, the Missouri Highway and Transportation Commission may enter upon the property and remove said materials to the extent to which advance payments were made thereon".

An area leased on property operated as a commercial business must be posted so as to divorce the site for stockpiling of highway materials from the commercial operation.

If either party to the lease agreement is incorporated, it is essential that an Acknowledgment by Corporation be attached for each corporation involved since an individual cannot legally bind a corporation without duly enacted authorization by the corporation's Board of Directors. A suitable form for this purpose is shown in *Agreement for Shifting State Highway Entrance*, page 1. Other forms may be used by some corporations and are acceptable if they fulfill the intent of the form illustrated. Leases involving corporations should not be accepted without the Acknowledgment.

Signatures by individuals must be notarized, or be witnessed by at least two disinterested persons. The address of witnesses should be shown.

When material is stored on property owned by a railroad and is accessible by a public roadway, it is not necessary to obtain a lease agreement to permit this material to be placed on the estimate as a stockpile material.

If hauling charges are to be included as part of the cost of materials allowed for payment, invoices for hauling charges must be provided by the contractor in the same manner as invoices for the material. An exception to this requirement is allowance for the cost of the rail freight. For rail freight the contractor should supply a copy of the first freight bill to substantiate the freight

rate. In lieu of submitting receipted freight bills, the contractor may then sign a statement on each material invoice indicating that freight charges have been paid. If the contractor prefers, a letter may be submitted listing several invoices and indicating freight charges that have been paid. Whichever procedure is adopted, the resident engineer must be assured that freight charges have been indicated as paid for all materials invoices submitted to verify quantities.

The engineer may also include in any payment estimate an amount not to exceed 90 percent of the invoice value of any inspected and accepted fabricated structural steel items, structural precast concrete items, permanent highway signs, and structural aluminum sign trusses. These items must be finally incorporated in the completed work and be in conformity with the plans and specifications for the contract. These items may be stored elsewhere in an acceptable manner provided approved shop drawings have been furnished covering these items and also provided the value of these items is not less than \$25,000 for each storage location for each project.

The engineer may also include in any payment estimate, on contracts containing 100 tons or more of structural steel, an amount not to exceed 100 percent of the receipted mill invoice value of structural carbon steel or structural low alloy steel, or both, which is to form a part of the completed work and which has been produced and delivered by the steel mill to the fabricator.

While the nature and quality of material is the contractor's responsibility until incorporated into the project, material presented for stockpile materials payment must be inspected prior to being approved for payment. The nature of that inspection is at the discretion of the engineer and may include sampling and testing to determine whether the material has a reasonable potential of compliance, once incorporated into the project. This sampling and testing may occur wherever the material is offered for stockpile materials payment, including stockpiles in quarries and at other off-project sites. Material that is a component of a mix may be compared to the associated mix design or to any other specification criteria that may apply.

### **127.2.3.3.1 Missouri Unmarked Human Burials Law**

If human skeletal remains are encountered during construction, their treatment will be handled in accordance with Sections 194.400 to 194.410, RSMo, as amended. When human remains are encountered, the Contractor shall first stop all work within a ~~50-ft~~330-foot or 100-meter radius of the remains, and secondly, shall notify the MoDOT Construction Inspector and/or Resident Engineer who will contact the Historic Preservation section. Historic Preservation staff will in turn notify the local law enforcement (to ensure that it is not a crime scene) and the State Historic Preservation Office (SHPO) as per RSMo 194 or to notify SHPO what has occurred and that it is covered by Missouri's Cemeteries Law, §§ 214. RSMo. If the contractor is unable to contact appropriate MoDOT staff, the contractor shall initiate the involvement by local law enforcement and the SHPO. A description of the contractor's actions will be promptly made to MoDOT.

### **127.2.9 Construction Inspection Guidance**

Mitigation by data recovery is usually completed prior to construction if the presence of cultural resources is known. If [artifacts](#) are discovered during construction activities, the Historic Preservation section must be immediately notified. This will allow an inspection of the site by MoDOT HP staff to determine if further investigation is necessary before construction activities continue.

[Sec. 107.8.2](#) and [Sec. 203.4.8](#) of the *Missouri Standard Specifications for Highway Construction* require the contractor to take steps to preserve any such artifacts that may be encountered and to notify the MoDOT Construction Inspector or Resident Engineer of their presence. If it is necessary to discontinue operations in a particular area to preserve such objects, this section of the specifications is basis for a work suspension. In order to ensure compliance with applicable state laws, the MoDOT Construction Inspector or Resident Engineer cannot release remains or artifacts or allow the contractor to disturb the area within the ~~330-foot or 100-meter~~50-ft buffer space around these discovered items, until after consultation with MoDOT HP staff and until after all applicable requirements from FHWA or SHPO have been addressed.

#### **127.2.9.1 Cultural Resources Encountered During Construction**

If cultural resources are encountered during construction, the contractor shall immediately stop all work within a ~~50~~330-foot or 100-meter buffer around the limits of the resource and shall not resume without specific authorization from a MoDOT Historic Preservation Specialist. The contractor shall notify the MoDOT Resident Engineer or Construction

Inspector, who shall contact the MoDOT HP within 24 hours of the discovery. MoDOT HP shall contact FHWA and SHPO within 48 hours of learning of the discovery and provide an evaluation of the resource and reasonable efforts to see if it can be avoided. FHWA shall make an eligibility and effects determination based upon the preliminary evaluation and consult with MoDOT, and SHPO a minimize or mitigate any adverse effect. FHWA will notify the Council and any tribes that might attach religious and/or cultural significance to the property within 48 hours of this determination. FHWA shall take into account Council and Tribal recommendations regarding the eligibility of the property and proposed actions, and direct MoDOT to carry out the appropriate actions. MoDOT will provide FHWA and SHPO with a report of the actions when they are completed. FHWA shall provide this report to the council and the tribes.

### **127.2.9.2 Human Remains Encountered During Construction**

If human remains are encountered during construction, the contractor shall immediately stop all work within a 330-foot, or 100-meter radius of the remains and shall not resume without specific authorization from MoDOT HP Staff, and either the SHPO or the local law enforcement officer, whichever party has jurisdiction over and responsibility for such remains. The contractor shall notify the MoDOT Construction Inspector and/or Resident Engineer who will contact the MoDOT HP section within 24 hours of the discovery. MoDOT HP staff will immediately notify the local law enforcement (to ensure that it is not a crime scene) and the SHPO as per RSMo 194 or to notify SHPO what has occurred and that it is covered by Missouri's Cemeteries Law, §§ 214. RSMo. MoDOT HP staff will notify FHWA that human remains have been encountered within 24 hours of being notified of the find. If, within 24 hours, the contractor is unable to contact appropriate MoDOT staff, the contractor shall initiate the involvement by local law enforcement and the SHPO. A description of the contractor's actions will be promptly made to MoDOT. FHWA will notify any Indian tribe that might attach cultural affiliation to the identified remains as soon as possible after their identification. FHWA shall take into account Tribal recommendations regarding treatment of the remains and proposed actions, and then direct MoDOT HP to carry-out the appropriate actions in consultation with the SHPO. MoDOT shall monitor the handling of any such human remains and associated funerary objected, sacred object or objects of cultural patrimony in accordance with the Missouri Unmarked Human Burial Sites Act, §§ 194.400 – 194.410, RSMo.

## 616.19.7 Traffic Pacing/Rolling Roadblock

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Traffic pacing/rolling roadblock is a traffic control technique that facilitates short duration overhead work operations by pacing traffic at a safe slow speed for a predetermined distance upstream of the work area, rather than being completely stopped. The pacing of vehicles shall be controlled by pilot vehicles (law enforcement vehicles with blue lights flashing, or protective vehicles) driven by uniformed law enforcement, MoDOT personnel, or contractor personnel. Any on-ramps or other access points between the beginning point of the pacing area and the work area shall be blocked until the pilot vehicles have passed. Two-way radios shall be used to provide constant communication between the pilot vehicles, MoDOT and/or contractor's workers, and the project engineer. Advanced signing warning motorists of the traffic pacing/rolling roadblock area ~~shall~~ may also be provided.

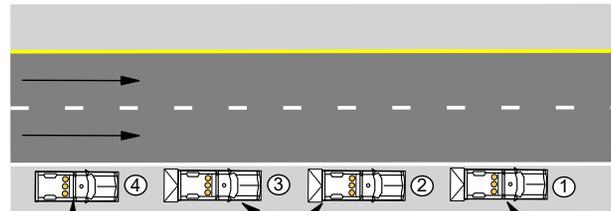
The most applicable location for this technique is on high-volume/high-speed urban and rural freeways and other multi-lane access controlled facilities for work such as overhead utility work, installing overhead sign structures, replacing sign panels, placing bridge girders, ~~and~~ installing cantilever trusses, installing traffic counters, etc. Utilizing traffic pacing/rolling roadblock for other types of work should be discussed with ~~Highway Safety and Traffic Division and~~ the district Work Zone Coordinator before being allowed.

Preparation of a traffic pacing/rolling roadblock design shall be completed ~~in order to~~ to plan and provide adequate work time to complete the short duration ~~overhead construction work~~. Based on the required work time and other inputs such as traffic volumes, regulatory speed and pacing speed, the traffic control plan defines the allowable pacing hours, pacing distance, location of warning signs, interchange ramp closures and other critical information. The Traffic Pacing/Rolling Roadblock Worksheet shall be used when planning to use this traffic control technique, in order to calculate the pacing distance and the time intervals during which a pacing operation may be allowed. Also refer to the Staging Plan Details and Traffic pacing/Rolling Roadblock Changeable Message Signs Layout.

# TRAFFIC PACING/ROLLING ROADBLOCK MAINLINE PACING DETAILS (1 DIRECTION OF FOUR LANE ROADWAY EXAMPLE)

Protective Vehicle/Truck Mounted Attenuators and Advance Warning Vehicles are shown for this scenario for Traffic Pacing/Rolling Roadblock Operation. Law enforcement may be used as alternative to Protective Vehicle/Truck Mounted Attenuators and Advance Warning Vehicles.

## STAGE ONE



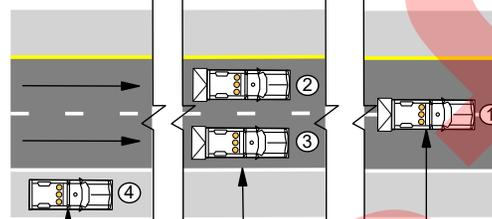
Vehicle Located on Shoulder At Beginning of Pacing Operation

Pace Setting Vehicle

Lead Vehicle (Optional)

Four vehicles located upstream of the work area at the beginning location of the traffic pacing operation.

## STAGE TWO



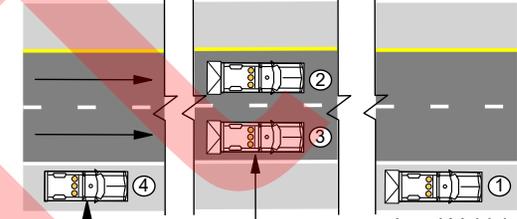
Vehicle Located on Shoulder At Beginning of Pacing Operation

Pace Setting Vehicle

Vehicle At The End Of Regular Traffic (Optional)

Once the vehicles are in place and the traffic control supervisor at the work area notifies all vehicles to begin the traffic pacing operation. The first three vehicles shall enter the travel lanes with the second and third vehicles immediately forming a side by side "pacing operation/rolling roadblock" of all lanes behind the lead vehicle.

