Chapter 3 — Loads and Load Factors

3.1—INTRODUCTION

The current AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications and applicable AASHTO Guide Specifications shall be the minimum design criteria used for all bridges except as modified herein.

Loads in this chapter shall be utilized in the design of bridges and other bridge sized structures.

3.2—LOAD FACTORS AND COMBINATIONS

The limit state load combinations, and load factors (γ_i) used for structural design shall be in accordance with the AASHTO LRFD Bridge Design Specifications Table 3.4.1-1 except as modified herein.

3.2.1—Strength Limit States

Ductility (η_D) and Redundancy (η_R) factors shall be taken as 1.0. Operational Classification (η_I) factor shall taken as 1.05 for critical or essential structures and 1.0 for all other structures. Refer to §1.9 for definition of critical or essential structure.

For all State bridges the load factor for vehicular live load (LL) and vehicular dynamic load allowance (IM) for the Strength I load combination shall be increased from 1.75 to 2.0 for superstructure primary member design except for deck slabs. For substructure, deck slabs, and superstructure secondary member design, the Strength I live load factor shall remain 1.75.

At the time when Nebraska was converting from the Standard Specifications for Highway Bridges to the LRFD Bridge Design Specifications, structures were designed using a HS25 truck in lieu of the required HS20. In order to continue providing similar superstructure sizes and to ensure new structure designs attain similar rating factors the γ_{LL} factor was increased for the Strength I load combination.

3.2.2—Extreme Event Load Combinations

Per LRFDBDS Article C3.4.1 $\gamma_{EQ} = 0.5$ unless analytically determined otherwise with Bridge Division Approval.

3.3—PERMANENT LOADS

3.3.1—Noncomposite Dead Loads (DC1)

Bridge deck, haunch, stay-in-place forms (5.0 psf), and diaphragms are considered a non-composite dead loads acting on the girders before concrete deck has cured.

3.3.2—Composite Dead Loads (DC2)

Railings and signage are considered superimposed dead loads distributed equally to all girders or distributed uniformly across concrete slabs.

In general, concrete barrier or rail loads are distributed equally to all girders for normal cantilever conditions. See Table 3.1 for weights of standard railing sections.

Interior Median Curbs (DC2): Interior median curbs will be designed and specified in the Plans as a composite load. In other words, a construction joint is mandatory (see details in Section §5.4.2).

Table 3.1—Rail Dead Loads

Rail Shape	Rail Type	Weight
39 in. SSCR	Closed	0.365 klf
39 in. OCR	Open	0.438 klf
42 in. NU	Open	0.441 klf
	Closed	0.524 klf
	Median	0.873 klf
34 in. NU	Open	0.373 klf
	Closed	0.455 klf
29 in. Nebraska	Open	0.270 klf
	Closed	0.382 klf
32 in. New Jersey Barrier	Closed	0.345 klf
42 in. New Jersey Barrier	Closed	0.413 klf
32 in. Temporary Barrier (via Standard Plan № 870)	Closed	0.432 klf

3.3.3—Future Surfacing and Utilities (DW)

Future surfacing is assumed to be 35 psf and shall be applied to all new superstructure and substructure designs.

Future surfacing loads shall only be included in the deflection calculations for shims if the overlay is constructed with the new bridge.

Bridges shall be analyzed both with and without future surfacing to ensure load envelopes are captured.

For typical bridge design no additional future utility load is required to be considered during design. If it is known utilities will be attached during construction or stated on the BDS, utility loads shall be accounted for during design.

3.4—LIVE LOADS

3.4.1—Pairs of Design Tandems

The pairs of design tandems described in LRFDBDS Article C3.6.1.3.1 shall be applied on all bridges that carry roadways of State Functional Classification Interstate or any structures with an ADTT not less than 5,000 vpd. ADTT shall be calculated per structure, for typical bidirectional structures use bidirectional ADTT. For ramps and other one-way structures use unidirectional ADTT.

State Functional Classification for each project can be found in the NDOT73 Planning Document submitted for each project with the Project Initiation Request (typically found on OnBase).

3.4.2—Live Load Deflection Limits for Steel and Concrete Superstructures

The optional deflection criteria in LRFDBDS Article 2.5.2.6.2 shall be mandatory on all State structures.

