Structural Design Manual

ALDOT Bridge Bureau

January 2023

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REVISIONS since *January 2022 Edition (August 2022 Revision)*

- Section 9.1: Deleted sentence in last paragraph relating to precast deck forms and deck systems.
- Section 10.2: For steel H piling, added reference to AASHTO LRFD 6.5.4.2. For precast prestressed concrete piling, revised table 10-2, added reference to AASHTO LRFD 5.6.4.4, added design parameters. For precast prestressed spun cast cylinder piling added wall thickness, revised presentation of design parameters, added reference to AASHTO LRFD 5.6.4.4.
- Section 16: Added additional vehicles for rating.

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PREFACE

I. ALDOT POLICY STATEMENT

All bridge and miscellaneous transportation structures in Alabama shall be designed in accordance with the ***ALDOT Structural Design Manual.*** All proposed exceptions shall have the prior written approval of the State Bridge Engineer prior to proceeding with design.

II. PURPOSE AND SCOPE

This manual contains specific design criteria policies mandated by the ALDOT Bridge Bureau applying equally to ALDOT as well as consultants completing structural designs. The primary purpose of this manual is:

- To provide interpretation and consistency in the application of the ***AASHTO LRFD Bridge Design Specifications****.*

- To encourage the uniform preparation of plans and specifications.

- To provide direction to be followed on projects under the authority or oversight of the Bridge Bureau. Exceptions, other than those noted herein, may be granted with the prior approval of the State Bridge Engineer. Such exceptions shall be documented per the procedures noted in the ***Bridge Plan Development Quality Control and Quality Assurance Plan and Checklist***.

Structural plans and specifications must clearly communicate the design intent and construction requirements of each project. This manual is targeted for internal Bridge Bureau use; however, consultants preparing designs for projects to be let through ALDOT are expected to follow the directives noted herein.

The contents of this manual generally follow the section headings of the ***AASHTO LRFD Bridge Design Specifications***. ALDOT exceptions to specific requirements of the ***AASHTO LRFD Bridge Design Specifications*** are indicated as follows:

ALDOT exception to AASHTO: *A description of the ALDOT exception is given here.*

This manual will be continually updated as revisions and improvements are warranted. Any questions, comments, concerns, and/or suggestions are welcomed and should be submitted to:

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Alabama Department of Transportation
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Montgomery, AL 36130-3050
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III. DESIGN METHOD/SPECIFICATIONS

All bridge and miscellaneous transportation structures in Alabama shall be designed using Load & Resistance Factor Design (LRFD), unless otherwise directed by the State Bridge Engineer. The governing design specification for all bridges and miscellaneous transportation structures in Alabama shall be the ***AASHTO LRFD Bridge Design Specifications, 9th Edition*** and applicable interims, along with any notations and exceptions indicated herein. Within this manual, the ***AASHTO LRFD Bridge Design Specifications*** is referred to as ***AASHTO LRFD***. Other AASHTO specifications & guides, as well as the related ALDOT manuals & documents listed below, shall also apply as appropriate.

Consultant prepared designs, whether prepared directly for the Bridge Bureau or any other office in the Department, shall be submitted according to the requirements given in the ***Alabama State Board of Registration for Professional Engineers and Land Surveyors Administrative Code, Chapter 330-X-11-.03***.

IV. RELATED MANUALS/DOCUMENTS

Other documents maintained and/or used by the ALDOT Bridge Bureau include the following:

- ***Bridge Plan Development Quality Control and Quality Assurance Plan and Checklist***
- ***Bridge Special Project Drawings***
- ***Quality Control Manual for Bridge Plan Detailing***
- ***ALDOT Guide for Developing Construction Plans (GDCP)***
- ***ALDOT Guidelines for Operation***
- ***ALDOT Hydraulics Manual***
- ***ALDOT Maintenance Bureau Bridge Inspection Manual Appendix I***
- ***ALDOT Special and Standard Highway Drawings***
- ***ALDOT Standard Specifications for Highway Construction***
- ***AASHTO Guide Specifications for LRFD Seismic Bridge Design, 2nd Edition and Interims***
- ***AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition and all Interims***

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V. APPROVAL

This document is approved for implementation and is effective as of the date shown.

4/4/2023

William T. Colquett, PE — Date
State Bridge Engineer

4/6/23

Edward N. Austin, PE — Date
Chief Engineer

04/06/2023

Mark Bartlett, PE — Date
Division Administrator
FHWA Alabama Division

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SECTION 1. INTRODUCTION

The provisions of ***AASHTO LRFD, Section 1*** shall apply to this section unless noted and/or excepted below.

1.1 LIMIT STATES

The value of the load modifier, η_i (see ***AASHTO LRFD, Article 1.3.2.1***) and its factors, η_D, η_R, and η_I, shall all be set equal to 1.00, unless otherwise directed by the State Bridge Engineer.

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SECTION 2. GENERAL DESIGN AND LOCATION FEATURES

The provisions of ***AASHTO LRFD, Section 2*** shall apply to this section unless noted and/or excepted below.

2.1 CLEARANCES

Criteria for clearances is presented in ***AASHTO LRFD, Article 2.3.3.***

ALDOT exception to AASHTO:

Horizontal and vertical clearances for roadway grade separation structures shall conform to ***ALDOT Guidelines for Operation, Section 3-25: Bridges Vertical Clearance for Highway Grade Separations New Construction and Criteria for Raising Existing Bridges*** *and* ***Section 3-76: Bent or Pier Placement Criteria for Proposed Bridges Overpassing Multilane Roadways****.*

Freeboard requirements for hydraulic structures shall conform to ***ALDOT Guidelines for Operation, Section 3-39: Design Flood Frequencies for Bridge Openings and Scour Evaluations.***

Criteria for bridge width is presented in ***AASHTO LRFD, Article 2.3.3.3.***

ALDOT exception to AASHTO:

Minimum clear roadway width (face of barrier to face of barrier) for new and reconstructed bridges should follow current ***AASHTO Policies (A Policy on Geometric Design of Highways and Streets*** *and* ***A Policy on Design Standards - Interstate System)*** *as noted below:*

Interstate:

- *Bridges less than or equal to 200 feet: Full width of the approach roadway including paved shoulders.*
- *Bridges greater than 200 feet: Width may be based on reduced left and right shoulder width of not less than 4 feet.*

Local roads and streets:

- *With curbed approaches: Match curb to curb width*
- *With shoulders and no curb:*

Design volume: < 400, traveled way + 2 ft. each side
400 to 2000, traveled way + 3 ft. each side
> 2000, approach roadway width[a]

Collector roads and streets:

- *With curbed approaches: Match curb to curb width*
- *With shoulders and no curb:*

Design volume: < 400, traveled way + 2 ft. each side
400 to 2000, traveled way + 4 ft. each side[a]
> 2000, approach roadway width[a]

[a] for bridges over 100 feet, traveled way + 3 ft. each side is acceptable

Arterial roads and streets:

- *Full width of approach roadway including paved shoulders and space allocated for bicycles/pedestrians.*
- *Bridges over 200 feet, width may be based on 4 ft. min. shoulder each side.*

NOTE: Prior to proceeding with final design, consult with the Region Engineer and/or Design Bureau for concurrence on bridge width.

2.2 DEFORMATIONS

Criteria for deflection is presented in ***AASHTO LRFD, Article 2.5.2.6.2***.

ALDOT exception to AASHTO:
*Live load deflection shall be checked for both loading options as given in **AASHTO LRFD, Article 3.6.1.3.2***

2.3 BRIDGE DECK DRAINAGE

Criteria for the design storm is presented in ***AASHTO LRFD, Article 2.6.6.2***.

ALDOT exception to AASHTO:
The design storm shall be the 10-year recurrence except where the low point of a sag vertical curve exists on the bridge wherein the 50-year recurrence shall be used. Exceptions to this policy shall have the prior approval of the State Bridge Engineer.

Criteria for deck drains is presented in ***AASHTO LRFD, Articles 2.6.6.3*** and ***2.6.6.4***.

ALDOT exception to AASHTO:
*Bridge deck drainage shall be allowed to fall freely to the ground through deck scuppers unless otherwise directed by the State Bridge Engineer. Typically, 4" Ø vertical scuppers spaced on 5' centers (max.) shall be provided in normal crown sections up to 44' gutter to gutter. In wider sections, and superelevated sections greater than 28', reduce scupper spacing to 4' centers (max.). Slots formed through the bottom of the barrier rail may be substituted with the prior approval of the State Bridge Engineer (see **Bridge Special Project Drawings BBR-1** and **BBR-2**).*

Scuppers shall be omitted over roadway lanes and railroad right-of-way's, 10' from bridge ends, and 5' from interior bents/piers.

Unless approved otherwise by the State Bridge Engineer, water spread shall be limited to the shoulder area and not allowed to encroach on the travel lanes.

Where it is probable that spread may exceed this limit (e.g. bridges in sag vertical curves, deck portions where drains are omitted, wide decks, decks in superelevation or transition, etc.), the spread shall be checked and if the spacings noted above are inadequate the use of larger diameter scuppers, reduced spacings, deck drain inlets, or a closed system may be required.

2.4 BRIDGE HYDRAULICS

Bridges and bridge culverts for waterway encounters shall be evaluated in accordance with ***GDCP Attachment 4*** and the ***ALDOT Hydraulics Manual***.

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SECTION 3. LOADS AND LOAD FACTORS

The provisions of ***AASHTO LRFD, Section 3*** shall apply to this section unless noted and/or excepted below.

3.1 PERMANENT LOADS

Criteria for Dead Loads (DC, DW, EV) is given in ***AASHTO LRFD Article 3.5.1***:

ALDOT exception to AASHTO:
Dead loads from wearing surfaces and future overlays as specified in ***AASHTO LRFD, Article 3.5.1****, shall not be included without the prior approval of the State Bridge Engineer.*

- Include 15 psf dead load (this includes the weight of concrete in the forms) for metal stay-in-place forms for bridge decks (as applicable).
- Precast concrete panels for use in forming bridge decks are prohibited.
- The barrier rail dead load shall be considered equally distributed across all girders. However, the dead load for girder design shall not be less than 25% of a single barrier rail weight.

3.2 WATER AND WIND LOADS

Criteria for Water and Wind Loads (WA, WL, WS) is given in ***AASHTO LRFD Articles 3.7 and 3.8***:

ALDOT exception to AASHTO:
Bridges exposed to coastal influences shall be designed in accordance with the latest ***AASHTO Guide Specifications for Bridges Vulnerable to Coastal Storms****.*

3.3 TEMPERATURE FORCE EFFECTS

Criteria for temperature force effects (TU, TG) is given in ***AASHTO LRFD Article 3.12***:

Thermal baseline shall be set at 70º F.

3.4 BRAKING FORCE

Criteria for Braking Force (BR) is given in ***AASHTO LRFD Article 3.6.4***:

ALDOT exception to AASHTO:
The Braking Force (BR) shall be 8.75% of the weight of the design truck or design tandem. The force shall be assumed to act horizontally at the top of the cap in either longitudinal direction to cause extreme force effects. It shall be distributed equally to all bearings. This is applicable to non-integral bents only.

All other provisions of ***AASHTO LRFD, Article 3.6.4*** *shall apply unless refined methods are used for the analysis.*

3.5 EARTHQUAKE EFFECTS

Criteria for Earthquake Effects (EQ) is given in ***AASHTO LRFD Article 3.10***:

ALDOT exception to AASHTO:
New bridges and applicable bridge widenings shall be designed and detailed to conform with the requirements noted below. If circumstances dictate otherwise (with the concurrence of the State Bridge Engineer), designs shall be based on the ***AASHTO Guide Specifications for LRFD Seismic Bridge Design, 2nd Edition and Interims****.*

The requirements noted in this section apply to conventional bridge types and bridges classified as "ordinary". Unless designated otherwise by the State Bridge Engineer, all new highway bridges and applicable widenings shall be classified as "ordinary". Non-conventional bridges and bridges classified as "recovery" or "critical" shall be designed to meet project specific requirements as defined by the State Bridge Engineer. See ***AASHTO Guide Specifications for LRFD Seismic Bridge Design, Article C3.1*** for definition of conventional and non-conventional bridges.

Widenings where shoulders only are being added and additional traffic lanes are not anticipated are not subject to earthquake effect requirements. Widenings where traffic lanes are being added and does not attach to the existing bridge (longitudinal open joint between bridge decks, separate intermediate substructure), are subject to earthquake effect requirements.