## STAGE THREE



Vehicle Located On Shoulder At Beginning Of Pacing Operation

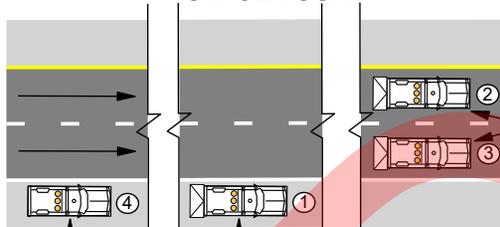
Pace Setting Vehicles

Lead Vehicle Located Approximately 500-feet Before Work Area On Shoulder (Optional)

The two pace setting vehicles shall begin to slow to the pacing speed for the duration of the traffic pacing operation.

The lead vehicle shall match the speed of the last vehicles ahead of the pacing vehicles and continue following traffic until a point approximately 500-feet in advance of the work area. The lead vehicle shall then come to a complete stop on the right shoulder. If required, protective vehicles with TMA sign(s) shall move in the travel lanes approximately 200-feet upstream of the work area once traffic has cleared the work area.

## STAGE FOUR

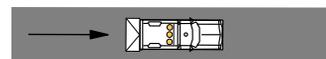
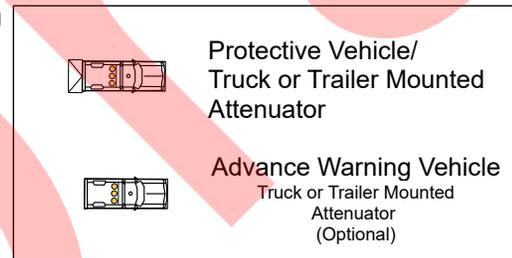


Vehicle Located on Shoulder at Beginning of Pacing Operation

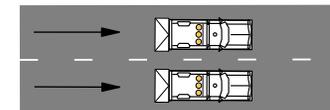
Lead Vehicle Located Approximately 500-feet Before Work Area On Shoulder (Optional)

When the pace setting vehicles are within approximately two miles of the work area they shall notify the onsite traffic control supervisor who will immediately inform the contractor on site supervisor of the pacing vehicles location. The contractor shall begin to clear the travel lanes of all equipment and debris in order to reopen all travel lanes.

In case of emergency the pace setting vehicles shall come to a complete stop once they reach the lead vehicle. If no emergency is encountered, the crash truck(s) shall be moved from the travel lanes and the two pace setting vehicles shall clear the work area and immediately move to the right shoulder or an area designated by the traffic control supervisor.



ONE LANE RAMP



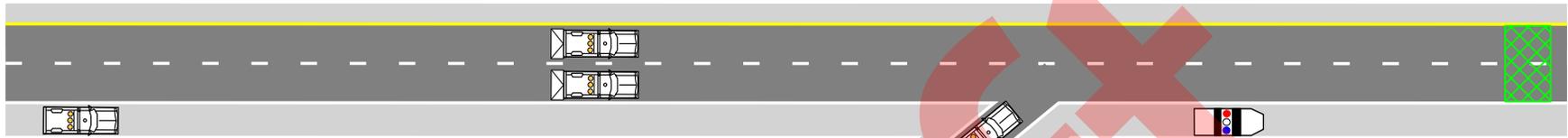
TWO LANE RAMP

Once notified by the on site traffic control supervisor to begin the traffic pacing operation each vehicle at the indicated ramp and position the vehicle across the ramp lane(s) to close ramp access.

Once the pacing operation passes the closed on ramp the vehicle on the ramp shall move from the ramp lane(s) to allow traffic to enter the mainline pacing operation.

### TRAFFIC PACING/ROLLING ROADBLOCK MAINLINE PACING DETAILS

When the operation begins, law enforcement may be located closer to the work space to catch/stop any vehicles getting by the pace setting vehicle or on-ramps.



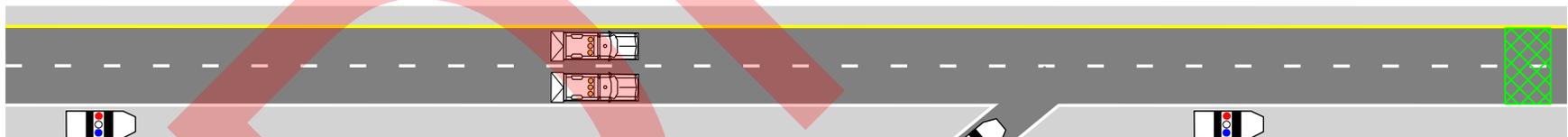
Law Enforcement Vehicle

This scenario show the use of law enforcement vehicles. Law enforcement may be located closer to the work space to catch/stop any vehicles getting by the pace setting vehicle or on-ramps.

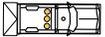


Law Enforcement Vehicle

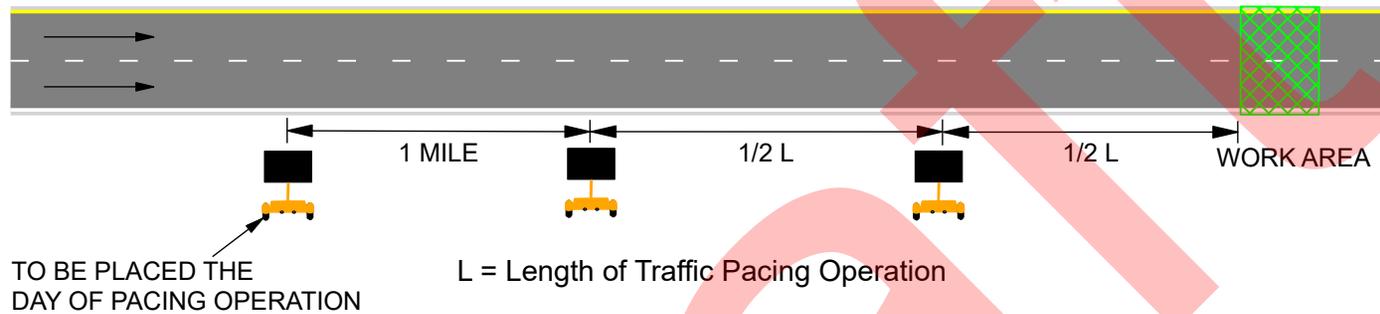
This scenario shows a combination of vehicle types. If Protective Vehicle/Truck Mounted Attenuators (PV/TMA) are available, the PV/TMA should be used in the open lane. Law enforcement may be located closer to the work space to catch/stop any vehicles getting by the pace setting vehicle or on-ramps.



Law Enforcement Vehicle

	Protective Vehicle/ Truck or Trailer Mounted Attenuator		Advance Warning Vehicle Truck or Trailer Mounted Attenuator (Optional)		Law Enforcement		Work Space
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## TRAFFIC PACING/ROLLING ROADBLOCK CHANGEABLE MESSAGE SIGNS (CMS) (Typical Placement and Messages)



**Based on roadway speed and traffic volume, CMS messaging may be a useful tool based on type of roadway and/or projects.**

### CHANGEABLE MESSAGE SIGN MESSAGE (MAINLINE AND RAMPS)

ONE WEEK PRIOR TO PACING OPERATION

EXPECT	MM
DELAYS	DD-DD
ON	X A.M. - X A.M.

DURING DAY OF PACING OPERATION

ROAD	EXPECT
WORK	PERIODIC
TONIGHT	DELAYS

DURING PACING OPERATION

SLOW	BE
TRAFFIC	PREPARED
AHEAD	TO STOP

## No changes to EPG 751.36.5.1 – 751.36.5.2

### 751.36.5.3 Geotechnical Resistance Factor ( $\phi_{stat}$ ) and Driving Resistance Factor ( $\phi_{dyn}$ )

#### LRFD Table 10.5.5.2.3-1

The factors for Geotechnical Resistance ( $\phi_{stat}$ ) and Driving Resistance ( $\phi_{dyn}$ ) ~~will usually~~ may be different because of the reliability of the different methods used to determine the nominal bearing resistance. Caution should be used if the difference in factors for Geotechnical Resistance and Driving Resistance are great as it can lead to issues with pile overruns. Also see [EPG 751.36.5.9](#).

#### Geotechnical Resistance Factor, $\phi_{stat}$ :

The Geotechnical Resistance factor is based on the static method used by the designer in determining the nominal bearing resistance. Unlike the Driving Resistance factor the Geotechnical Resistance factor can vary with the soil layers. If Geotechnical Resistance factors are not provided by the Geotechnical Engineer, ~~the static method and values~~ resistance factors may ~~shall~~ be selected from ~~LRFD Table 10.5.5.2.3-1~~ the table below. The values provided in LRFD Table 10.5.5.2.3-1 are only applicable if the end of drive criteria is based off the total pile penetration which is not recommended. For Extreme Event Limit States see LRFD 10.5.5.3.

**Table - Static Analysis Resistance Factors used for Pile Length Estimates**

Pile Type	Soil Type	Static Analysis Method	Side Friction <sup>1</sup>	End Bearing
			$\phi_{stat}$	$\phi_{stat}$
CIP Piles - Steel Pipe Shells	Clay	Alpha - Tomlinson	$\phi_{dyn}^2$	$\phi_{dyn}^2$
	Sand	Nordlund <sup>3</sup>	0.45 - Gates 0.45 - WEAP 0.55 - PDA	0.45 - Gates 0.45 - WEAP 0.55 - PDA
		LCPC <sup>4</sup>	0.70	0.45
		Schmertmann <sup>5</sup>	0.50	0.50

<sup>1</sup>For mixed soil profiles the lowest applicable resistance factor for clay or sand may be used to simplify the analysis.

<sup>2</sup> $\phi_{dyn}$  = see following section

<sup>3</sup>The Nordlund method is recommended for sand layers in mixed soil profiles where CPT data is not available.

<sup>4</sup>The resistance factors associated with the LCPC method are not statistically calibrated for reliability, but studies have shown this method to be one of the most reliable methods for predicting soil behavior from CPT data.

<sup>5</sup>Per LRFD 10.7.3.8.6g the Schmertmann method shall only be used for sands and nonplastic silts with CPT data.

For more detailed guidance see [SEG 25-001 New Policy for Friction Pile](#).

#### Driving Resistance Factor, $\phi_{dyn}$ :

The Driving Resistance factor shall be selected from LRFD Table 10.5.5.2.3-1 based on the method to be used in the field during construction to verify nominal axial compressive resistance.

<b><u>Pile Driving</u> Verification Method</b>	<b>Resistance Factor, <math>\phi_{dyn}</math></b>
FHWA-modified Gates Dynamic Pile Formula (End of Drive condition only)	0.40
Wave Equation Analysis (WEAP)	0.50
Dynamic Testing (PDA) on 1 to 10% piles	0.65
Other methods	Refer to LRFD Table 10.5.5.2.3-1

Use [EPG 751.50 Standard Detailing Note G7.3](#) on plans as required for end bearing piles driven to rock. This requirement shall apply to any type of rock meaning weak to strong rock including stronger shales where HP piling is anticipated to meet refusal. The verification method shown on the plans is only used to verify the nominal axial compressive resistance prior to reaching practical refusal. If the practical refusal criterion is met the field verification method shown on the plans is no longer considered valid.

