

ODOT Other Structures Design Manual

Oregon Department of Transportation

October 2026 Edition

Note: Revisions for future version will be marked with yellow highlight. Deleted text is not marked; past editions of the *Other Structures Design Manual (BDM)* are available for comparison on the Bridge website.

Preface

PURPOSE:

The purpose of the *Other Structures Design Manual (OSDM)* is to ensure the design of structures that are safe, practical, economical, and appropriate for the site through the establishment of standards and best practices.

Because this work is so diverse in its work portfolio, work on Other Structures is founded upon communication and coordination of work across ODOT business lines (e.g. Bridge, Geotechnical, Hydro, Environmental, Traffic, ITS, etc.).

FORMAT:

The *OSDM* is written in a two-column format with specifications in the left-hand column, and guidance and commentary on the right. For more information about the *OSDM* format, see the *BDM Format Guide*.

For any portions that are not written in two-column format, consult with the relevant section owners to clarify whether statements are requirements or guidance.

BACKGROUND:

A committee of Engineering and Technical Services Branch (ETSB) subject matter experts from a variety of disciplines was formed in 2023 to help ODOT better identify and design other structures. The *OSDM* is an effort to provide oversite and leadership of other structures; to provide definition for the body of work; update and maintain other structures standards; and define the roles and responsibilities for the delivery of other structures.

Bridge Section does not have specific ownership of material in the *OSDM*. Ownership remains resourced in a variety of ETSB Sections.

The *OSDM* documents design standards and construction practices that have proven to be successful in Oregon over the years. The *OSDM* is consistently updated to draw alongside the advancement of materials and construction techniques and is not intended to prevent the designer from exercising sound engineering judgment. The *OSDM* was developed to address the design of conventional non-bridge structures. Develop project specific design criteria for non-conventional structures.

For state-owned structures the specifications column of the *OSDM* is intended to modify and supplement national Structure Design Specifications (*OSDM 2.1*). Where in conflict, the *OSDM* controls.

DESIGN DEVIATIONS AND UPDATING:

Adhere to requirements in the specification column unless the section owner technical resource approves the modification. When varying from the *OSDM*, communicate with the relevant section owner technical resource regarding the need for a deviation or exception (*OSDM 2.2*).

If any *OSDM* section is found to be inadequate or out of date, consider requesting a *OSDM* update from the section owner technical resource. The form to request an update is on the bridge website.

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1 Introduction

See *Bridge CAD Manual (BCM)* for standards and practices pertinent to detailing of other structures.

Submit suggested updates for future *OSDM* revisions to Emily Clyburn using the OSDM Revision Request Form on the website.

1.1 Definition of Other Structures

An other structure is a highway structure other than a bridge.

Other Structures include but may not be limited to:

- Major Traffic structures (truss sign bridge, monotube sign bridge, butterfly sign structures, or monotube cantilever).
- Traffic structures (sign posts, illumination poles, signal poles, etc.)
- Small/static traffic elements mounted to bridges (aka, "structure mounts") and other structure or barrier.
- Retaining walls not carrying or experiencing loads from bridges.
- Sound walls.
- Buried structures
- Irrigation structures over highways.
- Vaults or manholes owned by the Roadway Unit.
- Both temporary and permanent structures.
- Tunnels (including drainage tunnels).
- Open bottom structures (arches and rigid frames).
- Cattle guards.
- Road closure gates.

Other Structures do not include (i.e., exclude):

- Bridges, including bridge abutment retaining walls and wingwalls.
- Structures that carry or experience loads from bridges – directly or indirectly (e.g., bridge foundation pressures). Refer to the *GDM* for the "Bridge Zone" in which discussion must occur to determine design roles and responsibilities inside this "zone".
- Buried structures with a span less than 6 feet.
- Wood poles, steel poles, fiber glass poles designed by ITS.
- Supports for weigh in motion (WIM) applications.
- Vaults, handholes, and junction boxes used in ITS and traffic applications.

1.2 Project Delivery

Each project has a project team made up of all various disciplines of engineering. The Bridge Design unit will oversee designing of and the delivery of project support for other structures. If outsourcing is required a contract for other structures will be prepared and administered by the Bridge Design unit. The identification of other structures warranting assistance by the Bridge Section is the responsibility of all disciplines and project team members.

Identify an other structure in the *Other Structures Type, Size & Location Report*.

Reference the *Project Delivery Guide* for additional thorough guidance about the project phases in addition to the information covered in this manual.

1.2.1 Structure Numbers

See *Table 1.2.1-1* for assigning structure number associated with other structures.

The Bridge Engineering Section assigns all structure numbers, generated through the Bridge Data System (BDS).

The Hydraulic Engineering Section assigns all the Drainage Facility IDs (DFI). See Culvert Section of the HM.

The Traffic Standards & Asset Management Unit and the ITS Unit may assign a traffic structure a Traffic Roadway Section (TRS) or ITS Unit of the Maintenance and Operations Branch (MOB) drawing number depending on the type of structure. See OSDM 5.4.

C 1.2.1

The structure number allows ODOT to put the structure into the inventory and provides the Maintenance crew a way to track maintenance for the structure. It also creates an entry in the BDS that can be referenced in the future.

A new structure number is required in cases where a structure (cantilever, sign bridge, butterfly) is moving to a new mile point. This method allows for the old structure number to be classified as an unused structure and direct users to the new structure number and drawings. The bridge log now shows a structure at the old mile point no longer exists.

Modifications to structural supports of existing structures can keep the same structure number because the location of the structure remains the same and only minor changes have been performed. Examples of modifications are structures being raised to make room for the overlay below, new signs, sign mount extensions and arms on a cantilever that are replaced with longer arms. The work that is performed requires a new structure work number that is associated with the structure number, necessitating new drawings. The location and main components do not change, but some structural modifications have been done that require a structural work number for that particular existing structure number.

Table 1.2.1-1 Structure Number Assignment Guidance

Other Structure Type	**Structure Number Required:**
Buried Structure	--
Box Culvert; Open Bottom Culvert; Rigid Frame	Yes
Culvert span between 12 inches and less than 20 feet	No DFI, see *HM 7*
Retaining Walls	--
Bridge Abutment	Yes. See *BDM*.
Bridge Retaining Wall; Highway Retaining Wall;	Yes
Minor Retaining Wall	No
Traffic Structures	**--**
Sign bridge, butterfly variable message sign (VMS), monotube cantilever, and high mast illumination pole	Yes
Ancillary traffic structures (e.g. attached to bridge rail/girder)	No
Tunnel	Yes
Sound Wall	Yes
Irrigation/Utility structures over highways	Yes
All others, misc.	No

1.2.2 Calculations & Calculation Books

Designers are responsible for well-organized, legible and neat design calculations properly assembled in a calculation book. REMEMBER: YOUR CALCULATION BOOK COULD BECOME AN EXHIBIT IN THE COURTROOM.

Follow *BDM 2.10.7* calculations and calculation books requirements for other structures.

1.2.3 Scoping

A cost estimate will be required for the superstructure and substructure based on historical cost data. You can obtain this data from the Bridge Section's yearly Bridge Cost Data document that includes traffic structures or by contacting the Specifications Unit for a recommended cost value for a specific structures bid item.

1.2.4 Preliminary Plans

In order to complete preliminary plans, the structure designer will need the types of structures used in the project, a roadway cross section at each structure, and the geotechnical report for soil design information.

1.2.5 Project Documentation after Final Plans

After the project has been released for bid, the project documents and calculations have to be archived for storage. Once the final signed drawings are sent in, they will be forwarded to the appropriate group for archiving.

Designers are responsible for preparing legible and neat design documents that are well organized. During project design, most records are kept at the designer's desk. Two files will be generated for each project. The first file will be the calculation book, *OSDM 1.2.2 and BDM 2.10.7*. When all work on the structure is complete, appropriate design documents should be assembled and included in a calculation book. The other file is the Structural Design File. The Structural Design File consists of a copy of the final design calculations, transmittal letters, email transactions for the project, any pertinent reference drawings, copies of the final drawings, structure number request forms, drawing number request forms, documentation of Bridge Data System entries and PCS report.

A copy of the project design file should be sent to the Traffic Structures group for archiving in their system. The engineer of record should at least keep a copy of all documents associated with the project for future reference. The preferred order of documents in the Structural Design File is shown in *Appendix 5A*.

1.2.6 Quality Control

Follow the Statewide Bridge Design Quality Plan outlined in *BDM 2.5* for other structures.

2 Other Structures Design, General

2.1 Design Standards

2.1.1 Standard Specifications and Standard Drawing Manuals

- *LRFD Bridge Design Specifications (10th Edition, 2024)* published by the American Association of State Highway and Transportation Officials (AASHTO).
- *AASHTO Guide Specifications for LRFD Seismic Bridge Design 3rd Edition (2023).*
- *AASHTO Guide Specifications for Seismic Isolation Design, 4th Edition (2014) with 2023 Interim revisions*.
- *Oregon Standard Specifications for Construction*, published by ODOT and pertinent special provisions (for all construction except bridges carrying railways).
- *Oregon Standard Drawings*, published by ODOT, Standards Engineer.
- *ODOT Discipline Manuals: Bridge Design Manual (BDM); Geotechnical Design Manual (GDM) Hydraulics Manual (HM); Highway Design Manual (HDM)*
- *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. (ASD)*
- *AASHTO Standard Specifications for Structural Supports for Highway Signs, Signals, and Luminaires (LRFD)*.
- *AASHTO Standard Specifications for Highway Bridges, 17th Edition*.
- *AASHTO Guide Design Specifications for Bridge Temporary Works, 2nd Edition, 2017*.
- *AASHTO LRFD Road Tunnel Design and Construction Specifications*.

2.1.2 Use of Oregon Standard Drawings and Standard Details

The Standard drawings and standard details prepared by ODOT have been developed through a long history of collaboration with Oregon contractors and fabricators. Consider impacts to both when making modifications.

Use Oregon standard drawings without significant change, as determined by the drawing Engineer of Record. Where a significant change to a standard drawing is needed, submit a design deviation request. Where an equivalent ODOT standard drawing or accompanying design detail exists, do not use standard drawings or design details from another state or agency without approval of a design deviation.

The standard details do not include the seal of the technical owner. The designer or the Engineer of Record (EOR) is responsible for sealing the contract plans with the standard details, and the design calculations which is specific to the project where the standard details are used.

The use of the standard drawings is required unless a new design and calculations are sent in for review. There are two main reasons for the use of the standard drawings. The first is that analysis and detailing take a considerable amount of time and money. The money that is not spent for the design in the project is spent towards a more conservative structure that covers most cases in the state. Secondly, a standard drawing takes a long time to be adjusted to a level where there are little to no manufacturing and construction issues. Items that are found to be an issue are corrected and a new drawing is released. New designs have a high probability each time to make the same errors and omissions that past designers have made.

To get a new detail on a standard drawing or get an existing detail changed, submit a request for change to standard drawing form. You can find this document and instructions on the ODOT Roadway internet web page. The proposed modification will be routed to the Traffic Structures group to get feedback and consensus about whether or not the detail should be changed. In many cases, a proposed change can be a substantial amount of work and current resource levels do not have the capacity to perform the work. Using this method will help ensure consistency and consensus of detail changes. Two other methods to update a Traffic Structures standard drawing is to contact the State Traffic Structures engineer to discuss the issue or to work through an issue that involves the standard during construction.

2.2 Design Deviations

Submit a request for a Design Deviation before replacing an established drawing or method from this manual.

The two-column layout visually separates standards from guidance with established standards stated in the left column. Deviating from language in the left column requires a Design Deviation unless stated otherwise.

Replacing standards includes design methods or details established in other states, presented in research reports, or developed by designers.

Prepare Design Deviation submittals to be consistent with *Guidelines for Drafting Liability Neutral Documents*.

C 2.2

Identify whether a Design Deviation is necessary in the DCSA.

The design of other structures requires multidisciplinary coordination in the design process. Concurrence from the participating discipline is required.

The State Bridge Engineer makes the final decision to accept or reject a request for Design Deviation.

Modification to standards cannot be based on preference or economy. They must be justified by structure geometry, configuration, constructability, and intended purpose. Use a standard drawing when it satisfies the need. When modifying a standard drawing, comply with appropriate design specifications (*LRFD, BDM*, etc.) to the fullest extent possible.

Engineers are encouraged to exercise good engineering judgment, which may result in innovative solutions, including new materials or techniques. Design Deviations allow the opportunity for these ideas to be documented and shared, potentially resulting in revisions to standard practice.

Contact the relevant technical resource to notify them that a Design Deviation has been identified and to confirm a Design Deviation is necessary. An email inquiry about the proposed modification suffices for confirmation on whether a formal Design Deviation is necessary or not. On outsourced projects, include the ABR (agency bridge reviewer) in all discussions concerning structural related Design Deviations.

Table 2.2-1 Design Deviation Concurrence and Approvals

Participating Discipline; OSDM Section	**Concurrence Required By:**	**Approval:**
Hydraulic, OSDM 3	State Hydraulic Engineer	State Bridge Engineer
Traffic, OSDM 5	State Traffic Structures Engineer	State Bridge Engineer
Geotechnical, OSDM 3, OSDM 4	State Foundation Engineer; Senior Retaining Wall Engineer	State Bridge Engineer
Roadway, OSDM 9	Roadway Standards Engineer	State Bridge Engineer
Bridge, OSDM	Bridge Standards Technical Resource	State Bridge Engineer

2.3 Bridge Location and Environment

C 2.3

Reserved for future use.

3 Buried Structures

C 3

This section covers the structural aspects of buried structure design and construction.

Buried structure design requires multidisciplinary coordination in the design process including roadway alignment design, survey and geotechnical data acquisition, hydrologic and hydraulic analysis, structure and foundation design, scour evaluation and countermeasures, environmental compliance, staging, shoring requirements and constructability.

Buried Structure: A structure, as defined in *AASHTO 12.1*, that is buried beneath two feet or more of soil.

Buried structures encompass an array of structures. Buried structure systems considered herein are metal pipe, structural plate pipe, long-span structural plate, deep corrugated plate, structural plate box, reinforced concrete pipe, reinforced concrete cast-in-place and precast arch, box and elliptical structures, thermoplastic pipe, and fiberglass pipe.

Based on the structures' function, different design standards apply. These design standards are outlined in the remainder of this section. For example, a tunnel carrying traffic is a buried structure but has different design requirements than a box culvert; open bottom structures have different design requirements than closed bottom structures.

ODOT is working towards providing standard drawings for buried structures with a span less than 20 feet. See *BR800* series.

Prior to 2026, the six foot large culvert definition was based on confined space criteria for inspection and was not related to structural conditions.

NBI culverts and buried structures must be load rated per the *ODOT Load Rating Manual*.

Buried structures with a span of 20 feet or more are included in the National Bridge Inventory (NBI).

3.1 Buried Structure Design Considerations

C 3.1

The *BDM* provides structural design criteria for bridges. The *OSDM* provides structural design criteria for buried structures.

The *GDM 18* provides foundation and geotechnical aspects of buried structure design.

The *HM* provides hydraulic design considerations for buried structures.

For the purposes of this section, span length is defined as the opening measured along the roadway centerline between extreme ends of the outermost opening.

This aligns with the NBI definition of a bridge.

Design buried structures for the effects of live load per *LRFD 3.6.1.2.6* except as modified below:

Neglect the effects of live load when the factored live load vertical crown pressure at the surface of the culvert is less than 10 percent of the sum of the factored vertical earth load plus factored vertical live load crown pressure.

Based on the results of *NCHRP 15-54 (Mlynarski et al., 2020)*.

Precast buried structures are designed by the manufacturer according to *SP 00595*. Ensure the designs of large buried structures comply with the following requirements:

- Precast elements consist of individual cells with continuous vertical joints, unless an engineered substructure is provided.
- For precast wingwalls, provide positive connections between wingwalls and reinforced concrete box culverts (RCBC) end sections

with short closure pours or weldments.
- Provide reinforcement continuity between precast footings and concrete aprons.

Metal buried structures are designed by the manufacturer according to *SP 00445*. Ensure the designs of large buried structures comply with the following requirements:

- Reserved for future use.

3.2 Corrosion Protection

C 3.2

Consider the degradation of buried structure materials resulting from corrosive and abrasive conditions.

For hydraulic structures, the invert receives the largest impact due to corrosion and abrasion; however, the surrounding soil properties and groundwater may impact other portions of buried structures.

For the following buried structure types:

- Cast-in-place reinforced concrete box
- Precast reinforced concrete box
- Precast segmental reinforced concrete box
- Precast reinforced concrete three-sided

provide the following:

- A waterproofing membrane on the top slab and lapped over the top slab joint as shown on the contract plans. Provide waterproofing on joints (sealant within the joint and sealing bands on the exterior face of the joints along the top and sides of the structure), and on the exterior top slab concrete surface.

A spray membrane is preferred due to durability and performance. While spray membranes are not used on bridge decks due to the risk of debonding of ACP, this condition is not relevant on buried structures.

Waterproofing is used to extend the service life of reinforced concrete box buried structures. Joint sealing materials are listed in *Standard Specifications 00595.11*.

Membrane lap length is typically 12 inches past the top slab/top wall joint.

- A corrosion protection system as shown in *Table 3.2-1*.

See environment definition in *BDM 1.2.4*.

Table 3.2-1 Corrosion Protection System for Buried Structures

Environment	**Marine and Coastal Areas**	**Snow and Ice and Mild Areas**
Precast and cast-in-place concrete	HPC	Per *BDM Table 1.5.1*
Non-prestress reinforcement	ChromX4100 or GFRP	
Minimum concrete clear cover for cast-in-place members	2 inches	Per *BDM Table 1.5.5-2*

For round metal, thermoplastic and concrete pipes under 20 feet in span refer to *Hydraulic Manual: Pipe Materials* for corrosion, abrasion and mitigation options.

3.3 Rails Over Buried Structures

For buried structures under 25 feet in span, provide a minimum TL-3 rail using roadway standards per the *HDM*.

When applicable, use Standard Drawing *RD471, RD472 or RD473* for guardrail over buried structures.

For buried structures 25 feet or greater in span, where the fill depth is greater than 40 inches, and none of the conditions are met, provide a minimum TL-3 rail using roadway standards *RD407*.

For buried structures 25 feet or greater in span that meet any of the following conditions provide a minimum TL-4 rail and use *BDM 1.13* bridge standards.

- Fill height of 40 inches or less.
- Identified as a SPIS (Safety Priority Index System) site.
- Identified as a freight route.
- Three or more accidents or a fatality have occurred in the past five years at the site.
- 45 mph or greater design speed.
- 40 mph design speed with 500 ADTT or greater.
- 35 mph design speed with 1000 ADTT or greater.
- 30 mph design speed with 1500 ADTT or greater.
- 25 mph design speed with 2000 ADTT or greater.

C 3.3

When selecting roadside safety hardware for buried structures, the decision to use roadway or bridge standards is based on culvert length, fill depth, and risk.

Use of *BR471* eliminates the need for transitions.
BR266 was retired for maintenance use only in 2025.

ODOT standard guardrail requires a minimum embedment of 40 inches. Lesser depths present an obstacle for continuous guardrail and is classified as low fill.

ODOT promotes highway planning that replaces or upgrades railing on existing buried structures to TL-4.

A Design Exception may be considered when a Test Level assessment per the procedure of *NCHRP Report 22-12(03)* recommends TL-3 or less. Contact the *OSDM* Technical Resource for rails.

Table 3.3-1 lists the ODOT standard bridge railings with current MASH test levels.

Table 3.3-1 MASH Buried Structure Rails

Drawing No.	Description	Tested or Evaluated	MASH Test Level	OSHA Compliant
RD472	Guardrail System Box Culvert Embedded Anchor Steel Post	Evaluated	3	No
RD473	Guardrail System Box Culvert Bolt-Thur Anchor Steel Post	Evaluated	3	No
DET3220-3224	Weak Post Guardrail Attachment to Culvert	Tested	3	No

3.4 Seismic Design Criteria

Perform seismic design of buried structures according to this section and the following:

- *ODOT GDM.*
- Section 10.8 of the *AASHTO LRFD Road Tunnel Design and Construction Guide Specifications,* 1st Edition, 2017 (Tunnel LRFD).
- Chapter 13 of the *AASHTO Technical Manual for Design and Construction of Road Tunnels – Civil Elements*, June 2010 (Tunnel Manual).

C 3.4

Additional information, including design examples, can be found in *NCHRP Report 611*.

3.4.1 Seismic Loading Effects

Design buried structures to accommodate the effects resulting from two types of seismic loading:

- Ground shaking (i.e., transient ground displacement, TGD); and
- Ground failure (i.e., permanent ground displacement, PGD).

C 3.4.1

TGD seismic loading refers to the vibration of the ground produced by seismic waves which can cause ovaling deformation (of circular cross-section structures) or raking deformation (of rectangular cross-section structures).

The geotechnical engineer will work closely with the structural engineer for evaluating the magnitude of TGD seismic loading and its effect on the structure.

PGD seismic loading refers to seismic geologic hazards including fault failure, liquefaction, liquefaction induced lateral spreading, settlement, downdrag, flow failure, and slope instability.

The PGD seismic loads are evaluated by the geotechnical engineer, who also estimates the loads and soil deformations acting on the structure. The structure engineer designs the structure to accommodate these loads.

From the static design standpoint, buried structures are classified as rigid (e.g., concrete structures) and flexible (e.g., structures made of corrugated metal sheets or thermoplastic materials).

Seismic analysis of buried structures are not required under the following conditions:

- Span length less than 6 feet.
- The 1-second spectral acceleration (S_{D1}) is less than 0.2g, or the design peak ground velocity (PGV) is less than 10 in/sec, except when they are subject to unstable ground conditions including landslides, liquefaction-induced ground movements, fault displacements, or any other type of permanent ground displacements.

Design buried structures that carry or convey traffic according to *Table 3.4.1-1*.

Table 3.4.1-1 Seismic Design Criteria for Buried Structures

Span (feet)	Required conditions (must meet all)[1]	Seismic Loading	Performance Criteria
6 ≤ S < 20	Structure is carrying a State Seismic Lifeline Route[2]; Site is identified as liquefiable; A three-sided rigid structure.	PGD	Life Safety
20 ≤ S < 30	Structure is located on the National Highway System (NHS)[2]; Site is identified as liquefiable; A three-sided rigid structure.	PGD	Life Safety
S ≥ 30	Structure is located on NHS or State's Highway Network (SHN)[2]	TGD[3] PGD	Life Safety Operational[4]

[1] – Structures not meeting all requirements listed do not need to be designed for seismic.

[2] – Refer to ODOT TransGIS for road classification.

[3] – Flexible structures with span length less than 60 feet do not need be evaluated for TGD.

[4] – The Operational Performance Criteria apply only to buried structures carrying traffic on a State Seismic Lifeline Route.

3.4.2 Earthquake Ground Motions

C 3.4.2

Use ground motions specified in *BDM 1.17.2.4* for seismic design of buried structures.