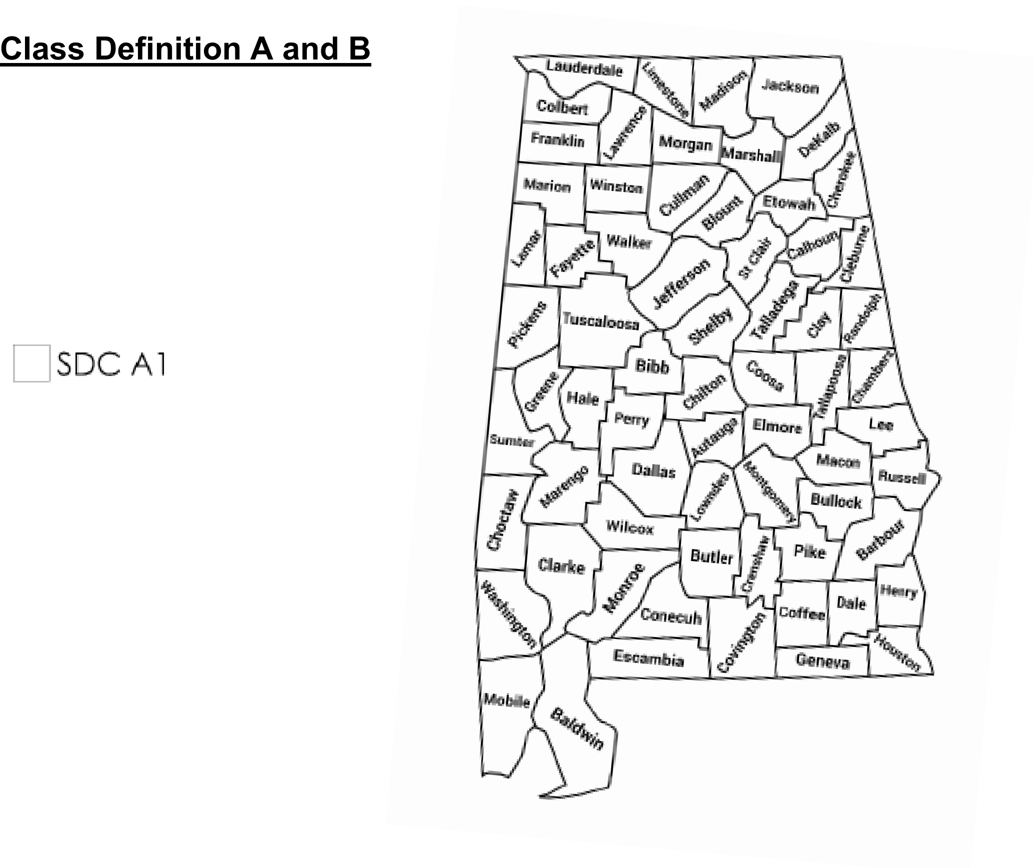
Seismic Design Category (SDC) Maps

The following maps depict the worst-case Seismic Design Category (SDC) for a county for different site class definitions. At the discretion of the Designer, a more accurate SDC for an individual site may be determined. The site class definition is determined and reported by the Bureau of Materials and Tests or Geotechnical Engineer of Record in accordance with the ***AASHTO Guide Specifications for LRFD Seismic Bridge Design, Article 3.4.2.***

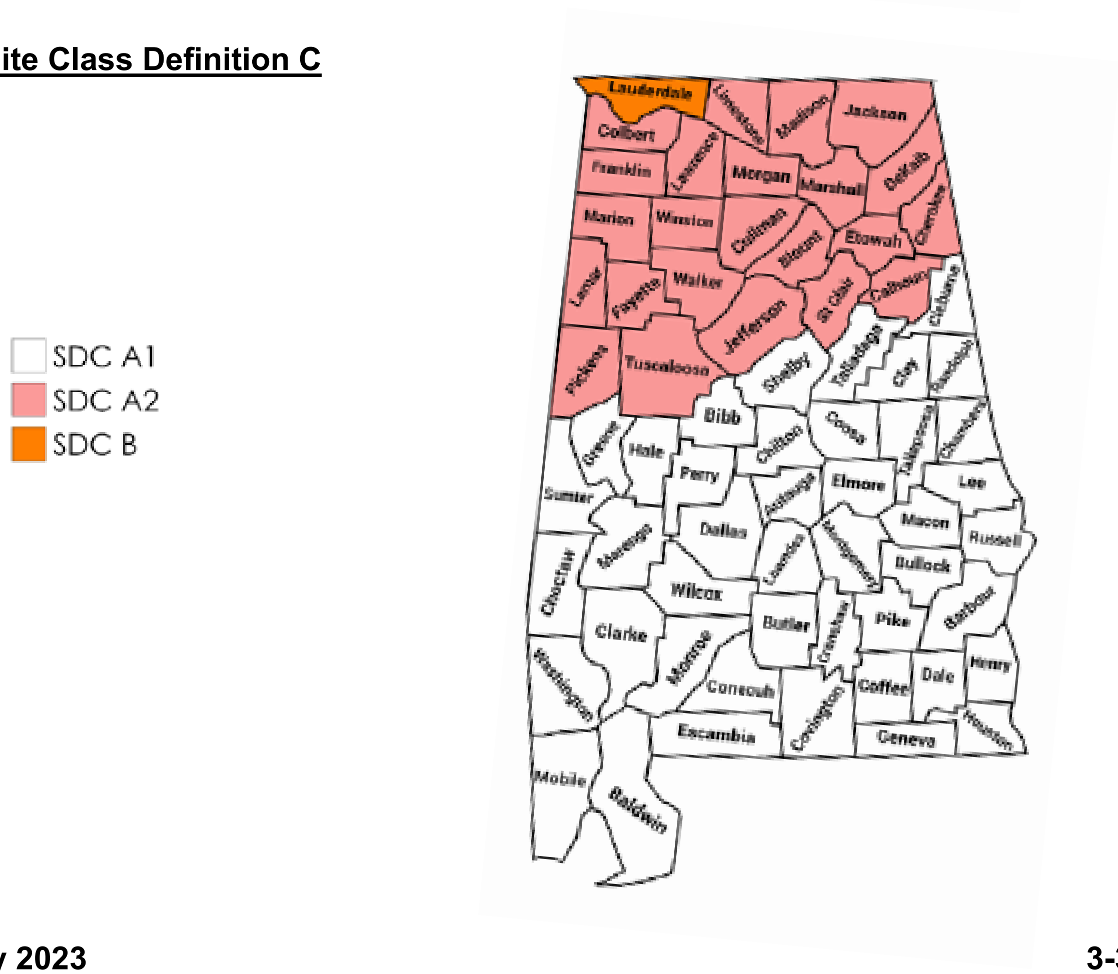
The SDC maps are partitioned based on values of S_{D1} as shown in the ***AASHTO Guide Specifications for LRFD Seismic Bridge Design, Table 3.5-1.*** SDC A is further partitioned based on values of S_{D1} as follows (see ***AASHTO Guide Specifications for LRFD Seismic Bridge Design, Article 8.2***):

- SDC A1: $S_{D1} < 0.10g$
- SDC A2: $0.10 \leq S_{D1} < 0.15g$

Site Class Definition A and B

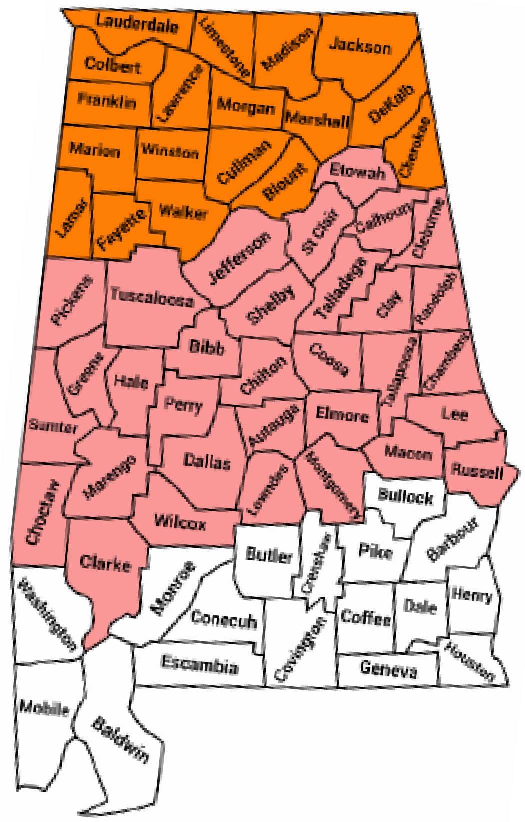


Site Class Definition C



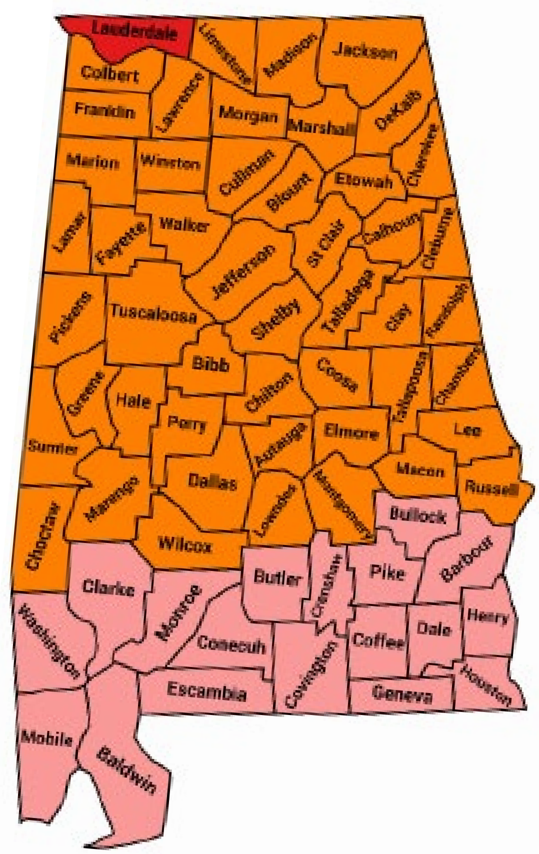
Site Class Definition D

SDC A1
SDC A2
SDC B



Site Class Definition E

SDC A2
SDC B
SDC C



Site Class Definition F

For bridges determined to be in Site Class F, special conditions apply, and designs shall be based on project specific requirements to be defined by the State Bridge Engineer.

Minimum Support Length

For all SDC, the requirement for minimum support length as specified in ***AASHTO Guide Specifications for LRFD Seismic Bridge Design, Article 4.12*** shall be met. Minimum support length requirements do not apply to single span bridges or single unit bridges (fully continuous superstructures, e.g., continuous steel girders, spliced post-tensioned concrete girders, etc.) except where vertical wall abutments are used.

Horizontal Connection Force

See ***SECTION 14.3*** for anchor bolt requirements.

Shear Blocks

Shear blocks are required for bridges in SDC B and C. See the ***Quality Control Manual for Bridge Plan Detailing*** for details.

Column Requirements

The following is applicable to bridges in SDC A2, B and C only.

Aspect Ratio:

For SDC B and C only, the minimum ratio of column height to maximum width should be 4.

Minimum and Maximum Area of Longitudinal Reinforcing:

The requirements noted below shall apply to the full length of the column:

- SDC A2 and B: $0.01 \times A_g \leq A_L \leq 0.06 \times A_g$
- SDC C: $0.01 \times A_g \leq A_L \leq 0.04 \times A_g$

A_g = Gross cross-section area of the column
A_L = Total area of longitudinal reinforcement

If reinforcement requirements for a given column cross section exceed the limitations noted above, increase the dimensions accordingly.

Splicing of Longitudinal Reinforcing:

Requirements for splicing of longitudinal reinforcement are as follows:

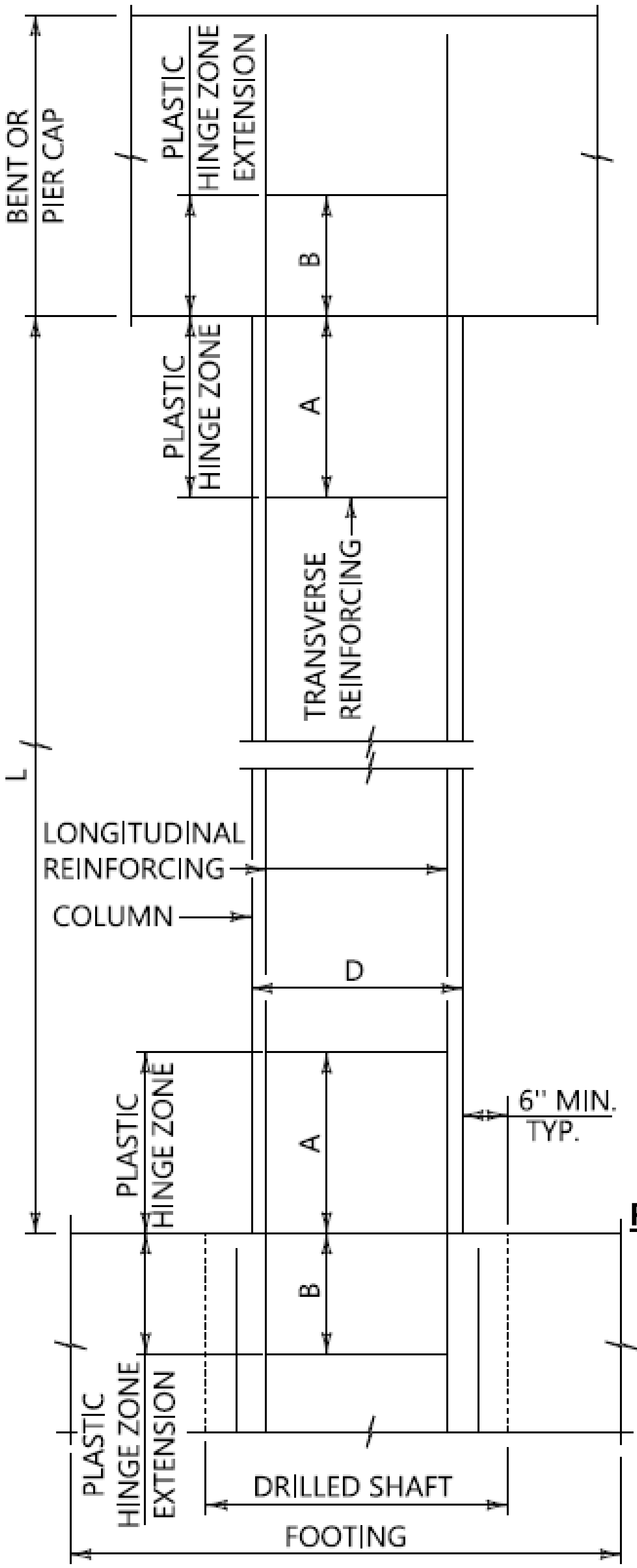
- SDC A2: Lap splicing of longitudinal reinforcement is permitted.
- SDC B and C: Lap splicing of longitudinal reinforcement is not permitted. Mechanical splices may be used that develop 125% f_{ye}. Splices shall be staggered such that the distance from one splice to the next for adjacent bars is 2'-0'' minimum measured along the longitudinal axis of the bar. Such splices shall occur outside the limits of the plastic hinge zone.