3.4.3—New, Reconstructed, and Rehabilitated Structures

New, reconstructed, and rehabilitated structures shall meet the requirements of AASHTO LRFD Bridge Design Specifications of HL93 live load.

See Chapter 1 for definitions of these terms.

3.4.4—Existing Superstructures

Existing superstructures shall meet the live load requirements below based on the classification of work being performed.

- Redeck, with or without additional widening: if feasible the structure shall be strengthened to HL93. If strengthening is not feasible the original design load shall be used.
- Widening of existing decks: original design load

If the original design load is unknown the following shall be assumed:

- State structures: HS20
- County and Municipal Structures: HS15

Structures may not be load posted after completion of work, unless they are County or Municipal Structures, and have a National Functional Classification of Local with ADT fewer than 400 VPD.

3.4.5—Existing Substructures

Where the superstructure design load is HL93, if feasible, the substructure shall be strengthened to HL93. If strengthening is not feasible, a load rating of the existing substructure shall be performed. If the existing substructure has adequate capacity to prevent load posting it may be used in place, if not it shall be replaced.

For all other superstructure design loads, the substructure design load shall the be original design load. If the original design load is unknown the following shall be assumed:

- State structures: HS20
- County and Municipal Structures: HS15

3.4.6—Dynamic Load Allowance

Dynamic Load Allowance shall be applied per LRFDBDS Article 3.6.2 with the clarification that abutment caps in contact with the soil are considered buried elements.

Scour is generally considered a temporary condition therefore designers need not include dynamic load allowance on piles being checked under scoured conditions.

3.4.7—Vehicular Collision Force

Where bridge intermediate supports are located within the clear zone Bridge Division's preferred method to address structure protection is to use heavy construction with pier columns having a minimum thickness of 3 ft. and a minimum cross-sectional area of 30 ft.[2]. The distance from the groundline up the beginning of rustication on hammerhead piers may be increased to 5 ft. to achieve this while maintaining a column section less than 3 ft. thick at the rusticated portion of the column. See §11.2.2.3 for hammerhead pier details.

3.5—WATER LOADS

Uplift and lateral loading on submerged girders shall be accounted for on structures where the design flood inundates part or all of the superstructure.

When considering buoyant force the elevation of any vent holes provided in girder webs shall be considered.

Designers may want to investigate lateral loading on intermediate supports taking into account any accidental misalignment between the axis of the intermediate support and the flow direction of the water.

For bridge components below the vent hole elevation, only the structure area contributes to the buoyant force (shaded area in Figure 3.1). For bridge components above the vent hole elevation the entire area cross section including trapped air contributes to the buoyant force (cross hatched area in Figure 3.1).

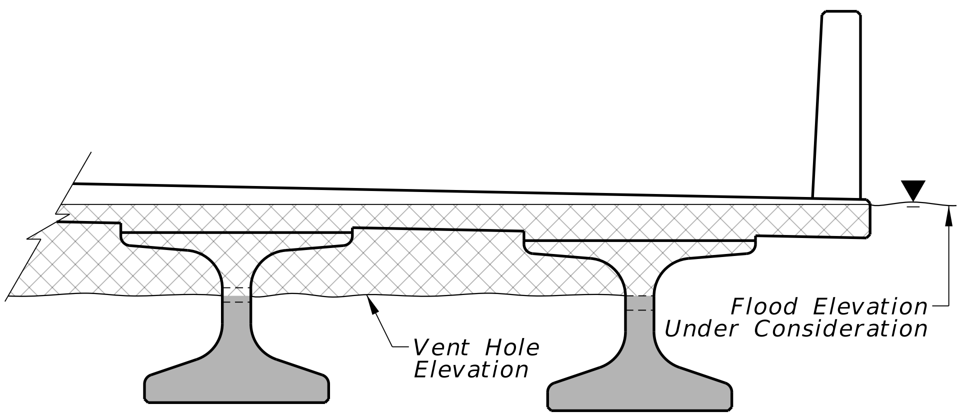

Figure 3.1—Buoyant Force Cross Section

3.6—WIND LOADS

Reserved for future use.