Adjust peak ground parameters according to *Table 3.4.2-1* based on the depth of the buried structure.

Table 3.4.2-1 Ground Motion Modification

Depth to Top of Buried Structure (ft)	Ratio of Ground Motion at Structure Depth to Motion at Ground Surface
≤ 20	0.95–1.0
< 20–50	0.75–0.95
< 50–100	0.5–0.75
≥100	0.5

3.4.3 Load Combinations for Transient Seismic Motion

Design buried structures for the following load cases resulting from transient seismic motions:

Load Case 1: EQ = ±100%EQ_H ± 30%EQ_V

Load Case 2: EQ = ±30%EQ_H ±100%EQ_V

where:

EQ_H = horizontal loads due to ovaling or racking deformation

EQ_V = inertia forces due to vertical seismic motions

For calculating the EQ_V, use a vertical seismic coefficient equal to 2/3rd of the horizontal design response spectral acceleration coefficient at a period of zero seconds, A_s.

C 3.4.3

3.4.4 Structural Design Check and Residual Displacement Limits

Refer to *Table 3.4.4-1* for structural strain limits for each performance criteria.

Table 3.4.4-1 Structural Strain Limits

Performance Criteria	Concrete	Reinforcing Steel[1]
Life Safety	0.003	0.02
Operational	0.003	0.002

1 - Refer to BDM for reinforcing steel allowed for seismic applications.

C 3.4.4

For post-earthquake residual displacement limits refer to *BDM Table 1.17.2.3-3*.

4 Retaining Structures

C 4

A bridge designer will provide structural design of retaining walls that support bridge bents. Include drawings with the structure drawings.

For all other free-standing retaining walls, refer to the *ODOT Geotechnical Design Manual*.

Retaining wall project development activities require integrated and coordinated effort of bridge, geotechnical, geology, and roadway disciplines. Coordination in the design process includes:

- Determine if retaining wall is needed and wall location design - [Roadway, Retaining Wall designer].
- Subsurface investigation planning, execution, identifying ground water, soil and rock properties for design [Geotechnical, Geology].
- Identify structure types for consideration, loading conditions, perform analysis and design, estimate cost, and recommend structure type [Geotechnical, Bridge or both]
- Evaluate recommended structure type (technical and cost estimate check), evaluate constructability [Retaining wall designer, Retaining wall checker, other project reviewers].
- Project design changes that affect the retaining wall [Project team process coordination]. Coordinate with other design elements.

Additional disciplines could be necessary dependent on the project. It is common for either the bridge engineer or geotechnical engineer to take the lead role in retaining wall design.

The retaining all chapter of the *ODOT GHE CAD Manual* provides guidance for Contract Plan Sheet development for retaining walls:

- Proper plan sheet series by retaining wall category (within J series of a bridge, a separate J series for the retaining wall, or G series).
- Reference as needed to the *Bridge CAD Manual (BCM)*.
- Sources of information for title block, structure name, structure number, BDS drawing number, calculation book number, file V-number, when applicable.
- Plans content by retaining wall category and system type.
- Plans Checklist.

5 Traffic Structures

Traffic structures are the most common structures that occur on the Oregon highway system. A traffic structure is defined as a structure that supports a signal, sign or luminaire. Currently there are over 200,000 traffic structures on the state highway system. The traffic structures portion of projects play a support role for other disciplines. Traffic structures primary role is to support highway devices, helping to make an efficient and effective transportation system.

This chapter will guide regional technical center and consultant personnel in the design of traffic structures. Specifically, the designer will learn how to produce contract documents and cost estimates for projects, provide construction support, and address nonstandard design issues. In addition, this chapter outlines common issues that occur with traffic structures and solutions.

This chapter includes recommended guidelines that the Traffic Structures designer can use for design and construction support on ODOT projects. This chapter is only a guideline and does not cover all cases the designer may encounter in a project. For nonstandard issues not covered in this chapter, contact the Traffic Structures Engineer.

5.1 Design Phase of Projects

5.1.1 Types of Traffic Structures

5.1.1.1 Standard Traffic Structures

Currently there are 13 standard traffic structures used on the state highway system. These standard traffic structures and associated *ODOT Standard Drawings* are:

- Multi-Post Breakaway (TM600, TM601).
- Triangular Base Breakaway (TM602).
- Truss Type VMS Bridge (TM606 through TM612).
- Truss Type Sign Bridge (TM614 through TM620).
- Monotube Cantilever Sign Support (TM621 through TM628).
- Slip Base and Fixed Base Luminaire Support (TM629, TM630).
- Traffic Signal Support (TM650 through TM653).
- Traffic Signal 60' Through 75' Mast Arm Supports (TM655 through TM658).
- Wood Post Sign Supports (TM670).
- Perforated Steel Square Tube (PSST) Sign Supports (TM681, TM687, and TM688).
- Monotube Walk-in VMS Cantilever (TM690 and TM691).
- Monotube VMS/Sign Bridge (TM693 and TM697).
- Monotube Type 1 VMS Walk-In Bridge (TM698).

The standard drawings can be downloaded from the ODOT website.

5.1.1.2 Non-Standard Traffic Structures

Nonstandard traffic structures will occasionally show up on a project. Nonstandard traffic structures are the responsibility of the engineer of record and should be sent to the State Traffic Standards group for design or review. The State Traffic Structures group will either provide or review the design calculations, drawings, and any Special Provisions that are necessary for the structure. The State Traffic Structures group will then evaluate if the nonstandard design will be used often enough to be given a standard detail number. If a standard detail is used often enough, it will be added to the TM600 series standard drawings. A nonstandard structure is any structure that does not meet a standard drawing (i.e., strain poles or temporary strain poles) or new structures with no standard drawing developed for the structure (i.e., camera poles).

Currently the standard drawings do not apply to the following structures:

- Signal poles that exceed the maximum loading.

- Signal poles that include loading not shown on the standard drawing.
- All temporary wood poles.
- Any structure with poor soil does not meet the requirements of the standard drawings.
- Extreme cross sections that do not meet the requirements of the standard drawings.

In these cases, the standard procedure is to mail the submittal for the structures or foundation to the State Traffic Structures group for review.

5.1.1.3 Traffic Structures Mounted on Bridges

There is one exception to the traffic structures process described in this chapter and that is when the structure is mounted onto a bridge. When a traffic structure is on a bridge, the bridge designer will design the structure and a bridge drafter will perform the drafting. In this case, the Traffic Structures designer will have very limited involvement with the structure. The Traffic Structures designer may be called upon to assist the bridge designer and drafter.

5.1.2 Role of the Traffic Structures Designer

The role of the Traffic Structures designer is to compile project site data and then fit the proposed traffic structure to the location. After the traffic structure is placed at the location, the designer creates and submits the Special Provisions and the cost estimate to the project team. Two or three project meetings occur during the design phase of the project and the project team members discuss the project plans, Special Provisions and cost estimate. The design phase is completed once the project has finished the bid process.

It is extremely important to have complete stamped details in the project plans for the contractor to make a complete bid. This will also help to make sure that stamped submittals do not have to be sent in to the resident engineer. This reduces the chances of construction time delays and costly change orders.

5.1.3 Design Tools

In addition to the documents listed in *OSDM 2.1.1*, the following is a list of engineering references the Traffic Structures designer will need for design. The references provide guidance for a large range of topics associated with traffic structures. Contact the Traffic Structures engineer with any questions associated with these references.

1. *Manual of Steel Construction Allowable Stress Design*.
2. *AWS D1.1 Structural Welding Code*.
3. *AWS D1.2 Structural Welding Code – Aluminum*.
4. *AWS D1.5 Bridge Welding Code*.
5. *NCHRP 411 Structural Supports for Highway Signs, Luminaires, and Traffic Signals*.

6. *NCHRP 412 Fatigue-Resistant Design of Cantilevered Signal, Sign and Light Supports*.
7. *NCHRP 469 Fatigue-Resistant Design of Cantilevered Signal, Sign and Light Supports*.
8. *Inch Fasteners Standards*.
9. *Aluminum Design Manual*.
10. *ASTM 01.01, 01.03, 01.04, 01.05, 01.06, and 01.08*.
11. *National Design Specification for Wood Construction*.

The following is a list of engineering analysis programs that the Traffic Structures designer will need for design:

1. Pole Analysis Program (PAP): Used to analyze signal mast arm poles, strain poles, illumination poles, and monotube cantilevers to the AASHTO ASD code.
2. Pole Structural Analysis Program (PSAP): Used to analyze signal mast arm poles, strain poles, illumination poles, monotube cantilevers, and monotube bridges to the AASHTO ASD and LRFD codes.
3. Lpile (this program may not be necessary if a geo/hydro designer can design the foundations): Used to design drilled shaft foundations.
4. Span_Wire_WL_Tension_Calcs_4th_Four_Cables_AASHTO.xls: Used to evaluate horizontal forces on strain poles. Available from the Traffic Structures engineer.
5. TBB Design Spreadsheet: Used to design triangular base breakaway sign supports and creates a printable shop drawing. Available for download at the Traffic Structures website.
6. MPB Design Spreadsheet: Used to design multi-post breakaway sign supports. Available for download at the Traffic Structures website.

5.1.4 Construction Assistance Estimate

As a method to control and forecast ODOT engineering expenditures for construction projects, the Construction resident engineer puts together a construction engineering budget for the region Construction engineer's approval. Other involved ODOT units submit their anticipated contract administration costs to the resident engineer before a project goes to contract. Each unit reports the estimated amount on the ODOT Project Budget Worksheet form.

Construction Assistance Estimate (example calculations)

Labor:

$$Checking\ Shop\ Drawings\ Time = 4\ days$$

$$Field\ trip\ time = 2\ days$$

$$Designer's\ time = 4\ days + 2\ days = 6\ days$$

$$Monthly\ Salary = \$3{,}581/month$$

$$Work\ Hours\ per\ month = 52\,\frac{weeks}{year} * \frac{40\frac{hours}{week}}{12\frac{months}{year}} = 1733.33\ hours/month$$

$$Loaded\ Rate\ Factor = 1.74$$

$$Designer's\ wages = \frac{\$3{,}581/month}{173.33\ hours/month} * 1.74 * 8\ hours/day = \$288/\text{day}$$

$$Designer's\ labor\ cost = 6\ days * \frac{\$288}{day} = \$1{,}728$$

Equipment:

$$Car\ Expense = \frac{\$30}{day} * 2\ days = \$60$$

$$Mileage\ Expense = \frac{\$0.20}{mile} * 300\ miles = \$60$$

$$Car\ Rental\ Cost = Car\ Expense + Mileage\ Expense = \$60 + \$60 = \$120$$

5.1.5 Standard Plans Information

Project plans that are produced for the project documents shall follow the standard format as provided by the border file available from the Traffic Standards & Asset Management Unit. The border file requires specific information and this section will discuss how to fill in that information. The specific information that pertains to traffic structures includes the drawing numbers, structure number, and calculation book number.

5.1.5.1 Procedure for Weld Designations on Contract Plans

Contract drawings will show the appropriate weld symbols, special weld details, special inspection requirements, field-verified structure dimensions, structure layout, member sizes and any nonstandard structural detailing. Weld symbols will conform to *ANSI/AWS A2.4*.

Contract drawings will show both the weld symbol and “CJP" that stands for complete joint penetration welds.

Contract drawings will show the effective weld size (E) for non-tubular, partial joint penetration (PJP) welds. For PJP T-Y-K tubular connections, the contract drawings will specify the use of AWS D1.1 Table 3.5 (Pre-qualified PJP Details for T-Y-K Tubular Connections).

Special inspection requirements will indicate the type of testing (UT/ RT/ MT/ PT/, etc.) and acceptance criteria. The AWS D1.1 requires visual inspection for all welds and additional inspection based on design requirements must be added to weld details on the contract plan drawings as required. The default acceptance criterion for UT or RT testing is static loading

unless cyclic tension is specified. Welded critical connections that have loading resulting in stress reversals are required to have UT or RT 100% with the cyclic tension acceptance criteria.

5.1.6 Standard Specifications

5.1.6.1 Concrete Specifications

The two main sections for concrete are Sections 00440: Commercial Grade Concrete and 00540: Concrete Bridges. Also included to support those two sections are 00920: Sign Support Footings, 00921: Major Sign Support Drilled Shafts, 00963: Signal Support Drilled Shafts, 02001: Concrete, 02020: Water, 02030: Modifiers, 02050: Curing Materials and 02690: PCC Aggregates. These sections describe the possible different components of concrete, the placement techniques, quality control and testing procedures.

5.1.6.2 Fasteners Specifications

The sections that pertain to fasteners are spread between several different chapters of the Specification. They include 00560: Structural Steel Bridges, 00930.40d, e & f: Metal Sign Supports, 00962.46(j)(2): Metal Illumination and Traffic Signal Supports, and 02530: Fasteners. These sections describe the installation, testing, different pieces and surface finishes.

5.1.6.3 Reinforcement Specifications

The sections that pertain to fasteners are in select areas. They include Sections 00530: Steel Reinforcement for Concrete and 02510: Reinforcement. These sections describe material grades, construction tolerances, splices and installation.

5.1.6.4 Structural Steel / Steel Pole Specifications

The three main sections for structural steel are Sections 00560: Structural Steel Bridges, 00930: Metal Sign Supports and 00962: Metal Illumination and Traffic Signal Supports. Also included to support those three sections are 02530: Structural Steel. These sections describe material grades, fabrication tolerances, surface finishing, erection procedures and chemical composition tolerances.

5.1.6.5 Submittal Specifications

The main section that addresses the submittal process is Section 00150.35: Plans, 3D Models, Working Drawings, and 3D Construction Models. Also included to support that section is 00930.02: Metal Sign Supports, 00962.02: Metal Illumination and Traffic Signal Supports, 00962.10: Metal Illumination and Traffic Signal Supports and 02560: Structural Steel.

5.1.7 Special Provisions

The following table outlines which Special Provisions apply to each traffic structure. The unique Special Provisions have been included in the table for reference; however, each unique Special Provision needs to be reviewed to ensure all project specific requirements are being met.

Table 5.1.7-1: Special Provisions Application To Each Traffic Structure

Special Provision Number	Special Provision Title	Standard Sign Bridge	Type 1 VMS Bridge	Type 2 Butterfly VMS Support	Cantilever Monotube	Camera Pole	Signal Poles
00330	Earthwork	X	X	X	X	X	X
00440	Commercial Grade Concrete w/ Structural					X	X
00510	Structure Excavation and Backfill	X	X	X	X	X	
00512	Drilled Shaft						X
00530	Steel Reinforcement for Concrete	X	X	X	X	X	X
00560	Structural Steel Bridges	X	X	X	X		
00910	Wood Sign Posts						
00920	Sign Support Footings	X	X	X	X	X	
00921	Major Sign Support Drilled Shafts	X	X	X	X		X
00930	Metal Sign Supports	X	X	X	X		
00942	Variable Message Sign (Type 1) Structural Components		X				

Special Provision Number	Special Provision Title	Standard Sign Bridge	Type 1 VMS Bridge	Type 2 Butterfly VMS Support	Cantilever Monotube	Camera Pole	Signal Poles
00955	Variable Message Sign (Type 2) Structural Components			X			
00962	Metal Illumination and Traffic Signal Supports						X
00963	Signal Support Drilled Shafts						X
00965	Camera Poles and Foundation					X	
02001	Concrete	X	X	X	X	X	X
02010	Portland Cement	X	X	X	X	X	X
02030	Modifiers	X	X	X	X	X	
02050	Curing Materials	X	X	X	X	X	
02530	Structural Steel	X	X	X	X	X	
02690	PCC Aggregate	X	X	X	X	X	X

5.2 Design

5.2.1 General

The Traffic Structures designs are in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. This code specifically includes design items that pertain to traffic structures. Other codes may work for designing the structure, but this code has been developed over the years to address specific items that pertain to traffic structures. The AASHTO code is required on projects that use federal funds and for all traffic structures installed on the Oregon State Highway System.

5.2.2 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals History

The AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals first code was published 1975. The booklet is 9" by 6", has a yellow cover and is 94 pages. The wind pressure equation from Section 1.2.5 is equal to .00256(1.3V)^2CdCh, which is the same basic equation that was used until the 2001 fourth edition AASHTO code was released.

The next AASHTO publication was the 1985 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. This manual switched to 8 ½" x 11", still had a yellow cover and is 69 pages. The wind pressure equation remained the same. Following the 1985 release was the 1994 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. It is 8 ½" x 11", has a navy blue cover and is 78 pages. The '94 code still has many existing standard designs existing that have not been converted to the newest code. The most recent code is the fourth edition 2001 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. This code changed the wind speeds from fastest mile per hour to 3-second gust and included fatigue design requirements as a direct response to structural failures that occurred from hairline fatigue cracks. Since the release of the 2001 AASHTO code, there have been 2002, 2003 and 2006 interims that apply.

The last version of the Allowable Stress Design (ASD) AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals is the sixth edition 2013. The Load and Resistance Factor Design (LRFD) was released in the first edition 2015 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. This is a significant modification from ASD that transitions the design of Highway Signs, Luminaires and Traffic Signals to the LRFD design methodology that is also currently used for Bridge designs.

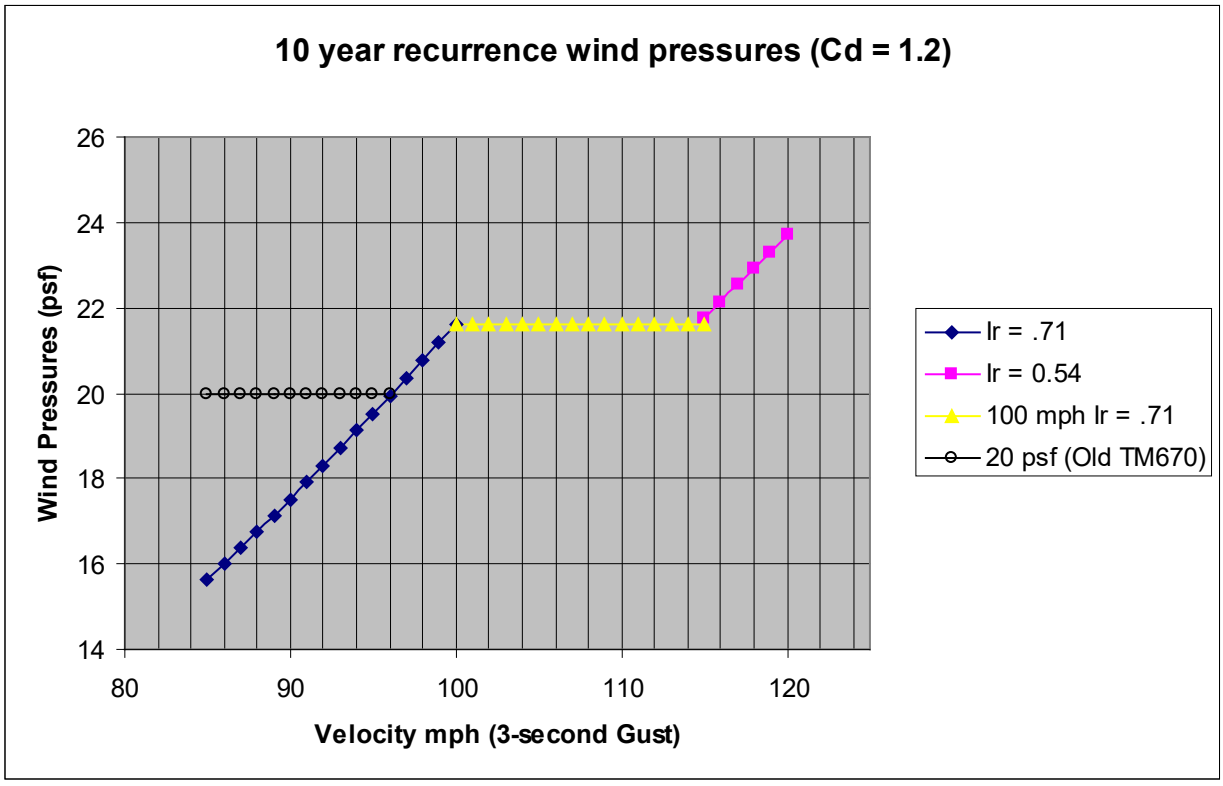
5.2.3 Wind Speeds and Pressures

There are two main types of wind speeds that have been used for the ASD design of traffic structures in the State of Oregon. The first is a fastest mile per hour wind speed and the second is a 3-second gusted wind speed. The fastest mile per hour wind speed was used in AASHTO codes published before the release of the 2001 AASHTO code. The 2001 AASHTO code introduced the 3-second gust wind speed and discusses the differences between the two wind speeds in section 3.8.2 - Basic Wind Speed of the fourth edition AASHTO code. In addition, there is good background information about this topic in section 3.8.5 Gust Effect Factor G of the fourth edition AASHTO code and discusses that the pressure is approximately the same but the equivalent 3-second wind velocity value is about 1.22 higher than the old fastest mile per hour wind velocity. The change from the fastest mile per hour to the 3-second gusted wind speed was necessary because most national weather service stations currently record and archive peak gust speeds and not fastest mile speeds. This resulted from a change in the equipment used to measure the wind. Using the gusted data, it takes the average of the gusted wind velocities over 3-seconds as the standard. This decreased the sample size, moved the average closer to the maximum gust and resulted in the value of the wind velocity from the fastest mile per hour to the 3-second gust method to increase. To make the pressure between the two codes approximately equal, the code adjusted the gust factor from (1.3)^2 = 1.69 down to 1.14.

Figure 3-2 of the fourth edition AASHTO code oversimplifies the minimum 3-second gusted wind speeds to use in Oregon. It shows hatched areas on the coast and the Cascades that signify a special wind region with no guidance about what to use. This resulted in investigating other alternatives to give designers guidance about the 3-second gusted wind speeds to use for their designs. The 2007 Oregon Structural Specialty Code Amendments in Chapter 16, Section 1612.1, and Figure 1609 shows an Oregon 3-second gusted wind speed map that, in general, is specified by county. This map was used to revise the 3-second gusted wind speed map shown on Standard Drawing TM671. The Standard Drawing TM671 shows a map of 3-second wind gusts for the state with a recurrence interval of 50 years. This 3-second gusted wind velocity with a 50-year recurrence interval is required to be used for every new design that uses the 2001 AASHTO code. Using this 50-year, 3-second wind velocity does not result in designing every structure to the same requirements. To take into account the different types of structures and the level of risk that an owner is willing to accept, the wind pressure equation adjusts the 3-second gust velocity with a 50-year recurrence interval by applying a wind importance factor, Ir. The Ir is based on the recurrence interval for each structure type. A 10-year recurrence interval compared to a 50-year recurrence interval will have a significantly smaller wind importance factor in the wind pressure equation that will be used to design the specific structure type. For example, a truss sign bridge will use a 3-second gusted wind speed of 110 mph for a 50-year recurrence interval, select a recurrence interval of 50 years, and the resulting Ir is 1.00. The resulting truss sign bridge wind pressure will be .00256*.87*1.14*110^2*1.0*1.2 = 36.87-psf. A wood post for a specific location in the state will use a 3-second wind velocity of

110 mph for a 50-year recurrence interval, select a 10-year recurrence interval of 10 years, and the resulting Ir will be 0.54. There is an asterisk by the 0.54 and the note in Table 3-2 states the design wind pressure for hurricane wind velocities greater than 100 mph should not be less than the design wind pressure using 100 mph with the corresponding non-hurricane Ir value. This note provides a transition between the non-hurricane to hurricane wind pressures. See Figure 1 for a graphical representation of the 10-year recurrence velocity versus pressure. The resulting wood post wind pressure will be .00256*.87*1.14*100^2*.71*1.2 = 21.63-psf. This result shows a wind pressure for wood posts that is 0.59 of the pressure used to design a truss sign bridge. In addition, Figure 1 shows a horizontal pressure of 20-psf that was used for the designs on the old TM670 Wood Post Standard Drawing. In many parts of the state, the wind pressures resulting from the 2001 AASHTO code are less than the 20-psf value used in the old TM670. Finally, for the higher wind areas in the state, the pressure has only been increased by 1.08.