Columns Supported on Drilled Shafts:

For special requirements for SDC C, see ***AASHTO Guide Specifications for LRFD Seismic Bridge Design, Articles 8.8.10, 8.8.11, 8.8.12, 8.8.13.***

Plastic Hinge Zone and Plastic Hinge Zone Extension:

Requirements for plastic hinge zones and plastic hinge zone extensions in reinforced concrete columns are shown in ***Figure 3.5.***



Plastic Hinge Zone

(1) Dimension A:

SDC A2 and B, the largest of:

- Maximum cross-sectional dimension D of the column
- L/6
- 18"

SDC C, the largest of:

- 1.5 x the maximum cross-sectional dimension D of the column
- Region of column where the moment demand exceeds 75% of the maximum plastic moment
- $L_p = 0.08 \times L + 0.15 \times f_{ye} \times d_{bl} \geq 0.3 \times f_{ye} \times d_{bl}$

(2) Maximum spacing of transverse reinforcing in plastic hinge zone is least of:

- 1/5 the least dimension of the column cross section
- $6 \times d_{bl}$
- 6"

(3) Minimum transverse reinforcement size:

#4 for #9 or smaller longitudinal bars
#5 for #10 or larger longitudinal bars
Transverse reinforcement shall be detailed with seismic hooks (135°) and shall engage the longitudinal reinforcement. See ***AASHTO Guide Specifications for LRFD Seismic Bridge Design, Article C8.6.3*** for examples of transverse reinforcement.

(4) Circular transverse reinforcement ratio:

$\rho \geq 0.003$ for SDC B and ≥ 0.005 for SDC C
Rectangular transverse reinforcement ratio:
$\rho \geq 0.002$ for SDC B and ≥ 0.004 for SDC C
See ***AASHTO Guide Specifications for LRFD Seismic Bridge Design, Article 8.6.5***

(5) Spiral reinforcement not allowed without prior approval of the State Bridge Engineer.

Plastic Hinge Zone Extension

(1) Dimension B:

SDC B and C, the largest of:

- ½ the maximum column dimension
- 15"

L = Column height in inches
f_{ye} = yield strength of reinforcement in ksi
d_{bl} = diameter of longitudinal bars in inches
ρ = transverse reinforcement ratio

Figure 3.5

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SECTION 4. STRUCTURAL ANALYSIS AND EVALUATION

The provisions of ***AASHTO LRFD, Section 4*** shall apply to this section unless noted and/or excepted below.

ALDOT has no analysis and evaluation considerations beyond those covered in the ***AASHTO LRFD Bridge Design Specifications****.*

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SECTION 5. CONCRETE STRUCTURES

The provisions of ***AASHTO LRFD, Section 5*** shall apply to this section unless noted and/or excepted below.

5.1 CONCRETE COMPRESSIVE STRENGTHS

Reinforced Concrete:

Designers shall refer to the current edition of the ***ALDOT Standard Specifications for Highway Construction*** for strengths to be used in different structures. Individual plan sheets for various structural members shall indicate the required concrete strength of that member.

- Superstructure (including barrier rails and deck) and substructure (including footings [except as noted below] and drilled shafts) concrete strength (f'_c) shall be 4.0 ksi
- Retaining wall and cast-in-place box culvert concrete strength (f'_c) shall be 4.0 ksi
- Seal footing and miscellaneous drainage structure concrete strength (f'_c) shall be 3.0 ksi

Greater concrete strengths may be utilized when required by design (subject to the prior approval of the State Bridge Engineer) and shall be noted accordingly on the contract drawings.

Prestressed Concrete:

The following values of f'_c @ 28 days shall be used for these structures:

Bridge Component	f'_c (ksi)
Girders	5.0 to 8.0*
Piles	5.0 to 6.0

Table 5-1

** Higher strengths shall require the prior approval of the State Bridge Engineer*

For prestressed concrete members, compressive strength of concrete used for design (f'_c) and at time of prestressing (strand release) (f'_{ci}) shall be specified on the contract drawings.

5.2 PRESTRESSED CONCRETE GIRDER DESIGN POLICY

The following policies shall be used for typical prestressed concrete girder designs using a composite concrete deck:

1. ALDOT preferred standard and modified shape AASHTO-PCI type girders along with solid and voided slab beams are presented in ***Figure 5.2a*** along with strand templates presented in ***Figure 5.2b***. Modifications of these girders or other girder types along with strand patterns may be proposed for use in special circumstances and shall have the prior approval of the State Bridge Engineer prior to implementation. Two vertical rows of 0.6'' strand is prohibited in 6'' webs unless approved by the State Bridge Engineer.

2. Girders shall be designed as simple spans for all dead and live loads. Spans shall not be made continuous for live load. To eliminate joints, decks may be made continuous (link slabs).

3. Girders shall be designed so that no tension occurs in the bottom of the girder after losses under the Service III load combination limit state. Exceptions to this policy shall have the prior approval of the State Bridge Engineer. In no case shall tension in Service III conditions exceed $0.0948\sqrt{f'_c}$ (ksi).

4. Prestressing strands shall be 0.5 or 0.6 inch in diameter, Low Relaxation, 270 ksi Ultimate Tensile Strength. Use strand areas as follows:

   - For 0.5" Ø strands, use A = 0.153 sq. in.
   - For 0.5" Ø Special strands, use A = 0.167 sq. in.
   - For 0.6" Ø strands, use A = 0.217 sq. in.

5. Shear steel reinforcement shall be spaced so that no additional reinforcement is necessary to address horizontal shear forces at the top of the girder and shall not be spaced greater than 18" o.c. Shear steel reinforcement in the girder ends shall be spaced 4" o.c. and shall extend from the end of the girder for a distance equal to the girder depth. Shear steel reinforcement shall be no smaller than #5's and shall extend above the top of the girder to engage the slab at the approximate mid-depth between top and bottom deck reinforcing with standard 90º hooks.

6. Confinement steel reinforcement shall be #3's spaced at 4" o.c. minimum and shall extend from the end of the girder for a distance equal to the beam depth.

7. Use K_1=1.16 (based on regional dolomitic limestone aggregate) in ***AASHTO LRFD, Equation 5.4.2.4-1*** for E_c, Modulus of Elasticity. Adjust the value of K_1 as appropriate for other aggregates if known. Unit weight of concrete shall be assumed to be 0.150 k/ft^3 unless known otherwise.

8. In ***AASHTO LRFD, Equation 5.9.3.1-1*** for total prestress loss in pre-tensioned members, the value of Δf_{pLT} shall be calculated using ***AASHTO LRFD, Article 5.9.3.3, Approximate Estimate of Time-Dependent Losses.*** The value for ***H***, relative humidity, shall be taken as 75%.

9. The following shall apply for purposes of computing ***expected*** camber and deflection values to be presented in the contract plans. A separate girder analysis run will be required to determine these values.

   - Use ***AASHTO LRFD, Article 5.9.3.4: Refined Estimate of Time-Dependent Losses***.
   - Time at strand release: 0.75 days.
   - Time from release of strands to pouring of the bridge deck: 120 days.
   - Relative humidity: 75%.
   - Final age: 27,500 days.
   - Concrete strengths: Use ***expected*** concrete strengths computed as follows:
     - At prestress transfer, f^*_{ci} :
       For 4 ksi $\leq f'_{ci} \leq$ 5 ksi, $f^*_{ci} = f'_{ci}$ + 1.95 ksi
       For 5 ksi $< f'_{ci} \leq$ 9 ksi, $f^*_{ci} = 0.9f'_{ci}$ + 2.45 ksi
     - At 28 days, f^*_c :
       For $f'_{ci} \leq$ 9 ksi, $f^*_c = 1.3f'_{ci}$ + 3.5 ksi

10. Girder designs should be based on a non-transformed section; however, a transformed section may be considered with the prior approval of the State Bridge Engineer. Elastic gains shall be neglected unless approved by the State Bridge Engineer. See ***AASHTO LRFD, Article 5.9.3.2.3a: Pretensioned Members*** and ***Article 5.9.3.3: Approximate Estimate of Time-Dependent Losses***.

11. Debonding of prestressed concrete girders shall be as given in ***AASHTO LRFD, Article 5.9.4.3.3***.

12. Per ***AASHTO LRFD, Article 5.9.4.4.1: Splitting Resistance***, relative to the anchorage zones in prestressed girders:

    "The resistance shall not be less than four percent of the total prestressing force at transfer."

ALDOT exception to AASHTO:
ALDOT defines, "...force at transfer", to be the stress inducing force in the girder end at release.

13. The following shall be shown on the camber diagram for prestressed concrete girders:

    - Deck thickness
    - Fillet @ centerline bearing
    - Total of deck thickness plus fillet @ centerline bearing thickness
    - Theoretical upward camber
    - Downward dead load deflection

    The reporting format for this information is graphically presented in the ***Quality Control Manual for Bridge Plan Detailing***.

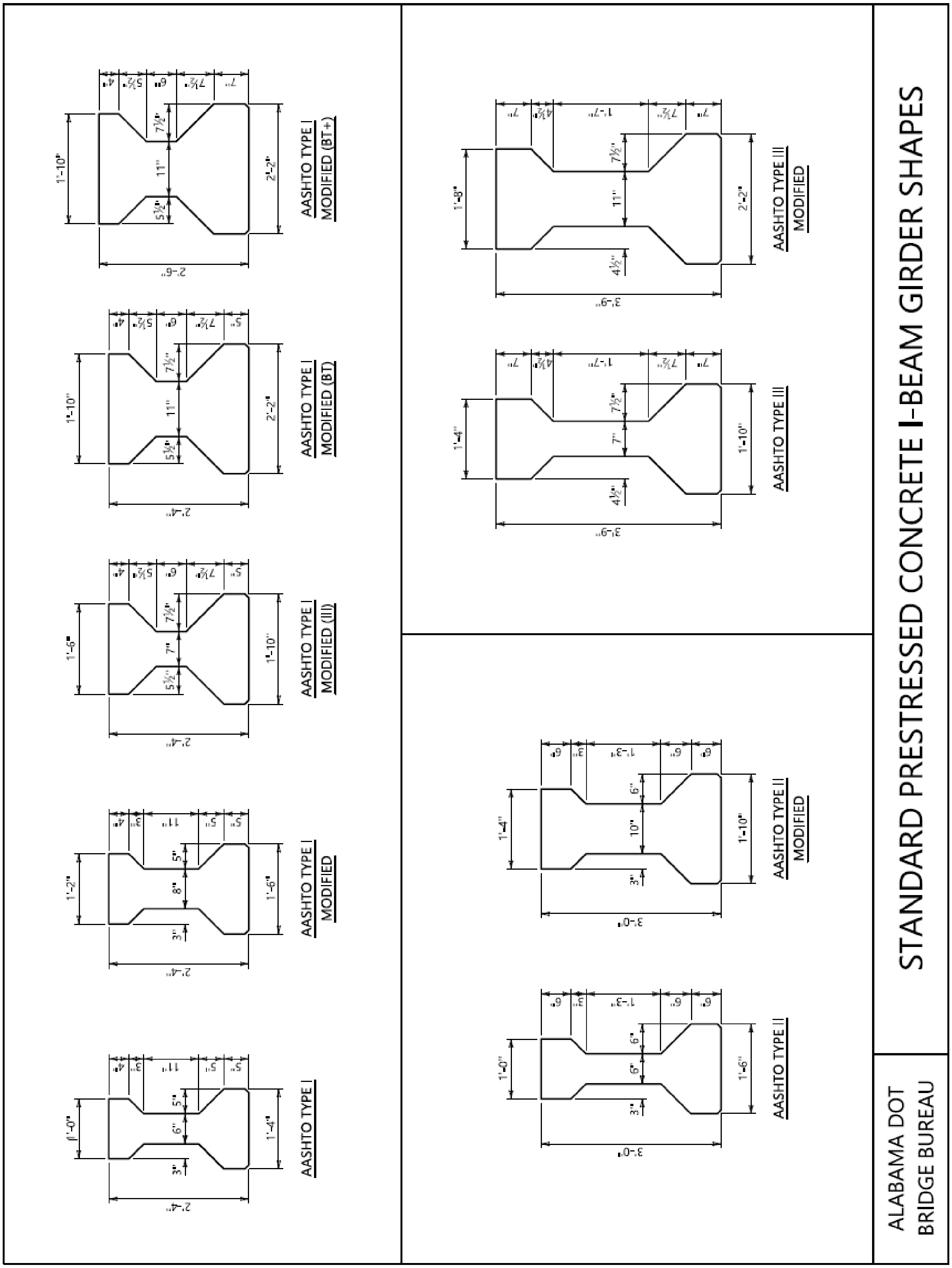

STANDARD PRESTRESSED CONCRETE I-BEAM GIRDER SHAPES
ALABAMA DOT
BRIDGE BUREAU
AASHTO TYPE I
AASHTO TYPE I
MODIFIED
AASHTO TYPE I
MODIFIED (III)
AASHTO TYPE I
MODIFIED (BT)
AASHTO TYPE I
MODIFIED (BT+)
AASHTO TYPE II
AASHTO TYPE II
MODIFIED
AASHTO TYPE III
AASHTO TYPE III
MODIFIED