For end bearing piles tipped in shale, sandstone, or rock of uncertain strength at any loading where the likelihood of pile damage is increased, the Foundation Investigation Geotechnical Report (FIGR) should give a recommendation for dynamic pile testing (PDA) or no PDA. For most end bearing piles, where a recommendation for field verification is not given in the FIGR, the designer will need to determine whether gates or WEAP is required for the pile driving verification method based on the loading demands on the pile or other factors.

For piles bearing on hard rock with MNACR less than 600 kips, FHWA-modified Gates Dynamic Pile Formula should be listed as verification method, and practical refusal criterion should control end of driving criteria. FHWA-modified Gates Dynamic Pile Formula is not considered accurate for pile loading (Minimum Nominal Axial Compressive Resistance) exceeding 600 kips. When pile loading exceeds 600 kips, use wave equation analysis, dynamic testing, or other method. Consideration should be given to using additional piles to reduce the MNACR below 600 kips.

Under special circumstances when rock limits or conditions are nonuniform, WEAP should be considered in order to limit pile damage since it requires further scrutiny of the site conditions with the proposed pile driving system.

Dynamic Testing is recommended for projects with friction piles where the soil profile is comprised primarily of sand. For bridges where the soil profile is comprised primarily of clays or evenly mixed clays and sands the recommended verification method is WEAP. When WEAP is specified as the

pile driving criteria for friction pile, provide standard note E2.28 below the foundation table. For more detailed guidance see SEG 25-001 New Policy for Friction Pile.

## No changes to EPG 751.36.5.4 – 751.36.5.9

### 751.36.5.9 Estimate Pile Length and Check Pile Capacity

#### 751.36.5.9.1 Estimated Pile Length

##### Friction Piles:

Estimate the pile length required to achieve the minimum nominal axial compressive resistance, MNACR, or required driving resistance,  $R_{ndr}$ , for establishment of contract pile quantities. Perform a static analysis using one of the methods given in EPG 751.36.5.3 Geotechnical Resistance Factor ( $\phi_{stat}$ ) and Driving Resistance Factor ( $\phi_{dyn}$ ) to determine the nominal resistance profile of the soil. For each soil layer the appropriate resistance factor,  $\phi_{stat}$ , shall be applied to account for the reliability of the static analysis method chosen in order to create a factored resistance profile. The penetration depth would then occur at the location where the factored resistance profile intercepts the factored load. The relationship between the static axial compressive resistance and required driving resistance for a uniform soil profile with a constant static resistance factor is given as follows: Similarly, for a uniform soil layer the adjusted nominal resistance,  $R_{nstat}$ , can be determined from the equation below:

$$\phi_{dyn} \times R_{ndr} = \phi_{stat} \times R_{nstat} \geq \text{Factored Load} \quad \text{LRFD C10.7.3.3-1}$$

Where:

$\phi_{dyn}$  = see [EPG.751.36.5.3](#)

$R_{ndr}$  = Required nominal driving resistance = Minimum nominal axial compressive resistance MNACR = Required nominal driving resistance

$\phi_{stat}$  = Static analysis resistance factor per LRFD Table 10.5.5.2.3-1 EPG 751.36.5.3 or as provided by the Geotechnical Engineer. Factors for side friction and end bearing may be different.

$R_{nstat}$  = Adjusted Required Nominal nominal static resistance due to static analysis reliability

Use soil profiles from borings and mimic soil characteristics as closely as possible in computations or software to calculate the geotechnical resistance and for estimating the length of pile. For more detailed guidance see SEG 25-001 New Policy for Friction Pile.

It is not advisable to design pile deeper than available borings or to reach capacity within the bottom 3 to 5 feet of borings. If a longer pile depth is needed to meet design requirements then request Geotechnical Section to provide deeper borings or increase the number of piles which will reduce load per pile as well as the required pile length.

For friction pile the top five feet of soil friction resistance may be neglected with SPM or SLE approval for possible disturbance from MSE wall excavation prior to driving pile.

### End Bearing Piles:

The estimated pile length is the distance along the pile from the cut-off elevation to the estimated tip elevation considering any penetration into rock. The estimated tip elevation shall not be shown on plans for end bearing piles.

The geotechnical material above the estimated end bearing tip elevation shall be reviewed for the presence of glacial till or similar layers. If these layers are present, then a static analysis shall be performed to verify if the required pile resistance is reached at a higher elevation due to pile friction capacity.

#### 751.36.5.9.2 Check Pile Geotechnical Capacity (Axial Loads Only)

Use the same methodology outlined in [EPG 751.36.5.9.1 Estimated Pile Length](#).

#### 751.36.5.9.3 Check Pile Structural Capacity (Combined Axial and Bending)

Structural design checks which include lateral loading and bending shall be accomplished using the appropriate structural resistance factors.

### 751.36.5.10 Pile Nominal Axial Compressive Resistance

The minimum nominal axial compressive resistance, **MNACR, or required driving resistance**,  $R_{ndr}$ , must be calculated and shown on the final plans. The factored axial compressive resistance will be used to verify the pile group layout and loading. The minimum nominal axial compressive resistance will be used in construction field verification methods to obtain the required nominal driving resistance.

Minimum Nominal Axial Compressive Resistance, **MNACR** = Required Nominal Driving Resistance,  $R_{ndr}$

= Maximum factored axial loads/ $\phi_{dyn}$

$\phi_{dyn}$  = Resistance factor of the dynamic method ~~to be~~ used to estimate nominal pile resistance during pile installation. LRFD 10.5.5.2.3.1

The value of  $R_{ndr}$  shown on the plans shall be the greater of the value required at the **Strength limit state and Extreme Event limit state**. This value shall not be greater than the structural nominal axial compressive resistance of the steel HP pile nor shall it exceed the maximum nominal driving resistance of the steel shell for CIP piles. See [EPG](#)

[751.36.5.5](#).

LRFD 10.7.7

For friction piles predominantly embedded and tipped in cohesionless soils the minimum nominal axial compressive resistance ~~shoudt shall~~ be limited to the values shown in the following table.

~~Please seek approval~~ **Approval** from the SPM ~~or~~, SLE ~~or owner's representative is required~~ before exceeding the limits provided ~~in this table~~.

### Maximum Axial Loads for Friction Pile in Cohesionless Soils

Pile Type	Minimum Nominal Axial Compressive Resistance ( $R_{ndr}$ ) <sup>1</sup> (kips)	Maximum Factored Axial Load (kips)		
		Dynamic Testing	Wave Equation Analysis	FHWA-modified Gates Dynamic Pile Formula
		$\phi_{dyn} = 0.65$	$\phi_{dyn} = 0.50$	$\phi_{dyn} = 0.40$
CIP 14"	210	136	105	84
CIP 16"	240	156	120	96
CIP 20"	300	195	150	120
CIP 24"	340	221	170	136

<sup>1</sup> The minimum nominal axial compressive resistance values are correlated to match the maximum design tonnage values used in past ASD practice. A factor of safety of 3.5 is used to determine the equivalent  $R_{ndr}$ .

#### 751.36.5.11 Check Pile Drivability

Drivability of the pile through the soil profile shall be investigated using ~~the GRLWEAP Wave-wave~~ **the GRLWEAP Wave-wave** equation analysis program ~~or other available software~~. ~~Designers may import soil resistances from a static analysis program or input soil values directly into Wave equation analysis program to perform drivability~~ **The static axial compressive resistance profile used in the wave equation analysis shall be determined using one of the approved static methods given in EPG 751.36.5.3.**

~~If soil values are to be directly input into Wave equation analysis program, enter in values of sand and clay layers with specific values of cohesion or internal friction angle or just by uncorrected blow count values obtained from borings.~~

Drivability analysis shall be performed by the designer for all pile types (bearing pile and friction pile) using the Delmag D19-42 hammer with manufacturer recommendations. The drivability analysis shall confirm that the pile can be driven to the minimum tip elevation, rock elevation or reach the minimum nominal axial compressive resistance prior to refusal and without overstressing the pile. If the drivability analysis shows overstress or refusal prior to reaching the desired depth a

lighter or heavier hammer from the table below may be used to confirm constructability. The drivability analysis is not intended to confirm that a pile can be driven through rock (shales, sandstones, etc...) where the likelihood of pile damage is increased and PDA is recommended to reduce loads and monitor pile stresses in the field. The drivability analyses performed by the designer do es not waive the responsibility of the contractor in selecting the appropriate pile driving system per Sec 702.3.5 (also discussed below).

Use soil profiles from borings and mimic soil characteristics as closely as possible for computations or in software to perform drivability analysis of any kind of pile.

### Structural steel HP Pile:

Drivability analysis shall be performed for ~~two cases~~ the box shape of the pile (i.e., not the perimeter).

1. ~~Box shape~~

2. ~~Perimeter~~

Drivability shall be performed considering existing condition without considering any excavation/ disturbance (i.e., possible disturbance to top 5 feet of soil from MSE wall excavation prior to driving pile), liquefaction or future scour loss.

### Hammer types:

#### Pile Driving Hammer Information For GRLWEAP

Hammer used in the field per survey response (2017)		
GRLWEAP ID	Hammer name	No. of Responses
41	Delmag D19-42 <sup>1</sup>	13
40	Delmag D19-32	6
38	Delmag D12-42	4
139	ICE 32S	4
15	Delmag D30-32	2
	Delmag D25-32	2
127	ICE 30S	1

150	MKT DE-30B	1
<sup>1</sup> Delmag series of pile hammers is the most popular, with the D19-42 being the most widely used.		

**Hammer usage in the field will be surveyed every five years. The above results will be revised according to the new survey and the most widely used hammer will be selected for drivability analysis.**

The contractor is responsible for determining the hammer energy driving system required to successfully drive the pile to the minimum tip elevation and to reach the minimum nominal axial compressive resistance specified on the plans. The contractor ~~shall~~ is required to perform a drivability analysis to select an appropriate hammer size to ensure the pile can be driven without overstressing the pile and to prevent refusal of the pile prior to reaching the minimum tip elevation. The contractor shall plan pile driving activities and submit hammer energy requirements to the engineer for approval before driving. There is an exception to the contractor's responsibility for the drivability analysis when WEAP is specified as the driving criteria for friction pile. When WEAP is specified for friction pile an inspector's chart will be provided for the contractor in the electronic deliverables. For more detailed guidance see SEG 25-001 New Policy for Friction Pile.

Practical refusal is defined at 20 blows/inch or 240 blows per foot.

Driving should be terminated immediately once 30 blows/inch is encountered.

### Nominal Driving Stress

LRFD 10.7.8

$$\text{Nominal driving stress} \leq 0.9 \cdot \phi_{da} \cdot F_y$$

For structural steel HP pile, Maximum nominal driving stress = 45 ksi

For CIP pile, Maximum nominal driving resistance, see [EPG 751.36.5.7.1.2](#) or [EPG 751.36.5.7.2.2](#) (unfilled pipe for axial analysis).