Figure 5.2.3-1: Minor Sign Structures Wind Velocity vs. Pressure



5.2.3.1 LRFD Wind Speeds

The first edition 2015 LRFD Specifications for Structural Support for Highway Signs, Luminaires and Traffic Signals contains Figures 3.8-1, 3.8-2, 3.8-3, and 3.8-4 that are based on the ASCE/SEI 7-10 Minimum Design Loads for Buildings and Other Structures Figures 26.5-1A, 26.5-1B, and 26.5-1C. There are locations in Oregon that are shaded and defined as special wind

regions and no wind speed is specified, but note 4 states "Mountainous terrain, gorges, ocean promontories and special wind regions shall be examined for unusual wind conditions." Also, Section 3.8.3 of the AASHTO LRFD code allows increasing the basic wind speed based on the records or experience.

The 2014 Oregon Structural Specialty code in Chapter 16 contains Figures 1609A, 1609B, and 1609C that have wind speeds on the east side of the state that match the ASCE 7-10 maps and the AASHTO LRFD maps. The Oregon Structural Specialty code wind maps also specify LRFD wind speeds to use in areas of the state with special wind regions. As a result, the LRFD ultimate wind speeds shown in the Oregon Structural Specialty Code wind maps have been used as minimum wind speeds on TM672.

The AASHTO LRFD 10-year Mean Recurrence Interval (MRI) map does not have a corresponding Oregon Structural Specialty Code wind map to address the special wind regions. As a result, a conversion based on the 1700-year wind map has been made to estimate the 10-year wind velocities in the Oregon higher special wind regions. The conversion is based on the velocity increase from the 1700-year MRI from the higher wind speed to the lowest wind speed for each area. This results in the lowest wind speed shown in the AASHTO LRFD map of 72 mph being multiplied by (130 mph / 115 mph) = 1.13 and (145 mph / 115 mph) = 1.26 to obtain the higher wind region area wind speeds of 72 mph * 1.13 = 81.39 mph rounded up to 82 mph and 72 mph * 1.26 = 90.8 mph rounded up to 91 mph.

5.2.3.2 Wind Directionality Factor Kd

The values of Kd shown in Table 3.8.5-1 are for the overall structure type and applied to everything on the structure, regardless of the configuration. The Kd has the effect of reducing the wind forces based on the probability that the alignment of the overall structure in the site-specific location will not produce the maximum load effect from the design. Structures with arms will have a lower probability that wind forces from different angles at the site-specific location will be the same as the maximum load effect from the design and results in a lower Kd value. A round vertical pole with a round appurtenance at the top will have a higher probability that the wind forces at the site-specific location will be similar to the maximum load effect from the design and results in a higher Kd value.

For example, the overall signal mast arm support has a vertical post, mast arm, luminaire arm, signals, signs, cameras, VMSs, and luminaires. The overall signal mast arm support will have a lower probability that wind forces from different angles at the site-specific location will be similar to the maximum load effect from the design. This results in a lower Kd value of 0.85 for the vertical post, mast arm, luminaire arm, signals, signs, cameras, VMSs and luminaires.

Another example is the design of a rounded vertical mount with a rounded appurtenance at the top that is part of the overall signal mast arm structure. There is a higher probability that wind forces from different angles at the site-specific mount on the signal mast arm will be similar to the maximum load effect used in the design of the mount. This results in a higher Kd value of

0.95 for the round vertical member and rounded appurtenance at the top. A conservative Kd of 1.0 can also be used.

5.2.4 Truss Sign and VMS Bridges

Truss sign and VMS bridges use the design requirements shown on drawings TM606 through TM612 and TM614 through TM620. These drawings contain ODOT's statewide standards for these structures. Any deviations from these standards for non-standard structures must be sent in to the Traffic Structures group for review and approval.

5.2.4.1 Roadway Vertical Clearance under Truss Sign and VMS Bridges

It is important for designers to accommodate the vertical clearance of a future 10'- 0" minimum sign height mounted at any location on the horizontal truss over the travelled way. The 10'-0" high sign will ensure that the bottom centerline of the chord will be at least 1'-6" above the bottom of the sign for the largest 7'-0" truss height. The resulting centerline of the horizontal truss from the roadway will be a minimum of 23'-0" that is calculated from the 18'-0" minimum vertical clearance plus the 5'-0" distance from the bottom of the sign to half the distance of a 10'-0" sign. This additional space from the bottom of the sign to the bottom chord gives the additional flexibility to remove signs and create more clearance to pass high loads under it if it is needed.

There are installations where the truss sign bridge only has signs on one side of the highway, but there is the possibility of the addition of a 10'-0" high sign at any location and the vertical clearance must be maintained at all locations over the traveled way. Also, the roadway can be sloped and the vertical clearance may be acceptable directly under the sign, but the vertical clearance may be inadequate at other adjacent locations when a future 10'-0" sign is added with the bottom of the sign located 5'-0" below the centerline of the horizontal truss.

The range of vertical clearance is between 18'-0" and 19'-0". During the design, you should use 18'-6" inches for determining the end post heights that will allow a tolerance of 6 inches for unplanned circumstances. An example of an unplanned circumstance is an overlay that may not have been included in the cross section that a Traffic Structures designer used for determining the clearances and resulting end post lengths.

5.2.4.2 Small Sign Placement

Signs that are shorter than the truss height can be centered on the truss at the request of the sign designer. The truss must satisfy the roadway vertical clearance requirements from section 2.5.1.

5.2.4.3 On Bridge Truss and VMS Signs

C 5.2.5.3

Mount Truss Sign or VMS bridges on bridge structures directly to a bridge bent or rigid location.

Bridges may have mounting locations that are more cost effective, structurally adequate, and located closer to the desire sign location.

5.2.5 Monotube Cantilever Sign Supports

Monotube sign supports use the design requirements shown on drawings TM621 through TM628. These drawings contain ODOT's statewide standards for these types of structures. Any deviations from these standards for non-standard structures must be sent in to the Traffic Structures group for review and approval.

The maximum length of arm that can be used on a monotube cantilever support is 50 feet and this value is shown on TM621. Monotube cantilever arm lengths that are longer than 50 feet have not historically been used by ODOT on the state highway system for non-redundant monotube cantilever sign supports. In addition, the Washington Department of Transportation and CALTRANS specify shorter arm lengths on their standard drawings than ODOT's 50-foot maximum.

5.2.5.1 Variable Message Signs Mounted on Monotube Cantilever Supports

Variable message signs use the design requirements shown on drawings TM621 through TM628, TM690, and TM691. These drawings contain ODOT's statewide standards for these types of structures. Any deviations from these standards for non-standard structures must be sent in to the Traffic Structures group for review and approval.

The maximum length of arm that can be used on a monotube cantilever VMS support is 50 feet and this value is shown on TM621. Monotube cantilever arm lengths that are longer than 50 feet have not historically been used by ODOT on the state highway system for non-redundant monotube cantilever sign supports.

5.2.5.2 Monotube Butterfly Sign Supports

A butterfly support has either one sign centered on the vertical post or two signs on two different arms attached on opposite sides of the vertical post. Most of the designs use the bolt and plate details from the monotube standard drawing for a specific arm length. Usually, both arms connect to the vertical post at the same elevation. Any differences in the bottom of sign elevation above the roadways are accommodated in the design. Attaching both arms at the same elevation will make the internal stiffener configuration different. Also, the fatigue cope at the bottom of the vertical post attachment plate will remove more section from the post that needs to be accounted for in the design. In addition, the single monotube cantilever usually has a handhole on the opposite side of the arm for wire access and having two arms will result in

moving the handhole to a location between the arms. There are some rare cases that may need to have the arms at different elevations. In these cases, there must be enough space between the bottom of the copes from the upper arm and the top stiffeners from the bottom arm to not interfere. Each arm will require a handhole opposite the arm for wire access when the arms are at different elevations.

It is important to include the torsion forces as specified in the AASHTO code. For a single sign with the sign centered on the vertical post, the torsion is the force on the sign multiplied by 15% of the sign width. For two signs mounted on arms across from each other, the torsion is equal the larger torsion from only one sign and arm. The reduction of torsion from the other sign and arm is conservatively neglected by the AASHTO code.

5.2.5.3 Monotube Cantilever Fatigue Loading

The monotube cantilever structures are susceptible to galloping, natural wind gusts and truck-induced gusts. These load cases must be included in the designs.

The AASHTO code states "truck-induced gust loading shall be excluded unless required by the owner." There are significant truck-induced loads applied to the monotube cantilevers and the code does not specify an alternative to address the truck-induced gusts. This requires the use of the loads specified in Section 11.7.4 until a satisfactory truck loading is addressed. For a custom design location, the truck speed may be reduced from 65 mph, which is the default in the code, to 55 mph. This reduction in speed may not be used for structures on I-5, I-84, I-405, I-205, US26 between mile points 64.3 through 73.0, I-105, I-82, and any other highway with similar characteristics to these highways.

5.2.6.4 On Bridge Monotube Cantilever Signs

C 5.2.6.4

When monotube cantilever sign supports are on a bridge structure, connect them directly to a bridge bent.

5.2.6 Monotube VMS/Sign Bridges

Monotube VMS and sign bridges use the design requirements shown on drawings TM693, TM627, TM628, TM694, TM695, TM696, and TM697. These drawings contain ODOT's statewide standards for these types of structures. Any deviations from these standards for non-standard structures must be sent in to the Traffic Structures group for review and approval.

The monotube bridge design is based on the vehicle speed VMS loading shown and the maximum amount of sign loading was optimized based on the structural details.

5.2.6.1 On Bridge Monotube VMS and Sign Bridges

C 5.2.7.1

When monotube VSM/sign supports are on a bridge structure, connect them directly to a bridge bent.

5.2.7 Minor Sign Support Structures

5.2.7.1 Wood Post Sign Supports

ODOT specifies the installation requirements and design tables for permanent and temporary sign supports on Standard Drawing TM670.

The design tables shown on the drawing use an X*Y*Z value that is in cubic feet. For a single sign, the X*Y*Z can be calculated by taking the area of the sign times the distance from the ground surface to the center of the sign. The designer must take into account the additional distance resulting from a surface that slopes down from the roadway. When there is more than one sign on a single post, each sign area, X*Y, is multiplied by the distance from the surface to the center of that specific area, Z. Each of the sign's X*Y*X values are added together for a total X*Y*Z value to use in the permanent or temporary sizing tables shown on TM670. A single post may not support enough sign area and a multiple post installation may be required. It is not recommended to use signs orientated in multiple directions on multiple post installations.

The design of the wood support has two controlling parameters. The first is the wind speed and wind pressure. Section 2.4 has additional information about the wind speed and pressure. The second parameter is breakaway dynamic performance. The fourth edition 2001 AASHTO code Section 12 for breakaway sign supports describes these requirements. For more detailed information about the specifics of the design, please go to the ODOT Standard Drawings website to view the Standard Drawing TM670 baseline report.

5.2.8 Signal Support Structures

5.2.8.1 Signal 0' through 55' Mast Arm Steel Supports

ODOT primarily uses 0' through 55' mast arm steel supports on the state highway system. The design and detail requirements are shown on drawings TM650, TM651, TM652, and TM653. The design uses the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals Allowable Stress Design (ASD). Any deviations from these standards are considered non-standard structures and must be submitted to the Traffic Structures group for review and approval.

Some issues that will drive a standard pole to become a nonstandard pole are as follows:

- Combining a standard traffic signal pole with a strain wire system.

- Dual mast arm signal supports.
- Adding very large guide signs to the pole (over 60 ft2).
- Steep site slope.
- Slope that starts closer than half the required footing depth for slopes on the opposite side of the mast arm attachment face.
- Slope that starts closer than the required footing depth for slopes located on the mast arm attachment face.
- Pole bases mounted on retaining walls at the back of the sidewalk that raise the pole base elevation.

Checking these items to see if they affect the traffic signal pole shop drawing is a straightforward procedure. Typically, between the contract plans and the digital video log (DVL), the Traffic Structures designer can determine if nonstandard conditions apply to the traffic poles. In the contract plans, review the sign plans and identify any signs supported on the vertical pole. Make sure the total sign area for a sign installation does not add up larger than 60 ft^2. Then verify the traffic signal poles do not support a span wire as shown on the traffic signal plans. The last three items can be verified with one resource. Having the highway number and milepost of the intersection allows the Traffic Structures designer to access the DVL. In the DVL, navigate to the site location and review the roadside slopes. If the slope does not seem excessive, then the standard foundations will probably be sufficient. If the slope seems large or starts close to the pole, then the Traffic Structures designer will need to collect site information for the pole installation. Contact the Traffic Signal designer and they should be able to provide you cross sections at the traffic signal pole and possibly site photos that may provide additional information about the site conditions. That cross section will allow the Traffic Structures designer to assess if the foundation should be nonstandard. If the foundation is determined to be nonstandard, then it should not be specified as an "X" pole, but a custom design should be provided in the contract plans.

Intersections that require the use of dual signal mast arms shall use an arm length that is listed on Standard Drawing TM650. The title of TM650 is Traffic Signal Supports General Details and Design Criteria and covers the design requirements for the custom dual mast arm. The required loading for each length of mast arm and the vertical post is shown on TM650. Some manufacturers have tried to use only the site-specific loads for the steel and foundation designs, but that does not account for additional future loading requirements that are shown on TM650.

5.2.8.2 Signal 60' through 75' Mast Arm Supports

The 60' through 75' mast arm steel supports design and detail requirements are shown on drawings TM655, TM656, TM657, TM658, and TM628. The design uses the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals Load and Resistance Factor Design (LRFD). The purpose of the longer mast arms is to remove the

use of strain wire signal supports that are more difficult to maintain. The longer mast arm designs are more critical structures and the designs follow the Major Sign Support design guidance with the exception that galloping is not required. TM655 requires the use of a horizontal 2.5 ft. x 3.0 ft. horizontal sign blank close to the end of the arm to prevent fatigue loads. In the event that the horizontal sign blank does not prevent fatigue loads, then the use of a dampener will be used for the site-specific conditions. Any deviations from these standards are considered non-standard structures and must be submitted to the Traffic Structures group for review and approval.

5.2.8.3 Signal Mast Arm Foundations

The details for the signal mast arm foundations are shown on Standard Drawing TM653 for 5 foot through 55 foot mast arm lengths and TM628 for 60 foot through 75 foot mast arms. The depth of the foundation must be designed using site-specific recommendations from a Geotechnical engineer and the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals either the ASD version or the LRFD version as needed.

The drilled shaft design depth shall follow the guidance in Chapter 16 of the Geotechnical Design Manual.

5.2.8.4 Signal Strain Pole Steel Supports

ODOT does not as a standard use strain pole, or span wire as defined in the code on the state highway system for new installations, except for the modification of an existing strain pole installation that is constructing a combination mast arm and strain pole.

The analysis of the loads on the messenger cable shall be designed according to Appendix A of the AASHTO code and to use the detailed method shown in Appendix A.8. The top deflections of the poles can be determined according to Appendix B.3 of the AASHTO code by overestimating the stiffness of the pole to reduce the top deflection and increase the cable force. A spreadsheet can be provided upon request from the State Traffic Structures engineer.

The shop drawings in the construction submittal should be reviewed to make sure that the poles provided will not make a significant change in the cable forces for the design of the poles.

5.2.8.4.1 Signal Strain Pole Foundation Supports

The drilled shaft design depth shall follow the guidance in Chapter 16 of the Geotechnical Design Manual.

5.2.8.5 Temporary Wood Strain Signal Pole Supports

The following are the general requirements for design of temporary wood poles:

1. Dead load and wind analysis using Appendix A of the 2001 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals using a wind speed of 110mph (3-second gust).
2. Importance factor (Ir) equal to 0.71.
3. Structural calculations for the wood strain pole using Section 9 of the 2001 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.
4. Calculate the messenger and guy wire tensions and compare to the allowable tensile load of the cable (not the ultimate breaking strength).
5. Helical anchor calculation. (See Section 2.9.3.1)
6. Bearing calculation at the bottom of the wood pole. (See Section 2.9.3.1)

5.2.8.5.1 Temporary Wood Strain Pole Support Foundations

The main foundation components are the helical anchor for the guy anchor and the bearing of the wood pole in the soil. If a project specific geotechnical report is not available then conservative soil design parameters can be assumed, however the assumed design values usually provide a deep foundation design.

The guy cables from the top of the pole produce a large vertical force in the wood pole that must be supported at the base. The diameter of the wood pole at the base is relatively small and typically does not provide enough bearing area for the soil to resist the vertical forces. The solution that has been used on past projects is to pour a 2 ft. diameter by 1 ft. pad that will be installed under the base of the wood pole. Another method that has been used is to compact ¾" +/- granular material under the wood pole for bearing. The width of the excavation is calculated from an assumed 45 degree angle from the bottom of the wood pole through the compacted material to the native soil. The required diameter or width is calculated to determine what is needed to resist the bearing. You should drill out the hole, compact the material in the bottom of the hole, level it, place the 2 ft. x 2 ft. x 1 ft. pad (or the compacted ¾" +/- granular material), place the wood pole, and backfill around the wood pole with well compacted granular material or a low density fill.

5.2.8.6 Signal Support Critical Design Items

The following are critical items that are incorporated into the ODOT designs:

1. Appropriate 3-second gusted wind speed for the area. The wind map in Figure 3-2 in the fourth edition 2001 AASHTO code does not always show the appropriate wind speed for the region.
2. A fatigue category of 1 or 2 must be used.
3. 50-year recurrence interval.

4. Hot-dipped galvanized steel and hardware. Include silicon content requirements from TM651.
5. Foundation design according to section 13.6 of the fourth edition 2001 AASHTO code. This will address water, sand, and cohesive soils.
6. Soil Geotechnical Report to perform foundation design.
7. Future loading conditions like 5 section head at the end of the mast arm, 5 section head for the closest signal to the mast arm, street name sign to meet MUTCD requirements, guide sign on the vertical post and cameras.
8. Main structural items to include in the calculations:
    a. Mast arm and luminaire arm.
    b. Mast arm and luminaire arm connection weld.
    c. Mast arm and luminaire arm connection bolts.
    d. Mast arm and luminaire arm connection plates.
    e. Vertical post.
    f. Vertical post base weld.
    g. Base plate.
    h. Anchor bolts.
    i. Foundation concrete and rebar.
    j. Embedment depth.
9. The design must be general enough that at least three manufacturers can bid on projects and provide poles on the state highway system.
10. Quality control for the material documentation. This must include the "Buy America" steel for projects funded with federal money.
11. Inspection of the fabrication.
12. Installations procedures for foundations, bolts, erection method, etc.

5.2.9 Luminaire Support Structures

Galvanized steel slip base and fixed base luminaire supports are typically used on the Oregon State Highway system. These standards are contained on ODOT Standard Drawings TM629 and TM630. There are projects that require the use of different style poles for aesthetic purposes and these are called ornamental or decorative lighting.

5.2.9.1 Slip and Fixed Base Luminaire Supports

The design and detail requirements for slip base and fixed base poles are shown on drawings TM629 and TM630. Any deviations from these standards are considered non-standard

structures and must be submitted to the Traffic Structures group for review and approval. The current design for these standards use the 1994 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals with a fastest mile per hour wind speed of 100 mph. In addition, the slip base design has been crash tested and approved by the FHWA. The proper orientation must be installed in the field to make sure that the structure reacts properly when impacted by an errant vehicle.

Truss sign bridges, monotube cantilevers, signal poles and square tube sign supports have currently been updated to the fourth edition 2001 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. The Illumination Standard Drawings are the next structure type scheduled to be updated to the new code.

5.2.9.1.1 Slip and Fixed Base Luminaire Support Foundations

The design of the foundations for the Standard Drawings TM629 and TM630 were based on the Rutledge method. This method can be referenced in the document "How to Design Pole-type Buildings" by Donald Patterson with copyright dates 1957, 1958, and 1962. The nomograph in Figure 1 shows the soil types and equations for determining the footing depths. This nomograph is very similar to the one that is shown in Figure 13-4 of the fourth edition 2001 AASHTO code. Section 13.10 states, "Small poles or posts for lighting and roadside signs may be embedded directly in the earth. An approximate procedure for calculating the required embedment depth, as outlined in the commentary, may be used." It is ODOT's interpretation that the luminaire supports shown on drawings TM629 and TM630 include the maximum size of poles that can be supported using Section 13.10 for new foundation designs. The minimum embedment depth must be equal to or greater than the depth required according to Section 13.10 of the fourth edition AASHTO code with an S1 value of 1500 psf.

Many luminaire foundations are installed on steeper slopes than the details shown on the standard drawings. This results in additional required length and custom foundation details. The additional depth can be stated in the luminaire project specific drawing table or a custom detail can be added for clarity.

5.2.9.2 Decorative Luminaire Supports

The use of decorative luminaire poles has increased over the past few years. These poles must satisfy the AASHTO Standard Specifications for Structural Support for Highway Signs, Luminaires, and Traffic Signals code requirements to be installed on the state highway system. In addition, installation procedures and requirements must be specified in the project plans and specifications. This section provides the design requirements necessary to use decorative luminaire supports instead of the ODOT Standard Drawings and Specifications for Slip Base and Fixed Base Luminaire Supports as shown on TM629 and TM630.

The current standard drawings for Slip Base and Fixed Base Luminaire Supports, which has been developed by ODOT over the years, has many qualified manufacturers and has pre-

qualified shop drawings to make the process more efficient. Decorative luminaire pole structural designs are typically based on the manufacturer's testing and are selected for the desired appearance by local communities and/or utility companies. The selected decorative luminaire poles must satisfy the requirements of the AASHTO Standard Specifications for Structural Support for Highway Signs, Luminaires, and Traffic Signals, installed with generally accepted construction procedures, have material quality control and allow lawful competition between manufacturers.