Figure 5.2a

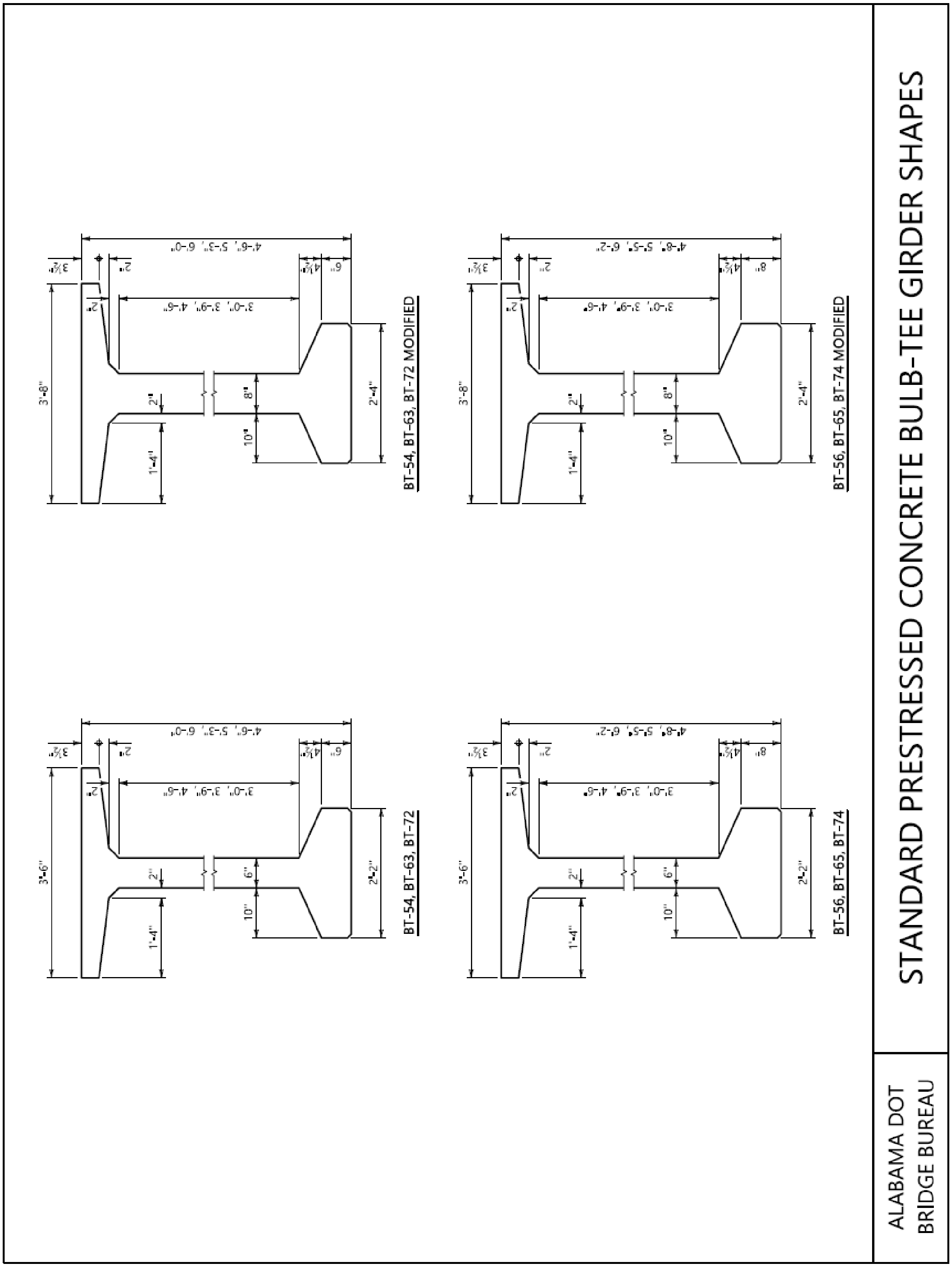


Figure 5.2a (cont.)

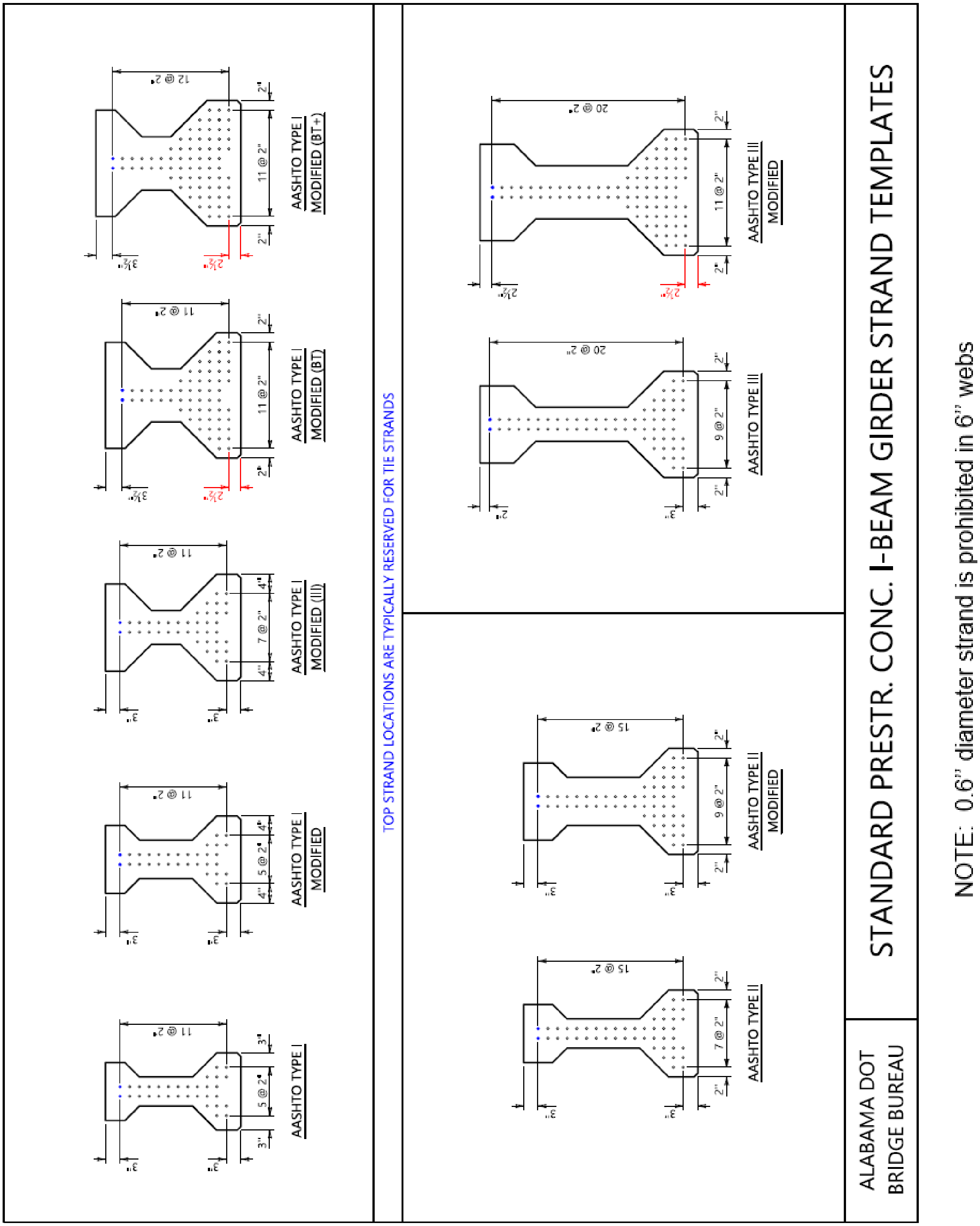
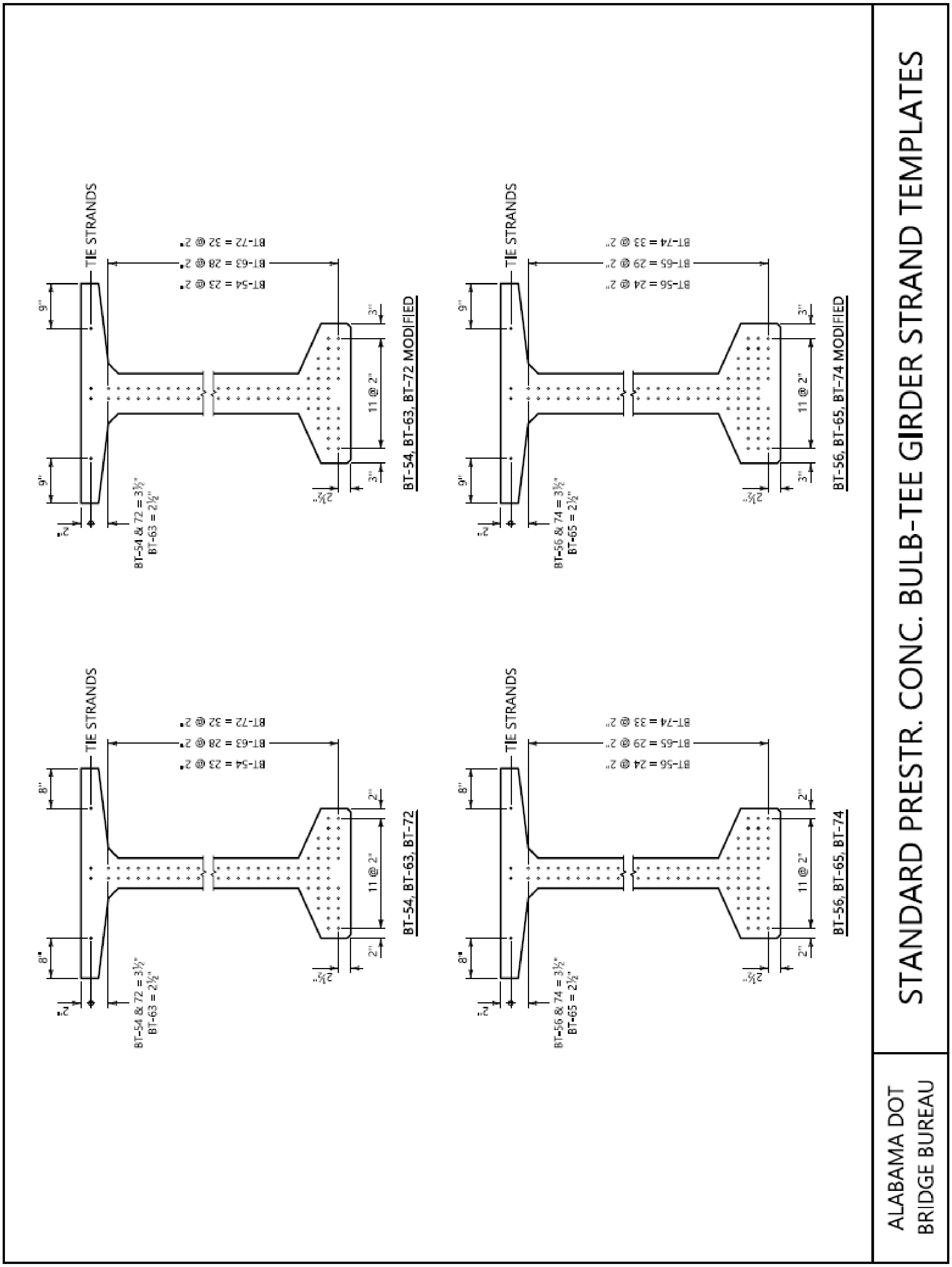

STANDARD PRESTR. CONC. I-BEAM GIRDER STRAND TEMPLATES
ALABAMA DOT
BRIDGE BUREAU
TOP STRAND LOCATIONS ARE TYPICALLY RESERVED FOR TIE STRANDS
AASHTO TYPE I
AASHTO TYPE I MODIFIED
AASHTO TYPE I MODIFIED (III)
AASHTO TYPE I MODIFIED (BT)
AASHTO TYPE I MODIFIED (BT+)
AASHTO TYPE II
AASHTO TYPE II MODIFIED
AASHTO TYPE III
AASHTO TYPE III MODIFIED
NOTE: 0.6" diameter strand is prohibited in 6" webs

Figure 5.2b



NOTE: 0.6" diameter strand is prohibited in 6" webs

Figure 5.2b (cont.)

5.3 INTERMEDIATE DIAPHRAGMS

For concrete girders, intermediate diaphragms shall be used only when required by calculation and shall be concrete.

5.4 STEEL REINFORCEMENT

Steel grade shall be as stated in the ***ALDOT Standard Specifications for Highway Construction*** and shall be indicated on individual plan sheets where reinforcing steel is called for.

For design clearances (concrete cover) used for reinforced concrete structures, see the ***Quality Control Manual for Bridge Plan Detailing, Section 3.3.3***.

The following reinforcing steel spacing requirements shall be satisfied:

1. Criteria for minimum and maximum spacing of reinforcement shall be in accordance with ***AASHTO LRFD, Article 5.10.3***.

ALDOT exception to AASHTO:
The maximum spacing of flexural reinforcement shall not exceed 9".

2. Where flexural reinforcement is placed in two or more layers, bars in the lower layers shall be placed directly below bars in the upper layer, with layers not less than 4" on center.

3. The use of #14 & #18 bars shall have the prior approval of the State Bridge Engineer.

4. The Designer is reminded to check the minimum reinforcement requirements of ***AASHTO LRFD, Article 5.10.6: Shrinkage and Temperature Reinforcement***.

5. Minimum reinforcement shall be provided in ends of bent/pier caps and abutment caps.

6. See ***SDM Section 3.5*** for splicing requirements for reinforced concrete columns in SDC categories A2, B and C.

5.5 DECKS

ALDOT standard poured in place concrete bridge decks shall have a minimum total thickness of 8'', 8½'' or 9'' (1'' minimum fillet plus deck thickness of 7'', 7½'' or 8'' dependent on girder spacing) at the critical point on the girder flange edge measured from the top flange top surface to the top surface of the deck. Calculated fillet at centerline bearing shall take into consideration this requirement and account for vertical curve, super-elevation transition, or other complex roadway geometries. The fillet shall be investigated for each girder line, as necessary, and adjustments made to meet minimum requirements. See ***SECTION 9, DECKS AND DECK SYSTEMS***.

