

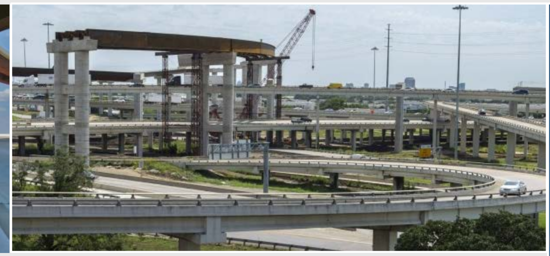
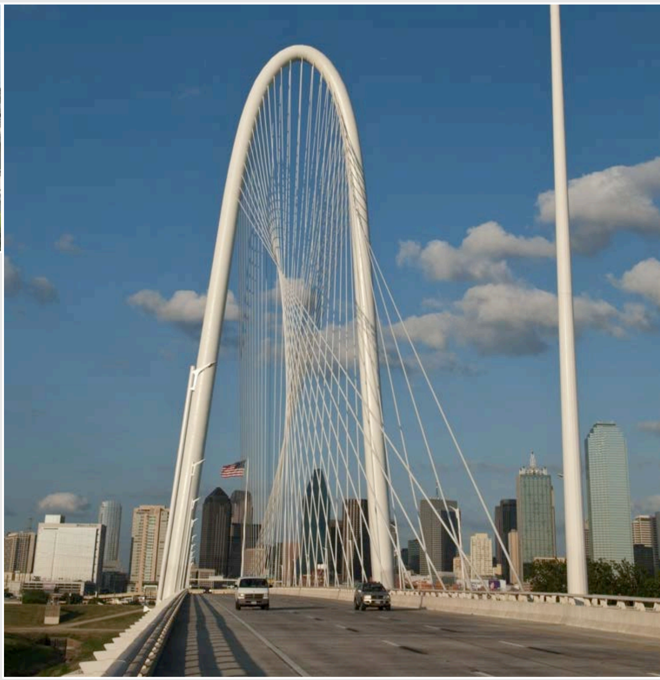

BRIDGE DESIGN MANUAL UPDATES

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LIMIT STATES AND LOADS

Vehicle Collision Force - Updated

Bents

- Do not investigate bents and piers for collision if the annual frequency for a bridge bent or pier to be hit by a vehicle, AFHPB, is less than 0.001 using Equation C3.6.5.1-1.
- **This applies only to the final condition after all construction is completed, not during construction phases with temporary traffic conditions. This applies when the roadway adjacent to the column is a bridge deck.**
- If the bent or pier needs to be investigated for collision and the design choice is to redirect or absorb the collision load, the protection must meet at least one of the following requirements:

Vehicle Collision Force - Updated

- **Only design the column to withstand the collision force in shear, not flexure, and do not consider the transfer of this force to the other elements such as bent caps, footings, piles, or drilled shafts.**
- Use a **0.9** load factor for all dead loads and **no** live load for the axial compression used for shear design.
- **Conservatively, the shear capacity can be determined with a β of 2.0 and θ of 45 degrees, with no applied vertical load, for non-prestressed sections as per Article 5.8.3.4.1.**