Traffic designer responsibilities: A Traffic designer that specifies a specific decorative luminaire support and associated foundation on the state highway system before the contract is let, or specifies general decorative pole requirements in the plans and has the contractor submit the required information, must satisfy the following state requirements:

- The pole must meet the fourth edition 2001 AASHTO Standard Specifications for Structural Support for Highway Signs, Luminaires, and Traffic Signals with all interims.
- Local 3-second gusted wind speed minimums must be satisfied.
- A minimum design life of at least 50 years must be used.
- A fatigue category II must be satisfied.
- Steel design must meet Section 5 of the fourth edition 2001 AASHTO code.
- Aluminum design must meet Section 6 of the fourth edition 2001 AASHTO code.
- The 1994 AASHTO Standard Specifications for Structural Support for Highway Signs, Luminaires, and Traffic Signals may be used instead of the fourth edition 2001 AASHTO code with a fastest mile wind speed that is equal to or greater than the local requirements.
- Fluted poles are only allowed on vertical posts that have a single luminaire load at the top. No fluted vertical poles are allowed on the state highways with luminaire arms that produce torsion in the vertical shaft.
- A fluted shell cover that fits around the standard round pole can be used. The fluted shell has a different drag coefficient and calculations are required for the pole and foundation.
- At least three manufacturers must be specified for each item of the decorative luminaire support to allow for lawful competition. If only one manufacturer is available, the statement "or approved equal" must be added. A public interest finding can be obtained if one specific product must be used.

Drawings, details, calculations and a statement certifying that ODOT and AASHTO standards have been met shall be stamped by a professional engineer registered in the State of Oregon and submitted to the Traffic designer according to 00150.35(b-1). This information will be forwarded to the Traffic Structures engineer for review.

ODOT Traffic Structures engineer responsibilities: Review the submittal and return comments within 21 days.

5.2.9.2.1 Decorative Luminaire Support Foundations

The design methodology from Section 3.6.1.1 applies to the decorative support foundations. Many of the details from TM629 and TM630 should be considered when creating a custom foundation drawing. One method is for a designer to specify one of the footings from the ODOT Slip Base and Fixed Base Luminaire Supports Standard Drawings TM629 and TM630.

Pre-cast footings are not recommended for use on ODOT projects. In many cases, the tops of the curbs and sidewalks have not been located and it requires more expertise to survey each footing installation to result in the correct top of footing elevations. It should be noted that many times the elevations that are used during the project to set the top of the footings with accurate survey techniques might not be the final elevation that the curbs and sidewalks are poured to because of roadway construction issues that occur during the project. Special requirements must be included in the plans and specifications to ensure proper installation. Provide details similar to those shown on the Slip Base and Fixed Base Luminaire Supports Standard Drawing. In addition, at least 1 foot below the bottom of the footing shall be filled with well compacted material. Also, a minimum space of 1 foot shall be provided around the entire footing and replaced with well compacted material. A low density fill may be substituted for the compacted material. A note or special provision statement must specify that "a foundation installation will be rejected when the top of the pre-cast foundation is lower than the surrounding sidewalks or curbs, the top of the pre-cast footing shall be no more than 2" above the top of the sidewalk or curb, and it shall not create a tripping hazard." Guidance for the grout between the base plate and the top of the foundation must be addressed and a drain hole must be specified.

5.2.9.2.2 Decorative Luminaire Critical Design Items

The basic principal for review calculations is to start at the luminaire and any material, bolt, welds or plates that are shown must have calculations to show that the AASHTO code is satisfied. The following are critical design items for the decorative luminaire poles:

1. Appropriate 3-second gusted wind speed for the area. The wind map in Figure 3-2 in the fourth edition 2001 AASHTO code does not always show the appropriate wind speed for the region.
2. A fatigue category of 1 or 2 must be used.
3. 50-year recurrence interval.
4. Main structural items to include in the calculations:
    - Luminaire connection.
    - Luminaire arm.

- Arm connection weld.
- Arm connection bolts.
- Arm connection plates.
- Vertical post.
- Vertical post base weld.
- Base plat or casting.
- Anchor bolts.
- Foundation concrete and rebar.
- Embedment depth.

5. The design must be general enough that at least three manufacturers can bid on projects and provide poles on the state highway system.
6. Quality control for the material documentation. This must include the "Buy America" steel for projects funded with federal money.
7. Inspection of the fabrication.
8. Installations procedures for foundations, bolts, erection method, etc.

5.2.9.3 Other Luminaire Supports

The use of other types of luminaire poles includes the use of aluminum, curved arm connections called davits and many other alternatives. These poles must satisfy the AASHTO Standard Specifications for Structural Support for Highway Signs, Luminaires, and Traffic Signals code requirements to be installed on the state highway system. In addition, installation procedures and requirements must be specified in the project plans and specifications. The information contained in Section 3.6.2 Decorative Luminaire Supports applies to these alternative types.

5.2.10.4 Luminaire Support Fatigue Requirements

Luminaire pole fatigue requirements are differentiated by the height and importance of the support. The fifth edition AASHTO code commentary C11.4 states, "Common lighting poles and roadside signs are not included because they are smaller structures and normally have not exhibited fatigue problems. An exception would be square lighting poles, as they have exhibited poor fatigue performance." The definition of typical lighting poles, which is assumed to be the same as common lighting poles, can be found in the AASHTO code commentary C1.4.2 that states, "The lighting of modern freeways includes the use of typical lighting poles, generally tubular pole shafts that support 1 to 2 luminaires and range in height from about 9 m (30 ft.) to 17 m (55 ft.)." Luminaire poles that are 55 feet and less in height with 1 to 2 luminaire

arms and do not have a square section are categorized as typical or common lighting poles and do not need to perform the fatigue calculations.

Luminaire poles and high mast towers over 55 feet and less than or equal to 100 feet shall be designed to a Fatigue Category II. High mast towers in excess of 100 feet shall be designed to a Fatigue Category of I.

5.2.10.5 On-Bridge Luminaire Mounts

C 5.2.10.5

See *BR900 series* for details.

Position all luminaire mounts a minimum of 3 feet, but no more than (span ÷ 8 feet) from a bridge bent.

Standard traffic lighting poles are the only traffic structures with standard bridge connection designs.

Luminaire poles are not breakaway or crashworthy elements.

Potential risk considerations include those listed in *BDM 1.13.5.*

Luminaires mounts are designed for TL-3 ZOI based on a 42 inch tall barrier (translates to 12 inches of intrusion behind top face of barrier.) See *BDM 1.3.6* for additional information.

5.2.10 Mounts to Structures and Supports

C 5.2.11

Mounts to structures and supports are the members and connections that attach a sign, signal, VMS, or access walkway to a structure like a bridge, sign bridge, monotube cantilever, signal mast arm support, multi-post breakaway, triangular base breakaway, wood post, perforated steel square tube, etc.

When feasible, locate traffic structures off the bridge. When placement on the bridge is necessary due to site constraints or design requirements the following traffic structures may be located on bridges:

- Standard lighting poles.
- Camera poles.
- Structure mounted signs (signing for traffic passing under bridge).
- Miscellaneous small signs (signing for traffic on bridge).

Placement of traffic structures on bridges is discouraged due to increased costs, complexity and maintenance. The decision on whether the traffic structure is located on the bridge and the exact location of the traffic structure on the bridge will be made by the bridge designer in conjunction with the project team.

When a traffic structure is on a bridge, the bridge designer will be responsible for the connection between the traffic structure and the bridge, including the anchor bolts, and will review or check the shop drawings associated with the bridge design responsibilities. The Traffic Structures Designer will have very limited involvement with the bridge structure, but is responsible for design of the traffic structure above the connection to the bridge.

Design loads and guidance for many common applications are in this manual, Section 5.

Structure mounted signs should preferably not exceed 7 feet in height.

In urban areas the required sign legend may dictate a larger sign panel. The bridge designer should work with the project team to arrive at an acceptable solution, considering effects on aesthetics, sight distance, and related factors.

5.2.10.1 Sign Mounts on Bridges

Sign mounts on bridges do not have design details in the Standard Drawings or standard details. Design a new sign mount on a bridge using the most recent accepted versions of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals LRFD*.

The following are the minimum requirements for sign mounts design on bridges:

1. Sign mounts on bridges shall have a corrosion resistant lifespan of at least 50 years.
    a. Use galvanized steel for the mounts, anchor rods, and hardware. Galvanized steel provides at least a 50-year corrosion lifespan at most locations that are not exposed to the coastal areas within 1 air mile of the Pacific Ocean.
2. Span Limitations by Mount Type:
    a. Single member cantilevered mounts are permitted to span up to 8 feet.
    b. Trusses, oriented in the vertical plane, are permitted to span up to 15 feet.
    c. Span is defined as the distance from the furthest out mount connection to the bridge to the location where the sign is attached to the mount.
3. Signs:
    a. Sign material is sheet aluminum, plywood or extruded aluminum.
    b. Extruded signs can be unsupported horizontally a maximum of 8 foot 6 inches between sign mounts.
    c. Extruded signs can be cantilevered horizontally a maximum of 3 feet past the mount. Use at least two sign mounts for signs wider than 6 feet.
4. Detail mounts to support the bottom of the sign. This typically includes a plate or angle, mount to the bottom of the vertical sign mount members. Example details are available in *TM602* and *TM618*.
5. Bolted Connection Requirements
    a. Design bolted connections to steel bridge members according to *AASHTO Standard Specifications for Highway Bridges and the ODOT Bridge Design Manual*.
    b. When bolts are not tightened to the proof load, use double nuts or locknuts.

c. Connect mounts to bridges in at least two locations with at least two bolts per location.

d. The minimum distance between bolted connections on a mount is 2 feet.

e. The minimum horizontal distance between mounts is 3 feet.

f. Follow the concrete anchors guidance in the *ODOT BDM*.

g. Verify that anchors will not interfere with rebar, pre-tensioned cables, post-tensioned cables, other through bolts, utilities, etc.

h. Provide adequate access to the bolts to tighten the anchor rods from the outside and inside.

6. Wind directions – The following are the wind directions to consider to determine the maximum reactions of wind from any direction:

    i. Wind perpendicular to the bridge longitudinal axis and towards the bridge.

    ii. Wind perpendicular to the bridge longitudinal axis and away from the bridge.

        1. Satisfy the number 8 requirements as needed.

    iii. Wind perpendicular to the sign face plan and towards the front face of the sign.

        1. Include mount members exposed to the wind.

    iv. Wind perpendicular to the sign face plane towards the back of the sign.

        1. Include mount members exposed to the wind.

        2. Satisfy the number 8 requirements as needed.

    v. Wind parallel to the bridge longitudinal axis towards the font face of the sign or the side of the sign if applicable.

        1. Include mount members exposed to the wind.

    vi. Wind parallel to the bridge longitudinal axis towards the back face of the sign.

        1. Include mount members exposed to the wind.

7. Investigate signs extending above the bridge deck for the following two load cases:

    a. The bridge blocks wind on the sign and mounts. Wind is applied only to the area of the sign and mounts exposed above or below the bridge.

b. The bridge does not block wind on the sign and mounts. Wind is applied to the full sign and mounts.

8. Locate sign mounts on bridges that meet the following:

   a. Attachment location has a CS≤2. Condition of the bridge can be obtained from the inspection report. Contact the region Bridge inspector about additional field inspections that may need to be performed.

   b. Do not place signs under bridge overhangs.

   c. Do not place signs directly under the drip-line of the structure.

   d. Provide a minimum 2 inches of clearance between the back side of the sign support and edge of the bridge.

9. Fatigue shall be considered in both the vertical and horizontal directions.

   a. Use the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals ASD or LRFD Section 11* Natural Wind gust loading applied in the wind directions specified in number 6 above.

   b. *Use AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals ASD or LRFD Section 11* Truck Gust loading applied in the vertical direction.

   c. Determine whether or not movement of the bridge will induce significant sign mount fatigue loads that must be investigated. When vertical movement is a concern, consider relocating the sign mount. When relocation is not possible, contact the state Traffic Structures engineer.

10. Seismic – *The AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals* does not require a seismic design for sign mounts.

11. Clearances – Follow the Overhead Structures Vertical Clearance Standards and Guidance in this Manual, the *Highway Directive TRA 07-15*, and the *Tech Bulletin RD17-02(B)*.

a. Position all new side mounted signs on bridges such that the bottom of the sign or lighting bracket does not extend below the bottom of the bridges (bottom of girder flange).

12. Maintain at least a nominal 2 inches between the bottom of the sign and the bottom of the bridge.

This is to ensure that the bottom of the sign is above the bottom of the bridge while accounting for construction tolerances and bracket arm sag.

c. Locations where the clearance under the bottom of bridge exceeds

18 feet 10 inches and results in the lowest bottom of sign clearance exceeding 19 feet shall obtain approval of the final bottom of sign clearance from the region Sign engineer and region Mobility coordinator.

5.2.11 Re-Use and Re-Analysis of Existing Structures

Sometimes a project will be scoped to reuse an existing sign, signal or illumination support. Each type of structure will have to be reanalyzed for new loading to ensure the structure is adequate. Each type of structure is addressed in the subsections below.

5.2.11.1 Truss Sign Bridges and Monotube Cantilevers

In order to reuse a truss sign bridge or monotube cantilever, several steps have to be followed. The first step is to locate the construction drawings from the original installation. Those drawings may be found using the Bridge Data System (BDS). If the original drawings cannot be located using the BDS, then the Roadway drawing database (RIAS) may provide additional information about possible bridge drawing numbers that are referenced on the #V-## roadway drawings in the basement of the Transportation building in Salem. Another method to find information on a structure is to check the field inspection reports. There are sometimes bridge number references listed in the comments sections from tags that are riveted to the vertical post of the structure. If the original construction documents cannot be located, a field crew will have to measure the structure and the designer will have to research the old standard drawings to find material grade and other pertinent information. You can use the original design code to analyze the structure, but no code older than the 1994 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals code will be allowed. The 1994 AASHTO code uses very similar design values to the preceding codes. Cases where the sign loading is smaller or luminaire loading is stated in the notes can be used to analyze the structure without a full analysis by providing a comparative area calculation. Changes in the area can affect the location of the area center and must be addressed when making this comparison. If the center of the proposed area is at a higher elevation with the same area size as the original, then the base reactions will be higher. Some of the old horizontal truss designs used a standard design sign area for the horizontal truss. The design area was equal to the estimated distance between foglines with an assumed sign height and luminaire loading. It was stated in the old Bridge Design Manual that for a project total sign area that was less than the design area of the horizontal truss could be used to design the end vertical posts and the foundation, but the area could not be reduced to a value lower than 75% of the horizontal truss design area. Cases where the loading is larger or the designer is not comfortable using an approximated estimate, then the structure must be analyzed using the new loading conditions to determine if the old structure can support the new loads. You can use either hand calculations or a computer analysis program to perform the structural analysis. The design shall check the steel members, member welds, connection plates, connection bolts, base plate, anchor bolts and foundation for structural adequacy. You can make a structure under the older code that requires small modifications (like adding some concrete to the top of the slab or a new vertical support that attaches the sign to the structure). More severe modifications are not allowed and the structure must be replaced using the most recent version of the fourth edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires,

and Traffic Signals. Finally, the condition of the structure must be reviewed by sending a field crew to inspect it or by reviewing an inspection report that has been performed within the last three years.

5.2.11.2 Multi-Post and Triangular Base Breakaway Posts

In order to reuse a multi-post and triangular base breakaway sign support, there are several steps you will have to follow. The first step is to determine the date the sign support was constructed. This can be determined from shop drawings associated with the sign support, the as-constructed drawings and possibly a sign inventory (depending upon the highway). Once the date has been determined, then the standard drawing for that period should be referenced to find out the pertinent structural information. With the existing structure's information, the sign support should be analyzed to support the new sign using the 1994 AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires and Traffic Signals. The steel sign post(s), base plate(s), anchor bolts and foundation should be checked. Another item that will require investigation is the condition of the sign support. Each sign support that will be reused should be determined if it meets the current standards for breakaway devices. The support should also be inspected for structural damage, corrosion and whether a reasonable amount (3mm or more) of galvanizing is left. The inspection will probably require weld inspection of the structure. This may be costly if many supports will be reused. If the structure is determined to be able to support the new sign, is structurally sound, and meets breakaway standards, the support can be reused. One point to consider is the cost associated with purchasing a new sign support; it may be reasonably comparable to reusing an existing sign support. A cost analysis should be done prior to the decision to reuse an existing breakaway sign support.

5.2.11.3 Mast Arm Signal Supports

The Signal Mast Arm Support Standard Drawings were in the Bridge Section until 2003 and then transferred to the Traffic Section. The design loading was increased in the TM650 design to accommodate future traffic safety requirements and results in more simplified analysis techniques.

5.2.11.3.1 Mast Arm Signal Supports before TM650

The following are general design guidelines for analyzing existing mast arm signal poles that do not use ODOT Standard Drawings TM650 through TM653:

1. Obtain all intersection and associated drawings that show plans and legends for the intersection. These may be obtained from the region.
2. Once the as-constructed date is known, determine which of the standard drawings are appropriate for that given date. There may be cases where the date is before a standard drawing was created.

3. Determine the level of inspection that will be required of this pole.
    a. Before 1980, full visual inspection and galvanizing thickness measurements are required. Inspect that all bolts are tight, no damage to the pole exists and that there are no areas where galvanizing touch-up may be required
    b. 1980 through current, full visual inspection to make sure that all bolts are tight, no damage to the pole exists and there are no areas where galvanizing touch-up may be required.
4. Send the spreadsheet "Mast arm Field Data Sheets (revision date)" to the field personnel that will be performing the work and include the name of the field crew doing the inspection. You can download the spreadsheet from the Traffic Structures website. Many cases exist where the information from this spreadsheet does not check out or make sense and the crew will have to go out again. Emphasize that any questions about the measurements should be addressed before they get out in the field.
5. From the field data, verify this information with the data from the appropriate standard drawing and as-constructed drawing. Any discrepancies between the two will have to be checked.
6. Signal mast arm supports installed according to standard drawings with the design loading specified can often use an X*Y*Z loading comparison analysis. This method adds the shear area (X*Y) or weight in the X, Y, Z directions. It also adds the moment of area (X*Y) times the distance from the base to the area center about the X, Y, and Z axes. The design and proposed total shear and total moments are compared. Do not accept a 5% proposed loading over the original design loading.

The following items are not required when a comparison method can be used.

7. The earlier design codes had the same wind pressures as the 1994 AASHTO code. All existing traffic structures are designed to the 1994 AASHTO code as a minimum requirement.
8. The wind speed to use for the reanalysis is 90 mph. This is a fastest mile per hour basic wind speed.
9. Run the pole using design requirements from the 1994 AASHTO code and check the CSR of the pole. Use a default yield strength of 48 ksi unless a more accurate value can be determined from project specific shop drawings.
10. Check the anchor bolts using an assumed yield strength value of 36 ksi as a default bolt yield strength unless a more accurate value can be determined from project specific shop drawings.
11. Check the base plate using a fixed condition at the bolt and a pinned condition at the pipe.

12. Check the foundation depth using the Rutledge Method. The reference of this document is "How to Design Pole-type Buildings" by Donald Paterson. Use an allowable average soil stress of 1500 psf.

5.2.11.3.2 Mast Arm Signal Supports TM650 and after

The design loading shown on the Standard Drawing TM650 added arm lengths up to 55 feet, a street name sign, a 5 section head at the end of the mast arm, a 5 section head on the mast arm closest to the pole, larger directional signs that increased from 2 feet x 2.5 feet to 2.5 feet x 3 feet, a 60 ft^2 guide sign on the vertical post, cameras and appurtenances on the vertical post. The increased design loading allows additional safety devices with easier analysis methods.

The following are general design guidelines for analyzing existing mast arm signal poles that use ODOT Standard Drawings TM650 through TM653:

1. Obtain all intersection and associated drawings that show plans and legends for the intersection. These may be obtained from the region.
2. Poles built to TM650 that were installed after 2003 are within the expected 50-year corrosion design life and a corrosion condition inspection is not required. Verify that the pole does not have dents, missing nuts, etc.
3. Compare the proposed loading to the original design loading to determine if the pole is structurally adequate to support the new loads.
    a. For signal mast arm supports where the structural adequacy is not easily determined by reviewing the proposed loading to the TM650 design loading, an X*Y*Z loading comparison can be made according to Section 2.12.3.1.
    b. The foundation depths on the project have been designed for the TM650 loading and additional foundation analysis is not needed if the proposed loading is less than the design loading.
4. You may need to perform a more detailed analysis, but this does not occur often. The following are items that can reduce the loads for the analysis:
    a. Use the site-specific wind speed for the signal mast arm support location.
    b. TM650 uses an 8-sided pole for the design based on manufacturer's capabilities. Adjust the shape factor for site-specific pole details as needed.

5.2.11.4 Signal Strain Pole Supports

Strain poles were commonly used on intersections with varying lengths of spans depending on the installation date. There was no standard drawing for strain poles until the drawing 35010, dated January 7, 1980, was released. So, strain poles that are dated before this date will most likely have little design information to use to verify field information.

The following are general design guidelines for analyzing existing strain poles:

1. Obtain all intersection and associated drawings that show plans and legends for the intersection. These may be obtained from the region.
2. Once the as-constructed date is known, determine which of the standard drawings are appropriate for that given date. There may be cases where the date is before a standard drawing was created.
3. Determine the level of inspection that will be required of this pole.
    a. Before 1980, full visual inspection and galvanizing thickness measurements. Inspect that all bolts are tight, no damage to the pole exists, and that there are no areas where galvanizing touch-up may be required
    b. 1980 through current, full visual inspection to make sure that all bolts are tight, no damage to the pole exists, and there are no areas where galvanizing touch-up may be required.
4. Send the spreadsheet "Mast arm Field Data Sheets (revision date)" to the field personnel that will be performing the work and include the name of the field crew doing the inspection. There are many cases where the information from this spreadsheet does not check out or make sense and the crew will have to go out again. Emphasize that any questions about the measurements should be addressed before they get out in the field.
5. From the field data, verify this information with the data from the appropriate standard drawing and as-constructed drawing. Any discrepancies between the two will have to be checked.
6. The earlier design codes had the same wind pressures as the 1994 AASHTO code. All existing traffic structures are designed to the 1994 AASHTO code as a minimum requirement. The later ASD and LRFD versions of the code may be used for the reanalysis.
7. The wind speed to use with the 1994 AASHTO code for the reanalysis is 90 mph unless a more accurate site-specific wind speed can be used. This is a fastest mile per hour basic wind speed. The ASD AASHTO codes after 2001 use the 3-second wind gusts shown on TM671 and the LRFD AASHTO codes use the 3-second wind gusts shown on TM672.
8. A reference to the AASHTO code Appendix A will help solve for the messenger cable dead load tension and wind load tension. The drag coefficient for the signals and signs may be reduced to 0.7 from 1.2 based on the swing effect after the lower tether breaks away when an "S" hook is used. A correlation of the dead load tension to the live load is stated on the old Standard Drawings 40397, 47231, BR966, and TM632 and can be used with the 1994 AASHTO code analysis. This statement is under bubble note 2 on the drawing and it states, "Dead load and wind load span wire design tension shall be 2.5 times the allowable span wire dead load tension." Calculate the dead load tension and multiply by 2.5 for the load to apply to the pole when performing calculations that used these standard drawings.