5.6 MASS CONCRETE

1. Bridge elements (excluding drilled shafts) to be designated as mass concrete shall be identified on the Contract plans. An element shall be designated mass concrete when the least dimension (**D_L**) is greater than 5 feet. All exceptions to this policy shall have the prior approval of the State Bridge Engineer.

   When determining member dimensions, the designer must consider the specification requirements for mass concrete (see ***Section 510.03(d)*** *of the* ***ALDOT Standard Specifications for Highway Construction***). When possible, proportion members so that mass concrete is avoided.

   See ***Figure 5.6*** for guidance in determining **D_L**.

2. The temperature of concrete during curing shall not exceed 160º F (***AASHTO LRFD, Article 5.14.2.5***).

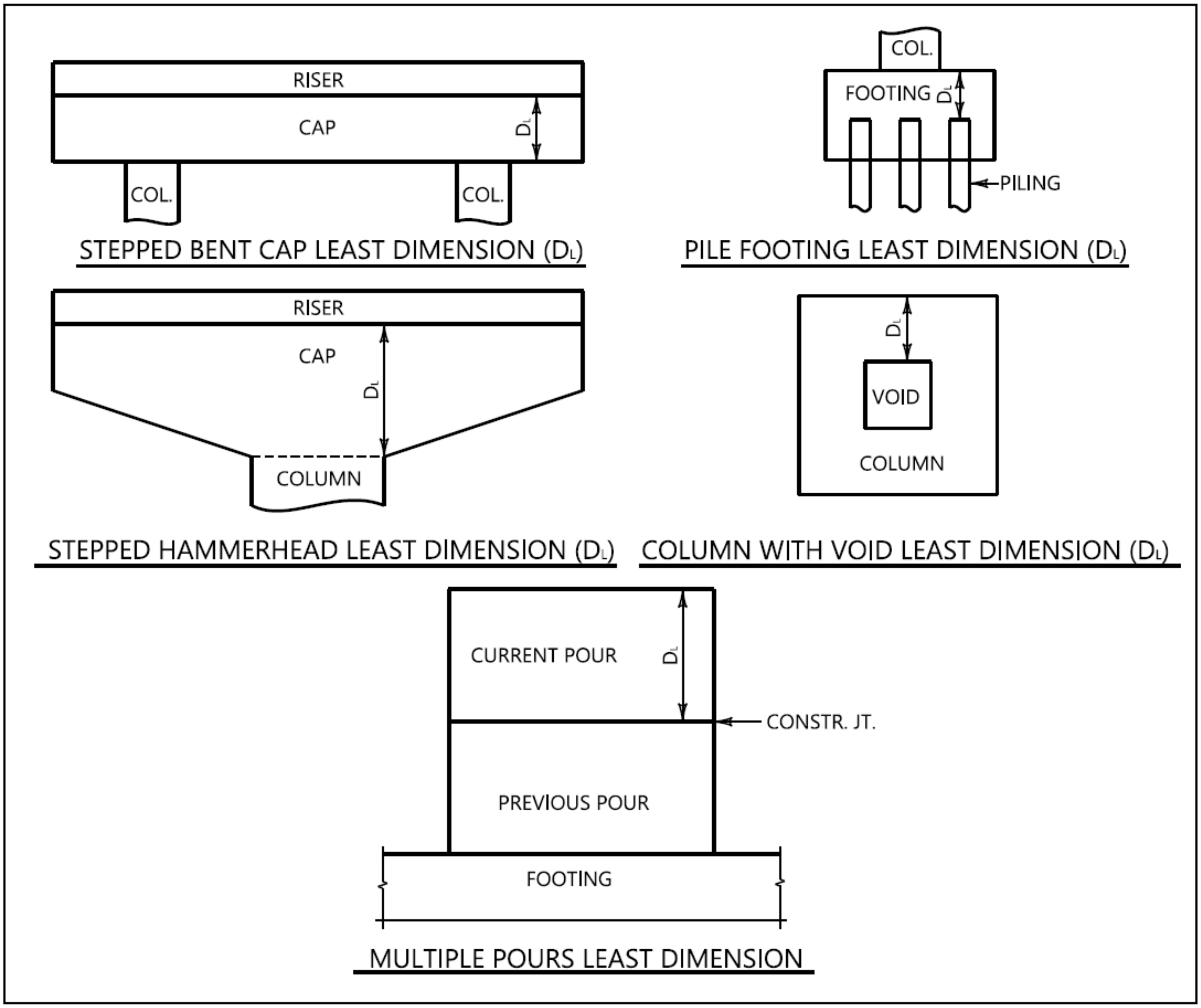
ALDOT exception to AASHTO:
The maximum temperature of concrete may be increased to 185º F when the concrete mix design requirements of ***Section 510.03(d)2*** *of the* ***ALDOT Standard Specifications for Highway Construction*** *are met.*

5.7 SUPERSTRUCTURE

All pre-cast pre-stressed concrete girders shall be designed as simple spans from bearing to bearing for all dead and live loads. Bridge decks may be continuous (link slab) (see ***Bridge Special Project Drawings EBEW*** for closed joint detail and ***Bridge Special Project Drawing SDR-1***) across an interior bent/pier up to the maximum span length as noted on ***Bridge Special Project Drawing SPGD-1***. Longer lengths will require the design of a special bearing(s) and must have the approval of the State Bridge Engineer.

No design shall exceed the deck joint limitations noted in ***SECTION 14.1*** when calculating the required joint opening. Use of finger joints for adjacent prestressed concrete girder spans is prohibited. Finger joints are allowed for prestressed concrete girder spans adjacent to structural steel girder spans. Finger joints are allowed in other concrete applications such as post-tensioned box girder spans with the approval of the State Bridge Engineer.

Superstructures made continuous for live load using pre-cast girders acting as simple spans for dead load are prohibited.


RISER
CAP
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STEPPED BENT CAP LEAST DIMENSION (DL)
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FOOTING
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PILING
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RISER
CAP
DL
COLUMN
STEPPED HAMMERHEAD LEAST DIMENSION (DL)
DL
VOID
COLUMN
COLUMN WITH VOID LEAST DIMENSION (DL)
CURRENT POUR
DL
CONSTR. JT.
PREVIOUS POUR
FOOTING
MULTIPLE POURS LEAST DIMENSION

Figure 5.6

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SECTION 6. STEEL STRUCTURES

The provisions of ***AASHTO LRFD, Section 6*** shall apply to this section unless noted and/or excepted below.

6.1 MATERIALS

Main members (such as girders, rolled beams, lateral bracing, diaphragms, stiffeners, and vertical connection plates) shall be AASHTO M 270 Grade 36, Grade 50, or Grade 70. Individual plan sheets shall indicate the required grade of those members.

The use of weathering steel shall have the prior approval of the State Bridge Engineer.

Miscellaneous members (such as armor plates, ladders, catwalks, and clip angles) shall be AASHTO M 270 Grade 36 or Grade 50.

Anchor bolts shall conform to AASHTO M 314.

6.2 GIRDER DESIGN POLICY

The following policies shall be used for the design of steel girders:

1. Girders shall be designed as a composite section in the region where the concrete slab is in compression under dead load. For continuous girders, the regions where the slab is in tension shall be designed as non-composite.

2. Flange plates shall be a minimum of 1” thick and 12” wide.

3. Use of hybrid sections (flange and web of different materials) in bridge sections (such as over bents) shall have the prior approval of the State Bridge Engineer.

4. Shop flange splices required by a change in plate thickness or width shall not be used unless a minimum of 1,500 pounds of structural steel can be saved by the addition of the shop splice.

5. The minimum radius for heat curving of beams and girders shall be checked in accordance with ***AASHTO LRFD, Article 6.7.7.2***. The plans shall note if heat curving is prohibited by the specifications.

6. Fabrication, transportation, and erection of structural steel members shall be considered during design. The length of shipped pieces (girder flanges and web) joined by bolted field splices shall not exceed 140’, and the gross weight of shipped pieces shall not exceed 50 tons. Longer pieces shall have the prior approval of the State Bridge Engineer.

7. Girder web depth to thickness ratio shall be proportioned so that longitudinal stiffeners are precluded (see ***AASHTO LRFD, Article 6.10.2.1.1***).

8. The following two sets of camber ordinates shall be calculated and shown:

    1. Camber due to dead load of steel only.

    2. Total non-composite dead load camber (dead load of both steel and concrete).

    Camber ordinates shall be calculated and shown at the same points required for incremental deck finished grade elevations, as follows:

    - Camber ordinates at 10^{th} points shall be provided for all spans up to 99’ in length.

    - Camber ordinates at 20^{th} points shall be provided for spans from 100’ to 199’ in length.

    - Camber ordinates at 40^{th} points shall be provided for spans 200’ and greater in length.

8. Minimum edge distances shall be as in the following table:

ALDOT exception to AASHTO:	
Bolt Diameter (in.)	**Min. Edge Distance (in.)**
7/8	1-1/2
1	1-3/4
1-1/8	2
1-1/4	2-1/4

Table 6-1

9. The minimum fillet weld size shall be as shown in the table on the following page. The minimum weld size shall be determined by the thicker of the two parts joined. The minimum fillet weld size shall be used unless a larger size is required by design based on the calculated stress. The weld size need not exceed the thickness of the thinner part joined. Fabrication of ancillary members, as defined in ***AASHTO/AWS D1.5M/D1.5:2020 Bridge Welding Code***, is exempted from these requirements.

Material Thickness of Thicker Part Joined	Minimum Size of Fillet Weld (in.)
To ¾" inclusive	1/4
Over ¾" to 1½"	5/16
Over 1½" to 2¼"	3/8
Over 2¼" to 6"	1/2

Table 6-2

For additional guidance regarding design considerations for fabrication, transportation, and erection of structural steel members, refer to ***AASHTO/NSBA Steel Bridge Collaboration Document G12.1-2020: Guidelines to Design for Constructability and Fabrication***.

6.3 SHEAR CONNECTORS

Shear connectors shall conform to criteria given in ***AASHTO LRFD, Article 6.10.10***.

ALDOT exception to AASHTO:

In addition to LRFD requirements, shear connectors shall only be studs with a minimum length of 5" and shall conform to AASHTO M 169.

Typically, smaller diameter shear studs are used (5/8'', 3/4'', 7/8''). At the discretion of the designer, larger studs (1'', 1 ¼'') may be used. This may allow fewer and wider spacing of studs.

6.4 SHOP CONNECTIONS

During fabrication of steel girders, the following policies shall be used for shop connections:

1. All shop-welded joints shall be made using pre-qualified joints for bridge applications based on ***AASHTO/AWS D1.5M/D1.5:2020 Bridge Welding Code,*** as adopted by ALDOT, and modified in accordance with the provisions of the ***ALDOT Standard Specifications for Highway Construction*** and any applicable special provisions.

2. Intersecting welds shall not be permitted.

3. The corners of transverse stiffeners shall be clipped and welded as follows:

   - Stiffener-to-web welds shall be terminated 1" ± ¼" from the clip.
   - Stiffener-to-flange welds shall be terminated ½" ± ¼" from the clip and the edges of the stiffener plate.

4. When design lengths of web and flange plates exceed available lengths from rolling mills, material may be shop spliced utilizing pre-qualified full penetration butt welds at approximately the one-quarter and/or three-quarter point of the required material lengths. Shop welded flange splices shall be a minimum of 2’ from shop web splices.

6.5 FIELD CONNECTIONS

Bolted connections shall be made using 7/8” Ø (minimum) ***ASTM F3125*** Grade A325 High Strength Bolts in standard sized holes. Holes in gusset plates for lateral bracing member connections may be oversized (hole spacing and edge distances must be increased also). All bolts, nuts and washers shall be mechanically galvanized in accordance with ***ASTM B695*** Class 50.

Field welding is prohibited except for attachment of bearings, shear studs, armor plate splices, pile cap plates and channels and sway-bracing.

6.6 DECKS

ALDOT standard poured in place concrete bridge decks shall have a minimum total thickness of 9’’ at the centerline of girder measured from the top flange top surface to the top surface of the deck ***and*** a minimum total thickness of 8’’, 8½’’ or 9’’ (1’’ fillet plus deck thickness of 7’’, 7½’’ or 8’’ dependent on girder spacing) at the critical point on the girder flange edge measured from the top flange top surface to the top surface of the deck. See ***SECTION 9, DECKS AND DECK SYSTEMS***.

SECTION 7. ALUMINUM STRUCTURES

The provisions of ***AASHTO LRFD, Section 7*** shall apply to this section unless noted and/or excepted below.

ALDOT exception to AASHTO:
Permanent aluminum structures and/or components are prohibited unless approved by the State Bridge Engineer.

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SECTION 8. WOOD STRUCTURES

The provisions of ***AASHTO LRFD, Section 8*** shall apply to this section unless noted and/or excepted below.

ALDOT exception to AASHTO:
Permanent wood structures and/or components are prohibited unless approved by the State Bridge Engineer.

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SECTION 9. DECKS AND DECK SYSTEMS

The provisions of ***AASHTO LRFD, Section 9*** shall apply to this section unless noted and/or excepted below.