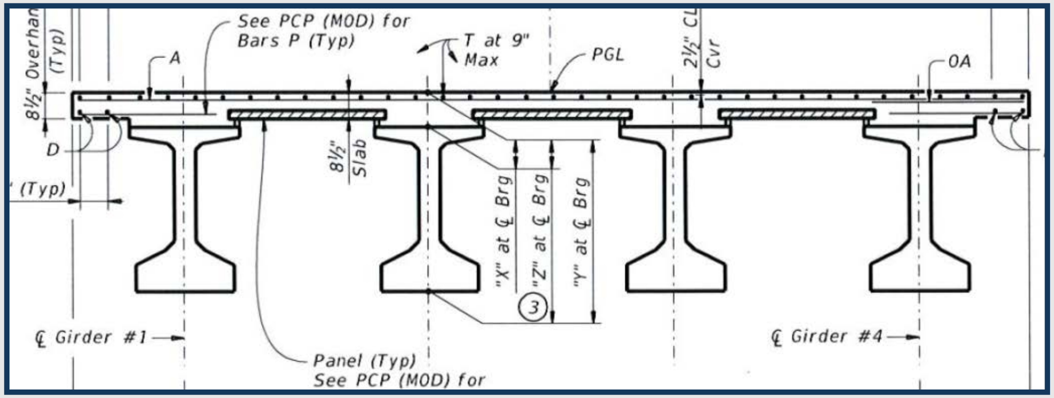
Vehicle Collision Force - Updated

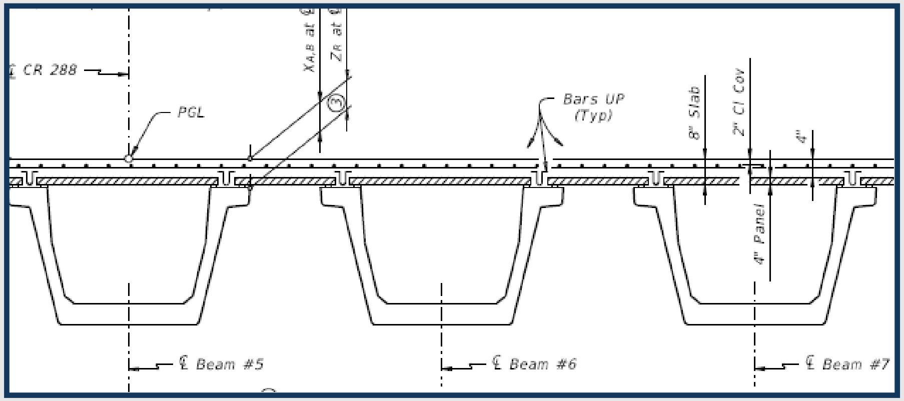
- **Bents with two or fewer columns or bents with a lack of redundancy such as straddle bents require special consideration. For these, consider only one shear plane for the resistance of the collision force.**
- For structures with a clear distance of **25 ft. or less** from the center line of a railway track meet the requirements of American Railway Engineering and Maintenance-of-Way Association (AREMA)

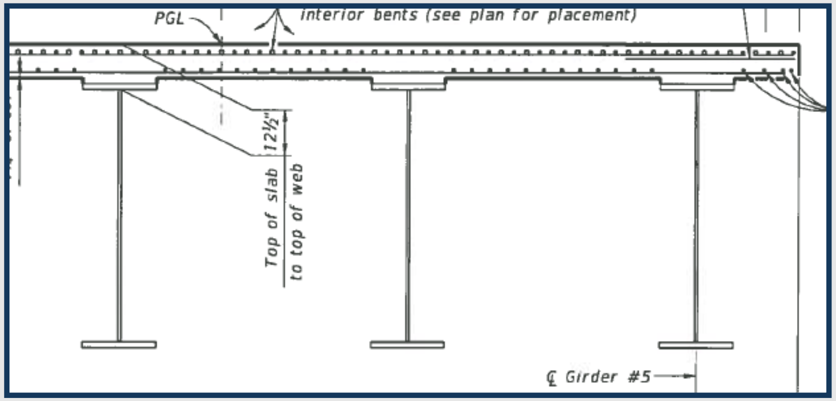
SUPERSTRUCTURE DESIGN

Revised Deck Design and Detailing

- **Consolidated Sections**
  - Section 2 - Concrete Deck Slabs on I-Girders, U-Beams, Spread Box Beams, Spread Slab Beams, Steel Plate Girders and Steel Tub Girders