If analysis indicates the piles do not have sufficient structural or geotechnical strength or drivability issues exist, then consider increasing the number of piles.

## E2. Foundation Data Table

### No changes to notes E2.1 – E2.27

**(E2.28) Use when WEAP is specified as the pile driving criteria for friction pile. Place an \* behind each instance of WEAP in the Foundation Data table. The pay item Pile Wave Analysis shall not be included when this note is used.**

\*See electronic deliverables file for pile driving inspector's chart(s). MoDOT will provide alternate charts for different driving systems as needed per request. With the request, the contractor shall provide the hammer manufacturer make and model, and any modifications to the manufacturer's recommended settings including hammer cushion information. The contractor shall provide the request 30 calendar days before pile driving operations begin.

# Category: 909 Transportation Systems Management and Operations (TSMO)

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Transportation Systems Management and Operations (TSMO) consists of operational strategies and systems that cost-effectively help optimize the safety, reliability, and capacity of the transportation system. MoDOT is continuously working to improve safety and alleviate congestion on its roadways; the effective application of TSMO strategies will help to further improve MoDOT's roadways by directly addressing many of the root causes of recurring and nonrecurring congestion.

Recurring congestion occurs in numerous locations in the interstate and state highway system and is typically the result of inadequate capacity of the existing highway facilities. Recurring congestion occurs most often during peak traffic periods. MoDOT is not funded to construct sufficient highway facilities to address all areas of recurring congestion.

Nonrecurring congestion occurs throughout the interstate and state highway system at any given time and is typically the result of:

- Work Zones (road construction and maintenance activities, permit work, etc.)
- Traffic Incidents
- Special Events.

Recurring and nonrecurring congestion both result in delay to motorists, adversely affect travel time reliability, and diminish highway safety. MoDOT is committed to integrating TSMO in all aspects of managing and operating the transportation system in Missouri.

## Articles in "909 Transportation Systems Management and Operations (TSMO)"

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The following 3 pages are in this category, out of 3 total.

- [909.1 Recurring Congestion](#)
- [909.2 Nonrecurring Congestion](#)
- [TSMO Resource Documents](#)

[Category: 900 TRAFFIC CONTROL](#)

The **Transportation Systems Management and Operations (TSMO) Program and Action Plan** applies strategies to optimize the performance of existing infrastructure and improves safety and reliability of transportation systems.

### Related Information

- [Statewide Transportation Improvement Program \(STIP\)](#)
- [SAFER Document](#)
- [TSMO Resource Documents](#)

Transportation Systems Management and Operations (TSMO) consists of operational strategies and systems that cost-effectively optimize the safety, reliability, efficiency, and capacity of the transportation system. Unlike traditional capacity-expansion projects that often require significant time and resources, TSMO emphasizes maximizing the performance of the existing system through proactive management and operational improvements.

MoDOT is continuously working to improve safety and alleviate congestion on its roadways. The effective application of TSMO strategies allows the agency to directly address the root causes of congestion:

- **Non-recurring delays** arise from unplanned or irregular events such as incidents, disasters, weather, work zones, and special events. These disruptions are inherently unpredictable, vary in severity and duration, and often require dynamic traffic management and interagency coordination to reduce their impact.
- **Recurring delays** occur regularly at specific locations, most often during peak traffic periods. This type of congestion is usually the result of demand exceeding the capacity of the existing system. MoDOT does not have the resources to construct enough highway capacity to eliminate all recurring congestion. Instead, TSMO strategies provide more cost-effective ways to manage demand and improve flow.

Several **foundational documents** guide MoDOT's TSMO program:

- [TSMO Program and Action Plan](#) – outlines MoDOT's statewide TSMO vision, goals, and implementation strategies.
- [TSMO Informational Memoranda](#) – provides background, technical details, and emerging practices in TSMO.
- [TSMO Benefit-Cost Reference Memo](#) – provides the benefit-cost information on TSMO applications that are critical to MoDOT's TSMO program and future work.
- [Work Zone Management Guidebook](#) – provides a comprehensive set of tools and strategies for work zone management and describes "advanced work zone" practices, guidance, and resources for implementation.
- [Connected and Automated Vehicle Action Plan](#) – articulates MoDOT's mission, vision, strengths, and strategic focus areas for leveraging CV/AV technologies, and lays out actions across institutional capability-building, outreach and education, and partnership development to support safe, efficient deployment.

By addressing both types of congestion, TSMO helps MoDOT achieve its mission of moving Missourians safely and reliably while making the best use of limited resources.

## 909.0 Introduction to TSMO

### 909.0.1 Overview of TSMO Strategies

TSMO strategies are the day-to-day operational actions MoDOT uses to actively manage and optimize the transportation system. These strategies translate MoDOT's mission into practical, real-time actions that improve safety, mobility, and reliability. They are organized according to whether they address **non-recurring delays** or **recurring delays** as follows:

[909.1 Non-Congested Route \(Non-Recurring Delays\)](#) – These strategies focus on managing temporary (whether short-term or long-term) capacity reductions caused by irregular or time-limited events that disrupt normal traffic conditions, ensuring that mobility and safety are restored efficiently and consistently.

- [909.1.1 Traffic Incident Management](#): Coordinates detection, response, and clearance across multiple agencies to minimize secondary crashes and return roadways to normal operation quickly.
- [909.1.2 Transportation Operations for Emergency Incidents or Disasters](#): Ensures system readiness and coordinated response during natural or human-caused disasters through planning, communication, and multimodal evacuation procedures.
- [909.1.3 Road Weather Management](#): Integrates environmental monitoring, data-driven decision support, and targeted maintenance to mitigate the effects of adverse weather on safety and mobility.
- [909.1.4 Work Zone Traffic Management](#): Applies smart work zone technologies and comprehensive traffic management plans to maintain safe and reliable travel through construction and maintenance areas.
- [909.1.5 Planned Special Event Management](#): Coordinates transportation, enforcement, and communication activities for scheduled events to maintain efficient system operations and traveler safety.

[909.2 Congested Route \(Recurring Delays\)](#) – These strategies address predictable and routine congestion caused by daily travel demand and capacity constraints on specific facilities or corridors, emphasizing active traffic management, system integration, and multimodal coordination.

- [909.2.1 Freeway Operations and Management](#): Improves freeway performance through corridor-level monitoring, adaptive control, and coordinated operations to enhance safety and travel-time reliability.
- [909.2.2 Arterial Operations and Management](#): Optimizes signal timing, intersection design, and corridor coordination to improve mobility and safety on surface streets.
- [909.2.3 Freight Operation](#): Enhances the efficiency and safety of freight movement through improved access, parking management, and technology-based monitoring along key freight corridors.
- [909.2.4 Vulnerable Road Users](#): Improves safety, accessibility, and comfort for VRUs through targeted infrastructure, operational strategies, and multimodal coordination.
- [909.2.5 Transit Operation](#): Strengthens transit reliability and accessibility through operational strategies such as priority treatments, multimodal hubs, and corridor management.

## 909.o.2 Relationship with Other Programs

TSMO is not a standalone initiative—it complements and enhances MoDOT's other programs:

- **Safety Programs**: TSMO contributes to MoDOT's safety goals, as outlined in the Strategic Highway Safety Plan and the SAFER Program (see [EPG 907.9 Safety Assessment For Every Roadway \(SAFER\)](#)), by reducing secondary crashes, improving work zone management, and advancing road weather management capabilities.
- **Asset Management**: TSMO strategies extend the life of infrastructure investments by ensuring facilities operate more efficiently and experience fewer incidents that accelerate wear.
- **Planning and Design**: TSMO principles should be incorporated early in the planning and design process so that operational strategies are built into projects from the start.
- **Maintenance**: Maintenance activities can be coordinated with TSMO tools such as smart work zones and ITS devices to reduce traffic disruptions.

- **Traveler Information:** TSMO strengthens customer service by providing real-time, accurate, and actionable information to the traveling public.

In practice, TSMO serves as the operational thread that connects safety, planning, design, maintenance, and customer service into a unified system-management approach.

### 909.0.3 Roles and Responsibilities for TSMO Implementation

This guide is designed to provide MoDOT staff and partners with a clear, practical reference for TSMO strategies. Table 909.0.3 highlights the roles and responsibilities of different staff in implementing and supporting TSMO strategies.

**Table 909.0.3. Roles and Responsibilities for TSMO Implementation**

<b>Role</b>	<b>Responsibility</b>
<b>Transportation Management Center (TMC) Operator</b>	Monitor traffic conditions, manage information systems, and coordinate incident response and traveler communication to maintain safe and efficient roadway operations.
<b>Emergency Response Operator</b>	Provide on-scene incident management, motorist assistance, and roadway clearance to restore normal traffic flow and enhance safety during disruptions.
<b>Maintenance Technician</b>	Implement maintenance related TSMO strategies; provide feedback and effort for continual improvement of these strategies and tools.
<b>Traffic Operations Engineer</b>	Implement traffic operations related TSMO strategies; provide feedback and effort for continual improvement of these strategies and tools.
<b>Transportation Planner</b>	Include TSMO and other traditional transportation improvement strategies in all planning efforts.
<b>Design Engineer</b>	Consider TSMO as an essential element of design, either as a direct improvement for the specific application or as an opportunity for the continuation of existing TSMO strategies.
<b>Construction Inspector</b>	Consult personnel who have the appropriate expertise when modifying a design or during construction inspection of TSMO support infrastructure.
<b>Work Zone Specialists</b>	Oversee temporary traffic control in construction zones; review and manage Transportation Management Plans (TMPs), ensure proper setup and quality of traffic control devices, assess risks, and provide input during planning and post-construction reviews to enhance safety and minimize disruptions.
<b>Information Systems Manager</b>	Provide oversight and management of field and central communications systems, computer and software, and other information systems resources.
<b>Human Resources Specialist</b>	Incorporate relevant related skills and experience into position descriptions where TSMO expertise is needed; assist with training programs to improve the knowledge, skills, and abilities of existing operations personnel.

<b>Emergency Management Agencies</b>	Support TSMO implementation by providing coordinated incident response, traffic control, emergency medical services, and roadway clearance; collaborate with MoDOT and TMC staff to improve incident management, responder safety, and system recovery during emergencies and planned events.
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## 909.0.4 TSMO Planning Framework

The TSMO Planning Framework provides a structured approach for MoDOT to translate its mission and agency goals into actionable objectives and strategies. It ensures that operational strategies are purpose-driven, measurable, and aligned with statewide priorities. This framework serves as a bridge between MoDOT's overarching mission and the specific strategies implemented across the TSMO program.

Table 909.0.4.1 identifies the core programmatic elements, MoDOT's goals and associated objectives, that guide how TSMO is planned, implemented, and evaluated.