3.7—ICE LOADS

When ice loads are to be included in design (ice affected structure is checked on the Hydraulic Information Sheet), bridge hydraulics is to provide ice load parameters (thickness of ice and effective ice crushing strength).

Ice Load shall be evaluated as part of Extreme Event II Load combination with consideration of Q_{100} design scour in combination with ice load being applied at the midway point between OHW and Q_{100} water surface elevation.

For bridges not specified as Ice Affected this load need not be considered.

See Bridge Hydraulic Guidelines for more information regarding this topic.

3.8—EARTHQUAKE EFFECTS

Seismic analysis shall be carried out on every structure.

Most structures and sites in the State of Nebraska qualify for Seismic Zone 1 which entails only checking the connection between the superstructure and substructures per LRFDBDS Article 3.10.9.2.

Where reducing the lateral load specified in LRFDBDS Article 3.10.9.2 is desired, a Uniform Load Elastic Method analysis of the structure can typically be undertaken.

Typically the easiest method for determining Site Class is using the boring logs from the Geotechnical Section of Materials and Research Division. Using the logs the $\overline{N}$ Method detailed in LRFDBDS Table C3.10.3.1-1 can be performed.

3.9—EARTH PRESSURE

When local soil parameters are not given in the geotechnical report, a unit weight of γ = 125 pcf and an angle of internal friction of φ = 25° may be used.

For culverts with a rise of not less than 6 ft. a geotechnical report with local soil parameters is required.

3.10—SUPERIMPOSED DEFORMATIONS

3.10.1—Uniform Temperature

Force effects and movement resulting from uniform temperature change shall be included in the design of structures.

Other design policies may provide factors to modify thermal movement calculations.

Table 3.2—Uniform Temperature Parameters

Parameter	Superstructure Material	
	Concrete	Steel
α	6.0×10^{-6}/°F	6.5×10^{-6}/°F
$T_{MinDesign}$	−20°F	−20°F
$T_{MaxDesign}$	115°F	120°F
Design Temperature Rise	50°F	75°F
Design Temperature Fall	70°F	90°F

AASHTO Method "B" design temperatures can vary across the state but the values given may be used statewide.

3.10.1.1—Movement Calculation

Design parameters shall be as shown in Table 3.2 and be design thermal movement range shall be determined using the equation:

$$TM = \alpha \times L \times (T_{MaxDesign} - T_{MinDesign})$$

Where

TM = design thermal movement range

α = coefficient of thermal expansion

L = Length from point of no movement to the point at which the length of expansion is desired.

Design thermal movement range is principally used for sizing expansion devices.

See §4.5 for guidance on determining the point of no movement based on structure stiffness.

3.10.1.2—Force Effects Due to Temperature

Design force effects due to thermal movement shall be calculated separately for rise and fall using ranges from Table 3.2. Both shear and flexure deflections shall be used in determining force effects due to enforced deflections.

In lieu of the 65% of total TM allowed in LRFDBDS Article 14.7.5.3.2 Bridge Division has chosen to specify rise and fall temperature for use in determining forces induced by thermal movement and design displacement on bearing devices. This also prevents having to reset bearings if the bridge is erected at a temperature far from its neutral temperature.

3.10.2—Shrinkage and Creep

For routine structure design, in lieu of a more precise analysis, shrinkage and creep of precast/prestressed girders may be assumed as 0.0003 ft./ft. This assumption does not apply to post-tensioned or other complex structures which should be individually analyzed per LRFDBDS Articles 5.4.2.3.2 and 5.4.2.3.3.

3.11—FRICTION FORCES

For bearings that utilize a PTFE sliding surface, design coefficients of friction shall be per LRFDBDS Table 14.7.2.5-1. Standard Specifications specify the use of an unfilled flat PTFE surface.

At fixed supports the larger of the direct friction force and the unbalanced friction force between all supports shall be used for design.

3.12—VESSEL COLLISION

For major structures on the Missouri River, vessel collision loads shall be determined via a site specific study.

3.13—BLAST LOADING

Structures where blast resistance is required shall be denoted on the BDS.

Where blast loading analysis is required, consultation with a specialty engineer specializing in blast loading is mandatory to determine appropriate explosive characteristics.

Last Updated: February 23, 2026