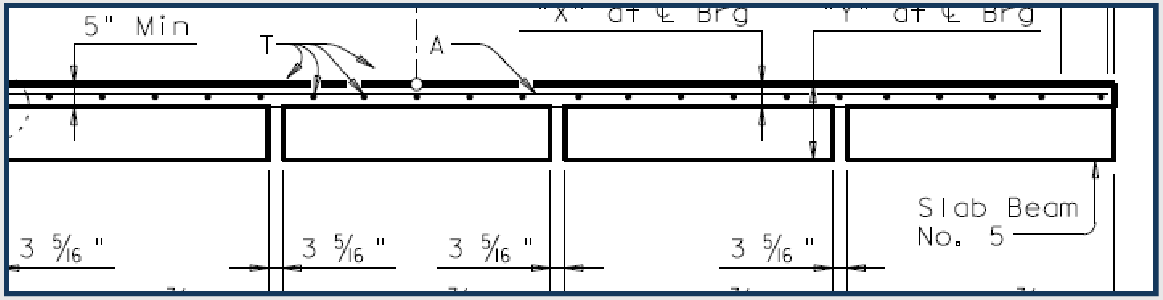


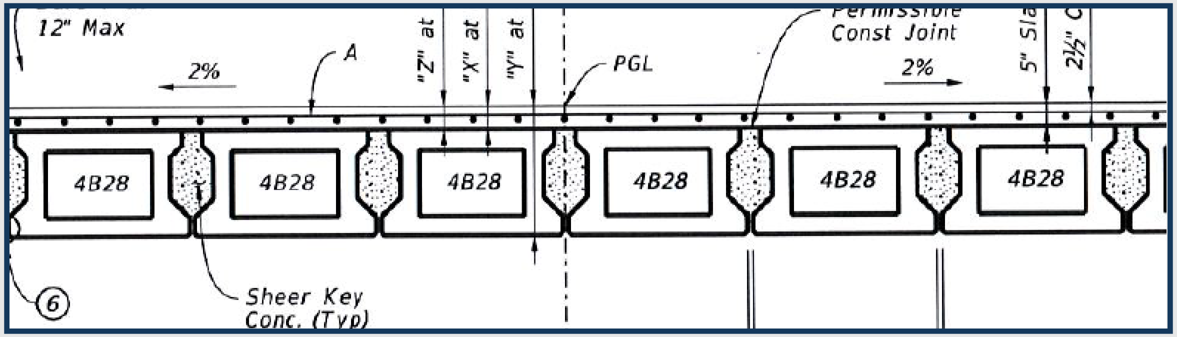




Revised Deck Design and Detailing

- **Consolidated Sections**
  - Section 3 - Concrete Deck Slabs on Adjacent-Framed Beams (Slab Beams, Double-Tee Beams, and Box Beams)





Revised Deck Design and Detailing

- **Added Optional Reinforcement**
  - Glass Fiber Reinforced Polymer (GFRP) bars
  - Deformed welded wire reinforcement (WWR)
  - Dual coated reinforcing steel
  - Low carbon/chromium reinforcing steel

