# SECTION 32
# SIGNS, LUMINAIRES, AND TRAFFIC SIGNALS

## 32.1 GENERAL REQUIREMENTS

This section provides guidance for the design and construction of signs, luminaires, and traffic signals. Such structures include but are not limited to:

- Bridge mounted signs.
- Ground mounted signs, including overhead sign bridges (that is, single span, multi-span), and cantilevered sign structures (that is, single sided, two sided/butterfly).
- Pole and wire systems for signs and traffic signals; and
- Poles for traffic lighting, luminaires, and traffic cameras.

Existing caissons are not to be reused for new sign structures unless they match the current standards or can be analyzed to verify they match any new loads from the current code.

## 32.2 CODE REQUIREMENTS

Unless modified herein, design of highway signs, luminaires, and traffic signals shall be in accordance with the most current edition of *AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals* (AASHTO LTS) or current M&S Standards. The M&S Standards take precedence, even though the current M&S Standards have not been updated to most current AASHTO LTS. If a design falls within the parameters of the M&S Standards, then the M&S Standards shall be used. A project specific or special design is only required when a project specific design does not meet the limits of the M&S Standard. When a project specific design is required, it shall follow the most current edition of AASHTO LRFD LTS. Where sign panels are changed or updated at existing sign structure locations, the original design assumptions may be used to evaluate the additional or revised signage.

When M&S Standard requires that the Contractor submit a design for the item, for example M-613-1 Roadway Lighting, then the design shall follow the most current edition of AASHTO LRFD LTS. A summary of Contractor submittals can be found in Table 105-1 of CDOT's Standard Specifications for Road and Bridge Construction.

Designs falling outside the limits of the S-Standards will require a special design. Sign structures are to follow the Major Structures requirements in the Structures Process outlined in Part E of the Policies and Procedures section of this BDM.

Due to concerns with fatigue, CDOT limits pole shapes to those that are round or have greater than or equal to the minimum number of sides defined in AASHTO LTS.

***AASHTO LTS 5.6.2***

## 32.3 DESIGN CRITERIA

Designs shall follow AASHTO LTS for all design elements and include the following design clarifications.

### 32.3.1 Loads

*32.3.1.1 Live Load*

Live load shall be applied at the most critical locations to determine the design envelope. ***AASHTO LTS 3.6***

*32.3.1.2 Ice Load*

Unless requested by the region, ice loading is not required. If ice load is to be applied due to the special icing requirement, consult the most recent edition of ASCE/SEI 07 for guidance. ***AASHTO LTS 3.7***

*32.3.1.3 Wind Load*

AASHTO basic wind speeds cannot be directly compared to wind speeds used for design in the current M&S Standards. The code design factors, probability of exceedance, and/or averaging times associated with the wind velocities in the M&S Standards vary. If the member selection tables in the M&S Standards do not accommodate the given sign panel and span dimensions, the structure design shall use the wind loads described herein.

All CDOT on-system sign structures and signals should be considered high risk and can cross travel ways if they fail. Thus, the basic wind speed, V, used to determine the design wind pressure shall be 120 mph per the 1700 year Mean Recurrence Interval (MRI) drawing shown in AASHTO LTS Figure 3.8-2a and discussed in C3.8. The basic wind speed shall be used except in the following circumstances: ***AASHTO LTS 3.8***

- Colorado's Special Wind Region (SWR) requires that the basic wind speed be calculated case by case. The western edge of the SWR follows the Continental Divide extending from the Colorado/Wyoming border south to the Colorado/New Mexico border. The eastern edge of the SWR is defined as a line extending from 5 miles west of I-25 at the Colorado/Wyoming border to 5 miles west of I-25 at the Colorado/New Mexico border, including all of Boulder County. A 300-year MRI shall be used to determine the basic wind speed and design wind pressure for all structures within this region.
- Figure 32-1 was developed from a partial SWR map for the northern section of the state. The southern portion of the map is a projection of the wind contours south to the border. An electronic Google Earth © version of this map is available and can be accessed by following this link: Colorado Gust Map.kmz. All data south of the "assumed data demarcation line" (39.39 degrees North) are assumed wind gust routes. Data are to be updated pending the completion of a wind gust study project.
- For special structures not noted previously, such as span wire signal structures, contact Unit Leader in coordination with the Signal SMEs for basic wind speed design values.

The alternate method for fatigue design per AASHTO LTS Appendix C shall not be used to determine alternative wind loads.

The effects of torsional load on caisson-soil interaction must be evaluated for all structures where torsional load is present due to wind load and structure geometry. This check is shown in Example 10 of this BDM.

Dampeners or other mitigation for galloping will be considered on a project basis since galloping is challenging to predict.