9.1 REINFORCED CONCRETE DECKS

For typical bridge deck on girder designs using metal stay-in-place forms or removable forms, all ALDOT Projects shall have a standard reinforced concrete deck as follows (see ***Figure 9.1***):

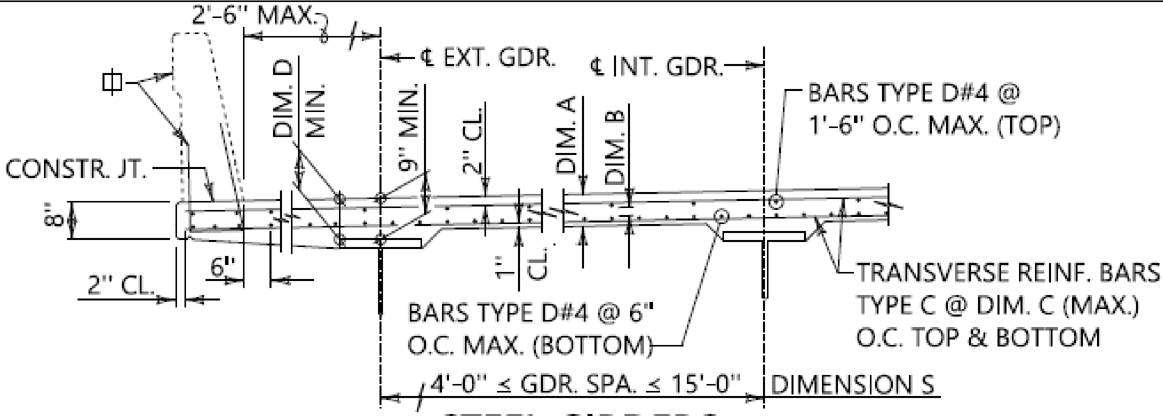
- Deck thickness: 7'' to 8'' for girder spacings noted below.
- Girder spacing: Minimum 4'-0'' to 15'-0'' maximum.
- Minimum flange width: 1'-0'' (steel or concrete).
- Maximum dimension from centerline of exterior girder to gutter line: 2'-6'' (may be increased up to 4'-9'' with approval of State Bridge Engineer).
- Minimum thickness: From top of flange to top of deck, 1'' plus deck thickness. See ***Section 5.5***.
- For steel girders, minimum thickness over top of flange at centerline girder: 9''. See ***Section 6.6***.
- Transverse reinforcement, top and bottom, Type ''C'', size as indicated, @ Dimension "C" o.c. max. equally spaced, measured longitudinally along bridge, 2'' clearance to top of deck, 1'' clearance to bottom of deck. Reinforcement shall be placed perpendicular to longitudinal axis of bridge for skews greater than 25 degrees. Reinforcement shall be placed parallel to skew for skews less than or equal to 25 degrees.
- Longitudinal reinforcement, top #4 (Type ''D'') @ 1'-6'' o.c. max. equally spaced, tied to and under top transverse reinforcement; bottom #4 (Type ''D'') @ 6'' o.c. max. equally spaced, tied to and on top of bottom transverse reinforcement, 1st bar top or bottom placed at 6'' from gutterline. For curved structures, reinforcement shall be placed parallel to the curvature.

Deviations from the parameters noted above will require a unique design and shall have the prior approval of the State Bridge Engineer.

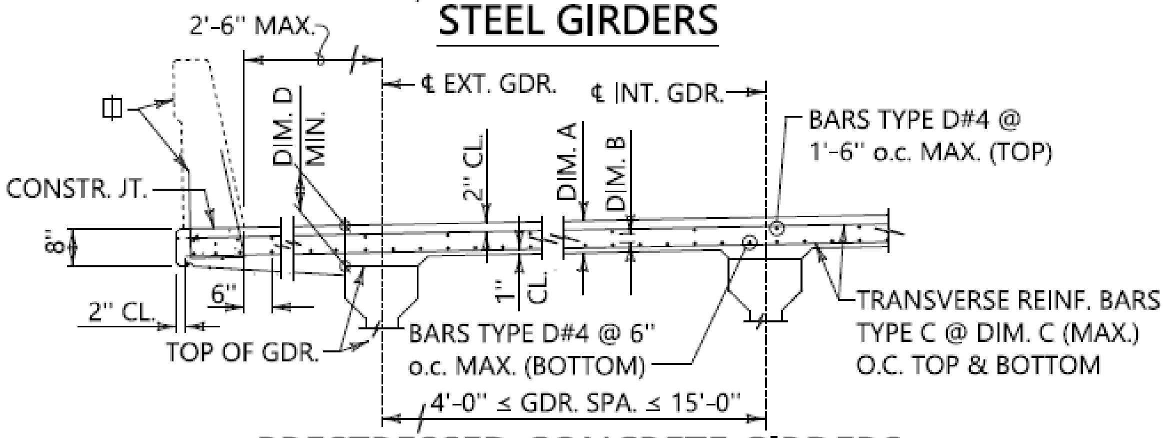
Other decks where the deck design is inherent in the design of the structure, such as segmental, NEXT beam, etc. are exempt from this Section and shall satisfy the provisions of ***AASHTO LRFD, Section 9***.

9.2 INCREMENTAL DECK FINISH GRADE ELEVATIONS

Incremental deck finish grade elevations shall be computed and tabulated in the plans per the requirements listed in the ***Quality Control Manual for Bridge Plan Detailing, Section 4.2.5***.



STEEL GIRDERS



PRESTRESSED CONCRETE GIRDERS

NOTE: AASHTO GIRDERS SHOWN. OTHER GIRDER TYPES SIMILAR.

DIMENSION S	BARS TYPE C SIZE	DIM. A	DIM. B	DIM. C	DIM. D
4'-0" ≤ S ≤ 10'-0"	#5	7"	1¾"	6"	8"
10'-0" < S ≤ 14'-0"	#6	7½"	2"	6"	8½"
14'-0" < S ≤ 15'-0"	#6	8"	2½"	5"	9"

ALDOT STANDARD BRIDGE DECK

NOTE: SKETCHES SHOWN ABOVE REPRESENT TYPICAL GIRDER TYPES USED BY ALDOT. OTHER GIRDER TYPES (I.E., RCDG, BOX, ETC.) WILL UTILIZE THE SAME STANDARD DECK UNLESS APPROVED OTHERWISE BY THE STATE BRIDGE ENGINEER.

⏀ NOTE: FOR DETAILS OF BRIDGE BARRIER RAIL AND REINF., SEE BRIDGE SP. PROJ. DWG. BBR-1 OR BBR-2.

(REV. JAN. 22)

Figure 9.1

SECTION 10. FOUNDATIONS

The provisions of ***AASHTO LRFD, Section 10*** shall apply to this section unless noted and/or excepted below.

10.1 FOUNDATION EMBEDMENT

Embedment of foundation elements into natural ground or graded fills or cuts shall be as noted below:

Grade Separations

Top of footing elevations shall be set so that there is a minimum of 2'-0'' below the lowest natural ground or finished grade elevation within a horizontal distance of 5'-0'' around the perimeter of the footing. Where a drilled shaft supports the columns, the top of shaft elevations may extend to natural ground or finished grade. When the design shaft diameter is 1'-0'' or greater than the diameter or diagonal of the column, the top of shaft elevation shall be set as noted above for footings. Where the difference in bottom of cap elevation and the top of shaft elevation is less than 4'-0'' the shaft should be extended to the bottom of the cap.

Waterway Crossings

Pile bents and concrete framed bents or piers on drilled shafts shall be designed for stability in the scoured condition accounting for contraction scour, pier scour and long-term degradation of the streambed. Top of drilled shaft elevations shall be set at natural ground, except where the difference in bottom of cap and top of shaft is less than 4'-0'' the shaft should be extended to the bottom of the cap. Top of drilled shaft elevations in open water shall be set 2'-0'' minimum above normal water elevation.

Concrete framed bents or piers, with driven pile, micro-pile or drilled shaft footings, shall be designed such that the top of footing is located below the streambed at a depth equal to the estimated long-term degradation and contraction scour depth (excluding pier scour). All exceptions to this requirement shall have the prior approval of the State Bridge Engineer. If an exception is approved, the designer shall consider corrosion potential of exposed piling, possible debris collection on shafts/piles, and unbraced lengths (exposed shaft/pile below footing plus depth to fixity). The design shall account for estimated long-term stream degradation, contraction, and pier scour depth. In no case shall the top of footing be located less than 2'-0'' below natural ground or mud line within a horizontal distance of 5'-0'' around the perimeter of the footing.

Spread footings are not allowed in material susceptible to scour.

A scour evaluation is not required for water crossing widenings where shoulders only are added to existing bridges. A scour analysis is required for widenings where traffic lanes are added.

Bridge scour shall be evaluated in accordance with ***FHWA Hydraulic Engineering Circular No. 18: Evaluating Scour at Bridges*** and ***ALDOT Guidelines for Operation, Section 3-39: Design Flood Frequencies for Bridge Openings and Scour Evaluations***.

10.2 PILING

The pile types and sections shown in the following tables are those typically used by ALDOT. Other pile types and sections may be proposed and used with the prior approval of the State Bridge Engineer. The Maximum Factored Design Load Allowed, P_{AL}, provided in the tables is for piles with full lateral support only. For pile types and sections not shown in the tables, the following equation shall be used to determine the allowable load with full lateral support only.

$$P_{AL} = \Phi_{AL} P_r \text{ , where } \Phi_{AL} = 0.65$$

Factored Structural Resistance of Piles, P_r, is defined by AASHTO. The Alabama factor, Φ_{AL}, reduces the resistance to values representative of past Departmental experience and is used to avoid problems associated with overstressing during driving.

Uplift in piling is not allowed without the prior approval of the State Bridge Engineer.

Steel "H" Piling (Grade 50 only) (see *AASHTO LRFD 6.5.4.2*):

Maximum Factored Design Load Allowed per Pile for Steel "H" Piling (tons)		
Pile Designation	**With Pile Points (Φ_c = 0.5)**	**Without Pile Points (Φ_c = 0.6)**
10x42	100	120
12x53	125	150
12x63	150	175
14x73	170	205
14x89	210	250
14x102	240	290
14x117	275	335

Table 10-1

Precast Prestressed Concrete Piling:

Prestressed concrete piling shall be selected from ***Bridge Special Project Drawing PSCP-1.*** Maximum loads shall be as noted below (*f'_c = 5 ksi, f_{pe} = 170 ksi, strand = ½" Ø Low Relaxation 270 ksi) (see* ***AASHTO LRFD 5.6.4.4****)*:

Maximum Factored Design Load Allowed per Pile for Prestressed Piling (tons)	
14" Square	150
16" Square	200
18" Square	250
20" Square	320
24" Square	385
30" Square	550
36" Square	710

Table 10-2

Precast Prestressed Spun Cast Cylinder Piling:

Wall thickness = 6''. Maximum loads shall be as noted below (f'_c = *7 ksi*, f_{pe} = *170 ksi, strand = ½" Ø Low Relaxation 270 ksi) (see* ***AASHTO LRFD 5.6.4.4****)*:

Maximum Factored Design Load Allowed per Pile for Spun Cast Cylinder Piling (tons)		
Diameter	**Number of Tendons**	**Maximum Load**
36"	8	650
	12	625
	16	600
42"	12	765
	16	745
	20	720
54"	16	1020
	20	1000
	24	975
66"	24	1255
	28	1230
	32	1210

Table 10-3

10.3 GEOTECHNICAL COORDINATION

Until the ALDOT Materials & Tests Bureau can develop a sufficient database upon which to base load and resistance factor designs, the following information shall be provided when requesting foundation design information:

- Substructure types and locations
- Pile/shaft sizes
- Number of piles/shafts per substructure unit
- Service I axial load per pile/shaft (tons)
- Maximum Strength I, III, or V axial load per pile/shaft (tons)
- Extreme Event II axial load per pile/shaft (tons) - [stream crossings]
- Elevations at which the axial loads are applied to the pile/shaft

SECTION 11. ABUTMENTS, PIERS, AND WALLS

The provisions of ***AASHTO LRFD, Section 11*** shall apply to this section unless noted and/or excepted below.

11.1 ABUTMENTS

Typically, spill-through stub abutments with the bridge joint inside the backwall shall be used. Semi-integral stub abutments may be used with the prior approval of the State Bridge Engineer. Fully integral abutments are not used. Typical foundation elements for these type abutments include steel H-piles, precast prestressed square concrete piles, drilled shafts, and spread footings depending on the subsurface materials present. Other pile types such as concrete cylinder piles and steel pipe piles, may be considered with the prior approval of the State Bridge Engineer.

Piling should be spaced to match girder spacing so that piles are located directly under girders. Designs where pile spacing does not locate piles under girders may be considered with the prior approval of the State Bridge Engineer. Abutment designs using drilled shafts or other large diameter pile types that are typically widely spaced are exempt from this requirement.

Other abutment types (e.g. end bent, wall, etc.) may be considered with the prior approval of the State Bridge Engineer.

11.2 BENTS/PIERS

Pile Bents:

Pile bents with reinforced concrete caps may be considered for support of spans 50 feet or less. Pile bents may be considered for support of spans greater than 50 feet with the prior approval of the State Bridge Engineer. Pile bents should only be considered where subsurface materials will allow the minimum penetrations into natural ground as noted in the ***ALDOT Standard Specifications for Highway Construction, Section 505.03(h)*** with consideration for scour when applicable. Typically, steel H-piles and precast prestressed square concrete piles should be used. Other pile types, such as concrete cylinder piles and steel pipe piles may be considered with the prior approval of the State Bridge Engineer.

Piling should be spaced to match girder spacing so that piles are located directly under girders. Designs where pile spacing does not locate piles under girders may be considered with the prior approval of the State Bridge Engineer.

Appropriate analysis shall be conducted to determine pile loads and ensure stability.