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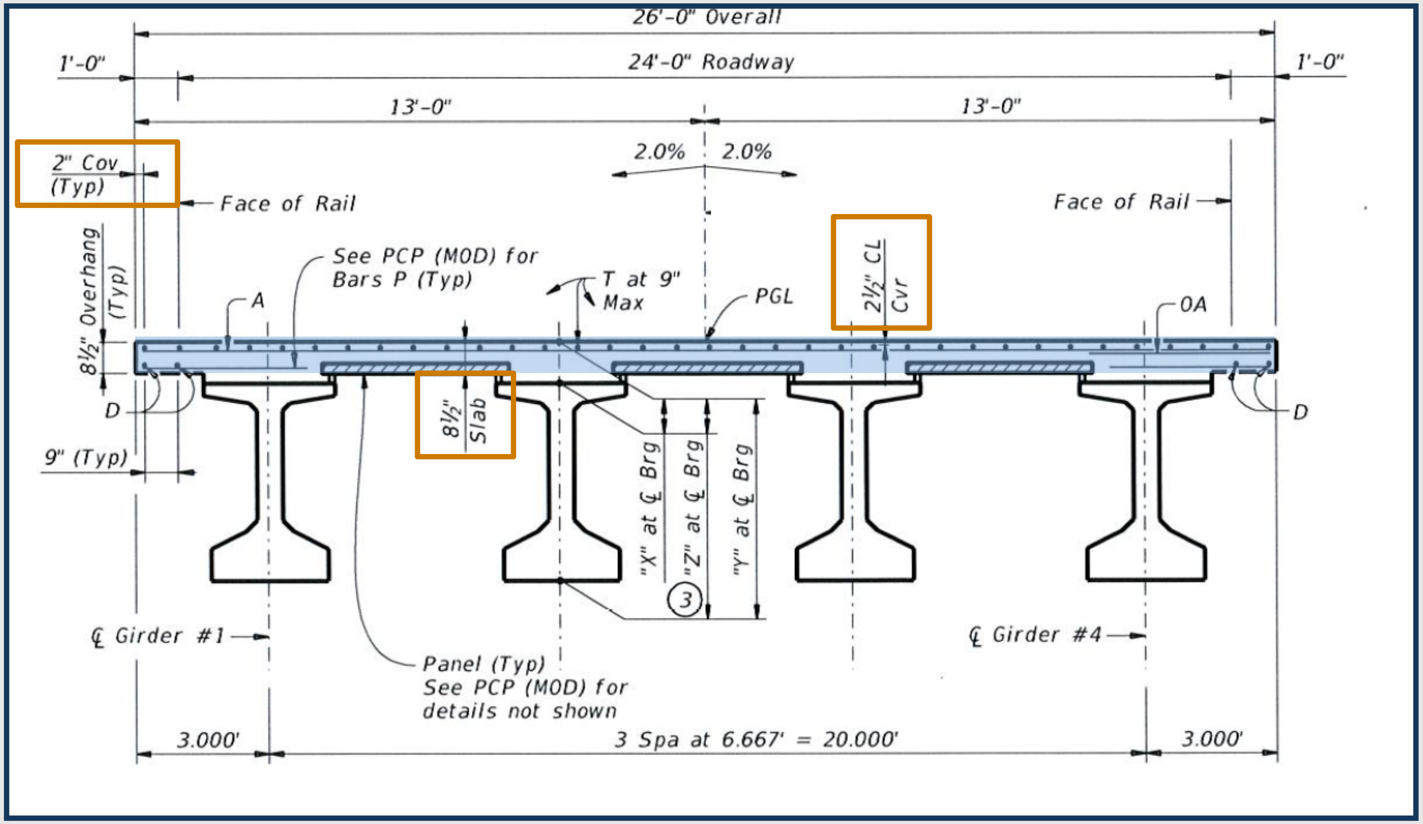
Revised Deck Design

- **Increased slab depth to 8.5″**
  - Cover to reinforcing bars is 2.5 in. clear to the top mat and 1.25 in. clear to the bottom mat. Cover to bar ends is 2 in.