**Table 909.0.4.1. Programmatic Element**

Goal	Objective
<b>Safety</b>	Reduce crash frequency and severity through proactive deployment of TSMO strategies (e.g., incident management, work zone safety, network operations).
<b>Reliability</b>	Provide predictable and consistent travel times across the system by proactively managing congestion and incidents.
<b>Efficiency</b>	Operate MoDOT's existing system efficiently and effectively through the application of TSMO programs before pursuing capacity expansion.
<b>Customer Service</b>	Provide timely, accurate, and useful traveler information that supports informed decision-making.
<b>Collaboration</b>	Strengthen TSMO-related education, training, and workforce development, while fostering cross-agency partnerships.
<b>Integration</b>	Incorporate TSMO principles in planning, project development, design, construction, and maintenance to ensure proactive, rather than reactive, system management.

Table 909.0.4.2 links MoDOT's mission to measurable outcomes and example TSMO strategies, demonstrating how operations initiatives directly support statewide goals.

**Table 909.0.4.2. Linking MoDOT Mission to Outcomes and Example TSMO Strategies**

Mission	High-Level Outcome	Example TSMO Strategy
<b>Improving safety (Moving Missourians safely)</b>	Reduction in crashes, fatalities, and serious injuries; safer travel for all users	<ul style="list-style-type: none"> <li>909.1.1 Traffic Incident Management</li> <li>909.1.3 Road Weather Management</li> </ul>

		<ul style="list-style-type: none"> <li>• 909.1.4 Work Zone Traffic Management</li> <li>• 909.2.1 Freeway Operations and Management</li> <li>• 909.2.2 Arterial Operations and Management</li> </ul>
<b>Providing high-value, impactful solutions (Delivering efficient and innovative transportation projects; asset management)</b>	Cost-effective improvements that maximize existing infrastructure and delay costly expansions	<ul style="list-style-type: none"> <li>• 909.2.1 Freeway Operations and Management</li> <li>• 909.2.2 Arterial Operations and Management</li> <li>• 909.2.3 Freight Operation</li> <li>• 909.2.4 Vulnerable Road Users</li> </ul>
<b>Improving reliability and mobility (Operating a reliable transportation system; Building a prosperous economy for all Missourians)</b>	Predictable travel times and improved system performance for people and freight	<ul style="list-style-type: none"> <li>• 909.1.1 Traffic Incident Management</li> <li>• 909.1.4 Work Zone Traffic Management</li> <li>• 909.1.5 Planned Special Event Management</li> <li>• 909.2.1 Freeway Operations and Management</li> <li>• 909.2.5 Transit Operation</li> </ul>
<b>Providing useful and timely traveler information (Providing outstanding customer service)</b>	Informed travel decisions by the public, increased user satisfaction	<ul style="list-style-type: none"> <li>• 909.1.2 Transportation Operations for Emergency Incidents or Disasters</li> <li>• 909.1.3 Road Weather Management</li> </ul>

### 909.0.5 Performance Metrics

Performance metrics provide the foundation for evaluating how well MoDOT's TSMO strategies are improving the safety, reliability, efficiency, and customer experience of Missouri's transportation system. The following tables present example measures that create a consistent framework for assessing the effectiveness of TSMO initiatives related to both non-recurring delays (Table 909.0.5.1) and recurring delays (Table 909.0.5.2). By monitoring these metrics over time, MoDOT can identify opportunities for improvement, enhance coordination across disciplines, and promote continuous advancement through data-driven decision-making.

**Table 909.0.5.1. Linking MoDOT TSMO Strategies for Non-Recurring Delays to Performance Metrics**

Strategy	Goals	Example Performance Metric
<b>909.1.1 Traffic Incident Management</b>	Enhance the <b>safety</b> of traveling public and incident responders	<ul style="list-style-type: none"> <li>• Number of secondary crashes per incident</li> <li>• Severity (fatalities/serious injuries) of secondary crashes</li> </ul>

Strategy	Goals	Example Performance Metric
		<ul style="list-style-type: none"> <li>Percent of incidents with secondary crashes recorded</li> <li>Number of responders struck-by crashes</li> <li>Severity of responder-involved crashes</li> <li>Percent of incidents with responder crash data recorded</li> </ul>
	Enhance <b>reliability</b> and <b>efficiency</b> of Missouri's transportation system	<ul style="list-style-type: none"> <li>Average roadway clearance time</li> <li>Average incident clearance time</li> <li>Percent of incidents meeting clearance time targets</li> </ul>
	Strengthen <b>coordination, communication, and collaboration</b> between MoDOT and TIM partners	<ul style="list-style-type: none"> <li>Number of formalized agreements signed</li> <li>Number of multi-agency TIM meetings held annually</li> <li>Number of TIM trainings held annually</li> <li>Partner participation rate in meetings/exercises</li> </ul>
	Establish <b>TIM policies, procedures, and protocols</b> within MoDOT	<ul style="list-style-type: none"> <li>Number of formal TIM policies/protocols adopted</li> <li>Percent of TIM coordinator positions filled and active</li> </ul>
<b>909.1.2 Transportation Operations for Emergency Incidents or Disasters</b>	Enhance <b>safety</b> and responder protection during emergency incidents	<ul style="list-style-type: none"> <li>Number of emergency-related crashes</li> <li>Severity (fatal/serious injury) of emergency-related crashes</li> <li>Percent of emergency incidents with responder safety data recorded</li> </ul>
	Improve <b>reliability</b> and <b>speed</b> of emergency response and system restoration	<ul style="list-style-type: none"> <li>Time to activate emergency operations</li> <li>Duration of emergency lane/road closures</li> <li>Percent of priority routes restored within target timeframes</li> <li>Emergency communication system uptime</li> <li>Average time to deploy emergency traffic control</li> </ul>
<b>909.1.3 Road Weather Management</b>	Improve <b>safety</b> under adverse weather conditions	<ul style="list-style-type: none"> <li>Number of weather-related crashes, fatalities, and serious injuries</li> <li>Crash rate per weather event</li> </ul>
	Enhance <b>operational readiness</b> and <b>timely</b> roadway treatment	<ul style="list-style-type: none"> <li>Time to treat priority routes during storms</li> <li>Percent of network treated within specific time thresholds</li> <li>Materials usage efficiency (salt, brine, abrasives)</li> </ul>
	Improve <b>traveler information</b>	<ul style="list-style-type: none"> <li>Traveler information system accuracy rate during storms</li> </ul>

Strategy	Goals	Example Performance Metric
	accuracy during weather events	<ul style="list-style-type: none"> <li>Number of travel information interactions (511 apps, CMS messages)</li> </ul>
<b>909.1.4 Work Zone Traffic Management</b>	Enhance <b>safety</b> for workers and motorists in work zones	<ul style="list-style-type: none"> <li>Number and rate of work zone crashes</li> <li>Number of work zone fatalities and serious injuries</li> <li>Number of work zone intrusions (near-miss events)</li> </ul>
	Improve <b>mobility</b> and reduce unexpected work zone delays	<ul style="list-style-type: none"> <li>Work-zone related delays</li> <li>Percent of work zones meeting mobility targets (queue length, speed, travel time)</li> <li>Average incident clearance time for work zone-related incidents</li> </ul>
<b>909.1.5 Planned Special Event Management</b>	Ensure <b>safe</b> travel conditions during special events	<ul style="list-style-type: none"> <li>Number and rate of special event-related crashes</li> <li>Vulnerable Road User (VRU) level of comfort/safety index near event venues</li> </ul>
	Improve <b>mobility</b> and minimize event-related congestion	<ul style="list-style-type: none"> <li>Travel time reliability during event periods</li> <li>Vehicle and pedestrian throughput at key access points</li> <li>Percent of events meeting planned operational performance targets</li> </ul>

**Table 909.0.5.2. Linking MoDOT TSMO Strategies for Recurring Delays to Performance Metrics**

Strategy	Goals	Example Performance Metric
<b>909.2.1 Freeway Operations and Management</b>	Support <b>safety</b> on managed freeway facilities	<ul style="list-style-type: none"> <li>Number and rate of crashes on freeway segments</li> <li>Number of secondary crashes</li> </ul>
	Improve <b>travel reliability</b> on freeway corridors	<ul style="list-style-type: none"> <li>Travel time reliability index</li> <li>Planning time index</li> </ul>
	Enhance operational <b>efficiency</b> on freeway corridors	<ul style="list-style-type: none"> <li>Average travel speed and delay</li> <li>Vehicle and truck throughput</li> <li>Number of recurring congestion hotspots mitigated</li> </ul>
<b>909.2.2 Arterial Operations and Management</b>	Enhance <b>safety</b> at signalized intersections and arterials	<ul style="list-style-type: none"> <li>Crash frequency and severity at signalized intersections</li> <li>Pedestrian and bicycle crash rate</li> </ul>
	Improve <b>efficiency</b> of arterial traffic flow	<ul style="list-style-type: none"> <li>Arterial travel time and delay</li> <li>Signal progression quality (arrival on green, bandwidth)</li> </ul>

Strategy	Goals	Example Performance Metric
		<ul style="list-style-type: none"> <li>Number of mitigated congestion hotspots</li> </ul>
	Enhance <b>reliability</b> of multimodal arterial operations	<ul style="list-style-type: none"> <li>Transit signal delay at signals (if applicable)</li> <li>Pedestrian crossing delay</li> </ul>
<b>909.2.3 Freight Operation</b>	Improve <b>efficiency</b> on key freight corridors	<ul style="list-style-type: none"> <li>Truck delay at bottlenecks</li> <li>Freight throughput (corridor or intermodal facility)</li> </ul>
	Enhance <b>reliability</b> of freight travel	<ul style="list-style-type: none"> <li>Truck travel time reliability index</li> <li>Number of freight-related congestion hotspots mitigated</li> </ul>
<b>909.2.4 Vulnerable Road Users</b>	Enhance <b>safety</b> and <b>comfort</b> for Vulnerable Road Users (VRUs)	<ul style="list-style-type: none"> <li>Number and rate of VRU crashes</li> <li>VRU level of comfort/safety index</li> </ul>
	Improve <b>connectivity</b> for walking and bicycling	<ul style="list-style-type: none"> <li>Miles of connected pedestrian/bicycle facilities</li> <li>Percent of network meeting connectivity standards</li> </ul>
	Support <b>sustainable</b> , multimodal travel options	<ul style="list-style-type: none"> <li>Share of trips completed using active modes</li> </ul>
<b>909.2.5 Transit Operation</b>	Enhance <b>mobility</b> of transit users	<ul style="list-style-type: none"> <li>Passenger throughput per route or corridor</li> <li>Average transit travel time</li> </ul>
	Improve transit <b>reliability</b> and on-time performance	<ul style="list-style-type: none"> <li>Percent of on-time arrivals</li> <li>Transit travel time reliability (travel adherence)</li> </ul>
	Improve customer experience and multimodal access	<ul style="list-style-type: none"> <li>Customer satisfaction survey results</li> <li>Pedestrian access quality (stop accessibility index)</li> </ul>

## Articles in "909 Transportation Systems Management and Operations (TSMO)"

The following 2 pages are in this category, out of 2 total.