9. A historic conservative design method applies a single resultant messenger load to the attachment point on the pole from the full force of each messenger cable calculated from the wind perpendicular to each cable span. An optional and less conservative design approach takes into account different wind directions to the pole and applies the messenger cable loads to the attachment points on the pole from the messenger cable forces calculated from the different wind angles.
10. Run the pole using design requirements from the 1994 AASHTO code, or later versions as required, and check the CSR of the pole. Use a default yield strength of 48 ksi unless a more accurate value can be determined from project specific shop drawings. The yield strength of the pole maybe difficult to determine. In some cases, the pole tag will have the manufacturer on it and a yield strength can be estimated based on the installation date. Another option to determine the yield strength is to obtain Brinell hardness test readings in the field, determine the tensile strength from ASTM A370 and then estimate the yield from the ratio of minimum yield stress to minimum tensile stress.
11. Check the anchor bolts using an assumed yield strength value of 36 ksi as a default bolt yield strength unless a more accurate value can be determined from project specific shop drawings. The Brinell hardness test method used for the pole steel can also be used on the anchor rods during the same site visit.
12. Check the base plate using a fixed condition at the bolt and a pinned condition at the pipe. This is a conservative method and a double curvature condition can be used based on engineering judgement for reanalysis.
13. Check the foundation depth using the Rutledge Method. The reference of this document is "How to Design Pole-type Buildings" by Donald Paterson. Use an allowable average soil stress of 1500 psf.

The preceding comments represent a minimum design that will be accepted by the State of Oregon for the analysis of existing poles.

5.2.11.5 Illumination Poles

The reuse of illumination poles on projects is not recommended. These poles have a wide range of ages and in many cases, the pole that is to be reused may not have any information about it. There are problems with reusing a pole where the original standard had one orientation and the new standard has a different rotation, as is the case with slip base poles. Another example is a high mast pole that had an older design that used a different diameter of bolt than the new standard. If the new standard was used to install the anchor bolts, then the base plate would not fit on the bolts that were installed. In each case, the requirement of investigating the exact pole that will be moved to make sure it can support the proposed loading to the current standards and to make sure the pole is in good shape takes time and money and results in a pole that is older with potential for additional mistakes.

The reuse of the pole still requires a new pole foundation, conduit, electrical wiring and most likely a light which brings most of the installation up to a new condition. The cost of the lighting pole is approximately $1,500 and this is approximately how much money may be spent to investigate the pole to relocate it. The end result is about the same amount of money is spent, but an older pole is installed and the life expectancy of the pole is reduced.

5.2.11.6 Questions to Investigate Before Re-Using a Structure

The following are questions to answer before a structure is reused or modified to support additional loads:

1. Is the intent of the project to bring the stretch of the highway up to all current standards?
    - Reanalyzing a structure to the 1994 AASHTO code does not necessarily bring the structure up to the current code. If a structure with new loading requires significant modifications or the signing cannot be brought up to the most recent codes because the structure cannot support it, then you should replace the structure. This will bring the signing and the structure up to the most recent codes, which is the intent of the project.
2. Is the structure old enough that it needs to be replaced in the next 10 years?
3. Most of the traffic structures are galvanized and have a lifespan of 50 years. If the structure is 45 years old and it is not known when the next time the structure will be replaced, then you should consider that the structure's galvanizing may be insufficient in five years. If corrosion starts, then there can be loss of section, and lower loads than the design load could fail the structure.
4. Is the structure in a location where there is currently a large project, a large amount of congestion with motorist inconvenienced during construction, and there is no project planned in the foreseeable future?
    - It may be cheaper during this project to not replace the structure, but if something happens to this structure because of its age or the modified signing is not sufficient, then going back into this area with a small project in the near future will not be received well by the traveling public.
5. Can the loading on the structure remain the same or can the loading be reduced to the point where the structure will work without any modifications?
    - There are occasions where some of the loading can be reduced to make the structure work.
6. Can the sign or signal be moved to another location on a different structure?

7. Can the structure be removed and still satisfy current codes and traffic design practices?
    - There have been instances where an old sign bridge can be removed and the signs can be placed on roadside signs and still meet code requirements.
8. Does the 50% rule apply?
    - The 50% rule recommends that if the cost of the repairs is 50% or less than the cost of a new structure, then the repairs should be completed.
    - This rule only applies when the previous questions have been answered and it is recommended to fix the structure.

5.2.12 Replacing Traffic Structures In-Kind

There are many instances where reanalysis of an existing structure is not required as long as the loading on the structure has not changed. The most common occurrence is when a vehicle has hit a structure and damaged it beyond field repair. This results in the determination of whether or not the structure must be brought up to the full new standards. In this case, the replacement of the structure uses the term "in kind." Replacing a structure "in kind" means that the original loading, dimensions, location and elevation does not change from what was shown on the original stamped plans for the installation. The engineering responsibility for the installation still remains with the engineer that stamped the original drawing. Changes to the loading, dimensions, location and elevation that modify it from the original plans results in requiring a new drawing and professional engineers stamp from the State of Oregon.

A structure that is severely deteriorated and needs to be replaced will need to have an engineer investigate and give a recommendation about whether or not it needs to be replaced in kind or replaced with a structure that satisfies the latest designs. In many cases, there are other structures in the area that will need to be replaced with the most recent design and it is not advisable to spend a lot of money to update one structure when it is known that many of the structures are going to be replaced with a project in the near future. Work with the region to determine if there is a project in the near future that will update this area. If it is only in the next year, then a temporary fix may be the best alternative.

5.2.13 Steel Design

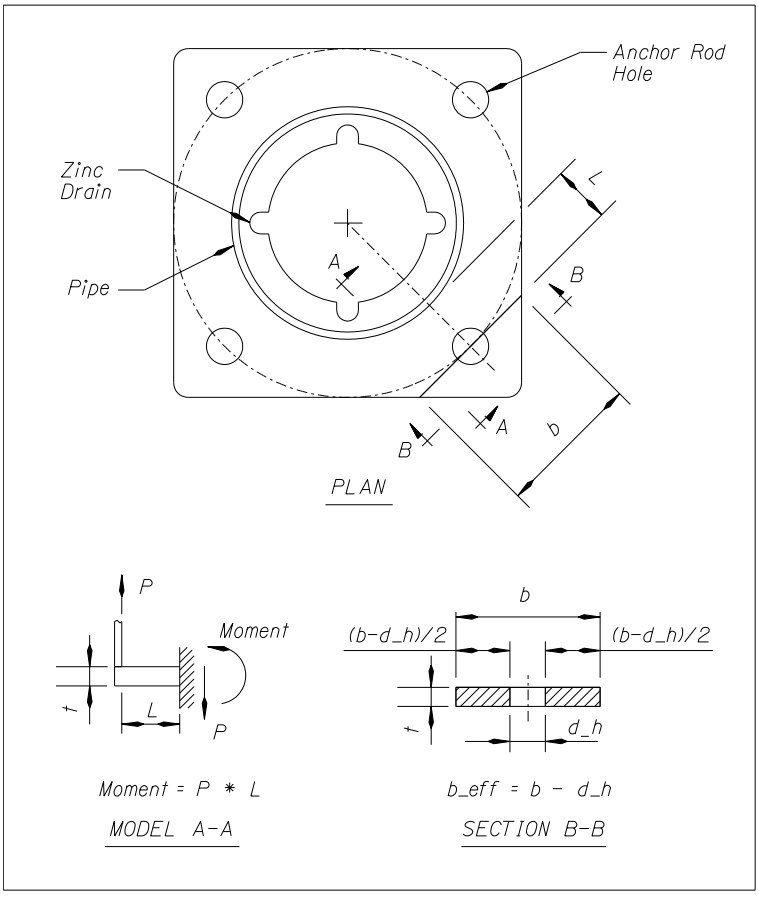
This section will discuss standard methods that can be used for the design of steel traffic structures. The methods are based on standard practice that have commonly been used and accepted.

5.2.13.1 Base Plates and Flanges

The calculation of the thickness of a base plate or flange is one of the most common designs that is used for traffic structures. The following method is a conservative design procedure that can be performed quickly with reasonable results.

The layout in Equation 2-1 shows a plan of a base plate attached to a pipe. There is a hole in the center with four keyed out sections that provide galvanizing drainage, which is called a zinc drain. At each one of the base plate corners there is a hole that is ¼" larger in diameter than the rod diameter, d_h. From the edge of the pipe to the center of the rod hole is considered the cantilevered distance, L, to use for the Moment calculation. The Moment will be equal to the distance, L, from the center of the rod hole to the edge of the pipe times the rod tension force, P. This method assumes that the force applied from the pipe is a point load and the nut on the rod creates a clamping force that is similar to a fixed condition. Once the Moment is known, the critical cross section is determined to be the line at the center of the rod hole that is perpendicular to the line from the center of the pipe to the center of the rod hole. The width, b, is the distance along the perpendicular line and extends from the edge of the plate through the center of the rod hole and goes to the other edge of the plate. The effective width, b_eff, is the b distance minus the width of the hole. The actual stress, F_act, from the loading is calculated from the Moment divided by the section modulus. The Moment of inertia, I, of the plate section is equal to Equation 2-1 and the distance to the extreme fiber is equal to t/2. The section modulus, S, is calculated according to Equation 2-2. Using an assumed thickness, t, the actual stress from the loads, F_act, can be calculated using Equation 2-3.

Figure 5.1.13.1-1: Base Plate Calculation Layout



Equation 2-1

$$I = \frac{b_eff \times t^3}{12}$$

Equation 2-2

$$S = \frac{I}{c} = \frac{\left(\frac{b_eff \times t^3}{12}\right)}{\left(\frac{t}{2}\right)} = \frac{b_{eff} * t^2}{6}$$

Equation 2-3

$$F_act = \frac{Moment}{S} = \frac{Moment}{\left(\frac{b_eff \times t^2}{6}\right)}$$

The 2001 fourth edition AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals Equation 5-8 specifies the allowable stress for rectangular plates to be Fb=.75*Fy. This allowable stress can be increased by 1/3 for Load Case 2 designs. If the actual stress, F_act, is less than or equal to the allowable stress, Fb, then the base plate is structurally adequate.

5.2.13.2 Bolting and Hardware

The AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals does not have design information for bolting hardware, except there is design information for anchor rods. It requires the use of the Standard Specifications for Highway Bridges, except for design guidance provided for anchor rods.

5.2.13.2.1 Minimum High Strength Bolt Diameters

The use of ½ inch diameter A 325 high strength bolts requires rotational capacity tests during construction and some of the bolts have not passed this test. This results in the rejection of the hardware, new testing, and time delays. It is recommended to not use ½" diameter A325 high strength bolts and to use a minimum of 5/8" diameter A 325 high strength bolts.

5.2.14 Proprietary Items in Federal-Aid Contracts

- Basis for requirements: Competition.
- 23 United States Code 112: "…the Secretary [of Transportation] shall require such plans and specifications and such methods of bidding as shall be effective in securing competition."
- Regulations apply to process or product specifications.
- What is proprietary?

- Product specified by brand name.
- A specification written around a specific product in such a manner as to specify an attribute or process that is unique to that product and excludes other similar products.
- Manufacture or use of the product by any party that would infringe on a patent or copyright or require payment of a premium royalty.

- A proprietary item on a federal aid project may be used only under the following conditions:
  - The proprietary item is allowed in competition with other equivalent products using one of following methods:
  - Nonproprietary – Generic end result specification.
  - Nonproprietary – Generic process or product attribute specification (may be patterned after a manufacturer's specification, but sanitized to eliminate reference to brand names and patented aspects and open enough to allow at least two alternatives).
  - Proprietary – Multiple brands with all (at least two and, preferably, three) alternatives specified; interim use only in exceptional circumstances. Use either manufacturer's specification incorporated into contract (proprietary) or name brands only in the contract documents with or without reference to manufacturer's specification or in the approved products list (proprietary).
  - A public interest statement can be developed by the highway agency and approved by FHWA when the product is either essential for synchronization (compatibility) with the existing system or it is the only suitable product or method that exists.
  - Other products or processes will not work.
  - Other products or processes may work but are otherwise unreasonable.

    Note: The two conditions above should be verified by the highway agency and documented. This finding should be periodically reviewed.
  - It is experimental. The intent and use of the experimental program is to permit the state adequate time to test and/or evaluate new and untried materials or products capable of providing the intended function upon which they can further develop team research, not to otherwise circumvent the prohibition against brand name items. Reports must be prepared and submitted to FHWA for dissemination to other interested agencies.

5.2.15 Overhead Structures Vertical Clearance Standards and Guidance

The standard drawings for the truss sign bridge, VMS sign bridge, monotube cantilever, signal mast arm, and signal strain pole supports specify clearances of the bottom of signs to be between 18′-0″ to 19′-0″. Submit proposed vertical clearances under traffic support structures to the region Mobility liaison to verify that the vertical clearance above the state highway is acceptable for the project specific corridor. Vertical clearances for traffic support structures that are above 19′-0″ are considered non-standard and require submitting a design exception for approval to the Traffic Roadway Section according to Chapter 14 of the ODOT Highway Design Manual. The design exception request process for increasing the vertical clearance greater than the above mentioned 19′-0″ will need to consider safety, operations and impact to other design features in order to support the approval of the design exception.

5.3 Construction Phase of Projects

5.3.1 General

After the design phase is finished, the project is advertised for bid. The bid documents consist of the project plans and Special Provisions produced by the Design team. The contractors will review the plans and put together a bid based on the project plans and the material quantities reported in the Special Provisions. Once the bidding process is finished and the project is awarded to a contractor, the construction phase of the project begins.

During the construction phase, the ODOT Design team will have a preconstruction meeting with the contractor. ODOT or the contractor will collect field data, submit shop drawings for review, have the traffic structures fabricated once the shop drawings are approved and then the traffic structure will be erected in the field. Depending upon which traffic structure is/are being used in the project, the construction process can either have minimal oversight by the Traffic Structures designer or the Traffic Structures designer can become quite involved. One change to the design team is changing from the project leader to the resident engineer. This change occurs when the project advertisement t is posted.

The resident engineer (RE) is responsible for coordinating the efforts between the contractor and their subcontractors and ODOT personnel. This means all required project submittals, requests for information, construction problems and material substitutions will be sent through the RE, who will be the point of contact for the project. All communications made to personnel outside of ODOT should be made through the RE, unless the Traffic Structures designer has received permission to respond to questions. However, requests for information or clarification by suppliers or fabricators may be answered directly if we have received written or verbal (with attached email confirmation) permission from the contractor to deal directly with the supplier and the RE agrees. If the request involves a matter that might be a point of disagreement with the supplier and inspector or RE, the RE should be consulted before responding. Before making recommendations on problems or answering questions, consider the following:

- Review the plans for potential conflicts and consequences from problems or proposals.
- Review contract specifications and special provisions for potential conflicts, restrictions to and/or conformance of proposals.
- Discuss the problem with the Traffic Structures engineer; it may have happened before and a good solution may have already been developed.

Note: Some proposals may require concurrence from the FHWA on federal aid projects when changes to the contract are under consideration.

In all cases, the RE should be copied on all communications to keep everyone informed.

Each construction project proceeds differently. All of these steps should occur during construction, however, the order will vary from project to project. The following sections describe each portion of the construction phase and the goal of the Traffic Structures designer.

5.3.1.1 Pre-Construction Meeting

The preconstruction meeting is intended to allow communication between the contractor and the design team. At this meeting, the Traffic Structures designer should report any issues the contractor may encounter in the project. Some examples of this would be extreme slopes at the traffic structures installation site, special materials being used in the project, erection sequences using cranes, utility conflicts from changes being made after the project is let, and special foundation construction issues. We suggest providing any information that is special to the project and/or may be missed by the contractor during construction. Consider that if you make the contractor aware of special construction issues at the preconstruction meeting, it may prevent a construction problem later.

5.3.1.2 Field Survey Data

The field data provided for the project will vary. For a majority of the traffic structures, the designer will not review field survey data. The other disciplines will review the survey data to verify the design is appropriate. The seven main structures the Traffic Structures designer will review are traffic signal support, truss type, VMS sign bridge, truss type sign bridge, butterfly VMS support, camera pole, high mast illumination, and monotube cantilever sign supports. The pieces of information that you will want to check for these traffic structures are how the surveyed cross section compares to the cross section used in the design, post height, arm length (monotube), footing cover, and span width (sign bridges). The field data will probably be submitted on paper, so the Traffic Structures designer will have to transfer the data to MicroStation for comparison. There are field verification forms that can be downloaded from the Traffic Structures for truss sign bridges, truss VMS bridges, and monotube cantilevers. The new specification contains language that requires a field verification form for major sign supports. For the traffic signal support, the survey data only needs to be reviewed if the site has special soil slope conditions.

For traffic signal poles, signs, and luminaire poles, the contractor will submit cross sections with elevations for specific points on the structures for review by the Signal/Illumination designer. The difference in final grade elevation at the support post and the final grade elevation at the point of interest on the pavement should be field verified in order to account for differences in these elevations. Field verification of signal and lighting pole dimension “BL” and field verification of overhead sign support post height should be performed prior to preparation of working drawings. The field verification date shall be submitted for review along with the steel pole/steel shop drawing submittals. The post lengths for luminaire poles and signal poles are determined from the field data and should be confirmed by the Signal, Sign, Illumination, and ITS designer prior to the Traffic Structures designer’s review.

The resident engineer is responsible for making sure that the contractor performs the field verification. The resident engineer is also responsible for forwarding the completed field verification data to the appropriate designer for review. Working drawings should not be prepared until ODOT has reviewed field verification data.

5.3.1.3 Shop Drawings / Structure Fabrication

There are two types of shop drawing processes. The classification of each type is dependent upon if the shop drawing has been sealed by a registered engineer in the State of Oregon. If the shop drawings are sealed by a registered engineer, then the sealing engineer takes responsibility of the structure during and after installation. If the shop drawings have not been sealed, then the engineer that sealed the original design is responsible for the structure during and after installation.

5.3.1.3.1 Sealed Shop Drawings

Per the Oregon Standard Specifications for Construction book, Sections 00150.35 and 00962.02, all supplier or manufacturer designed signal, luminaire, and sign support drawings (including the engineer's calculations) placed on a state highway will be submitted for review and are required to be prepared, signed, and stamped with the seal of an engineer registered to practice in the State of Oregon. This requirement also includes pre-qualified drawings from manufacturers, foundation details, and calculations.

Sealed shop drawings are submitted for several different conditions. Currently, traffic structures have pre-qualified and non-pre-qualified structures. Pre-qualified structures encompass traffic signal poles and illumination poles. Pre-qualified structures have been reviewed and standard pole designs have been accepted for use. Any project can use a pre-qualified structure as long as the designer does not exceed the maximum design load criteria on the standard drawings. The Traffic Structures designer may receive a copy of the shop drawings for their records. Shop drawings for standard traffic structures with pre-qualified shop drawings do not have to be reviewed, however, the Traffic Structures designer may want to verify that correct poles and loading have been provided for the project. Nonstandard structures that reference pre-qualified structures have to be reviewed and encompass camera poles and some signal poles. Each project that includes a camera pole or nonstandard signal pole requires shop drawings to be reviewed by the Traffic Structures designer. The Traffic Structures designer should then comment on the shop drawings according to the procedure outlined in the Oregon Specification book, Section 00150.35(d)(1). Along with sealed shop drawings, calculations will be submitted from the engineer of record for shop drawings. The Traffic Structures engineer should review the calculations to make sure there is agreement that the structure has been designed to support the loads as shown on the project plans. This review should cover any horizontal and vertical members, base plates, anchor bolts, and foundations required for the structure. Shop drawing review can be one of the most time consuming portions for the Traffic Structures designer during the construction phase. As a general

guideline, for nonstandard signal pole/strain pole submittals with one re-submittal being required, it may take up to 12 hours to finish four poles. This considers checking the calculations, verifying the pole loading, checking the site conditions for slope, and verifying the information on the shop drawings to the pre-qualified shop drawings. A general guideline for sign bridge or cantilever mono-tube submittals with one re-submittal being required, it may take up to 48 hours to finish one structure. This includes checking all the dimensions on the pieces, verifying field survey data with the shop drawing dimensions, checking material grades and ASTM designations, reviewing the weld submittals and welding procedures, checking the field data against the original design cross section and verifying general compliance with the requirements per the standard drawing.

For submittals that have no comments, place a stamp on the submittal that states "accepted." When only minor notes are made on the details and the drawings do not need to be resubmitted, use the statement "accepted with comments." Critical changes that must be addressed and must be resubmitted will have a stamp placed on the submittal that states "returned for correction." An email or transmittal that includes comments about the items that do not meet the plans, specifications, standards, and ODOT manuals shall be included with the returned, unstamped document. It is extremely important to have complete stamped details in the project plans for the contractor to make a complete bid. This will also help to make sure that stamped submittals do not have to be sent in to the resident engineer. This reduces the chances of construction time delays and costly change orders.

If you have concerns, write an email to the resident engineer stating your concerns and request a re-submittal when the concerns are addressed. Concerns may be marked on the shop drawings and sent with the email to the resident engineer. Retain a copy of the email and marked shop drawings for the submittal file and discard any remaining copies. If possible, and with prior permission of the contractor and resident engineer, the checker may talk by phone directly to the supplier to resolve concerns and decrease turn-around-time.

When all concerns are satisfied, write an email to the resident engineer stating the shop drawings are acceptable for the intended use. Retain a copy of the email and shop drawings for the file and send one copy of the shop drawings to the Traffic Structures group.

5.3.1.3.2 Unsealed Shop Drawings

Unsealed shop drawings are submitted for review by the Traffic Structures designer. These drawings are intended to be fully reviewed by the Traffic Structures designer. Check the shop drawings to ensure they match the appropriate details from the project plans and standard drawings. Specifically, check the material grades, bolt diameters and bolt circle, hole diameters, plate thickness, member size, member length, camber, reinforcement bar size and placement. The Traffic Structures designer should then comment on the shop drawings according to the procedure outlined in the Oregon Specification book, Section 00150.35(d)(2). This procedure is as follows:

After checking submittals for in-house designs, mark the submittals as follows and return to the resident engineer:

- "Approved."
- "Approved As Noted."
- "Returned for Correction."

Use a stamp that indicates the date you completed the review and your name. Stamp the submittal clearly on the front page so the stamp is easily visible in the file.

For this type of review, the engineer of record is responsible for approving the shop drawings and fabrication cannot proceed until the shop drawings are provided in an approved form. Every time the shop drawing review is finished, the shop drawing must be returned to the resident engineer's office. A note should be included in the transmittal that a copy of the final approved "redlined" shop drawing should be sent to the Materials Inspection crew leader.