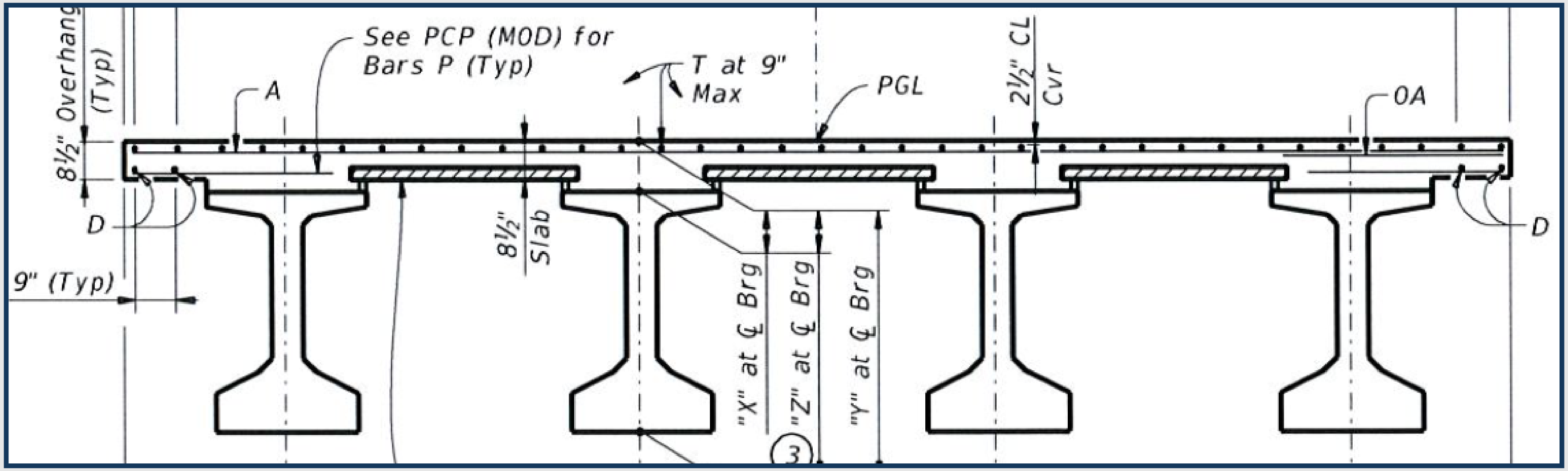


Revised Deck Design

- **Geometric Constraints - Revised overhang dimensions**
  - Maximum overhang is 3.33 ft. beyond the design section for negative moment specified in AASHTO LRFD Article 4.6.2.1.6, but not more than 1.3 times the girder depth.
  - Minimum overhang is 0.5 ft. from top beam or flange edge except for spread slab and box beams, which have a 0 ft. minimum overhang.
  - The overhang need not extend past the exterior girder more than 6 in. beyond the flange edge (0 in. for spread slab or box beams). An overhang is not required for girders and beams for the temporary condition of having a stage or phase construction joint located on top of their flange.

Revised Deck Design

- **Changed to Empirical Deck Design**



What is Empirical Deck Design?

- The Empirical Design Method is based on laboratory testing of deck slabs. This testing indicates that the loads on the deck are transmitted to the supporting components mainly through arching action in the deck, not through shears and moments as assumed by traditional design.

Revised Deck Design

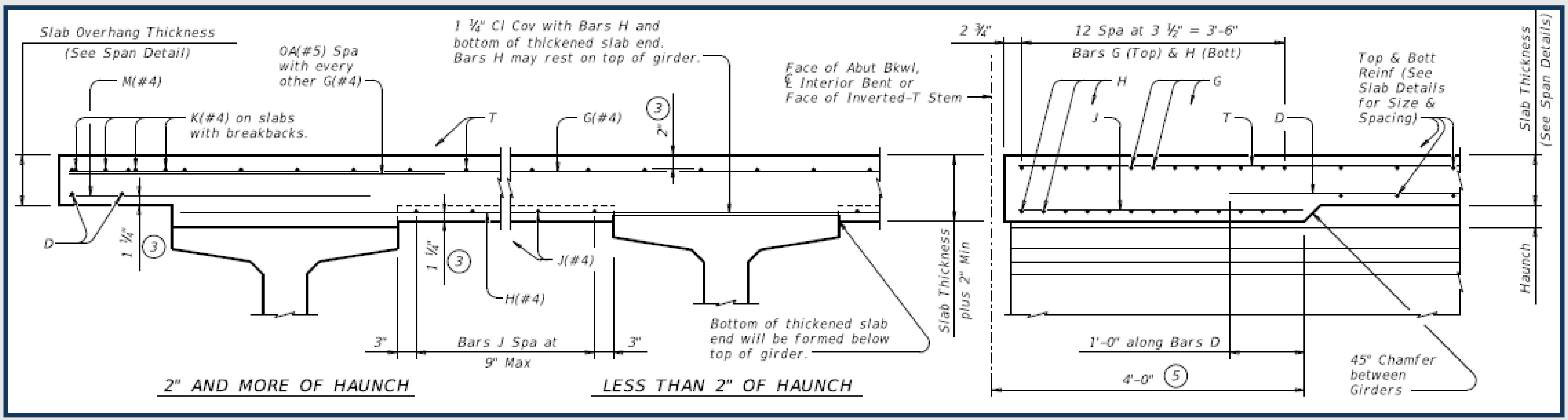
- **Changed to Empirical Deck Design**
- Where applicable, use the Empirical Design of **AASHTO LRFD Article 9.7.2** with the following exceptions:
  - **Top mat reinforcement is No. 4 bars at 9-in. maximum spacing (0.27 sq. in./ft.) in both transverse and longitudinal direction.** Place longitudinal bars closest to the top slab surface. In the overhangs, place No. 5 bars extending 2 ft. minimum past fascia girder web centerline between each transverse No. 4 bar.
  - **Bottom mat reinforcement is No. 4 bars at 9-in. maximum spacing** (0.27 sq. in./ft.) in both transverse and longitudinal directions. Place transverse bars closest to the bottom slab surface.