Multi-Column Framed Bents:

Reinforced concrete framed bents should generally be used when span lengths exceed 50 feet. Typically, foundation elements of these structures consist of pile footings, spread footings, and drilled shafts. Steel H-piles and precast prestressed square concrete piles are commonly used in driven pile footings. Other pile types such as concrete cylinder piles and steel pipe piles (or alternatives such as drilled shafts) may be used with the prior approval of the State Bridge Engineer. Where drilled shafts extend to the bottom of the bent/pier cap, the cap shall be a minimum of 6 inches wider than the diameter of the drilled shaft.

Single Column Piers:

Single column “hammerhead” piers may be considered where appropriate and with the prior approval of the State Bridge Engineer. Designs utilizing a single drilled shaft shall have the prior approval of the State Bridge Engineer.

Wall Piers & Seal Footings:

Wall piers may be considered where appropriate and with the prior approval of the State Bridge Engineer.

Structural seal concrete footings shall be reinforced.

11.3 RETAINING WALLS

The Department’s Special and Standard Drawings book has retaining wall details to address fill heights of up to 34’. These details are provided on ***Bridge Standard Drawing RW 10-4***. For fill heights greater than 34’ requiring special design, the engineer shall be responsible for providing a design that satisfies the latest AASHTO design requirements. Unless geometrics or foundation conditions dictate otherwise, information shown on ***Bridge Standard Drawing RW 10-4*** shall be used as guidance in preparing the necessary plan details.

Responsibility for design and details of retaining walls shall be as follows:

- Temporary retaining walls – The contractor shall be responsible for providing the design and details for all temporary retaining walls.

- Permanent conventional walls – The Bridge Bureau shall be responsible for providing the design and details for all permanent conventional retaining walls unless a consultant has been contracted to provide such items as part of a complete set of plans.

- Permanent proprietary walls – The contractor shall be responsible for providing the design and details for all permanent proprietary retaining walls.

SECTION 12. BURIED STRUCTURES AND TUNNEL LINERS

The provisions of ***AASHTO LRFD, Section 12*** shall apply to this section unless noted and/or excepted below.

12.1 REINFORCED CONCRETE BOX CULVERTS

The Hydraulic Section of the Bridge Bureau is responsible for sizing all bridge culverts. The Hydraulic Section is responsible for recommending whether the culvert shall be cast-in-place or precast, and the culvert type shall be shown on the roadway plans. The Bridge Bureau (or a selected consultant) is responsible for the design and details of cast-in-place culverts and for reviewing the contractor's structural details for precast culverts. The State Bridge Engineer will furnish culvert standard drawings and details as needed.

Cast-In-Place Culverts:

The Bridge Bureau (or a selected consultant) is responsible for the design and details of all cast-in-place concrete box culverts, open bottom culverts that are to be constructed on sound rock foundation, and special culvert or special hydraulic structures. The Roadway Designer is responsible for providing the basic geometric, fill height, and slope information needed for the design and detailing of the hydraulic structure.

Precast Culverts:

The structural design and details for precast culverts shall conform to the provisions of ***ASTM C1577*** (using LRFD design methodology). For culvert openings and fill heights not covered in this specification, the contractor shall submit a design (prepared and stamped by an Alabama Registered Professional Engineer not employed by the Alabama Department of Transportation) to the State Bridge Engineer for approval in accordance with the ***ALDOT Standard Specifications for Highway Construction***. The Bridge Bureau is responsible for the review of the designs and details submitted.

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SECTION 13. RAILINGS

The provisions of ***AASHTO LRFD, Section 13*** shall apply to this section unless noted and/or excepted below.

13.1 BRIDGE RAILINGS

Use bridge railing as detailed on ***Bridge Special Project Drawing BBR-1, BBR-2,*** or ***BBR-M*** as appropriate. Use approach railing and/or barrier as per roadway standard drawings and/or plans.

ALDOT exception to AASHTO:
MASH approved, TL-4 rated railing shall be provided on new bridges located on ALL roadway categories with the exception of precast bridges on secondary roads which may continue to use the TL-3 rated New Jersey rail unless otherwise approved by the State Bridge Engineer.

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SECTION 14. JOINTS AND BEARINGS

The provisions of ***AASHTO LRFD, Section 14*** shall apply to this section unless noted and/or excepted below.

14.1 EXPANSION JOINTS

Use armor plate open joints as shown on ***Bridge Special Project Drawing SBD-1***. For bridges with high skews or other unusual joint situations for which the guidelines below might not apply, an alternate arrangement may be proposed to the State Bridge Engineer for approval.

Joints shall be set for a 1½'' opening (perpendicular to joint) at 70° F unless otherwise required and subsequently indicated on the plans. The calculated minimum joint opening should be no less than ½''. When the calculated maximum joint opening exceeds 3'', a structural steel finger joint shall be used.

Example drawings of current finger joint details are shown in the ***Quality Control Manual for Bridge Plan Detailing*** or are available by contacting the State Bridge Engineer. Finger joints shall be constructed with a continuous neoprene drainage trough (minimum 3/16" thick) for the full length of the joint.

Any other joint type shall have the prior approval of the State Bridge Engineer.

14.2 BEARING DEVICES

Bearings shall preferably be elastomeric Type 2, Type 4, or Type 5, in accordance with the ***ALDOT Standard Specifications for Highway Construction***. Type 1 bearings are approved for use only on short span precast structures as described in **SECTION 18, PRECAST BRIDGES**.

Elastomeric bearings shall be designed using "Method A", as described in ***AASHTO LRFD, Article 14.7.6***, with a durometer hardness of 50 for laminated pads and 60 for plain pads. The minimum distance from the edge of the elastomer (or the corner of the elastomer when bearings are skewed relative to the cap) to the edge of the cap or pedestal shall be 4".

14.3 ANCHOR BOLTS

This section discusses anchor bolts that connect the bridge superstructure to the substructure. Anchor bolts for other applications such as sign support structures, high mast lighting, etc. are not covered in this section.

Anchor bolts shall have rolled threads (see *NOTE* at end of section) and shall be set in corrugated anchor bolt wells. See ***Bridge Special Project Drawing SBD-1*** and the ***Quality Control Manual for Bridge Plan Detailing*** for pedestal, anchor bolt and anchor bolt well details. For anchor bolts with diameters larger than those specified on ***Bridge Special Project Drawing SBD-1***, the anchor bolts shall be detailed on the plans. Additionally, anchor bolt well diameter shall be increased proportionally. 5½'' minimum shall be provided between the edge of the pedestal and centerline of the anchor bolt. 8½'' minimum shall be provided between the edge of the cap and the centerline of the anchor bolt.

For bridges in SDC Category A1 (see ***SECTION 3.5***), anchor bolts shall be sized to resist a horizontal connection force equal to 0.15 times the vertical reaction due to the tributary permanent load. Anchor bolts for bridges in SCD Category A2 (see ***SECTION 3.5***) and greater shall be sized, at a minimum, to resist a horizontal connection force equal to 0.25 times the vertical reaction due to the tributary permanent load. Appropriate anchor bolts should be selected from ***Bridge Special Project Drawing SBD-1*** unless larger sizes are required to meet the requirements noted above.

NOTE: Anchor bolts with rolled threads have a smaller body diameter than the specified nominal diameter of the anchor bolt. For example, a 1 ½'' nominal diameter anchor bolt with rolled threads will have a body diameter of approximately 1 3/8''. When determining anchor bolt requirements, if the body diameter is a critical factor the designer must verify that the specified number and diameter of anchor bolts will meet design requirements.

SECTION 15. DESIGN OF SOUND BARRIERS

The provisions of ***AASHTO LRFD, Section 15*** shall apply to this section unless noted and/or excepted below.

ALDOT has no design considerations beyond those covered in the ***AASHTO LRFD Bridge Design Specifications***.

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SECTION 16. BRIDGE RATING

Bridge superstructures shall be analytically load rated in accordance with the requirements of the ***ALDOT Maintenance Bureau Bridge Inspection Manual Appendix I***. In addition to the suite of posting vehicles noted in ***Appendix I***, vehicles Crane 1, Crane 2, Crane 3, Barnhart and Mammoet shall be rated. The following conditions shall apply for rating the Barnhart and Mammoet vehicles only:

A. No other vehicles are on the bridge while the special vehicle is crossing the structure.

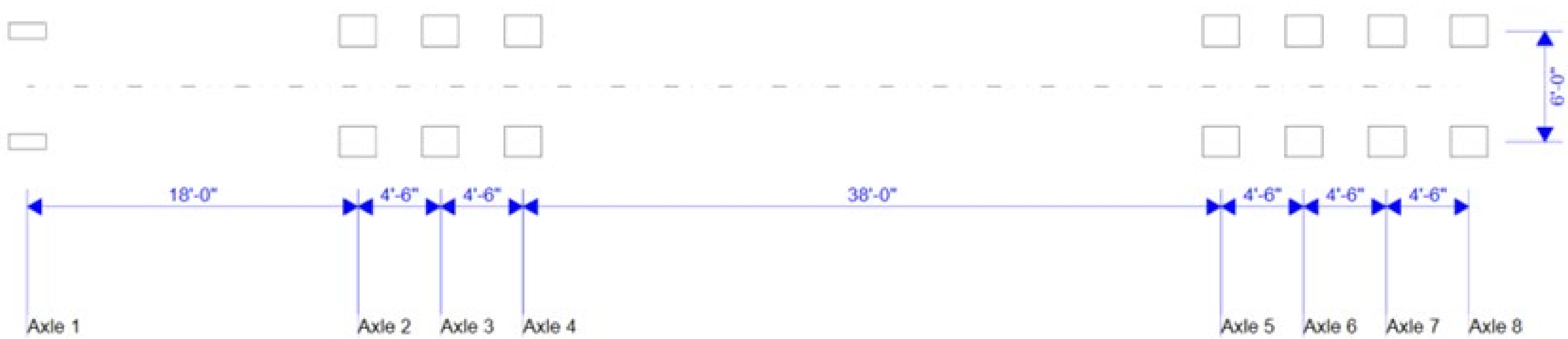
B. The special vehicle is centered on the structure while crossing the structure.

C. The impact factor may be reduced to zero (i.e., the special vehicle crosses the structure at 5 mph or slower without accelerating or decelerating).

Configurations for Crane 1, Crane 2, Crane 3, Barnhart and Mammoet vehicles are shown on pages 16-2 through 16-6. All structures shall achieve a passing rating for all vehicle loading conditions.

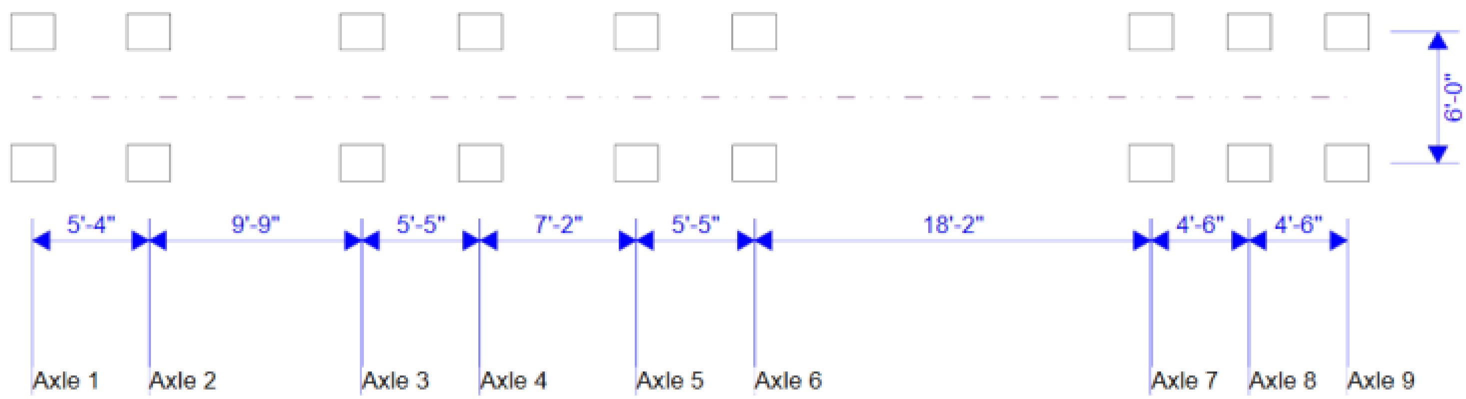
Consultant designed bridges shall be rated by the Consultant when directed by the State Bridge Engineer. Accordingly, the Consultant agreement should contain appropriate provisions for rating.