**Table 32-1: Wind Speed Data at Other Mean Recurrence Intervals**

| Line Color | Mean Recurrence Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | 10 years | 25 years | 50 years | 100 years | 300 years | 700 years | 1700 years |
| Green | 75 mph | 85 mph | 90 mph | 95 mph | 105* mph | 115 mph | 120 mph |
| Blue | 85 mph | 95 mph | 100 mph | 105 mph | 120 mph | 125 mph | 135 mph |
| Yellow | 90 mph | 100 mph | 110 mph | 120 mph | 130 mph | 140 mph | 150 mph |
| Peach | 100 mph | 110 mph | 120 mph | 130 mph | 140 mph | 150 mph | 160 mph |
| Orange | 110 mph | 120 mph | 130 mph | 140 mph | 155 mph | 165 mph | 175 mph |
| Red | 115 mph | 130 mph | 140 mph | 150 mph | 165 mph | 175 mph | 190 mph |
| Pink | 150 mph | 165 mph | 180 mph | 190 mph | 210 mph | 225 mph | 245 mph |

* min value of 120 mph must be used in design

#### *32.3.1.4 Fatigue Load*

***AASHTO LTS Section 11***

An infinite life fatigue design approach shall be applied for overhead sign structures, luminaire supports, and traffic signal structures.

## 32.4 BRIDGE MOUNTED STRUCTURES

***AASHTO LTS Section 2***

Bridge mounted sign panels, signal systems, and luminaires are not permitted unless otherwise approved by Unit Leader.

If a bridge mounted sign, luminaire, or signal is approved by Unit Leader, it shall be positioned such that the bottom of the component is located a minimum of 2 in. above the bottom of the bridge girder to allow for sag and construction tolerances. For aesthetics, it is preferred that the sign structure not extend above the top of the bridge rail.