Revised Deck Design

- **Changed to Empirical Deck Design**

Where applicable, use the Empirical Design of **AASHTO LRFD Article 9.7.2** with the following exceptions:

- Slab regions adjacent to expansion joints are reinforced as shown on the standard drawings depicting thickened slab end details. No additional reinforcement in end regions, including those skewed over 25 degrees, is needed in these cases.

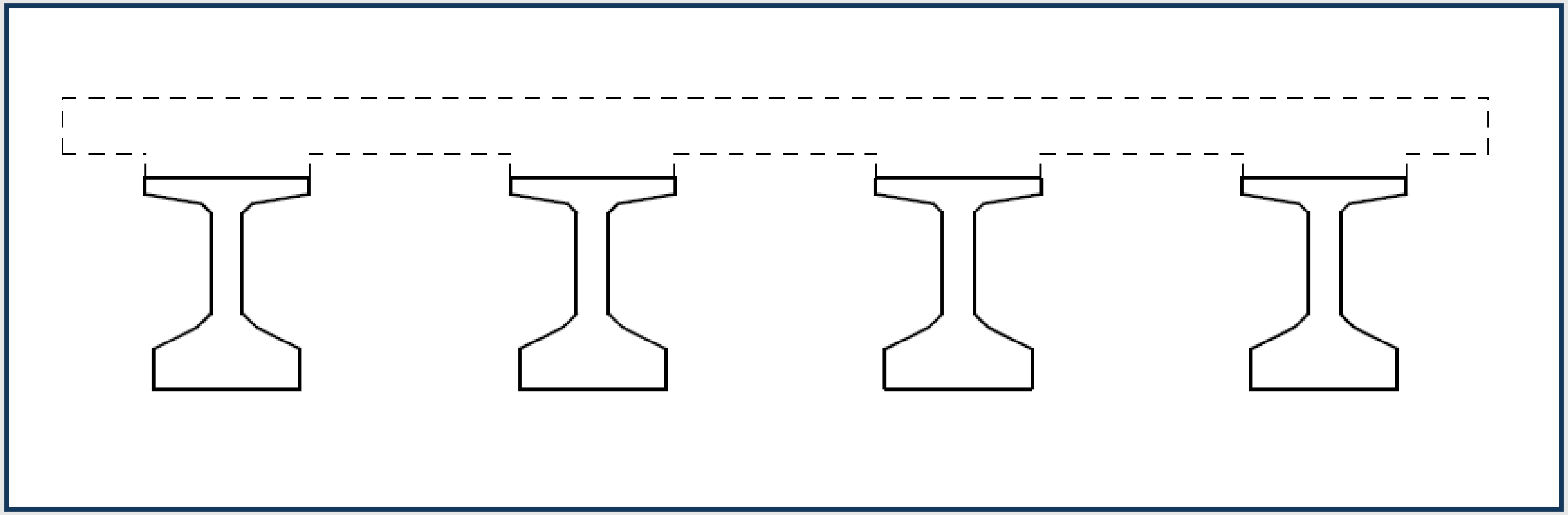


Revised Deck Design

- **Changed to Empirical Deck Design**
  – Use the provisions of Article 9.7.3 where the provisions listed before for empirical deck use are not met.
  – The minimum amount of longitudinal reinforcement in the top mat is No. 4 bars at 9-in. maximum spacing for these deck designs.

Revised Number of Girders

The minimum numbers of I-girders in any roadway width is **four if the span is over a lower roadway and the vertical clearance is less than 20 feet. Otherwise, a minimum of three I-girders per span may be used.**



Added Straight Strand with Debonding to TxGirders

- Straight strand designs with and without debonding are permitted provided stress and other limits noted below are satisfied. Debonded strands must conform to Article 5.11.4.3 except as noted below.

