CHAPTER 2
DESIGN DATA

2-1 Variations from Current AASHTO Standard Specifications and Interims

Article 3.3 Dead Load

For all bridge floors, except those on movable spans, the design dead load shall include an additional 20 lbs/ft^2 (1.0 kN/m^2) for future bituminous wearing surface. For movable spans and other unusual type spans, use 8 lbs/ft^2 (0.4 kN/m^2) for future wearing surface.

Article 3.5 Overload Provisions

Disregard the overload provisions for working stress design.

Article 3.7 Highway Loads

For all highways regardless of truck traffic, the minimum live load shall be the HS20 (MS18). See Section 2-2.

For all HS20 (MS18) loads, include a special loading consisting of 2 axles only, spaced 4'-0" (1.2 m) apart with 24,000 lbs (107 kN) on each axle. See Figure 2-1. This special loading controls for simple spans 37 feet (11.3 m) and less. The HS20 (MS18) ~~(HS20)~~ controls for simple spans in excess of 37 feet (11.3 m). See Figure 2-2. For continuous spans, the special loading should be investigated for spans up to 40 feet (12.2 m). Design for this special loading if resulting stresses are greater than those for HS20 (MS18) loading. The distribution factor for the fraction of wheel load to any stringer is to be the same as used for present specification loads. The lane loading remains the same as for the HS20 (MS18) loading.

Article 3.23 Distribution of Loads to Stringers, Longitudinal Beams, and Floor Beams

For superstructure design, disregard the 25% allowable stress increase in outside stringers under sidewalks. For substructure design, calculate reactions using simple beam distribution for loads in all positions. Keep the truck within its design traffic lane. For width of design traffic lane, see Figure 2-3.

For exterior beams and stringers located at the gutter line or beneath the curb, distribute the live load according to the AASHTO Standard Specifications.

Design the exterior beams and stringers to have at least as much capacity as interior beams and stringers.

Article 3.25.1

Distribution of Wheel Loads on Timber Flooring: Transverse Flooring

Normal to the direction of span for plank floor distribution = 12" (305 mm), instead of "width of plank".

Article 4.5.15

Driven Piles: Spacing, Clearances, and Embedment

12 inch (305 mm) prestressed concrete piles shall not be spaced less than 2'-9" (840 mm) center to center in footings. In general, embed pile heads into concrete as follows:

Embedment - Type of Pile
(Dimension to be measured at centerline of pile)

Type of Structure	Timber	Steel HP	Steel Pipe	12" (305 mm) (~~12"~~) Prestressed Concrete	Prestressed Concrete Larger Than 12" (305 mm) (~~12"~~)
Abuts. & Ret. Walls	9" (230 mm)	9" (230 mm)	12" (300 mm)	9" (230 mm)	12" (300 mm)
End Bent & Bent Caps	12" (300 mm)	12" (300 mm)	12" (300 mm)	12" (300 mm)	12" (300 mm)
Pile Footings	9" (230 mm)	9" (230 mm)	12" (300 mm)	9" (230 mm)	12" (300 mm)

NOTE: Special cases, including Seismic Performance Category B or vessel impact analyses, may require more embedment.

Article 4.6.6.2.2

Drilled Shafts: Splices

Splices of longitudinal reinforcing steel in drilled piers do not need to be staggered, and may occur in the same horizontal plane. However, minimum reinforcement spacing must be maintained.

Article 4.6.6.2.5

Drilled Shafts: Reinforcement and Reinforcement Cover

Reinforcement and reinforcement cover for drilled piers shall be as described in Section 7-7.

Articles 8.15.5.7 and 8.16.6.7

Special Provisions for Slabs of Box Culverts

- Service Load Design - Shear stress v_c shall be computed by AASHTO Equation 8-14, but v_c need not be taken less than $0.95\sqrt{f'_c}$ $(0.08\sqrt{f'_c})$ for single cell or multicell box culverts.
- Load Factor Design - Shear strength V_c shall be computed by AASHTO Equation 8-59, but V_c need not be taken less than $2\sqrt{f'_c}\,bd$ $(0.017\sqrt{f'_c}\,bd)$ for single cell or multicell box culverts.

Article 8.17.2.1.3

Distribution of Reinforcement Steel: Flexural Tension Reinforcement

The maximum spacing requirements of d/6 shall not apply to caps of end bents or multi-column piers.

Article 9.15.2.1

Allowable Stresses: Temporary Stresses Before Losses Due to Creep and Shrinkage

Tension in other areas,

- For girders and cored slabs: 200 psi (1.4 MPa) or $3\sqrt{f'_{ci}}$ $(0.25\sqrt{f'_{ci}})$ at end

~~For girders: 0 psi (0 MPa) at end~~

Article 9.15.2.2

Allowable Stresses: Stress at Service Load After Losses Have Occurred

Tension in the Precompressed Tensile Zone,

- For cored slab: 0 psi (0 MPa) at mid span
- For girders at Corrosive Sites: 0 psi (0 MPa)
- For prestressed concrete panels at Corrosive Sites: 0 psi (0 MPa)

For other girders and panels, the tension is limited to $6\sqrt{f'_c}$ $(0.5\sqrt{f'_c})$.

Article 10.20.1

Diaphragms and Cross Frames: General

For intermediate diaphragms on rolled beams used in simple spans, the vertical transverse stiffener need not be rigidly connected to top and bottom flanges. There shall be a 4 inch (100 mm) gap between both the top and bottom flanges and the vertical stiffener. See Figures 6-103, 6-104 and 6-105 for details.