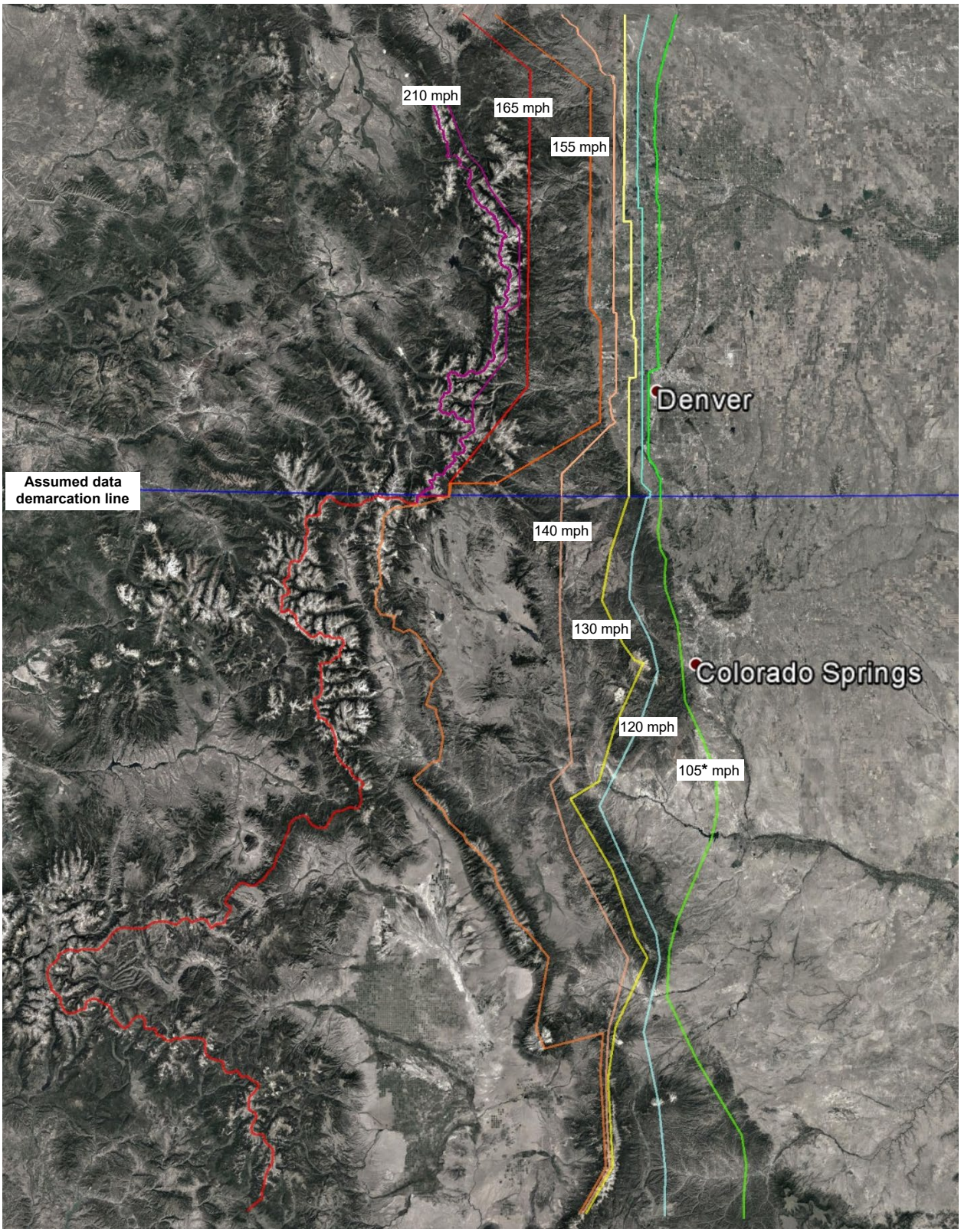


**Figure 32-1: Partial Special Wind Region Map (300 year MRI)**

(* min value of 120 mph must be used in design)

Unless the Traffic Engineer directs otherwise, place bridge mounted sign structures normal to an approaching vehicle's line of sight. For horizontally curved roadways below bridges, place bridge mounted sign structures normal to a 500-ft.-long chord that extends from the intersection of the centerline of travel lanes and the back face of the bridge barrier to a point on the centerline of travel way (see Figure 32-2).

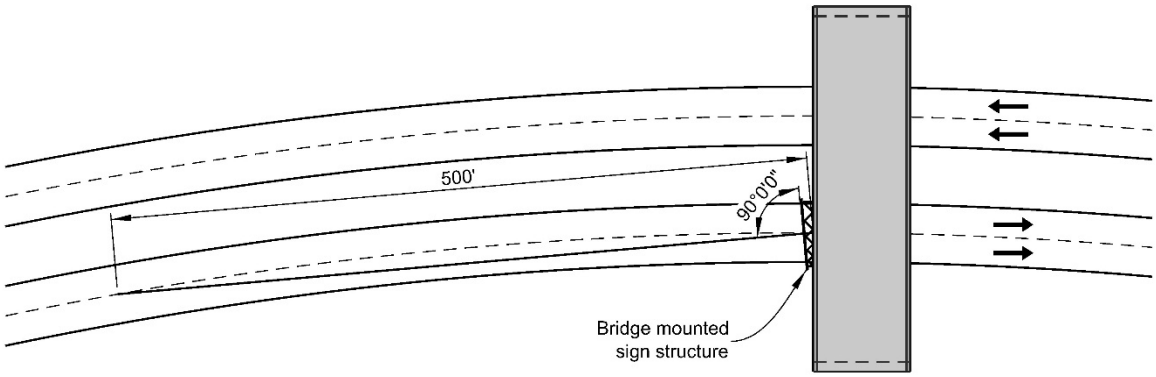


**Figure 32-2: Sign Alignment for Curved Roadways**

Expansion type concrete anchors are undesirable for attaching sign support brackets to the supporting structure because of vibration and pullout concerns. Instead, A307 or A325 bolts shall be used as through bolts or A307 all-thread rod may be used to make drilled-in-place anchor bolts bonded to the supporting concrete with an approved two-part epoxy system. If the anchor is in continuous tension, the Designer shall use only an epoxy system if it is approved for use in continual tension loading. Many epoxy systems are not allowed if the anchor is in continuous tension. Refer to ACI 318 and ACI 355.4 for more information on using post-installed adhesive anchors. Through and drilled-in-place anchor bolts can be used to resist direct tension and shear loads. Unless a refined analysis permits shallower anchorage, a minimum depth and diameter of drilled holes for bonded anchor bolts shall be 9 bolt diameters plus 2 in. and one bolt diameter plus 1/8 in. respectively. Bonded anchors bolts are 100 percent effective if the spacing and edge distance is equal to or greater than 9 bolt diameters and are considered to be 50 percent effective when the edge distance or spacing is reduced to 4.5 bolt diameters. Edge distances and spacings less than 4.5 bolt diameters are not allowed.

Use cast-in-place A307 J-bolts for new concrete work.

When an approved proprietary bolting system is specified, add the following note to the plans:

> "The bolting system is to be installed using the manufacturer's recommendations."

When an approved two-part epoxy system is specified, add the following note to the plans:

"The two-part epoxy system shall be installed using the manufacturer's recommendations."

For torque limits for all through bolts and tension limits due to permanent service dead load for bonded anchor bolts, see Table 32-2. Use interpolation for values not shown in the table.

**Table 32-2: Torque and Tension Limits**

| Bolt Type | Bolt Diameter | Torque (ft-lbs) | | Tension Limit (lbs) |
|---|---|---|---|---|
| | | Dry | Lubed | |
| A307* | 0.50 | 25 | 20 | 1400 |
| | 0.75 | 85 | 60 | 3300 |
| | 1.00 | 200 | 150 | 6000 |
| A325* | 0.50 | 70 | 50 | – |
| | 0.75 | 240 | 180 | – |
| | 1.00 | 350 | 265 | – |

* A36 may be substituted for A307; A449 may be substituted for A325.