

**SECTION 6: STEEL STRUCTURES**

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## 6.1 SCOPE

This section contains guidelines to supplement provisions of Section 6 of the AASHTO LRFD Bridge Design Specifications for the analysis and design of steel components, splices and connections for beam and girder structures, frames, trusses and arches, as applicable. Metal deck systems in relation to steel stay-in-place formwork are covered in Section 9 of these guidelines.

Minimum vertical clearance for a bridge should be established based on future roadway configuration. For bridges spanning over railroads, minimum vertical clearance shall be based on the most recent railroad grade separation guidelines.

Design level load ratings of all bridges shall be performed per MBE (The Manual for Bridge Evaluation) latest edition. For new bridges the design Operating Load Rating (using HL93 live load) shall be 1.8 or more, unless approved by ADOT Bridge Group for bridges with specific circumstances. For widening of bridges the minimum design Operating Load Rating (using HL93 live load) shall be the Operating Load Rating (using HL93 live load) of the existing bridge or 1.5, whichever is greater. Coordination and approval from ADOT Bridge Group will be required in instances where these provisions cannot be met, for widening of existing bridges.

## 6.4 MATERIALS

### 6.4.1 Structural Steels

Structural steel shall conform to the requirements specified in AASHTO LRFD Table 6.4.1-1, with the selection based on strength, serviceability and overall economy. All structural steels shall be ASTM A709 Grade 50 or 50W (AASHTO M270 Grade 50 or 50W).

ASTM A709 Grade 36 (AASHTO M270 Grade 36) steel may be used for miscellaneous applications, such as, anchor bolts, expansion joints, rods etc. All miscellaneous steel hardware exposed to weathering action shall be galvanized.

### 6.4.3 Bolts, Nuts and Washers

All structural fasteners shall be high-strength bolts, ASTM A325 (AASHTO M164). Type 1 bolts should be used with steels other than weathering steel. Type 3 bolts conforming to either ASTM A325 (AASHTO M164) or ASTM A490 (AASHTO M253) may be used with weathering steel. All washers, nuts, and bolts shall be galvanized. Type 1 bolts may be either hot-dip galvanized in accordance with ASTM A153 (AASHTO M232) Class C or mechanically galvanized in accordance with ASTM B695 (AASHTO M298) Class 50 with prior approval from ADOT Bridge Group.

### 6.4.7 Stainless Steel

The specifications of stainless steel material and their applications are listed in AASHTO LRFD Article 6.4.7. Stainless steel plate for use as a flat mating surface shall conform to AASHTO LRFD Article 14.7 as well as Section 14 of these guidelines.

#### 6.4.8 Cables

Cables restrainers used to restrain a bridge under seismic loads shall conform to 3/4-inch diameter preformed, 6 x 19, wire strand core or independent wire rope core (IWRC). Cables shall be galvanized in accordance with the requirements in Federal Specification RR-W-410D and Right Regular Lay manufactured of improved plow steel with a minimum breaking strength of 42,000 pounds.