Crane 1 (160k)



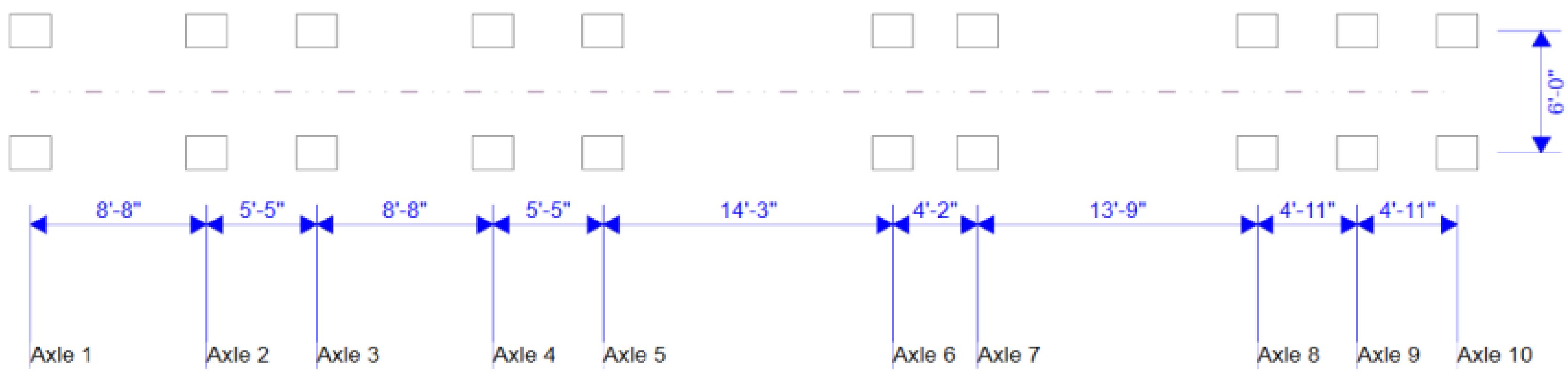
Axle no.	Axle load (kip)	Gage dist. (ft)	Wheel contact width (in)	Axle spacing (ft)	
				Minimum	Maximum
1	14.00	6.00	10.0000		
2	22.00	6.00	20.0000	18.00	18.00
3	22.00	6.00	20.0000	4.50	4.50
4	22.00	6.00	20.0000	4.50	4.50
5	20.00	6.00	20.0000	38.00	38.00
6	20.00	6.00	20.0000	4.50	4.50
7	20.00	6.00	20.0000	4.50	4.50
8	20.00	6.00	20.0000	4.50	4.50
Totals:	160.00			78.50	78.50

Crane 2 (170k)



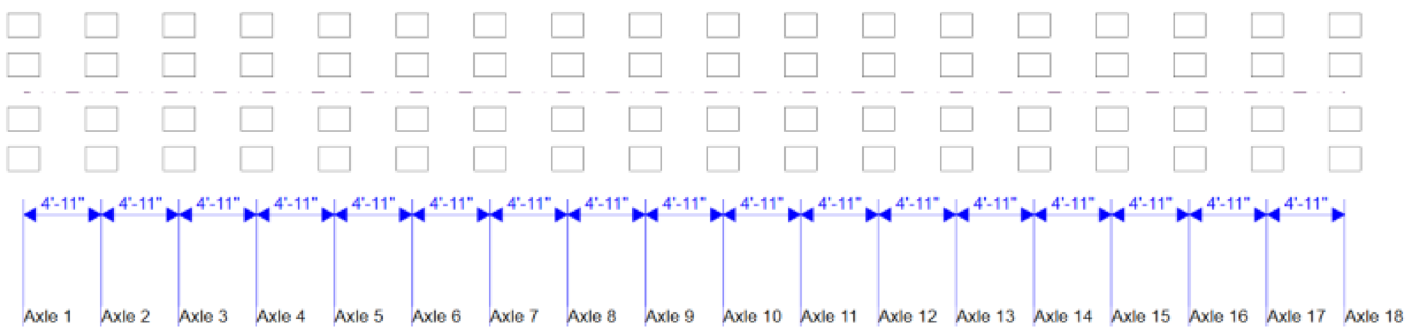
Axle no.	Axle load (kip)	Gage dist. (ft)	Wheel contact width (in)	Axle spacing (ft)	
				Minimum	Maximum
1	16.00	6.00	20.0000		
2	15.00	6.00	20.0000	5.33	5.33
3	22.00	6.00	20.0000	9.75	9.75
4	22.00	6.00	20.0000	5.42	5.42
5	22.00	6.00	20.0000	7.17	7.17
6	22.00	6.00	20.0000	5.42	5.42
7	16.90	6.00	20.0000	18.17	18.17
8	16.90	6.00	20.0000	4.50	4.50
9	16.90	6.00	20.0000	4.50	4.50
Totals:	169.70			60.25	60.25

Crane 3 (189k)

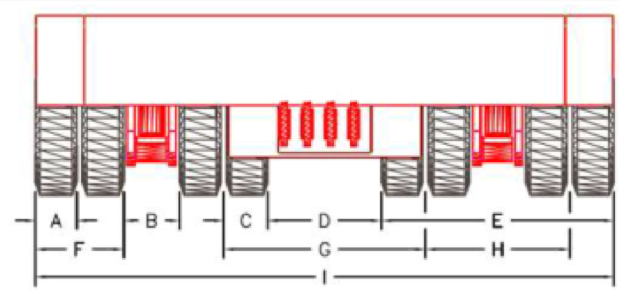


Axle no.	Axle load (kip)	Gage dist. (ft)	Wheel contact width (in)	Axle spacing (ft)	
				Minimum	Maximum
1	17.10	6.00	20.0000		
2	17.90	6.00	20.0000	8.67	8.67
3	17.70	6.00	20.0000	5.42	5.42
4	18.10	6.00	20.0000	8.67	8.67
5	18.40	6.00	20.0000	5.42	5.42
6	20.40	6.00	20.0000	14.25	14.25
7	20.40	6.00	20.0000	4.17	4.17
8	19.60	6.00	20.0000	13.75	13.75
9	19.60	6.00	20.0000	4.92	4.92
10	19.60	6.00	20.0000	4.92	4.92
Totals:	188.80			70.17	70.17

Barnhart (544k)



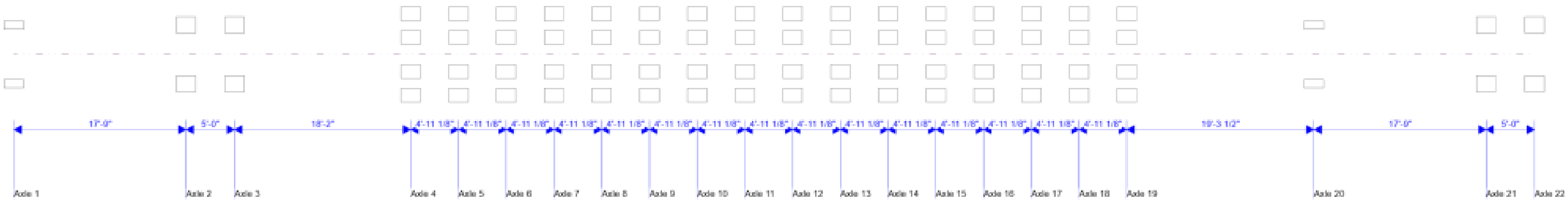
Axle no.	Axle load (kip)		Wheel contact width (in)	Axle spacing (ft)	
				Minimum	Maximum
1	30.18		20.0000		
2	30.18		20.0000	4.92	4.92
3	30.18		20.0000	4.92	4.92
4	30.18		20.0000	4.92	4.92
5	30.18		20.0000	4.92	4.92
6	30.18		20.0000	4.92	4.92
7	30.18		20.0000	4.92	4.92
8	30.18		20.0000	4.92	4.92
9	30.18		20.0000	4.92	4.92
10	30.18		20.0000	4.92	4.92
11	30.18		20.0000	4.92	4.92
12	30.18		20.0000	4.92	4.92
13	30.18		20.0000	4.92	4.92
14	30.18		20.0000	4.92	4.92
15	30.18		20.0000	4.92	4.92
16	30.18		20.0000	4.92	4.92
17	30.18		20.0000	4.92	4.92
18	30.18		20.0000	4.92	4.92
Totals:	543.20			83.58	83.58



A =	8.5"
B =	0'-11"
C =	9"
D =	1'-11"
E =	3'-11"
F =	1'-6"
G =	3'-5"
H =	2'-6"
I =	9'-10"

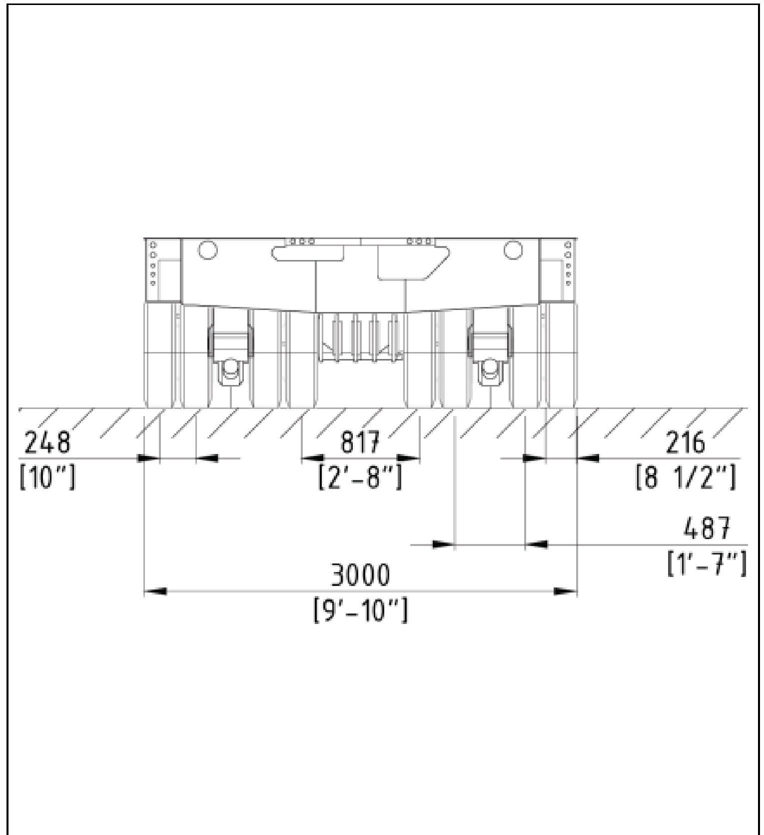
Trailer Cross Section

Mammoet (743.5k)



Axles 1-3 and axles 20-22 are standard gauge (6 ft. spacing). For axles 4-19 see the trailer cross section below.

Axle no.	Axle load (kip)		Wheel contact width (in)	Axle spacing (ft) Minimum	Axle spacing (ft) Maximum
1	18.00		10.0000		
2	23.00		20.0000	17.75	17.75
3	23.00		20.0000	5.00	5.00
4	38.47		20.0000	18.17	18.17
5	38.47		20.0000	4.92	4.92
6	38.47		20.0000	4.92	4.92
7	38.47		20.0000	4.92	4.92
8	38.47		20.0000	4.92	4.92
9	38.47		20.0000	4.92	4.92
10	38.47		20.0000	4.92	4.92
11	38.47		20.0000	4.92	4.92
12	38.47		20.0000	4.92	4.92
13	38.47		20.0000	4.92	4.92
14	38.47		20.0000	4.92	4.92
15	38.47		20.0000	4.92	4.92
16	38.47		20.0000	4.92	4.92
17	38.47		20.0000	4.92	4.92
18	38.47		20.0000	4.92	4.92
19	38.47		20.0000	4.92	4.92
20	18.00		20.0000	19.29	19.29
21	23.00		20.0000	17.75	17.75
22	23.00		20.0000	5.00	5.00
Totals:	743.46			156.71	156.71



Trailer Cross Section

SECTION 17. STRUCTURES FOR TRAFFIC CONTROL DEVICES AND HIGHWAY LIGHTING

All structures shall be designed in accordance with the requirements of the ***ALDOT Standard Specifications for Highway Construction, Section 718.03(a)2*** unless noted and/or excepted below.

17.1 OVERHEAD HIGHWAY SIGN STRUCTURES

Overhead highway sign structures shall be designed in accordance with the ***AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition***, including the 2015, 2019, 2020 and 2022 interim revisions.

Overhead Sign Bridge (OHSB) and Overhead Cantilever (OHC):

The contractor is responsible for submitting completed design(s) of required overhead sign structures as well as the accompanying foundation(s) with details, including shop drawings, in accordance with the ***ALDOT Standard Specification for Highway Construction, Section 715: Overhead Roadway Sign Structures*** and ***Section 718: Structures for Traffic Control Devices and Highway Lighting***.

Bridge Mounted and OHSB or OHC Mounted to Bridge Substructure:

Definitions:

- Sign Structure – The structure that is attached to a bridge member providing support to the sign brackets.
- Sign Brackets – The structural members to which the sign is directly attached.

The Bridge Bureau or consultants under direct contract with the Department shall be responsible for providing the substructure design and details for bridge-mounted signs. The contractor is responsible for submitting shop drawings in accordance with ***ALDOT Standard Specification for Highway Construction, Section 715: Overhead Roadway Sign Structures*** and ***Section 718: Structures for Traffic Control Devices and Highway Lighting***.

Re-evaluation of Existing OHSB or OHC:

The Bridge Bureau or a consultant under direct contract with the Department shall be responsible for re-evaluating existing OHSB or OHC sign structures where additional signage is needed or existing signs are replaced with larger ones. The specifications and design methodology used to conduct the analysis shall be the same specifications and design methodology used to design the original structure.

Anchor Bolts

The Standard Specifications allow either rolled or cut threads (see Section 891.08). Rolled threading methods yield a smaller body diameter than the nominal diameter of the anchor bolt whereas cut threads will have a body equal to the nominal diameter. When determining anchor bolt requirements, if the body diameter is a critical factor the designer should consider the differences between rolled and cut thread anchor bolts and must verify that the specified number, type and diameter of anchor bolts will meet design requirements.

SECTION 18. PRECAST BRIDGES

The term “Precast Bridges” used here refers to bridges consisting of precast concrete bridge components that are typically used on off-system roadways (secondary roadways maintained by Local Public Agencies). These include precast superstructure channel beams, precast barrier rails, precast abutment caps, precast intermediate bent caps, and precast abutment wing panels.

The Bridge Bureau maintains an inventory of ***Bridge Special Project Drawings*** that contain standard details (including spans, barrier rails, abutments, and bents) for span lengths of 24’, 34’ and 40’ and for bridge widths (gutter to gutter) of 24.5’, 28’ and 40’.

Precast bridges shall only be used with tangent alignments, 0% grade, and 0° skew. All exceptions shall have the prior approval of the State Bridge Engineer.

For more information, see ***ALDOT Guidelines for Operation, Section 3-70: County Bridge Projects using Precast Members & Pile Bent Construction***.

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