5.3.1.3.3 Traffic Structures without a Standard Drawing

In these cases, the standard procedure during construction is mailing the submittal for the steel poles or foundation to the Traffic Structures engineer of record for review. The structures will be reviewed and recommendations/comments provided about the structures.

5.3.1.4 Field Erection

After shop drawings have been approved by the Traffic Structures designer, the shop drawings are then returned to the resident engineer's office. The resident engineer will then send the shop drawings back to the contractor and send a courtesy copy to the ODOT Materials Inspection crew leader. It is important that the ODOT Materials group receive a copy to know that the project needs to be inspected and who is the engineer of record. See *Section 2.5.8.4* for a description of the inspection process. In the sign bridge structures and the cantilever monotube sign supports, the standard drawings provide the accepted erection procedure. The contractor has the option to alter this procedure; however, to alter the procedure, the contractor has to submit the change for review. The submittal should clearly show how the procedure will be changed and provide calculations to support that the change will not adversely affect the structure during the erection process.

5.3.2 Shop Drawing Review

5.3.2.1 General Requirements

Shop drawings are submitted electronically for approval. You can use a copy as a working drawing and use the original later for final comments and the review stamp. Once the drawings are finished, one copy is retained for the file and an email is sent to the resident engineer or the assistant. Any details that do not meet the standard drawings must be accepted by the Traffic

Structures engineer. The process to get a new detail or detail changed on a standard drawing is to submit a Request for Change to Standard Drawing form. You can find this document and instructions on the ODOT Roadway internet web page. The proposed modification is routed to the Traffic Structures group to get feedback and consensus about whether or not the detail should be changed. In many cases, a proposed change can be a substantial amount of work and current resource levels do not have the capacity to perform the work. Using this method will help ensure consistency and consensus of detail changes.

Main items to check on sign bridge and monotube cantilever shop drawings are:

1. Anchor bolt material, grade, number, bolt circle diameter.
2. Base plate material, number of holes, bolt circle diameter.
3. Number of bolts in the arm connection.
4. Angle of flange on vertical post.
5. Angle of deflection required to achieve the camber.
6. Method used to obtain camber (smooth curved members or angled end plates).
7. Resulting angle of plate on the arm that will achieve the camber angle and takes into account the vertical post flange angle.
8. Location of arm and sign bridge attachment.
9. All structural details of plates, bolts at the connections.
10. Walkway layout and clearances for VMS bridge.
11. Verify field survey data matches original roadway cross section used in design.
12. Reinforcement size, grade, location, and quantity.

Main items to check on pre-qualified signal poles and luminaire poles are:

1. Check grade elevations to see if unusual ground profiles exist at the poles.
2. Verify pole loading does not create a nonstandard pole configuration.

Main items to check on nonstandard structures (such as signal poles, camera poles, foundations, unusual sign supports) are:

1. Verify pole loadings (signals, signs on mast arm and vertical post, and luminaries).
2. Check for pole reactions that are greater than allowed from a standard foundation.
3. Check grade elevations to see if unusual ground profiles exist at the poles.
4. Review pole foundation design and check conformance to TM631 or TM653.
5. Plate size, material, number of holes.
6. Anchor bolt and connection bolt size, material, number.

Many times these structures may be located throughout a plan set (Bridge, Roadway, Illumination, etc.), so the Traffic Structures designer should do a quick visual check of the entire plan set.

Main items to check on weld submittals are:

1. Shop drawings.
    1. Weld symbols for all the welds on the contract drawings.
    2. Joint designations.
    3. Fabricator welding procedure specification identification number (WPSID).
    4. Material grades.
    5. Dimensions.
    6. Special inspection requirement.
    7. Non-tubular partial penetration welds.
        i. Effective weld size (E).
        ii. Groove depth (S) applicable for the weld.
        iii. Applicable WPSID for T-Y-K tubular connections.
2. Welding procedure specifications (See Section 2.5.8.5 for a detailed discussion).
    1. Check welding procedure specification submitted for each weld procedure specification identification number (WPSID) shown on the shop/working drawings.
    2. Weld symbols on the WPS match the weld symbols on the shop/working drawings and contract drawings.
    3. When all WPS submittal requirements have been met, the designer will forward the WPS to the appropriate welding expert who will check the WPS and return to the designer. See Section 3.5, Review of Structural Welds and Welding Procedure Specification for information on special topics in weld reviews.

5.3.3 Traffic Structures Construction Records

After every submittal is reviewed, the Traffic Structures designer should keep a copy of the submittal and transmittal in a file folder. This folder is called the Traffic Structures Submittal folder. The submittals should be kept in chronological order at the bottom of the folder. The transmittals should be kept in chronological order and placed on top of the submittals. Other documents contained in the Traffic Structures Submittal file are job pertinent emails or plan revisions that may occur during the course of the project construction support.

Send in copies of finalized shop drawings to the Traffic Structures group with any explanations summarizing problems encountered in the project. This allows Technical Services to be aware of design issues and keep the standard drawings updated and accurate.

5.3.4 Communication with the Outside

After the project is awarded to a prime contractor, requests for additional information may be submitted for clarification of the project plans, specifications or general questions. The requests for information should be sent to the resident engineer (RE). The Construction resident engineer will then forward requests for information to the appropriate person. If a request for information is not made through the RE, the request should be redirected to the RE so they are kept informed of all information concerning the project.

In some instances, the RE may request that the Traffic Structures designer field the questions directly from the contractor. You should only pursue this procedure if the RE approves of the change and this change will help the project timeline. When the requests are sent directly to the Traffic Structures designer, you have to assume additional responsibilities. Any communication made with the contractor shall be documented and a courtesy email shall be sent to the RE's office. Before any decision is made, the Traffic Structures designer should discuss the situation with the RE. Since the RE is responsible for overseeing the construction progress and inspection, the RE needs to be informed of all changes that are made.

5.3.5 Special Topics in the Construction Phase

The construction phase can be a very challenging part of the overall project. Commonly, issues will arise during construction requiring immediate attention. Many times construction crews are sent home and construction delays can be attributed to a response that is not provided within a reasonable time. Requests for assistance should be given high priority and a timely response. In all issues, especially nonstandard issues, contact the Traffic Structures engineer for acceptance and consultation. The Traffic Structures group is interested in all issues that occur during a project so we can stay aware of common problems that may be occurring. In addition, the issue may have already been solved in a previous project and could be used again as a solution. Construction assistance may include some or all of the following:

- Cost data reports.
- Structure inventory sheets.
- Checking shop drawings.
- Review of temporary construction drawings.
- Review of deviations from the standard drawings.
- Interpretation of plans and specifications.
- Resolving conflicts in the plans.

- Providing recommendations on construction problems.
- Field trips to resolve construction problems.
- Field trips to review construction.
- Review of price agreements.
- Review contract change orders.
- Review of contractor proposals for resolving construction problems.
- Review of contractor value engineering proposals.
- Preparation and archiving of calculation books.

5.3.5.1 Traffic Signal Poles

Traffic signal poles can have project shop drawing submittals with or without pre-qualified drawings. If pre-qualified drawings have been reviewed by the Traffic Standards group to verify that the details satisfy the requirements shown on the standard drawings, then this information does not need to be reviewed again as long as each drawing number and revision matches the project special provisions.

5.3.5.1.1 Signal Pole Shop Drawing Reviews with Pre-qualified Drawings

Project signal shop drawing submittals that use pre-qualified drawings do not need to be reviewed by a designer with a structural emphasis. The Signal engineer of record will perform the review for the project.

5.3.5.1.2 Signal Pole Shop Drawing Reviews without Pre-qualified Drawings

Project signal shop drawing submittals that do not have pre-qualified drawings, according to the project special provisions, must be reviewed by a designer with a structural emphasis to check the details shown are according to the contract plans and specifications. Details not shown in the contract plans and specifications require stamped calculations. The Signal engineer of record will perform the general review for the project and verify all the information is there before forwarding the signal shop drawing submittal to the structural designer. The following are items to perform during the structural signal pole shop drawing submittal process:

1. The signal shop drawings and calculations must be stamped by a professional engineer licensed in the State of Oregon.
2. The signal shop drawings must be submitted separately from the luminaire shop drawings in accordance with the bid items used on the project.

3. Obtain the project plan drawings and make sure that there are no conflicts for the signal pole details to determine what pole types must be used. The following are some conflicts that have been found on previous projects:
    a. Mast arm and luminaire arm lengths.
    b. Handhole orientations.
    c. Pole types.
4. Conflicts in the plans require the Signal engineer of record to give direction about the correct details to use.
5. The manufacturer's last approved shop drawings are typically used as a reference. The project and reference shop drawings are printed and all items on the project drawings are checked and highlighted to make sure the information is correct and has not changed. Manufacturers have made small changes from one project to the next that can be difficult to find.
6. Check the terminal cabinets, handholes, and hubs orientation and elevation.
7. Answer any questions or comments on the shop drawings from the manufacturer. In many cases, the questions are a result of a conflict in the plans that require a clarification.
8. Poles that have been independently analyzed before do not need to be run again, but poles that have not been run require an independent analysis to check the poles, plates, and bolts to verify they are structurally adequate.
9. Check the connection bolt lengths to make sure that there is enough thread that the nut does not bottom out on the shank and that there is enough threads past the end of the nut after tightening.
10. Check the pipe weld to the bolt washer physical fit.
11. Check the bolt physical fit at the top and bottom of the mast arm connection plates on the pole side to make sure that the bolt washers do not hit the gusset and ring stiffener welds. The flange plate is angled and results in an acute angle on the bottom that reduces the clearances for the bolt to be inserted and for tools to tighten the bolt.
12. The electronic drawings and calculations are marked up with the redline comments and a review stamp is placed on the drawings in accordance with Specifications Section 00150.35 and calculations. An email is sent to the Signal engineer of record with the reviewed files attached and a summary of the comments. This email summary adds additional information to the redline comments to help clarify the issues.
13. The signal pole field verification forms on the Construction Forms website for the super structure and the foundation must be completed. This is usually performed by the signal designer, construction office and contractor.

5.3.5.2 Cantilever Monotubes

Cantilever monotube sign supports are custom designed structures at each installation. The standard drawing has 10 different standard designs that fit to each installation site. Some issues that may arise during the construction phase of a cantilever monotube sign support are the following:

- Contractor's survey cross section does not match the plan cross section.
- The cantilever was fabricated differently than the standard drawing.
- The reinforcement cage does not match the reinforcement as shown in the standard drawing.

Reviewing these items is time consuming, so the Traffic Structures designer should allocate enough time to completely check for any discrepancies. Fabrication issues are one of the more difficult issues to resolve.

If the construction issue is that the survey cross section does not match the plan cross section, then the situation has more flexibility. You can still make changes to the project, if necessary. The contractor's cross section may differ from the survey data in the design base map. First, make sure the cross section was taken at the location used in the design of the traffic structure. If the cross section was not taken at the correct location, you should direct the contractor to the appropriate location for a new cross section. If the cross section was taken at the correct location and it still does not match the cross section in the plans, then further investigation is required. The Traffic Structures designer needs to understand that the base map is constructed from a collection of survey points. The survey points are connected together to generate a three dimensional base map that can be used to create cross sections for the project. So each cross section is an interpolation between survey data. The contractor's survey data is the actual data collected from the structure's position in the project. The Traffic Structures designer can expect a slight discrepancy between the two cross sections and verify the structure will continue to meet the standard drawings. In the case where the field cross section is considerably different from the cross section on the certified drawings in the plans and the structure no longer meets the standard drawing, then the Traffic Structures designer should notify the resident engineer's office. The resident engineer, contractor, sign designer, and Traffic Structures designer will determine a solution about how to correct the issue.

5.3.5.3 Truss Sign Bridges and Truss VMS Bridges

Truss type variable message sign bridges have had a number of problems associated with the construction of the end posts, the galvanizing process and substitution for steel due to material composition. These issues required extensive meetings to reach a consensus about how the issues should be handled. Contact the Traffic Structures engineer for a complete explanation of the issues and the solution to each issue.

Another issue that has occurred was a contractor using the incorrect anchor bolt circle template. In one case, the shop drawings were redrawn to use a smaller tube size (per the standard drawing) so additional space could be provided for a smaller anchor bolt circle. In another case, the anchor bolt circle was larger than required so new calculations were performed to check the increased Moment arm between the tube wall and the anchor bolt.

5.3.5.3.1 Truss Bridge Shop Drawing Reviews

The shop drawings for these structures must be thoroughly reviewed by the engineer of record to make sure that all of the details shown on the standard drawing are used by the manufacturer. It is the responsibility of the engineer to make sure the correct details as shown on the standard drawings are used, because these details are based on many years of refinement that have been tested through successful project installations. Proposed detail modifications must be made to the drawing through a Standard Drawing Revision request that can be downloaded from the internet. This request will allow a review by a committee of technical people from the regions, Technical Services, and consultants to investigate the detail and whether or not it will be an improvement from the one currently shown on the drawing.

It is important to make sure that all diagonals are concentric so the forces from the chords and the diagonals pass as close as possible through the working point. The standard drawings and most of the shop drawings are two dimensional, so it can be difficult to see if these diagonals are concentric. At the field splice location; there are two of the four joints that will have the diagonals pointing to it. There will be the top or bottom face diagonal, the front or back diagonal, and an interior diagonal between the flanges (many times called the paddle). This issue also occurs at the horizontal to vertical end truss joints. Two of the four joints will have a top or bottom face diagonal, a front or back diagonal, and one diagonal from the vertical end truss.

5.3.5.4 Triangular base and Multi-Post Breakaway

Breakaway structures are special due to the crash testing that is associated with the device. The triangular base breakaway (TBB) and the multi-post breakaway (MPB) have loading criteria that have to be met. The first criterion is the allowable wind force acting on the structure. Each standard has an associated design that allows different post sizes according to the size of sign being used at the installation. The second criterion is the breakaway action of the special base plate configuration. The most common issue that occurs for these types of structures is that the base plate is not oriented in the correct fashion to match the standard drawing. To correct this, the accepted solution is to remove and replace the installation. Another common issue that occurs is the sign structure is installed on a steep slope.

5.3.5.5 Camera Poles

Camera poles have been used for several years and the design has become well defined. The few issues that have developed for these structures concern the top tenon plate and the

handhole. The camera manufacturer changed how the camera slip joint attaches to the pole, so the top tenon plate had to be increased to match the new connection. The handhole size has come under scrutiny because the Maintenance crews were having difficulty using the old style of handhole (two smaller handholes aligned vertically over each other). The camera pole manufacturer has proposed using one larger handhole in place of the two smaller handholes. We retained David Evans & Associates to perform a finite element analysis of a pole with the larger handhole and write a report summarizing the results. Based on the report finding, the Traffic Structures group accepted the use of the large handhole as long as the combined stress ratio at the location of the handhole does not exceed 0.60. Typically, the camera poles are controlled by the 1" deflection requirement to limit camera shake under service loads. Contact the Traffic Structures engineer for details and requirements to include on a drawing. Use Special Provision 00965 for the camera pole projects.

5.3.5.6 Highmast

There is a guideline that states not to use highmast illumination poles in current projects. In some instances, a project may replace an existing highmast pole and then becomes an exception to the guideline. The old ODOT Standard Drawings for Highmast Poles have been removed because it is not used frequently enough to be considered a standard. In addition, a structural designer needs to be involved to assign structure numbers, perform a foundation design, and provide stamped plans and specifications.

Traffic structures have encountered very few issues with highmast poles, mainly due to the lack of use of this type of structure. The first issue is reusing an existing highmast pole. In this case, the intent was to relocate an existing highmast pole. To perform this move, the highmast pole has to be disassembled for relocation and then a new foundation with the correct anchor bolt circle has to be placed. We have encountered problems with the slip connection on the highmast poles. Due to the repetitive temperature movements, the slip joint can seize and the highmast pole cannot be disassembled. The Traffic Structures group has determined it is unacceptable to cut the highmast pole at the joint and then weld the pieces back together once the pole has been lowered. Another issue is the anchor bolt circle has to be placed correctly to fit the base plate. This will take considerable coordination between the field crew and the foundation contractor. The last issue concerns new poles used to replace old poles. In the pole analysis calculations, the engineer needs to demonstrate the handhole rim will increase the area of the cross section to 120% of the original cross section. In addition to the 120% of the area, the handhole rim needs to maintain the section properties of the original area. This means the new area needs to equal 120% of the old area and the moment of inertia, section modulus, polar moment of inertia, and radius of gyration all need to be at least equal to the original values.

5.3.5.7 Illumination Poles

Illumination poles are currently a pre-qualified structure. The Illumination designer will typically callout the location and height to luminaire on the project documents. Once the

submittal is sent in for review, the Illumination designer will verify the submitted poles match the field data. The Traffic Structures group has encountered very few problems with the illumination review process. Typically, the illumination poles remain with the requirements of the standard drawing and the review process can be completed in a quick manner.

One situation that Traffic Structures has encountered in relation to illumination poles, outside of the standard drawing, are luminaire poles supported upon a bridge rail. In this instance, the base reactions have to be checked against the reactions for the illumination poles. Each instance can be different and you have to work with the Bridge engineer to determine how conduct the base reaction review. Another challenge for illumination poles are the slip base luminaire poles installed on slopes. In many instances, if the luminaire pole is installed on a slope, then the base should probably be fixed, however, luminaire poles are usually specified to have a slip base. The slope can adversely affect the slip mechanism during a crash event and it may not be possible to install the foundation per the standard drawing. In addition, the slope can provide less support at the top and the foundation may need to be increased from the depth shown on the standard drawing.

5.3.5.8 General Steel Items

There are a small number of issues with steel used in traffic structures that may surface during a project. This section discusses some of the specific issues that have been addressed and provides the Traffic Structures recommendation, when appropriate.

5.3.5.8.1 Carbon Equivalency

The carbon equivalency is important to steel structures because the percentage of carbon equivalency (based upon the silicon content of the steel) will determine how susceptible the steel is to embrittlement during the hot-dip galvanizing process. In the case of the ODOT project, Biggs Variable Message Sign, an end truss was hot-dip galvanized to meet the requirements of the standard drawing. When the end truss was removed from the zinc bath, the strut that connects the tops of the tubes for the end post had pulled out of the tube wall. After further investigation, ODOT decided to limit the carbon equivalency, silicon content, and tin content to very specific ranges and changed the steel detailing for the top and bottom struts for the end posted to bolted connections. These limitations were implemented to avoid cold cracking. Refer to Annex XI of the AWS D1.1 for additional discussions on this issue. Over the last few years, ODOT has not had another failure in the galvanizing tank. The carbon equivalency requirement was added only to truss bridges as a direct result of failures of end posts in the galvanizing tanks.

The lack of issues in the galvanizing tank has led to changing the wording in the note section of the Truss Bridge Standard Drawings. The note used to state “The maximum carbon equivalent (CE) is 0.40% for the base metal. Use the AWS D1.1 CE formula. Tin content of the galvanizing shall not exceed 0.18%.” This note has been revised to state “The maximum carbon equivalent (CE) is 0.40% for the base metal. Use the AWS D1.1 CE formula. Preheat according to AWS D1.5

Annex VIII using the hydrogen control method and high degree of restraint when the carbon equivalent (CE) of the steel exceeds 0.40%." This revised statement notifies the manufacturers that they must follow CE requirements for truss bridges, but it allows for a quicker turnaround time under construction.

5.3.5.8.2 Hot-Dip Galvanizing

The purpose of hot-dip galvanizing is to coat a piece of steel with a covering of molten metal (of which a large percentage of the composition is zinc) in order to protect the steel from corrosion due to environmental conditions. The process of hot-dip galvanizing is controlled by ASTM Specifications ASTM A 123 & A 153. This process is performed by dipping a piece of steel (i.e., a signal mast arm) into a series of tanks that clean the steel, prepare the surface of the steel, and finally coat the steel in molten zinc. The zinc coating protects the steel from corrosion by sealing the surface so the steel does not come into contact with oxygen and moisture. In the event that the zinc coating becomes damaged, then the coating surrounding the damaged area will corrode and protect the steel. More information and a demonstration video are available from the American Galvanizers Association website.

5.3.5.8.3 Touch-Up Galvanizing

Touch-up galvanizing is intended to repair a small section of a hot-dip galvanizing that has become damaged (i.e., the zinc from the hot-dip galvanizing process has been removed from the surface of the steel). The repair is achieved by resealing the steel surface to protect the structure from the environment. Touch-up galvanizing is controlled by ASTM Specification A 780. The galvanizing can be repaired by three different methods. These methods are hot stick, zinc paint, and zinc spray. Hot stick repair is achieved by applying a new coat of zinc to the steel by heating a zinc rod or powder with a low melting point over the damaged area. The steel being repaired must be heated to a temperature of 600 degrees prior to application of the new zinc. The heat bonds the zinc rod or powder to the steel surface. Hot stick repair is the most time-intensive repair. Zinc paint repair applies a thick layer of zinc rich primer over the damaged area. Zinc paint does not use heat to bond the paint to the steel surface; the seal is achieved by the paint drying on the steel structure and creates a Band-Aid over the damage. Zinc paint is faster than hot stick repair and slower than zinc spray. The last repair method, zinc spray, covers the damaged area with a thin layer of zinc paint that is discharged from a pressurized metal spray can. The repair method is the same as the zinc paint. Zinc spray is the fastest repair method of the three.

In general, touch-up galvanizing is not accepted for new structures being installed on projects. Traffic Structures has decided that for new projects, structures should be provided to the site without damage to the galvanizing. If the galvanizing is extensively damaged, the structure should be stripped of the galvanization and hot-dip galvanized again. The process of stripping and re-galvanizing will add time and cost to the project. The amount of time and cost will depend upon the schedule of the galvanizing facility. There are circumstances where the use of touch-up galvanizing is acceptable. Each case has to be handled individually and the

circumstances and severity of the repair have to be considered. You must submit a request for information (RFI) to the Resident Engineer to request acceptance of the proposed procedure. The RFI must include the project name, contract number, how the damage occurred, the extent of the galvanizing damage, what type of galvanizing repair method will be used, and any time or background issues that may affect the project.

5.3.5.8.4 Material Lab Inspectors

The Materials Lab group has a crew of inspectors that are responsible for inspecting steel components for sign bridges, butterfly supports, and cantilever monotubes. Every project that includes overhead signing or butterfly supports will require inspection from ODOT personnel. A Portland Inspection crew leader is responsible for inspecting all fabricated overhead signing or butterfly supports. After the Traffic Structures designer is finished reviewing the shop drawings, they should ask the resident engineer's office to send a courtesy copy of the shop drawing to the Portland Inspection crew leader. The courtesy copy should include all the Traffic Structures designer's comments (redlines) and a copy of each round of review should go the Materials Inspection crew leader. Once the shop drawing is approved by the Traffic Structures designer, the Inspection crew leader will assign someone to visit the fabrication shop during the manufacturing of the structural support.