## **6.6 FATIGUE AND FRACTURE CONSIDERATIONS**

### 6.6.1 Fatigue

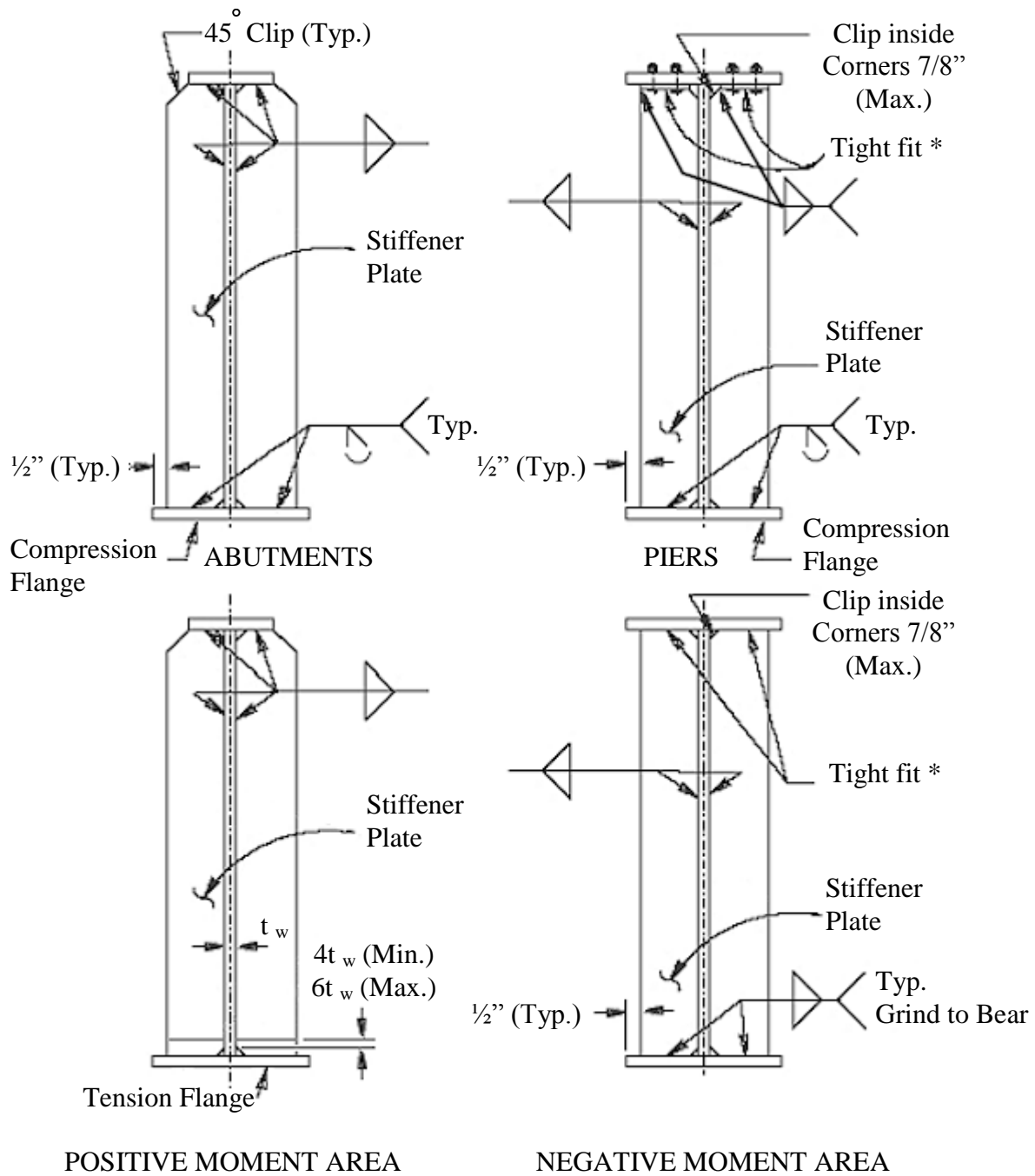
#### 6.6.1.2 Load-Induced Fatigue

Structural members including splices, stiffeners, bracings, shear connectors, and fasteners, subjected to stress reversal due to applied live loads shall be designed, to limit stress due to fatigue, using welding detail categories A through C (refer to AASHTO LRFD Table 6.6.1.2.3-1). Welding detail category D and E shall not be used.

#### 6.6.1.3 Distortion-Induced Fatigue

Transverse connection plates shall be connected to both the compression and tension flanges as stated in AASHTO LRFD Article 6.6.1.3.1. Structural bolts shall be used for plate connections to the tension flange. The following stiffener connection details should be followed.

FIGURE 1 – STIFFENER PLATE DETAILS



\* See AASHTO LRFD Articles 6.6.1.3.1 and 6.10.11.1.1 for additional requirements.

### 6.6.2 Fracture

For Charpy V-notch testing, temperature zone levels shall be determined by the elevation of the structure location. The Charpy V-notch impact requirements for structural steel shall be for Temperature Zone 1 at elevations less than 6,000 feet and Temperature Zone 2 at elevations 6,000 feet and higher.