- [909.1 Non-Congested Route \(Non-Recurring Delays\)](#)
- [909.2 Congested Route \(Recurring Delays\)](#)

Category: [900 TRAFFIC CONTROL](#)

## ~~909.2 Nonrecurring Congestion~~

Nonrecurring congestion can occur at any location at any time and results in delay to motorists as well as a potential for subsequent traffic incidents. TSMO strategies should be utilized to address each type of nonrecurring congestion generator:

### Construction

- As an initial step, a project design should be selected to eliminate or minimize additional delays and traffic queueing during construction. [EPG 616.13 Work Zone Capacity, Queue and Travel Delay](#) provides tools to assess the traffic impact of the proposed project design(s).
- Once a project design has been determined, the [MoDOT Work Zone Impact Analysis Spreadsheet](#) will assist in determining which smart work zones strategies should be included in the project to provide information and warnings to motorists to improve work zone safety and traffic mobility. Additionally, the [Work Zone Management Guidebook](#) provides information about tools and strategies for work zone management that will maximize safety and minimize the impacts to traffic. The [Work Zone Management Guidebook Presentation](#) provides additional information about the guidebook. Additional information can also be found in [EPG 616.13 Work Zone Capacity, Queue and Travel Delay](#) and [EPG 616.14 Work Zone Safety and Mobility Policy](#).
- When traffic incidents occur within a work zone, it is imperative to clear the incident and restore traffic as quickly as possible. To aid in this effort, a project-based traffic incident management (TIM) plan should be developed for all significant projects on interstate and freeways.

### Traffic Incidents

Traffic incidents occur without warning at any time and location on the highway system. On all segments of the interstate and freeway highway system, traffic incident management (TIM) plans should be developed in coordination with law enforcement and local responders to:

- Reduce response and clearance times
- Develop alternate plans for handling affected traffic
- Communicate and coordinate between responders
- Communicate traffic impacts to motorists.

Reference [MoDOT's Strategic Traffic Incident Management Plan](#) for additional information.

[Category: 909 Transportation Systems Management and Operations \(TSMO\)](#)

## 909.1 Non-Congested Route (Non-Recurring Delays)

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### 909.1.1 Traffic Incident Management

Traffic Incident Management (TIM) reduces the impact of roadway incidents by coordinating detection, response, and clearance activities among transportation, law enforcement, fire, EMS, towing, and other partners.

While crashes, disabled vehicles, and cargo spills are the most common focus of TIM programs, there are a broader set of disruptions that should be routinely monitored and managed including:

- Debris in the roadway

- Grass fires
- Lane-blocking emergency vehicles
- Vehicle fires
- Heavy congestion

By incorporating this broader incident set, TIM strategies ensure operators and responders are prepared for a wide range of events that may impact traveler safety and network performance. The following sections outline key strategies for TIM.

**Users:**

- TMC Operators → Detect and coordinate response ([909.1.1.3 Components](#)), disseminate traveler information ([909.1.1.1 Traffic Incident Management Plans](#)).
- Maintenance Technicians → Assist with clearance and roadway restoration ([909.1.1.3 Components](#)).
- Emergency Management Agencies → Critical frontline responders ([909.1.1.2 Stakeholders](#)).

### 909.1.1.1 Traffic Incident Management Plans

Traffic incidents occur without warning at any time and location on the highway system. On all segments of the interstate and freeway highway system, TIM plans should be developed in coordination with law enforcement and local responders to:

- Reduce response and clearance times.
- Develop alternate plans for handling affected traffic.
- Communicate and coordinate between first responders.
- Communicate traffic impacts to motorists.

Reference [EPG Category:948 Incident Response Plan and Emergency Response Management](#) for additional information.

### 909.1.1.2 Stakeholders

Effective TIM depends on collaboration among a wide range of partners. Law enforcement, fire/rescue, EMS, and towing operators provide immediate on-scene response, while MoDOT personnel and TMCs deliver critical support through detection, traffic control, and traveler information. Each stakeholder brings unique capabilities, and coordinated multi-agency response ensures faster clearance, safer conditions for responders, and more reliable outcomes for the traveling public.

### 909.1.1.3 Components

The core components of TIM—detection, verification, response, clearance, and recovery—create a structured framework for managing roadway incidents. Detection and verification confirm the incident type and location; coordinated response mobilizes the appropriate agencies; clearance restores traffic lanes and removes hazards; and recovery ensures the roadway is returned to normal operation. Addressing each component systematically reduces incident duration and enhances both safety and reliability.

## 909.1.2 Transportation Operations for Emergency Incidents or Disasters

Emergency operations ensure safe and effective evacuation and mobility during disasters such as floods, tornadoes, earthquakes, or other emergencies. The following sections outline key strategies for emergency operations during disasters.

**Users:**

- Emergency Management Agencies → Coordinate disaster response ([909.1.2.1 Frameworks and Coordination](#)).
- Transportation Planners → Prepare evacuation plans ([909.1.2.2 Preparedness and Planning](#)).
- Traffic Operations Engineers → Manage ingress and egress traffic flow ([909.1.2.3 Operational Strategies During Disasters](#)).
- TMC Operators → Monitor evacuation routes and push real-time traveler information ([909.1.2.3 Operational Strategies During Disasters](#)).

### 909.1.2.1 Frameworks and Coordination

MoDOT's emergency transportation operations shall be conducted in accordance with the National Incident Management System (NIMS) and the Incident Command System (ICS). These frameworks establish the standard structure, terminology, and coordination processes for incident and disaster response at the local, state, and federal levels.

**National Incident Management System (NIMS):**

- Provides a nationwide approach for incident management and coordination.
- Provides emergency transportation operations guidance for interoperable collaboration with law enforcement, fire, EMS, emergency management, and federal partners.
- Establishes common terminology, communication protocols, and resource management procedures to support multi-agency operations.

**Incident Command System (ICS):**

- Serves as the on-scene management structure for all types of incidents.
- Defines clear roles, responsibilities, and reporting relationships across agencies.
- Provides guidance on unified command structures, filling roles such as transportation branch directors, field observers, or technical specialists.
- Provides flexibility to scale operations for localized or statewide events.

For detailed response information, please contact MoDOT's Safety and Emergency Management.

### 909.1.2.2 Preparedness and Planning

- Develop and exercise evacuation and emergency operations plans.
- Use simulation and scenario testing to identify gaps and strengthen interagency protocols.
- Establish pre-designated staging areas for resource allocation, evacuation support, and vehicle marshaling.

### 909.1.2.3 Operational Strategies During Disasters

- **Traffic Management:** Complete rapid damage assessment and plan and publish routes for ingress and egress to the impacted area.
- **Multimodal Evacuations:** Utilize buses, school buses, and regional transit providers to assist in large-scale evacuations.
- **Route Monitoring:** Employ field observations, cameras, and sensors to track evacuation route conditions in real time.
- **Public Information:** Provide timely traveler information, evacuation messaging, and updates in coordination with media partners.

### 909.1.3 Road Weather Management

Road Weather Management strategies improve mobility, reliability, and safety during weather events through strategies such as targeted traveler information, warnings, and operational interventions including Variable Speed Limits (VSL). The following sections outline key strategies for road weather management.

**Users:**

- TMC Operators → Operate dynamic message signs and push alerts ([909.1.3.1 Road Weather Warnings/Alerts and Dynamic Message Signs](#); [909.1.3.2 Road Weather Information Systems](#)).
- Maintenance Technicians → Respond to weather conditions, deploy treatment ([909.1.3.2 Road Weather Information Systems](#)).
- Traffic Operations Engineers → Oversee VSL and integrate road weather information systems data ([909.1.3.1 Road Weather Warnings/Alerts and Dynamic Message Signs](#); [909.1.3.2 Road Weather Information Systems](#)).

#### 909.1.3.1 Road Weather Warnings/Alerts and Dynamic Message Signs

Displays real-time information to warn motorists of roadway incidents, construction or congestion ahead that could pose a hazard or cause delays.

Procedures for Dynamic Message Signs are outlined in [EPG 910.3 Dynamic Message Signs \(DMS\)](#).

#### 909.1.3.2 Road Weather Information Systems

Measure real-time atmospheric parameters, pavement conditions, water level conditions, visibility, and sometimes other variables. Comprises Environmental Sensor Stations (ESS) as they also cover non-meteorological variables in the field, a communication system for data transfer, and central systems to collect field data from numerous ESS.

### 909.1.4 Work Zone Traffic Management

Work zone strategies reduce risk to workers and travelers while minimizing delays during construction and maintenance activities. These strategies apply to both short-term and long-term work zones, recognizing that every project, regardless of duration, can significantly affect roadway operations and safety. The following sections outline key strategies for work zone traffic

management.

**Users:**

- Design Engineers → Incorporate TMP and ITS strategies into project design ([909.1.4.1 Traffic Management Plan](#); [909.1.4.4 Use of Intelligent Transportation Systems](#)).
- Work Zone Specialists → Review and manage TMPs, oversee traffic control device setup, and ensure compliance with MoDOT standards ([909.1.4.1 Traffic Management Plan](#); [909.1.4.2 Traffic Incident Management Plan](#)).
- Construction Inspectors → Enforce work zone traffic control measures ([909.1.4.2 Traffic Incident Management Plan](#)).
- Traffic Operations Engineers → Oversee ITS integration and system strategies ([909.1.4.3 Smart Work Zones](#); [909.1.4.4 Use of Intelligent Transportation Systems](#)).
- TMC Operators → Monitor work zones and disseminate real-time traveler information ([909.1.4.4 Use of Intelligent Transportation Systems](#)).

### 909.1.4.1 Traffic Management Plan

The Transportation Management Plan (TMP) consists of strategies to manage the work zone impacts of a project. Each TMP is tailored to the unique conditions of a project and typically incorporates three coordinated elements: Traffic Control Plan (TCP), Traffic Operations (TO), and Public Information (PI).

As an initial step, a project design should be selected to eliminate or minimize additional delays and traffic queueing during construction. [EPG 616.13 Work Zone Capacity, Queue and Travel Delay](#) provides tools to access the traffic impact of the proposed project design(s).

For additional detail on the required elements, development process, and documentation standards for TMPs, reference [EPG 616.14.9 Work Zone Transportation Management Plan](#).

### 909.1.4.2 Traffic Incident Management Plan

When traffic incidents occur within a work zone, it is imperative to clear the incident and restore traffic as quickly as possible. To aid in this effort, a project-based traffic incident management (TIM) plan should be developed for all significant projects on interstate and freeways.

Reference [EPG Category 909.1.1.1 Traffic Incident Management \(TIM\) Plans](#) for additional information.

### 909.1.4.3 Smart Work Zones

Once a project design has been determined, the [MoDOT Work Zone Impact Analysis Spreadsheet](#) will assist in determining which smart work zones strategies should be included in the project to provide information and warnings to motorists to improve work zone safety and traffic mobility. Additionally, the [Work Zone Management Guidebook](#) provides information about tools and strategies for work zone management that will maximize safety and minimize the impacts to traffic. The [Work Zone Management Guidebook Presentation](#) provides additional information about the guidebook. Additional information can also be found in [EPG 616.13 Work Zone Capacity, Queue and Travel Delay](#) and [EPG 616.14 Work Zone Safety and Mobility Policy](#).

#### 909.1.4.4 Use of Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) devices (cameras, sensors, communication systems) provide detection and real-time monitoring of work zones.