The inspector usually visits a fabrication shop several times during a project. During the inspection, the inspector will verify the critical member dimensions and lengths (end posts, bridge spans, and member sizes). If any discrepancies have occurred between the approved shop drawings and the fabricated structure, the inspector will notify the resident engineer. The resident engineer will then contact the engineer of record to discuss possible solutions to the problem. Any changes made to a traffic structure that deviate from the standard drawings require approval from the Traffic Structures engineer. Submit copies of all proposals for approval prior to fabrication.

The Traffic Structures group has developed a document that helps the Traffic Structures designer to check the fabricated horizontal sign bridge to the field data from the footing placement. This document is titled "Sign Bridge Horizontal Span Inspection Sheet." In this sheet, the inspector is instructed to measure the centerline distance between the outside holes of the horizontal bridge on all four chords. This allows the Traffic Structures designer to verify the four chord spans are within tolerance to place the bridge and verify the span distance between the sign bridge footings will allow the bridge to be placed.

5.3.5.8.5 Review of Welds and Welding Procedure Specifications

The Traffic Structures designer must ensure that the welds shown on the shop drawings are in accordance with the standard drawing or custom detail. Welds that are different from those shown on the standard drawing must be sent in to the Traffic Structures group for review. In many cases, the type of weld has been specified to accommodate fatigue design requirements from the AASHTO code.

Weld Designations on Submittals

When shop drawings for a particular portion of the project are submitted for a review, the submittal includes weld designations that will be used to construct the traffic structure. As the Traffic Structures reviewer, you should look for several specific items. These items are outlined in the list below:

1. Verify the weld symbol in the standard drawing, pre-qualified or nonstandard project drawing matches the weld symbol in the shop drawing. Look for the type of weld (Fillet, V-Groove, etc.,), weld size, all around designation, grinding designations, weld length, weld spacing and weld angle.
2. If the weld symbol is different and the company has provided a reasonable explanation why the weld change was required, review the weld stress calculations for adequacy. Verify the correct yield stress was used and the shear flow has been calculated correctly at the weld location.
3. If the weld symbol is different and the company has not provided a reasonable explanation why the weld was changed, then change the shop drawing to reflect the correct weld symbol and return the submittal.

Welding Procedure Specification Review

For each weld designation submitted in the shop drawings, a welding procedure specification (WPS) will be submitted for review. The WPS outlines the details for each weld used in the fabrication of a structure. Due to the special nature of the WPS, it should be sent to the Bridge Section's welding expert for review. Some manufacturers have already sent in WPS's for review and those submittals can be checked quickly against the approved sets.

5.3.5.9 General Concrete Items

5.3.5.9.1 Commercial Grade Concrete vs. Bridge Concrete

Two types of concrete can be used on traffic structures. The first type is commercial grade concrete (CGC). Commercial grade concrete is also referred to as 440 concrete. This concrete is controlled by the Specification Section 440. Commercial grade concrete is specifically used for all traffic structure footings and is classified as a structural item for both sign bridge structures, cantilever monotubes, and butterfly sign supports. The specific qualities of CGC concrete are as follows:

- The minimum compressive strength is limited to 3000 psi (as modified by the Special Provisions for Specification Section 440).
- The Quality Control technician (QCT) collects samples before pumping and performs testing.

The second type is bridge concrete. Bridge concrete is also referred to as 540 concrete or structural concrete. This concrete is controlled by the Specification Section 540. Bridge concrete is not typically used for traffic structures. The specific qualities of bridge concrete are as follows:

- The minimum class to use is 3600 psi (as modified by the Special Provisions for Specification Section 540), unless specified otherwise.
- According to the ODOT Manual for Testing Procedures (MFTP).

The main differences between commercial grade concrete and structural concrete are the quality control testing and the concrete placement guidelines. Structural concrete placement guidelines are very stringent about the placement of concrete and how the concrete material is tested. Section 540 of the Specifications defines what the QCT and Concrete Control Technician (CCT) have to test, the construction tolerances, how the concrete can be transported, and limitations for handling and placing the concrete. Section 440 of the Specifications only defines general guidelines for testing and placing concrete.

5.3.5.9.2 Manuals for Construction Testing

The Nonfield-tested Materials Acceptance Guide and Manual of Field Test Procedures are documents that can be downloaded from the ODOT website. It documents quality control procedures to follow for non-field tested and field tested materials.

The following is an example of signal pole quality control using the Nonfield-tested Materials Acceptance Guide. The specification 00962.10 requires to furnish steel pole material meeting the requirements of 02530 and 2530.80 states "Acceptance of steel poles will be according to 165.35." In 165.35 there are requirements for a Test Results Certificate, Quality Compliance Certificate and Certificate of Origin of Steel Materials. The table in the Nonfield-tested Materials Acceptance Guide gives a listing under Section 00962 of T, Q, and O. These designations are the same quality control items that are required in the specification.

The following is an example of 00440 concrete quality control for field tested materials. Section 4(D) of the manual has a table that shows the requirements for field testing 00440 commercial grade concrete. The requirements list the material and operation, description, test method, form, and quality assurance. The tests that are performed are sampling air content slump, concrete temperature, and strength. These requirements are not specifically listed in Section 440 of the specification, but are required under 00440.15 that requires quality control according to Section 00165. Section 00165.10 requires field tested materials will be accepted according to the ODOT Manual of Field Test Procedures.

5.3.5.9.3 Concrete Compressive Strength

The minimum compressive strength for concrete can be interpreted as four different values between the standard drawings and the Standard Specifications book. In the standard drawings, minimum compressive strengths are called out as 3600 psi, and 3000 psi. The English

Standard Specifications 00440 and 00540 require compressive strengths of 3300 psi. The Special Provisions for 00440 and 00540 require compressive strengths of 3000 psi and 3600 psi. The four compressive strengths that are specified are 2900 psi, 3000 psi, 3300 psi, and 3600 psi. This section will discuss which structures should use which compressive strength.

The current standard of practice for contract documents is specified in Section 00150.10(a). Discrepancies between documents will be resolved with contract change orders taking highest precedence, then Special Provisions, agency prepared drawings specifically applicable to the project and bearing the project title, reviewed and accepted stamped working drawings, standard drawings, approved unstamped working drawings, supplemental specifications, standard specifications and all other contract documents not listed. A note on a drawing shall take precedence over drawing details.

The first category addresses structures that specify the use of commercial grade concrete with a compressive strength of 3000 psi. These structures include Multi-post Breakaway Sign Supports (TM600), Triangular Base Breakaway Sign Supports (TM602), 90 deg Rotational Sign Support (TM605), Standard VMS Bridge (TM607), Standard Sign Bridge (TM15), Standard Cantilever Monotube (TM623), Luminaire Poles (TM629), Signal Poles (TM650), Butterfly Sign Supports (Nonstandard), and Camera Poles (Nonstandard). Multi-post and triangular base breakaway sign supports specify, "All concrete shall be commercial grade concrete (f'c=3000 psi)." The current Standard Specification for 440 concrete states under Section 440.12, Bullet 4, "Compressive strength – unless otherwise noted, CGC shall attain a 28-day compressive strength of at least 3300 psi." The Special Provisions for 00440 alter the compressive strength to 3000 psi, however, the "unless otherwise noted" language remains in the specification. Under this set of information, the concrete used on the breakaway sign supports should have a compressive strength of 3000 psi. Luminaire, signal, and camera poles specify, "Footing concrete shall be commercial grade concrete (f'c=3000 psi) unless shown otherwise in the Special Provisions." As stated earlier, the Special Provisions require 3000 psi concrete; however, in this case the standard drawing and Special Provisions specify the same compressive strength.

The second category addresses structures that specify the use of bridge concrete. Structures that use bridge concrete specify classes of concrete. The class corresponds to the compressive strength of the concrete. Bridge concrete also requires extra testing. That testing is explained in the Field Test Procedure Manual. Traffic structures typically do not require bridge concrete.

5.3.5.9.4 Low Strength Cast-In-Place Members

For commercial grade concrete with 28-day compressive strengths below 100% of specified compressive strength, it will have to be evaluated for structural adequacy. Section 440 of the specifications discusses in detail how low strength concrete should be handled. In general, the resident engineer should contact the Traffic Structures designer and the Traffic Structures engineer to verify if the low strength concrete will be acceptable. If members are found to be adequate, then the concrete can be accepted at a reduced price that is determined by the resident engineer.

By comparison, for 540 Bridge Concrete any strengths below 100% of specified strength, the resident engineer will approve the structural adequacy. The designer will review each case and will send a written recommendation to the resident engineer to remove or leave the concrete in place. If members are found to be adequate, then the concrete will be accepted at a reduced price. For a detailed discussion of low strength bridge concrete, refer to Section 540.17(c)(4).

5.3.5.9.5 Concrete Placement

Concrete placed for a traffic structure is specified by Special Provision Section 440.40 (b) or 540.48(a). The Special Provision adds a sentence to the 440.40 (b) Specification to say, "For sign supports, signal supports, and luminaire supports, place concrete according to 00540.48(a)." The two main points for placing concrete per 540.48 (a) is (1.) the placement should be made as close as possible to the final position and (2.) placing concrete that requires dropping more than 5 feet shall use a tremie. These two conditions ensure that during concrete placement, the aggregate will not segregate from the concrete mix. If the concrete mixture does segregate, then the compressive strength may not be achieved and the foundation may possibly need to be rejected.

5.3.5.10 General Wood Items

ODOT uses temporary wood strain poles and wood posts, but these topics were not finished at the time this manual was released.

5.3.5.11 General Products

5.3.5.11.1 Accepted Products for Traffic Engineering and Operations Section

The Traffic Engineering and Operations Section have created three lists of qualified products that can be used for traffic signal installations on state highways. The first list is referred to as the Blue Sheets. The Blue Sheets are reserved for items that are outside of the controller cabinet. The Green Sheets are reserved for items that are used in the controller cabinet, including the cabinet itself. The Red Sheets are reserved for products that have been given exempt status concerning the requirement of being UL of NRTL listed products. For a detailed discussion of the Blue, Green, and Red Sheets refer to the ODOT Traffic Signal Design Manual.

5.3.5.11.2 Qualified Products List

The Structure Services Unit is responsible for evaluating various products to determine if they meet ODOT's Specifications for use on construction projects. The results are published semi-annually in the Qualified Products List or QPL. The QPL is a comprehensive listing of all finished products found to be acceptable by ODOT for use with specific categories in roadway construction and maintenance. Additional information and the list of products can be searched at the following QPL website.

Any proprietary product that is used on a project must be approved by the Structure Services Unit. If the Traffic Structures designer encounters a new product during a project that the contractor wants to use, any information pertaining to the new product must be sent to the Traffic Structures engineer for review. Once the Traffic Structures engineer accepts the new product, the Structure Services Unit will be notified of the request for testing samples. See Appendix F for a general description of the product review process through Structure Services Unit.

The QPL includes many different products, however, the list shown below includes the specific items that pertain to traffic structures:

- Admixtures for concrete.
- Portland cement.
- Coating for rebar splices.
- Coating for epoxy coated rebar.
- Concrete anchors, mechanical & resin.
- Concrete modifier: Fly ash & silica fume.
- Non-shrink grout.
- Rebar manufacturers.
- Rebar slice, mechanical.
- Square tube sign supports.

Most of the products listed above are not accounted for in the standard drawings and, if they are used in a project, have to be approved by the Traffic Structures engineer. The items that do not have to be approved are admixtures, Portland cement, non-shrink grout and rebar manufacturers, as long as the product is listed on the QPL.

5.4 Drafting

5.4.1 General

The Traffic Structures group was moved from the Bridge Section to the Traffic Roadway Section (TRS) in 2002. During this transition, ODOT decided that the Traffic border would be used for all projects that contained Traffic Structure designs except for those attached to bridges. In 2006, the ITS group moved from the Traffic Roadway Section to the Maintenance and Operations Branch (MOB) and therefore began assigning MOB drawing numbers instead of TRS drawing numbers for plan sheets with ITS traffic structures. The Traffic and MOB borders use an 11-in. x 17-in. border instead of a full size 32-in. x 22-in. border.

A Signal, Sign, Illumination, ITS, or Temporary Traffic Control designer sends design requests. Once the specific group is identified, the border will be according to that group's standard practice and will use a drawing number associated with that group. The TRS or MOB drawing number will be located on the left top side of title block and it is generated from the Traffic Standards & Asset Management Unit or the ITS Unit. It is recommended that the structural designer obtain the TRS or MOB drawing number from the designer at the same time that the other TRS or MOB drawing numbers are assigned to ensure that the TRS or MOB drawing numbers are in sequential order in the plans. Placing the Traffic structures support drawings with the associated traffic drawings eliminates searching the often voluminous bridge drawing section of the plans.

Traffic Structures that are mounted on a bridge will use the Bridge standards and procedures for creating the plan drawings. These structures are considered to be part of the bridge structure that it is attached to and will have the same structure number as the bridge structure number and will have a structural work number listed under the bridge structure.

5.4.1.1 Location Map

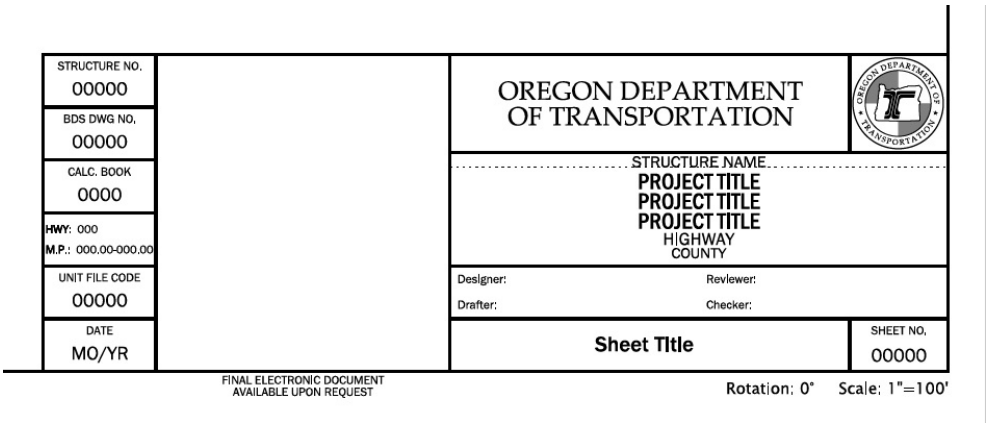
Using a project location map in the upper right hand corner of the site-specific Traffic Structures drawing increases the risk that it will not match the Roadway and Signing drawings and is best not to include it on the plan drawings. In addition, the location map takes up space on the drawing that is needed when multiple structures are specified on one drawing. Finally, when multiple traffic structures are shown on one drawing, adding a location map that covers each location can be difficult to accomplish and unclear.

5.4.2 Borders and Title Blocks

The border will be according to the Signal, Sign, Illumination, ITS, or Temporary Traffic Control guidelines.

The title block shown in Figure 3 represents a project plans sample. This is where additional changes will be required to make the border fit the specific group format. Enter the structure No., BDS DWG. No., CALC Book, and structure name as needed.

Figure 5.4.2-1: Traffic Structures Title Block Modifications



The bridge DWG. No., structure No., and structure name can be obtained from the regional Bridge drafter. Please see the CALC Books section in this manual for where to obtain a CALC Book number. It is important to have these three items listed on the drawing when providing a major sign structure like truss sign bridges, monotube cantilevers, or butterflies. The bridge drawing number, structure number, and structure name are used to track, inspect, create reports, and search for these structures in the future.

It is standard practice to have either the stamping engineer or the designer working under the direction of the stamping engineer, specified in the "Designed by Name" location. In addition, the person who checks the work is placed in the "Reviewed by Name" location and the drafter specified in the "Drawn by Name" location. Reviewing a design is not the same as checking a design, so "Reviewed by" can be changed to "Checked by."

Traffic does not place a location map on the top right of the drawings. At the top right corner there can be up to three lines. The top line will be the type of support. The second line will be the intersection, if applicable. The third line will be the highway name and the mile point. The sheet heading font style can be found under the signal text styles dropdown list. You can add a location map if you prefer under the description lines.

5.4.3 Fonts and Line Styles

In general, the text and lines should follow the same standards that are used by the Bridge Section. The Bridge drafting standard will be used for everything besides the information listed in this chapter. Reference the Bridge Design and Drafting Manual for additional information.

5.4.4 Sheet Title

The sheet title will be according to the Contract Plans Manual for the Signal, Sign, Illumination, ITS, or Temporary Traffic Control series that applies.

5.4.4.1 Geotechnical Data Sheet

Place Geotechnical data sheets for Traffic Structures according to the Geo, Hydro and Environmental CAD Standards Manual.

5.4.5 As Constructed Drawings

The *As-Constructed Plan Technical Services Bulletin TSB08-01(B)* has an effective date of 06/01/2008, and its purpose is to establish a uniform and consistent process for preparing and distributing as-constructed plans. The Technical Bulletin requires that the *Contract Plan Development Guide and the Construction Manual* be updated to reflect the guidance in the *TSB08-01(B)* bulletin.

The Mylars for Traffic Structures drawings are specific to the Illumination, Signing, Signals, or ITS group and will have the drawing number for this group in the title block. The resident engineer's office will assemble the project as-constructed plans and send them to the region Technical Center after a project is complete. A designer that is interested in reviewing the redlines that were made on the as-constructed drawing during construction to ensure that they are correct must contact the region Technical Center to coordinate the review. After the review process, the as-constructed plan drawing set for the project is sent to the ODOT Maps and Plans Center and distributed to the specific Traffic or ITS group with which the original Mylar was archived. The Traffic or ITS as-constructed drawings are scanned for FileNet and the drawing is stored with the original Mylar.

Local agency projects on the state highway must send as-constructed drawings to the local agency liaison for distribution. Permit projects on the state highway must send as-constructed drawings to the permit specialist for distribution.

Appendix 5A – Project Checklist

Project Name:

PCS Key Number:

Highway Number:

Milepost:

Designer:

Preliminary Plans: Date:

- Find out types of structures used on the project from the designer. See Section 1.4.1.
- Find location of structures used on the project from the designer. See Section 1.4.1.
- Request cross sections from the roadway designer at each location. See Section 1.4.1.
- Request a Geotechnical Report at each location. See Section 1.4.1.
- Receive cross sections.
- Receive Geotechnical Reports.
- Draft each structure on the border and reference the cross sections provided by Roadway.
    - Check vertical clearances of the sign and structure over the roadway.
    - Check the horizontal clearances between the structure and the roadway.
    - Verify structures fall within the standard drawings for each structure type.
    - Notify region Motor Carrier liaison of new vertical clearances approval.
- Calculate cost estimate for structures. See Section 1.4.1.
- Place calculations in calculation book. See Section 1.6.4.
- Attend Preliminary Plans meeting. See Section 1.4.1.

Advanced Plans: Date:

- Receive and incorporate Preliminary Plans meeting and comments. See Section 1.4.2.
- Update cost estimate from Preliminary Plans meeting comments.
- Download the latest copy of the special provisions. See Section 1.6.2.
- Modify special provisions to match the project requirements.

- Send advanced plans, updated cost estimates, and special provisions to Specifications writer.
- Add any additional calculations to the calculation book.
- Attend advanced plans meeting. See Section 1.4.2.

Finals Plans: Date:

- Receive and incorporate advanced plans meeting comments. See Section 1.4.3.
- Update cost estimate from advanced plans meeting comments.
- Verify special provisions from advanced plans meeting comments.
- Send a final copy of documents (plans, specs, cost estimates) to the Specification writer.
- Attend Plans in Hand meeting if necessary. See Section 1.4.3.
- Finish project documentation after project has been released for bid. See Section 1.5.

Bid Let: Date:

6 Tunnels (structural elements)

C 6

Tunnels as defined by the *AASHTO Technical Committee for Tunnels (T-20),* are enclosed roadways with vehicle access that is restricted to portals regardless of type of structure or method of construction. Tunnels do not include enclosed roadway created by highway bridges, railroad bridges or other bridges.

Design tunnels according to *AASHTO LRFD Road Tunnel Design and Construction Specifications*.

Tunnels are intended for transportation or utility passage (vehicles, rail, pedestrians, utilities) and requires special operational features like ventilation, lighting, fire/life safety, or egress.

7 Sound walls, General

Design sound walls according to the guidelines provided in *LRFD Section 15*, and *ODOT Geotechnical Design Manual, Section 16.6*.

Investigate the soil condition specific to the sound wall site and include in the Geotechnical Report.
The design and detailing requirements for sound walls on bridges and retaining walls adjacent to the traveling public are different than the ones away from the traveling public. The failure of these sound walls is a safety hazard for the traveling public.

ODOT currently has three standard designs for sound walls which are designed in accordance with *AASHTO Guide Specifications for Structural Design of Sound Barriers, 1989*. The three standard sound wall designs are:

- Standard Reinforced Concrete Masonry Sound Wall Details; *BR730*
- Standard Precast Concrete Panel Sound Wall Details; *BR740*
- Standard Masonry Sound Wall on Pile Footing; *BR750 & BR751*

C 7

It is recommended that this be taken care of early in the project's development.

7.1 Sound walls mounted on Bridges

Do not locate sound walls on bridge structures where feasible alternative locations exist.

Where feasible alternative locations do not exist and sound walls must be located on bridges, limit the total height, as measured from the top of bridge deck to the top of the sound wall, to 8 feet.

Only crash tested sound walls are allowed on bridges.

On bridges where the sound wall does not meet crash test requirements of MASH Test Level 4, place sound walls a minimum of 4 feet beyond the gutter line of an ODOT approved standard bridge railing.

C 7.1

Sound walls on bridge structures cause a disproportionate increase in bridge cost because of strengthening the deck overhang and exterior girder. These structures may increase the risk to traffic below during seismic events or in case of vehicular impact. In addition, sound walls on bridges interfere with normal maintenance inspection access.

The 8 foot height limit is per the crash tested result and how the cargo truck interacts with the wall and barrier: NCHRP Report 350 Evaluation of the T501 Bridge Rail with Sound wall (tamu.edu). There is no crash tested result to support sound walls taller than 8 feet.

In lieu of crash-testing, design sound walls for vehicular collision forces according to *LRFD Section 15.8.4*.

Sound walls may be combined with the traffic railing as long as the structural system meets the crash test requirements of MASH Test Level 4 criteria.

8 Utilities

8.1 General

Permanently relocate utilities in advance of the project, when feasible.

When there is a utility relocation or modification on a project, utility design is to be provided by the utility owner. When utility work is included in an ODOT Contract, the utility owner is responsible for supplying plans, specifications, estimates, and calculations conforming to the documented requirements.

On new construction, the State provides the concrete inserts in the deck for hangers, holes through diaphragms, crossbeams and endwalls, and pipes under the approach slabs. When a utility owner requests additional conduits in a sidewalk or concrete rail, special attachment brackets, inspection walkways, etc., it is the expense of the utility owner.

The State and utility owners within project limits need an agreement before their utility work can be included in the project. The Utility & Railroad Coordinator in the Right of Way section coordinates such agreements.

Include a minimum of two future 3 inch trade size conduits on new NHS bridges for Agency Communication Infrastructure. Determine the outside diameter of conduits for sizing holes through diaphragms, crossbeams, endwalls, and pipes under approach slabs.