## 6.7 GENERAL DIMENSION AND DETAILING REQUIREMENTS

### 6.7.2 Dead Load Camber

Steel structures shall be cambered during fabrication to compensate for non-composite and composite dead load deflections, and for vertical profile. Non-composite loads include weight of steel members and deck slab. Composite loads include weight of barrier, median, sidewalk etc. The future wearing surface shall not be included in the camber calculation. Camber information shall be provided on structural plans.

### 6.7.3 Minimum Thickness of Steel

Minimum thickness of steel shall conform to AASHTO LRFD 6.7.3 with the following exceptions:

- Structural steel including bracing, cross-frames, gusset plates, closed ribs in orthotropic decks, and fillers, shall not be less than 3/8-inch in thickness. The web thickness of rolled shape sections are exempted.
- Welded plate girder webs and flanges shall be sized in 1/8-inch increments. Webs shall not be less than 1/2-inch in thickness.

### 6.7.4 Diaphragms and Cross-Frames

Rolled beams and plate girders shall be provided with cross-frames or diaphragms at each support and with intermediate cross-frames or diaphragms placed in all bays, at intervals not to exceed 25-feet. Other design criteria and provisions for diaphragm and cross-frames shall conform to AASHTO LRFD Article 6.7.4. Flexibility of the bracing system should be evaluated to assure ductility of the diaphragms and cross frames. The stiffener plates, which also serve as connection plates, shall be placed parallel to the skew, for skew less than or equal to 20 degrees. Stiffener plates shall be placed normal to the web for skew greater than 20 degrees. Transverse intermediate stiffeners that are not connection plates shall be placed normal to the web.

## **6.10 I-SECTION FLEXURAL MEMBERS**

### 6.10.1 General

#### 6.10.1.3 Hybrid Sections

Hybrid I-Section members shall not be used without the prior approval of ADOT Bridge Group.

#### 6.10.10 Shear Connectors

Welded stud shear connectors shall be used and shall conform to AASHTO LRFD Article 6.4.4. Welded stud shear connectors shall be installed in the field to improve the safety of construction personnel. Channel shear connectors shall not be used.

#### 6.10.11 Stiffeners

##### 6.10.11.1 Transverse Intermediate Stiffeners

For exterior girders, transverse stiffeners shall be placed on the inside face only. Refer to Figure - 1 Stiffener Plate Details in Article 6.6.1.3 of these guidelines for detailing requirements.

##### 6.10.11.2 Bearing Stiffeners

Each stiffener plate shall be attached to the compression flange by full penetration groove welds. Refer to Figure - 1 Stiffener Plate Details shown in Article 6.6.1.3 of these guidelines for detailing requirements.

##### 6.10.11.3 Longitudinal Stiffeners

Longitudinal stiffeners shall not be used without prior approval of ADOT Bridge Group. Webs shall be sized to eliminate the need for longitudinal stiffeners.

#### 6.10.12 Cover Plates

##### 6.10.12.1 General

Welded cover plates shall be a minimum 1/2-inch narrower than the flange to which they are attached in order to accommodate a 1/4-inch fillet weld. Welded cover plates wider than the flange can contribute to a reduction in fatigue strength and shall not be used. Cover plate ends shall not be welded.

## **6.11 BOX SECTION FLEXURAL MEMBERS**

Selection of these members requires ADOT Bridge Group approval.

## **6.13 CONNECTIONS AND SPLICES**

### **6.13.3 Welded Connections**

#### **6.13.3.1 General**

In addition to AASHTO LRFD Article 6.13.3, all welding except for stud shear connectors shall be performed in the fabrication shop. With the exception of retrofit or repair work, no welding shall be performed in the field without prior approval of ADOT Bridge Group.

Provisions in AASHTO/AWS D1.5M/D1.5 Bridge Welding Code shall be followed to ensure appropriate information is provided in the contract documents to facilitate proper fabrication and quality control.