Article 10.24.3.2 **Fasteners (Rivets and Bolts): Washer Requirements**

All high strength bolts shall have a hardened washer under the element turned in tightening.

Article 14.3 **Material Properties**

When designing elastomeric bearings, the shear modulus shall be 110 psi (0.76 MPa) for 50 durometer hardness and 160 psi (1.10 MPa) for 60 durometer hardness.

Article 14.5.3.2 **Bending Moment**

The moment transferred by elastomeric bearings need not be considered in the design of bridge substructures or superstructures.

2-2 Live Loads

Minimum design live load shall be HS20 (MS18) or alternate loading unless otherwise instructed by the Unit Head.

2-3 Dead Loads

An additional dead load must be included in the design when using metal stay-in-place deck forms. This additional dead load will consist of 3 lbs/ft^2 (0.145 kN/m^2) for the weight of the metal form plus the weight of concrete in the valleys of the forms which shall be taken as the weight of 1 inch (25 mm) additional concrete over the deck area formed. For wide girder spacings, consideration should be given to increasing this weight due to the possible use of deeper stay-in-place forms.

When prestressed concrete panels are used for prestressed concrete girder spans, girders shall be designed for additional dead loads due to the possible use of metal stay-in-place forms.

For steel beams and girders, an additional dead load of 10 lbs/ft^2 (0.48 kN/m^2) shall be included in the non-composite dead load for the stress check due to the temporary construction loading. This loading is included in both the Composite I-Beam and Composite Plate Girder computer programs. When Merlin Dash is used for the design, the composite beam should be designed, and the deflections computed without the construction load. The non-composite stresses should then be checked with the construction load added as a Load Type 2.

Superimposed dead loads such as barrier rails, medians and any dead load which would be applied after the deck is cast shall be distributed equally to all beams for bridges up to 44 feet (13.4 m) in width. In the case of bridges over 44 feet (13.4 m) wide, these loads shall be distributed equally to the first three beams adjacent to the loads.

Weights of various types of rails are as follows,

- One bar metal rail: 10 lbs/ft (0.15 kN/m)
- One bar metal rail with 1'-6" (457 mm) concrete parapet: 235 lbs/ft (3.43 kN/m)
- Two bar metal rail with 2'-6" (760 mm) concrete parapet: 455 lbs/ft (6.64 kN/m)
- Three bar metal rail: 25 lbs/ft (0.36 kN/m)
- Concrete barrier rail: ~~371~~406 lbs/ft (~~5.41~~5.92 kN/m) for 2'-8" (813 mm) section
- Concrete median barrier: 414 lbs/ft (6.04 kN/m)

Concrete weight for foundation seal design shall be based on 140 lbs/ft^3 (22.0 kN/m^3).

Unit weights for lightweight concrete are as follows,

- Unreinforced lightweight concrete: 115 lbs/ft^3 (18.0 kN/m^3)
- Reinforced lightweight concrete: 120 lbs/ft^3 (18.8 kN/m^3)

2-4 Friction Force

The force caused by an expansion bearing sliding on its bearing plate on the supporting substructure element must be included in the design of the structure. These forces are determined by multiplying the coefficient of friction by the total dead load reaction on the bearing. For steel on steel, use a coefficient of 0.30, and for stainless steel on teflon, use a coefficient of 0.10. For elastomeric bearings, the force required to deform the elastomeric pad is found by using the following equation:

$$F = \frac{(\text{Shear Modulus}) \times (\text{Contact Area}) \times (\text{Deflection Due to Temperature})}{\text{Thickness (Effective Rubber)}}$$

2-5 Temperature

Provision shall be made for stresses and movements resulting from variations in temperature.

The range of temperature shall generally be as follows,

- Steel Structures: - 0°F to 1~~2~~20°F (-1~~8~~8°C to ~~50~~50°C)
- Concrete Structures: 20°F to 10~~0~~0°F (-~~6~~6°C to ~~38~~38°C)
- Assumed normal fabrication and erection temperature: 60°F (16°C)

2-6 Earth Pressures

Earth pressures on structures such as retaining walls and wing walls which retain fills shall be determined using Rankines' Formula. In special cases good engineering judgment will be required in determining the most suitable design method. In no case shall a structure be designed for less than an equivalent fluid pressure of 40 lbs/ft^3 (6.3 kN/m^3).

2-7 Differential Settlement

When differential settlement needs to be addressed by the Structure Design Unit, the Soils and Foundation Section will indicate the amount of differential settlement in the Foundation Recommendation. If no differential settlement is specified in the recommendation, then the differential settlement has been considered by the Soils and Foundation Section in their foundation design. Generally, the Soils and Foundation Section will consider differential settlement in their foundation design if it is less than 1 inch (25 mm) over a period of time. If the differential settlement is greater than 1 inch (25 mm) over a period of time or if the structure is particularly sensitive to settlement, then the Structure Design Unit must consider the specified settlement in the bent design.

2-8 Seismic Loads

All structures must be designed in accordance with the Standard Specifications for Seismic Design of Highway Bridges. To determine if a structure is to be designed for Seismic Performance Category A or B, see Figure 2-4.

The Soils and Foundation Section will specify on the Foundation Recommendation the Soil Profile Type as defined in the AASHTO Standard Specifications. For preliminary design only, a North Carolina Site Coefficient Map showing soil profile type is shown in Figure 2-5.