Procedures for ITS devices are outlined in [EPG 910 Intelligent Transportation Systems](#).

### 909.1.5 Planned Special Event Management

Special event management strategies ensure safe and efficient mobility during large gatherings, sporting events, and other planned activities. The following sections outline key strategies for planned special event management.

**Users:**

- Transportation Planners → Develop TMPs for special events and coordinate agencies ([909.1.5.1 Pre-Event Planning](#); [909.1.5.4 Post-Event Evaluation](#)).
- Traffic Operations Engineers → Design strategies for traffic flow and multimodal support ([909.1.5.2 Implementation](#)).
- TMC Operators → Manage day-of-event operations and traveler communications ([909.1.5.3 Day-of-Event Operations](#)).
- Emergency Management Agencies → Manage access, safety, and enforcement ([909.1.5.2 Implementation](#)).

#### 909.1.5.1 Pre-Event Planning

- Develop Transportation Management Plans (TMPs) with input from MoDOT, local agencies, law enforcement, transit providers, and event organizers.
- Identify needs for Emergency Operations Center (EOC) and Joint Operations Center (JOC) activation, staffing augmentation, and resource staging for high-profile or large-scale events (e.g., sporting events, major concerts, parades, funerals, festivals, eclipse, political events).
- Plan for multimodal access (transit, walking, biking) and freight restrictions, where applicable.

#### 909.1.5.2 Implementation

- Deploy traffic control devices, signage, and ITS in advance of the event.
- Coordinate with law enforcement and emergency management on enforcement zones, access control, and responder staging.
- Conduct interagency briefings to confirm roles, responsibilities, and communication protocols.

#### 909.1.5.3 Day-of-Event Operations

- Manage traffic and crowd circulation using TMC monitoring, field staff, and real-time traveler information (dynamic message signs, push alerts, social media).
- Coordinate with EOC/JOC if activated to ensure situational awareness and resource support.
- Adjust plans dynamically to address congestion, incidents, or security needs.

### 909.1.5.4 Post-Event Evaluation

- Conduct after-action reviews with MoDOT staff, law enforcement, emergency management, and event organizers.
- Document lessons learned, identify gaps in staffing or coordination, and refine TMPs for future events.
- Capture performance measures such as clearance times, delay estimates, and traveler feedback.

[Category: 909 Transportation Systems Management and Operations \(TSMO\)](#)

## 909.1 Recurring Congestion

Highway segments with recurring congestion are candidates for highway improvements. While adding capacity by constructing additional lanes may not be feasible, other TSMO strategies should be considered as alternate solutions which are often more economical than traditional construction solutions. Strategies such as integrated corridor management (ICM), active transportation and demand management (ATDM), ramp metering, and lane management may provide substantial improvements to recurring congestion.

[Category: 909 Transportation Systems Management and Operations \(TSMO\)](#)

## 909.2 Congested Route (Recurring Delays)

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### 909.2.1 Freeway Operations and Management

Freeway operations strategies enhance safety, reduce recurring congestion, and improve travel time reliability on major corridors. The following sections outline key strategies for freeway operations and management.

#### **Users:**

- TMC Operators → Monitor and adjust dynamic controls, coordinate corridor operations, and manage incident response ([909.2.1.1 Ramp Management and Control](#); [909.2.1.3 Dynamic Speed Limits](#); [909.2.1.4 Queue Warning](#); [909.2.1.5 Integrated Corridor Management](#); [909.2.1.6 Traffic Management Centers](#)).
- Traffic Operations Engineers → Design freeway operations strategies, oversee policy-sensitive strategies, and evaluate corridor performance ([909.2.1.2 Part-Time Shoulder Use](#); [909.2.1.5 Integrated Corridor Management](#); [909.2.1.6 Traffic Management Centers](#); [909.2.1.7 Managed Lanes](#)).
- Information Systems Managers → Maintain ITS infrastructure, support automated detection, and ensure system integration for real-time operations ([909.2.1.5 Integrated Corridor Management](#); [909.2.1.6 Traffic Management Centers](#); [909.2.1.8 Automated Incident Detection](#)).

**Policy Coordination** – Any consideration or application of the following strategies in Missouri should be closely coordinated with MoDOT’s **Central Office of Highway Safety and Traffic (COHST)** to ensure consistency with policy, design standards, and operational oversight.

### 909.2.1.1 Ramp Management and Control

Ramp management and control strategies, including ramp metering and adaptive ramp management, regulate vehicle entry onto freeways to improve merging operations, reduce conflicts, and smooth overall traffic flow. This remains a dynamic application where it is implemented, with operational adjustments based on corridor conditions.

Currently, Missouri does not operate continuous ramp metering systems. Instead, ramp meters are activated dynamically based on real-time traffic conditions when metrics (such as speed, volume, and/or density) exceed predefined thresholds.

### 909.2.1.2 Part-Time Shoulder Use (Hard Shoulder Running)

Part-time shoulder use, also known as hard shoulder running, allows roadway shoulders to serve as temporary travel lanes during peak periods, incidents, or emergencies. Applications may be designed for all vehicles or limited to transit operations.

This strategy is increasingly being implemented by peer agencies across the country, particularly in corridors with limited right-of-way or peak-period capacity needs. While Missouri does not currently have any active applications of part-time shoulder use, the concept may present opportunities in select corridors - especially where traditional widening is not feasible and where shoulders are constructed to full-depth pavement standards.

### 909.2.1.3 Dynamic Speed Limits

Dynamic speed limits adjust posted speed limits in real time based on conditions such as traffic flow, weather, or incidents. This approach has been applied by several peer agencies to improve safety, smooth traffic flow, and reduce crash risk.

In Missouri, there are no permanent applications of dynamic speed limits in routine freeway operations. However, the strategy may hold value in targeted, temporary contexts—particularly in work zones where changing conditions require more flexible speed management.

### 909.2.1.4 Queue Warning

Queue warning systems are designed to alert motorists of slow or stopped traffic ahead, reducing the likelihood of sudden braking and rear-end collisions in congested conditions. These systems typically consist of roadside sensors and Changeable Message Signs (CMS) that detect traffic slowdowns and display real-time warnings to approaching drivers. When sensors identify slowed or stopped vehicles, signals are transmitted to the CMS, which then display queue warning messages. Placement of sensors and signs is critical—warnings should activate when a queue extends to within 1–2 miles upstream, depending on speed, to provide adequate driver reaction time. In Missouri, current applications of queue warning rely exclusively on Dynamic Message Signs (DMS) rather than flashing beacons.

### 909.2.1.5 Integrated Corridor Management

Integrated Corridor Management (ICM) refers to coordinated operations across multiple facilities within a corridor—primarily freeways and parallel arterials. The goal is to manage congestion holistically by making better use of available capacity, balancing demand, and improving traveler information.

### 909.2.1.6 Transportation Management Centers

Transportation Management Centers (TMCs) serve as the operational backbone of ICM. From TMCs, MoDOT staff monitor real-time traffic conditions, manage ITS devices, coordinate incident response, and adjust strategies such as ramp metering or queue warning. This centralized approach enables proactive management of corridors, ensuring safety and reliability during incidents, work zones, and peak travel periods.

### 909.2.1.7 Managed Lanes

Managed lanes are roadway segments where access and use are actively regulated to improve traffic flow, safety, or reliability. Common approaches used nationally include bus-only lanes and truck-only lanes. These treatments are typically considered in locations with recurring congestion, limited right-of-way, or freight movement challenges.

At present, Missouri has no active managed lane facilities.

### 909.2.1.8 Automated Incident Detection

Automated incident detection systems use roadside sensors, video feeds, and software algorithms to identify crashes, stalled vehicles, or other disruptions in real time. These systems often integrate AI-based analytics with CCTV camera footage to detect unusual traffic patterns or stopped vehicles more quickly than traditional operator observation alone. By providing earlier notification of likely incidents, automated detection enhances safety, reduces secondary crashes, and improves response times for emergency and traffic management personnel.

## 909.2.2 Arterial Operations and Management

Arterial operations strategies improve mobility, safety, and reliability on surface streets through targeted improvements, signal operations, and multimodal accommodations. These strategies focus on reducing congestion at bottlenecks, enhancing intersection performance, and supporting consistent travel across urban and suburban corridors.

In Missouri, arterial management is often a shared responsibility between MoDOT and regional or local partners. For example, the Kansas City region's Operation Green Light program coordinates arterial signal timing and corridor operations in collaboration with MoDOT and multiple local jurisdictions. Other examples include MoDOT's partnership with St. Charles in the St. Louis region and collaboration with the City of Springfield and the Ozarks Transportation Organization. Similar arrangements may exist in other regions where MPOs, cities, or counties lead day-to-day arterial management. Practitioners should recognize that depending on the corridor and location, responsibility for arterial operations may rest with another entity, requiring coordination and partnership to ensure consistent system performance.

The following sections outline key strategies for arterial operations and management.

**Users:**

- Traffic Operations Engineers → Manage signals, coordination, and adaptive timing ([909.2.2.3 Traffic Signal Program Management](#); [909.2.2.4 Traffic Signal Timing and Coordination](#); [909.2.2.5 Transit Signal Priority](#)).
- Design Engineers → Implement innovative intersections and targeted improvements ([909.2.2.1 Targeted Infrastructure Improvements](#); [909.2.2.2 Innovative Intersection Designs](#)).
- TMC Operators → Oversee corridor signal adjustments and incident response ([909.2.2.4 Traffic Signal Timing and Coordination](#); [909.2.2.6 Arterial Dynamic Shoulder Use](#)).

**Policy Coordination** – Any consideration or application of the following strategies in Missouri should be closely coordinated with MoDOT’s **Central Office of Highway Safety and Traffic (COHST)** to ensure consistency with policy, design standards, and operational oversight.

### 909.2.2.1 Targeted Infrastructure Improvements

Targeted infrastructure improvements are localized enhancements that address recurring bottlenecks or multimodal safety concerns on arterial corridors. Common treatments include new or extended turn lanes to reduce delay at intersections, access control to improve traffic flow and safety, and bus pullouts to minimize transit-related delays. Pedestrian and bicyclist accommodations such as crosswalk improvements, refuge islands, and protected lanes also support safer and more reliable mobility for all users.

### 909.2.2.2 Innovative Intersection Designs

Innovative intersection designs apply alternative layouts to improve safety and efficiency where traditional designs are constrained. Examples include restricted crossing U-turns (RCUTs), median U-turns, and displaced left-turn (continuous flow) intersections, which reduce conflict points and increase throughput. These designs are increasingly considered where right-of-way is limited, traffic volumes are high, or safety issues persist with conventional layouts.

Additional information can be found in [EPG 233.5 Intersection Alternatives](#).

### 909.2.2.3 Traffic Signal Program Management

A comprehensive traffic signal program provides the framework for maintaining effective corridor operations. Program elements include monitoring and evaluating existing signal systems, scheduling recurring retiming efforts, and integrating new technologies over time. A proactive, programmatic approach ensures that signals are managed consistently across jurisdictions, providing reliable performance and minimizing inefficient, piecemeal adjustments.

Procedures for signal operation and maintenance are outlined in [902.5.8 Responsibility for Operation and Maintenance](#).