C 8.1

When utilities are not relocated in advance of the project, it is preferred for the work to happen as part of the construction contract, installed by the contractor.

This avoids often difficult coordination between the Contractor and utility owner. This also avoids the need for the utility owner to conduct work after the contract is complete, which often requires performing repairs of the constructed facility like patching newly placed roadways and bridge elements.

This is regarded as providing minimal accommodation which essentially has zero or negligible cost (**de minimis**, or below the threshold of actually costing the program) compared to not providing these items, and is acceptable per an opinion from the Oregon Department of Justice. All other costs for materials and labor related to the utility installation are the responsibility of the utility company.

In 2022, ODOT was required by state and federal rules to have a Broadband program. Installation of conduits for future telecommunication needs are a critical part of supporting the Broadband program.

Trade size is per the National Electrical Code (NEC) for use with electrical work. Inside and outside dimensions can vary based on material types. Rigid metallic, HDPE, PVC, and others have different inside and outside dimensions. However, they all have the same trade sizes.

For bridges inside incorporated city limits or in metropolitan planning areas, provide for future needs with two 12 inch diameter holes on each side of the bridge in addition to the specific utility requirements.

This applies to all bridges, including those carrying the freeway. While ODOT policy typically does not permit longitudinal installations of utilities within freeway right of way, there is an FHWA hardship exception process that could result in future installations.

8.2 Special Utility Considerations

C 8.2

GENERAL REQUIREMENTS

Install wire line type crossings, such as fiber optic line, in conduit.

Provide transverse supports for utility lines as required.

Provide expansion fittings at each expansion joint or install on rollers as allowed by applicable safety codes.

ELECTRICAL LINES

Provide appropriate bonding jumpers across expansion fittings for electrical installations.

See *NEC 250.98*.

High voltage power distributions lines greater than 22,000 volts are not allowed.

In extraordinary circumstances where alternate crossings are not practical, high voltage lines can be considered. Additional cost to the utility will not be considered reason enough to place power lines on bridges.

Lines with 600 volts or less are allowed.

Line with voltage greater than 600 volts but less than 22,000 volts will be evaluated on a case-by-case basis.

Provide adequate shielding for electric power distribution lines.	This is to eliminate adverse effects of electromagnetic fields on radio signals, fuel injection systems, reinforcing and structural steel, and maintenance personnel.
Provide adequate circuit protection. Locate disconnects within 1000 feet of the utility's first anchorage to the bridge.	This is to reduce the risk of electric shock hazards and allow for disconnection of the line upon request from ODOT.
Conduit embedded in concrete is to be Sch. 80 PVC (preferred) or stainless steel.	Other embedded steel conduit is not allowed due to corrosion concerns. Where possible, PVC conduit is preferred to reduce the potential for damaging lines when pulling them through. See *NEC 334.15(B)*. Galvanized embedded conduit is not permitted due to dissimilar materials.
Hot-dip galvanize external steel conduit.	

GAS LINES

The following language applies to gas lines or other lines carrying volatile materials.	
Provide Sch. 40 steel pipe or approved equal. Install automatic shut-off valves at or near each end of the bridge.	
Case lines full length of enclosed or box type bridges. Vent casings to the outside of the bridge at each end and at high points.	
Protect lines that are accessible from ground from damage, both accidental and intentional.	Protection could include barrier and fencing with locked access.
Have gas line corrosion protection systems reviewed by the Bridge Section Preservation Unit. See *BDM 2.14.10.*	

WATER LINES AND SEWER LINES

Case segments of lines whose failure could undermine the bridge footing(s) or be an environmental hazard.	

Lines are to be hot-dip galvanized steel, ductile iron pipe, or approved equal.

HDPE pipe can be considered approved equal when the following conditions are met:

- When wrapped for UV protection, or when the pipe is encased (i.e., not exposed to UV or corrosive environment) and
- When the pipe is adequately supported.

Corrosion protection systems for utilities may include cathodic protection, except when attaching to steel structures.

Provide transverse supports near each coupling for lines and line thrust blocks as required.

In enclosed or box type bridges, make provisions for a line failure. Provide drain holes or grating at low points in the cells. Provide low pressure sensing shut-off valves or fully encase the line to minimize leakage inside the bridge girders.

8.3 Utility Location on Bridges

C 8.3

Locate the utility installation to avoid the following:

- Adverse effect on the appearance of the bridge.
- Restriction to inspectability and maintainability of the bridge.
- The risk of potential vehicle impacts when the bridge spans another roadway or railroad crossing.
- Modification of structural members.

On structures over freeways, locate the bottom of utility line a minimum of 18 feet above the roadway surface.

Do not hang from cross-frames, diaphragms, or main beams. Suspend utility lines from the deck.

Install the utility between girders or in the sidewalk or rail when applicable. Locate the utility as close as possible to the exterior of the bridge to allow access by snooper crane, when no other access is provided.	This may not be possible when staging of the bridge is not compatible. See *BDM 1.2.10* for safety and accessibility guidance.
Provide sufficient space around utilities for maintenance activities.	Maintenance activities include cleaning and repainting steel members.
Do not extend utilities and supports below the bottom of the superstructure, except when transitioning to a buried utility. Place transitions only at bents or abutments.	
When the utility is placed on the outside of the rail or exterior girder on stream crossings, place it on the downstream side of the bridge.	This is to minimize the chance of damage from floating debris.
Do not hang utilities against the sides of decks that have no curb. When required to put utilities on the side, provide spacers from the deck so they do not trap debris.	
Avoid exterior mounted utilities in snow and ice areas, as defined in *BDM 1.2.4.3*.	
Do not place utilities below the outfall of bridge drainage.	
Avoid attaching utilities to timber elements.	Many timber elements require replacement during the bridge's life.
Avoid going through end bents with a history of approach settlement.	This is common on shallow end bents without approach slabs. Excavation may increase settlement, settlement may cause the utility to shear, or the utility may get in the way of installing sheet pile or approach slabs in the future.

8.4 Design and Detailing Guidelines

C 8.4

EARLY DESIGN TASKS

As an early design task, determine:

- Requirements for carrying existing and future utilities on bridges.
- Requirements for accommodating utilities in the vicinity of other structures (i.e. box culverts, sound walls, retaining walls, or especially mechanically stabilized earth (MSE) walls).

See *OSDM 8.1*.

During the site visit, identify any utilities present on, or in the vicinity of, the bridge.

Document utility decisions in the DCSA.

Coordinate with the Utility Specialist to determine project utility needs and location as early as possible in the design process. See *BDM 2.14.10*.

GENERAL CONSIDERATIONS

When the proposed utility weighs more than 90 pounds per linear foot or causes modification of a structural member, the utility company will be required to provide a load rating of the bridge per *BDM 1.3.2.2*.

The load rating will have the utility loading superimposed onto the bridge, so that it can be determined whether the bridge has sufficient loading carrying capacity for the installation of the utility. When available, provide a set of bridge plans for load rating use. All plans must be field verified, because not all As-Constructed bridge plans are accurate. See *BDM 2.10.8* and the *LRFR manual* for additional information.

Use existing utility accommodations located on the bridge, when possible.

REQUIREMENTS FOR ATTACHMENT TO BRIDGE

The following requirements apply to both new and existing bridges.

Design utility attachments to the currently accepted *AASHTO LRFD Bridge Design Specifications* as modified by this manual. Design utility lines in accordance to the governing industry standard for the type of installation.

Design utility installations so that a failure will not:

- Result in damage to the bridge.
- Be a hazard to traffic.
- Endanger the public.

Design individual members and the entire bridge for all loads imposed by the utility.

Utility attachments may exert large forces at the point of connection. Consider loads or movements that might be imposed on the utility by the bridge, such as from temperature, wind, or earthquake movements.

Restrain the utility line to prevent the line hitting bridge structural members. Use longitudinal **and** transverse supports or anchorages as needed.

Space utility supports for future utilities as follows:

- 2 feet minimum from abutment face.
- 8 foot maximum on center parallel to the utility line for Agency Communication Infrastructure.
- 10 foot maximum on center parallel to the utility line for other utilities.

Specify hot-dip galvanized steel utility supports, including fasteners and anchorages.

ATTACHMENT ANCHORING DESIGN GUIDELINES

Post-Installed Anchors

Follow the design requirements of *BDM 1.5.11.2*.

Design attachments that use a single anchor at each attachment point to remain serviceable if one of the other nearest attachments were to fail.

Mechanical anchors may be used when the following considerations are satisfied:

- Anchors are of a type that will maintain capacity under dynamic or vibratory type loads.
- Provide at least two anchors at 1.33 capacity-to-demand per attachment for redundancy, or design attachments with a single anchor to provide a capacity-to-demand ratio of 2.0.

Review as-constructed plans and locate post-installed anchors to avoid conflicts with existing reinforcement.

Refer to *SP 00535, 00589* for additional information.

Cast-In Anchors

In the absence of specific instructions from the utility company, provide hot-dip galvanized expanded coil cast-in anchors with closed-back ferrule, threaded for rods or bolts installed in a new bridge deck.

When design of utility attachment using cast-in anchors is required, follow *BDM 1.5.11.3.*

ATTACHMENT DETAILING GUIDELINES

Locate holes in transverse members centered in the bay between the first interior and the exterior girders except for side-by-side girders.

Maintain the alignment of utility holes as straight as possible, both vertically and horizontally, to avoid difficulties in placing utility pipes.

Consider construction tolerances and variables in the design of brackets and hangers. Incorporate slotted holes, adjustable rod lengths, etc. into the attachment design.

Where utility holes are provided in the ends of the bridges for future utilities, form each hole with a pipe sleeve made of galvanized smooth steel pipe (1/4 inch min. thickness), or PVC pipe (Sch. 40 min.) of the same inside diameter as the utility hole.

When an approach slab is required, place a pipe through the sleeve to a point 5 feet minimum beyond the end of the approach slab, parallel to the centerline of the bridge. From the end of the pipe extension, angle the pipe at a 45 degree angle until the pipe is outside the shoulder.

Form a hole 1 inch larger in diameter than the pipe into the backwall or end beam. After the pipe is installed, fill the void around the pipe with a compressible material.

See *BDM A1.11.2.9-1*.

Utility holes and pipes under approach slabs may need to be a larger diameter to accommodate joint splices, couplers, or bells at connections.

For side-by-side girders provide for future utilities through the end wall closure pours with one of the following options:

- Capped 8 inch diameter blockouts.
- Embedding a 6 inch diameter PVC pipe in the wall and extending it 8 to 10 feet beyond the bridge bent.

Limit the number and size of conduits in the bridge rail to assure ease of placement and proper consolidation of the concrete, and function of the bridge rail.

See *BDM Appendix Figure A1.11.2.9-1*.

For side-by-side girders with CIP concrete decks, a space between two adjacent girders may be provided to allow for placement of a utility line.

Give special attention to details at expansion joint couplings because these tend to be much larger in diameter than the conduit.

UTILITY LABELING

Utilities are to be labeled at each approach or first anchorage to the bridge and every 200 feet according to *American Public Works Association (APWA)* standards with color code and owner, contact information, etc. Adjust spacing to include one label in each bay bounded by beams and diaphragms.

See *SP 00589* for additional requirements.

8.5 Items for Design Submittal or Permit Review

C 8.5

Requests for attachments to bridges are submitted by Utility Companies to District. District makes the final decision on the permit application in consideration of comments and recommendations by the RBLE.

Refer to *BDM 2.14.10* for roles and responsibilities and information.

Coordinate with District to ensure the utility permit includes requirements that the utility company will:

- Perform routine maintenance to the utility installation to ensure it remains in serviceable condition.
- Promptly respond and repair failing utilities.
- Remove utility apparatuses when no longer in service.

Maintenance access will not be allowed from the freeway for bridges carrying freeways or bridges carrying highways over freeways.

- Provide utility plans and calculations stamped by an Engineer that is registered in the State of Oregon. Include the following in the submittal:
- Vertical, lateral, and longitudinal loading, as appropriate.
- Maximum and operating pressures for pressurized systems.
- Waterline thrust blocks.
- Loadings to be carried by the bridge and their location.
- Calculations for attachment connections or brackets.
- Details of the pipe, casing, vents, and shut-off valves.
- Utility hanger details.
- Utility labeling.
- Maintenance.
- access plan.

Maintenance access plan should limit traffic impact for all classes of bridges.

9 Miscellaneous Other Structures

C 9

This section will define standards for miscellaneous other structures as they are developed.

Examples of miscellaneous other structures could include non-bridge headwalls, non-bridge wingwalls, cutoff walls, concrete lined channels, culvert invert paving, concrete energy dissipators, mail supports; cattle guards; road closed gates, vaults or manholes.

Appendix A – Abbreviations (Initialisms and Acronyms)

A

A&E	Architectural and Engineering
AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials (since 1973)
ABC	Accelerated Bridge Construction
AC	Asphalt Concrete
ACI	American Concrete Institute
ACP	Asphalt Concrete Pavement
ACT	Area Commission on Transportation
ACWS	Asphalt concrete wearing surface
ADA	Americans with Disabilities Act
ADT	Average daily traffic (see Definitions)
ADTT	Average Daily Truck Traffic
AEE	Association of Engineering Employees
AHP	Analytic Hierarchy Process
AISC	American Institute of Steel Construction
a.k.a.	Also known as
ANSI	American National Standards Institute
API	Area of Potential Impact
APJ	Asphaltic Plug Joint
APM	Area Project Manager Agency Project Manager
APWA	American Public Works Association
AREA	American Railway Engineering Association
AREMA	Manual for Railway Engineering of the American Railway Engineering and Maintenance-of-way Association
ARS	Accident Records System (Accident Data Unit, Transportation Research Section)
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society

B

B-Team	Team of Bridge Engineering Section Supervisors & Engineers
BART	Biological Activity Reaction Test
BCM	Bridge CAD Manual
BDC	Bridge Design Coordinator
BDM	Bridge Design Manual
BDS	Bridge Design System (AASHTO software)
BDS	Bridge Data System (ODOT software)
BDWO	Bridge Design Work Order
BLT	Bridge Leadership Team
BMDM	Bridge Maintenance Design Manual
BMP	Best Management Practice
BNSF	Burlington Northern Sante Fe Railroad
BPR	Bureau of Public Roads (now FHWA)
BR	Bridge
BRASS	Bridge Rating and Analysis of Structural Systems (software)
Brg.	Bearing
BRSFUP	Bridge Rail Safety Features Upgrade Program
Bt.	Bent

C

C	Degrees Celsius Compression
CAD	Computer-aided drafting
CAFL	Constant Amplitude Fatigue Limit
CalTrans	California Department of Transportation
CBC	Conventional Bridge Construction
CBR	Major Steel Bridges
CF	Cubic feet
CFRP	Carbon Fiber Reinforced Polymer
CFS	Cubic Feet per Second
CG	Center of Gravity
CICS	Customer Information and Control System (Transportation inventory and Mapping Unit software on the mainframe)
CIP	Cast-in-place

CL	Centerline
	Clear
CMP	Construction Mitigation Plan
	Construction Management Plan
	Corrugated metal pipe
CMR	Change Management Request
CPM	Critical Path Method (method of scheduling)
	Consultant Project Manager
CQCR	Comments, Questions, Concerns and Requests
CQP	Consultant Quality Plan
CSL	Crosshole Sonic Log
CSZE	Cascadia Subduction Zone Earthquake
CTP	Continuous Trip Permit
Ctr.	Center
CUP	Conditional Use Permit
CWI	Certified Welding Inspector
CY	Cubic yard

D

D	Depth
DAP	Design Acceptance Plans
DAW	Design Acceptance Workshop
DBE	Disadvantaged Business Enterprises
DCSA	Bridge Design Criteria and Standards Assessment
DD	Bridge Design Deviation
DE	Design Exception
Dia.	Diameter
DIS	Dynamic Isolation System, Inc.
DL	Dead load
DOS	Disk Operating System for personal computers
DOT	Department of Transportation
DQP	Design Quality Plan

E

E&C	Engineering and Contingencies (used in cost estimates)

EAC	Emulsified Asphalt Concrete
EB	Eastbound
El.	Elevation
Elev.	Elevation
EOR	Engineer of Record
ESR	Evaluation Service Report
Extg.	Existing

F

F	Degrees Fahrenheit
FEMA	Federal Emergency Management Agency
FF	Far face (don't use for "fill face")
FFO	Full Federal Oversight
FHWA	Federal Highway Administration (formerly BPR)
FRP	Fiber Reinforced Polymer
ft-k	foot-kips
ft-lbs	foot-pounds
FWS	Future Wearing Surface

G

Galv.	Galvanized
GDM	Geotechnical Design Manual
GFRP	Glass Fiber Reinforced Polymer
GIS	Geographic Information System
GPR	Ground Penetrating Radar
GR	Grade
GSD	AASHTO Guide Specifications for Seismic Design
GTR	Geotechnical Report

H

HDM	Highway Design Manual
HM	Hydraulics Manual
HPC	High Performance Concrete
HPS	High Performance Steel
HQ	Headquarters

I

IBC	International Building Code
IC	Internal Curing
ID	Inside diameter Identification
IGA	Inter-Governmental Agreement
ISA	Internal Shear Anchor
ITS	Intelligent Transportation Systems

J

Jt.	Joint

K

k	Kilo, one thousand
K	Kip (kilopound, 1000 pounds)
kg	Kilogram, metric mass unit
km	Kilometer (1000 meters)
kN	KiloNewton, metric force unit
KSF	Kips per Square Foot
KSI	Kips per Square Inch

L

LAG	Local Agency Guidelines
Lbs	Pounds
LF	Linear feet
LL	Live load
LMC	Latex Modified Concrete
LPA	Local Public Agency
LRFD	Load Resistance Factor Design
LRFD	*AASHTO LRFD Bridge Design Specifications*
L.S.	Lump Sum

M

m	Meter, metric length unit
	Milli, one thousandth
M	Mega, one million
MASH	Manual for Assessing Safety Hardware
Max.	Maximum
MBJS	Modular Bridge Joint System
MBM	Major Bridge Maintenance
MC	Microsilica concrete
	Miscellaneous Channels
MCTD	Motor Carrier Transportation Division
Min.	Minimum
MP	Milepoint, milepost (even milepoint)
MPCO	Multi-Layer Polymer Concrete Overlay
MOT	Maintenance of Traffic
MSC	Minor structure concrete
MSCS	Management Scheduling Control System (to replace PCS)
MSE	Mechanically Stabilized Earth (retaining walls)
MT	Magnetic Particle

N

N	Newton, metric force unit
NACE	National Association of Corrosion Engineers
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standards
NCHRP	National Cooperative Highway Research Program (from the Transportation Research Board)
NDE	Non-destructive Evaluation
NDT	Non-destructive Testing
NEPA	National Environmental Protection Act of 1969
NHI	National Highway Institute
NHS	National Highway System
NLF	No Load Fit
NRST	Nonredundant Steel Members
NSBA	National Steel Bridge Alliance
NSM	Near Surface Mount
NTS	Not to Scale

O

OC	On Center (center-to-center)
OD	Outside Diameter
ODOT	Oregon Department of Transportation
ODLAP	ODOT Delivery of Local Agency Projects
OHWM	Ordinary High Water Mark
ORS	Oregon Revised Statutes
OSHA	Occupational Safety and Health Administration (U.S.)

P

Pa	Pascal, metric stress or pressure unit
PA	Price Agreement
PCC	Portland Cement Concrete
	Point on compound curve
PCF	Pounds per Cubic Foot
PCI	Prestressed Concrete Institute
PCS	Project Control System (to be replaced by MSCS)
PD	Project Delivery
PDG	Project Delivery Guide
PDLT	Project Delivery Leadership Team
PE	Professional Engineer (registered)
PFSJ	Precompressed Foam Silicone Joint
PL	Project Leader
	Plate
PM	Project Manager
POR	Professional of Record
PPC	Premixed Polymer Concrete
	Precast Prestressed Concrete
PQR	Pre-Qualification Request
	Public Relations
P/S	Prestressed Concrete
PS&E	Plans, Specifications & Estimate
PSBS	Project Specifications Bid System
PSDC	Project Specific Design Criteria

PSF	Pounds per Square Foot Precast Spread Footing
PSI	Pounds per Square Inch
P/T	Post-tensioned concrete
PVC	Polyvinyl chloride
PWS	Present Wearing Surface

Q

QA	Quality Assurance
QC	Quality Control
QPL	Qualified Products Listing

R

R	Radius
R, 1R	Resurfacing
R/W	Right of Way
RBI	Region Bridge Inspector
RBLE	Regional Bridge Lead Engineer
RCBC	Reinforced Concrete Box Culvert
RCDG	Reinforced Concrete Deck Girder
Rdwy.	Roadway
RE-CP	Resident Engineer – Consultant Projects
RFI	Request for Information
RFP	Request for Proposals
RR	Railroad
RRR, 3R	Resurfacing, Restoration and Rehabilitation
RRRR, 4R	Resurfacing, Restoration, Rehabilitation and Reconstruction
RT	Radiographic

S

SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy of Users of 2005
SDC	Seismic Design Category
SDCL	Simple for Dead and Continuous for Live Load
SDLF	Steel Dead Load Fit

SF	Square feet
SFC	Silica Fume Concrete
SFLMC	Silica Fume Latex-Modified Concrete
SHPO	State Historic Preservation Office
SIDL	Superimposed Dead Load
Sl.	Slope
SOW	Statement of Work
SP	*ODOT Construction Specifications*
Spcg.	Spacing
Spcs.	Spaces
SPMT	Self-Propelled Modular Transporters
SPT	Standard Penetration Test for soils
SR	Sufficiency Rating
Std.	Standard
STIP	State Transportation Improvement Program
STP	Single Trip Permit
STRUDL	Structural Design Language
SY	Square Yard

T

T&E	Threatened and Endangered
TCP	Traffic Control Plan
TcP	Time cost per person
TDLF	Total Dead Load Fit
TiAB	Titanium Alloy Bars
TIP	Thermal Integrity Profile
TL	Test Level
TP&DT	Temporary Protection and Direction of Traffic
TPAR	Temporary Pedestrian Accessible Routes
TPM	Transportation Project Manager
TS&L	Type, Size and Location (formerly called preliminary)
TSF	Tons per Square Foot (don't use)
Typ.	Typical

U

UBIT	Under Bridge Inspection Truck
UHPC	Ultra High Performance Concrete
UPRR	Union Pacific Railroad
USCG	United States Coast Guard
USGS	United States Geological Survey
UST	Underground Storage Tank
UT	Ultrasonic

V

Var.	Varies
VE	Value Engineering

W

WOC	Work Order Contract
WPS	Welding Procedure Specifications
WS	Wearing surface
WSDOT	Washington State Department of Transportation
WSC	Wire Strand Core (cables)
Wt.	Weight

X

Y

Z

Appendix B – Revision History

Table AB-1: Revision Log

Revision Date	Description	By
10/2026	First Publication	E. Clyburn