### 909.2.2.4 Traffic Signal Timing and Coordination

Traffic signal timing and coordination strategies are a cost-effective approach to improve arterial operations. By updating signal timing plans and coordinating operations across intersections, agencies can reduce delays and support more predictable travel along corridors. These strategies allow signal operations to reflect current traffic conditions, land use patterns, and system changes, while also providing a foundation for integrating advanced technologies such as adaptive control.

#### Applications:

- **Traffic Signal Retiming** – Updating the timing plans for one signalized intersection or a corridor of intersections based on the latest traffic volumes. Retiming is recommended every few years or after significant changes to transportation systems or land use within a given area.
- **Traffic Signal Coordination** – Coordinating traffic signal timing along a corridor to enable a “green wave” of vehicles traveling through a sequence of signals. Coordination optimizes the splits and offsets of signals to allow for smoother, progressive traffic flow.
- **Adaptive Traffic Signal Control** – Coordinating traffic signal timing across a network using real-time detector data to accommodate current, prevailing traffic patterns. This allows for dynamic adjustment of timing in response to fluctuating traffic conditions.

### 909.2.2.5 Transit Signal Priority

Transit signal priority (TSP) strategies adjust signal phasing to reduce delay for buses and improve the efficiency of transit operations. TSP can extend green phases and/or provide early green intervals to help transit vehicles move more consistently through intersections. By enhancing the speed and reliability of bus service, TSP supports multimodal goals and encourages greater use of transit along arterial corridors.

### 909.2.2.6 Arterial Dynamic Shoulder Use

Arterial dynamic shoulder use provides additional capacity and improves multimodal efficiency by repurposing existing roadway space under defined conditions. Dynamic shoulder use allows roadway shoulders to operate as travel lanes during peak periods or special events, while maintaining their primary role for emergency access during off-peak times. This strategy can help reduce delays, improve vehicle-throughput, and support multimodal goals in areas where right-of-way is constrained and traditional widening is not feasible. Successful implementation requires clear operational policies, appropriate signing and striping, and coordination with enforcement and transit partners to ensure safety and effectiveness.

Although Missouri does not currently implement arterial dynamic shoulder use, the approach may offer targeted benefits in select corridors—especially where traditional widening is not feasible and where shoulders are constructed to full-depth pavement standards.

## 909.2.3 Freight Operation

Freight operations strategies address truck mobility, parking, and safety near freight generators such as ports and distribution centers. The following sections outline key strategies for freight operations.

**Users:**

- Transportation Planners → Coordinate freight corridors, permitting, and parking strategies ([909.2.3.1 Freight Operations Around Ports and Generators](#); [909.2.3.2 Truck Parking](#); [909.2.3.3 Regional Permitting](#)).
- Traffic Operations Engineers → Oversee technology applications and truck restrictions ([909.2.3.1 Freight Operations Around Ports and Generators](#); [909.2.3.4 Technology Applications for Freight](#); [909.2.3.5 Connected and Automated Freight Vehicles](#)).

Reference MoDOT's [2022 State Freight and Rail Plan Documents](#) for additional information.

### 909.2.3.1 Freight Operations Around Ports and Generators

Freight hubs such as ports, intermodal yards, and distribution centers generate concentrated truck activity that can create localized congestion and safety concerns. Targeted operational improvements may include intersection upgrades, dedicated freight lanes, improved signage, or optimized signal timing along key freight corridors. These measures reduce bottlenecks, improve travel time reliability for trucks, and minimize conflicts between freight and passenger vehicles in high-demand areas.

### 909.2.3.2 Truck Parking

Adequate truck parking is essential for driver safety, freight efficiency, and regulatory compliance. Strategies include the development of new truck parking facilities, upgrades to existing rest areas, and the integration of real-time availability systems that help drivers locate spaces. Reservation tools and wayfinding applications can further support efficient parking use and reduce the safety risks associated with unauthorized shoulder or ramp parking.

### 909.2.3.3 Regional Permitting

Freight often crosses multiple jurisdictions, and inconsistent permitting processes can add delay and administrative burden. Regional permitting strategies streamline requirements by coordinating across state, county, and local agencies. Harmonizing size, weight, and routing approvals enhances efficiency for carriers while reducing redundant processes for agencies, particularly along high-volume freight corridors.

### 909.2.3.4 Technology Applications for Freight

Technology provides powerful tools for managing freight mobility. Examples include routing platforms that help drivers avoid weight-restricted bridges or low-clearance structures, monitoring systems that track freight movement in real time, and automated clearance technologies at weigh stations or ports of entry. Collectively, these applications enhance efficiency, improve safety, and provide data to better manage freight corridors.

### 909.2.3.5 Connected and Automated Freight Vehicles

The freight industry is a leading sector for testing and deploying connected and automated vehicle (CV/AV) technologies. Applications may include platooning, automated truck-mounted attenuators, or fully automated long-haul freight operations. These technologies have the potential to improve safety, reduce driver fatigue, and increase efficiency in freight corridors. Early deployment efforts

require coordination with industry, agencies, and technology providers to ensure infrastructure readiness and to evaluate operational impacts.

## 909.2.4 Vulnerable Road Users

Vulnerable road users (VRUs) are individuals who travel without the protection of an enclosed vehicle and therefore face a greater risk of serious injury in a collision. VRUs include pedestrians, roadway workers, individuals using wheelchairs or other personal mobility devices, bicyclists, motorcyclists, and users of electric scooters and other micromobility devices. The following sections outline key strategies to improve safety, access, and comfort for these users within the transportation system.

### Users:

- Design Engineers → Implement bike lanes, pedestrian facilities, and safety enhancements ([909.2.4.1 Safety Enhancements](#); [909.2.4.2 Pedestrian and Accessibility Facilities](#); [909.2.4.3 Bicycle Lanes and Cycle Tracks](#)).
- Transportation Planners → Support multimodal planning and education programs ([909.2.4.1 Safety Enhancements](#); [909.2.4.4 VRU Education](#)).

### 909.2.4.1 Safety Enhancements

Selective deployment of safety enhancements should be informed by [EPG Category:907 Traffic Safety](#) and tailored to the needs of VRUs. Enhancements may include improved crossings, lighting, signing and pavement markings, speed management strategies, traffic calming measures, work zone protections for roadway workers, and design treatments that reduce conflicts involving motorcyclists and micromobility users.

### 909.2.4.2 Pedestrian and Accessibility Facilities

Sidewalks, shared-use paths, accessible curb ramps, transit stop connections and enhanced or grade-separated crossings should be prioritized where safety risks, accessibility needs, or network gaps are identified. Integrating these facilities in alignment with Complete Streets principles ([EPG 907.10 Complete Streets](#)) helps ensure safe, efficient access for pedestrians and individuals using wheelchairs or other mobility devices.

### 909.2.4.3 Bicycle Lanes and Cycle Tracks

Where conditions and community priorities warrant, dedicated bike lanes or protected cycle tracks can significantly enhance comfort and safety for bicyclists and other micromobility users, including users of electric scooters and similar devices. MoDOT's Complete Streets guidance ([EPG 907.10 Complete Streets](#)) supports integrating these features into designs that serve all users – including VRUs – within roadway corridors.

### 909.2.4.4 VRU Education and Outreach

Support community-informed education and outreach programs that promote safe behaviors among VRUs. Programs may address the needs of pedestrians, bicyclists, micromobility users, motorcyclists, individuals with disabilities, and drivers, and may include collaboration with local

schools, community organizations, advocacy groups, employers, transit agencies, and public safety partners.

## 909.2.5 Transit Operation

Transit operations strategies improve speed, reliability, and accessibility of transit services. The following sections outline key strategies for transit operations.

### Users:

- Transit Agencies → Operate BRT, implement TSP, and manage transit vehicles ([909.2.5.1 Transit Signal Priority](#); [909.2.5.2 Bus Rapid Transit](#); [909.2.5.3 Transit-Only Lanes](#); [909.2.5.4 Transit Operation Vehicles](#)).
- Transportation Planners → Plan multimodal centers and support dynamic transit strategies ([909.2.5.2 Bus Rapid Transit](#); [909.2.5.3 Transit-Only Lanes](#); [909.2.5.5 Multimodal Transportation Centers](#)).
- Traffic Operations Engineers → Support signal priority and corridor treatments ([909.2.5.1 Transit Signal Priority](#); [909.2.5.2 Bus Rapid Transit](#); [909.2.5.3 Transit-Only Lanes](#)).

### 909.2.5.1 Transit Signal Priority

Transit Signal Priority (TSP) strategies modify traffic signal operations to reduce delay and improve on-time arrivals for buses and other transit vehicles.

Additional information on TSP is provided in [EPG 909.2.2.5 Transit Signal Priority](#).

### 909.2.5.2 Bus Rapid Transit

Bus Rapid Transit (BRT) incorporates a combination of dedicated lanes, intersection treatments, and enhanced stations to provide faster and more reliable bus service. Treatments such as queue jump lanes and high-capacity vehicles further enhance performance. BRT can serve as a cost-effective alternative to rail in high-demand corridors, delivering rapid, frequent, and reliable service with improved passenger amenities.

### 909.2.5.3 Transit-Only Lanes

Transit-only lanes provide additional capacity and improve multimodal efficiency by repurposing existing roadway space under defined conditions. Transit-only lanes dedicate roadway space to buses, enabling more reliable service and improving schedule adherence in congested corridors. This strategy can help reduce delays, improve person-throughput, and support multimodal goals in areas where right-of-way is constrained and traditional widening is not feasible. Successful implementation requires clear operational policies, appropriate signing and striping, and coordination with enforcement and transit partners to ensure safety and effectiveness.

This strategy may offer targeted benefits in select corridors where shoulders are constructed to full-depth pavement standards.

**Policy Coordination** – Any consideration or application of Transit-Only Lanes in Missouri should be closely coordinated with MoDOT's **Central Office of Highway Safety and Traffic (COHST)** to ensure consistency with policy, design standards, and operational oversight.

#### 909.2.5.4 Transit Operation Vehicles

Transit vehicle operations may require unique roadway considerations. Streetcars, for example, share corridors with general traffic and necessitate signal coordination and geometric design adjustments for turning movements. Similarly, buses may require accommodations such as bus pullouts, curb extensions, or boarding islands to improve efficiency and passenger safety. These vehicle-specific considerations support smoother operations and minimize conflicts with other modes.

#### 909.2.5.5 Multimodal Transportation Centers

Multimodal transportation centers serve as hubs that integrate multiple travel modes, including bus, rail, bike, and pedestrian connections. These facilities improve regional accessibility by consolidating transfers in a single location and providing amenities such as shelters, ticketing, and real-time traveler information.

In Missouri, existing park-and-ride facilities present opportunities to serve as future multimodal centers. When thoughtfully designed, these centers encourage greater transit use, strengthen first- and last-mile connections, and elevate the role of transit in supporting regional mobility.

[Category: 909 Transportation Systems Management and Operations \(TSMO\)](#)

## TSMO Resource Documents

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[+/-] TSMO Resource Documents

[+/-] Category 1

[+/-] Category 2

[Category: 909 Transportation Systems Management and Operations \(TSMO\)](#)