The maximum debonding length is the lesser of:

  - **one-half the span length minus the maximum development length**
  - **0.2 times the beam length**
  - **15 feet**

Not more than 75 percent of the debonded strands, or 10 strands, whichever is greater, shall have the debonding terminated at any section, where section is defined as an increment (e.g. 3 feet, 6 feet, 9 feet).

Note: Maximum debonding length requirements apply to all beam types.

Revised Prestress Losses

- AASTHO adopted new prestress loss provisions thru interim provisions in 2006. These provisions significantly reduced the number of strands, but were never adopted by TxDOT. Instead, TxDOT used the prestress losses from the 2004 AASHTO LRFD and did research.
- Research Report - Garber, D., J. Gallardo, D. Deschenes, D. Dunkman, and O. Bayrak. 2012. "Effect of New Prestress Loss Estimates on Pretensioned Concrete Bridge Girder Design." Austin: Center for Transportation Research, The University of Texas at Austin. http://library.ctr.utexas.edu/ctr-publications/0-6374-2.pdf
- The researchers found that the prestress loss provisions within the *2004 AASHTO LRFD* Bridge Design Specifications were overly conservative, though relatively straightforward to implement. The *AASHTO LRFD 2012* prestress loss provisions were found to be unnecessarily complex, unconservative, and no more precise than the AASHTO LRFD 2004 provisions.

Revised Prestress Losses

- The research recommended losses that are
  - *Simple to implement*
  - *More conservative and precise*
  - *Less significant of a design impact*
- TxDOT is adopting the losses from the research.
- The use of the *2004 AASHTO LRFD* Bridge Design Specifications is still permitted.

Revised Prestress Losses

Use the following equations to determine prestress losses:

Total prestress loss, $\Delta f_{pT} = \Delta f_{pES} + \Delta f_{pSR} + \Delta f_{pCR} + \Delta f_{pR}$

Elastic shortening, $\Delta f_{pES} = \frac{E_p}{E_{ci}} f_{cgp}$, where $f_{cgp} = 0.7 f_{pu} A_{ps} \left(\frac{1}{A_g} + \frac{e_p^2}{I_g} \right) - \frac{M_g e_p}{I_g}$

Shrinkage loss, $\Delta f_{pSR} = E_p \left(\frac{140 - H}{4.8 + f'_{ci}} \right) 4.4 * 10^{-5}$

Creep loss, $\Delta f_{pCR} = 0.1 \left(\frac{195 - H}{4.8 + f'_{ci}} \right) \left(\frac{E_p}{E_{ci}} \right) \left(f_{cgp} + 0.6 \Delta f_{cd} \right)$, where $\Delta f_{cd} = -\frac{M_{sd} e_p}{I_g}$

Relaxation loss, $\Delta f_{pR} = \frac{2 f_{pt}}{K_L} \left(\frac{f_{pt}}{f_{py}} - 0.55 \right)$

Other Additions to the Manual

- Spread Slab Beam Section
- Spliced Precast Girders

– Materials
– Geometric Constraints
– Structural Analysis
– Design Criteria
– Detailing

SUBSTRUCTURE DESIGN

Foundations

- Design foundations to be in compression under Service I Load Combination.
- Exceptions are permitted only where additional foundation elements and/or repositioning foundation elements cannot prevent tension in the foundation elements under Service I Load Combination.

Columns for Multi Column Bents

- **Geometric Constraints**
  - The minimum size column and drilled shaft for grade separation structures is 36-in. diameter unless a larger size is noted elsewhere . Column and drilled shaft sizes smaller than 36-in. diameter are permissible for widenings only for similitude.

Columns for Multi Column Bents

- Structural Analysis
  - Analysis and design is not required for round columns supporting multi-column bents when certain conditions are met involving:
    - Column spacing
    - Column height,
    - Columns reinforcement
    - Superstructure type
- If these conditions are not met, column design and analysis, including second order effects and stiffness reduction from cracked concrete, is required.

Columns for Multi Column Bents

- **Detailing**
  - For non-contact lap splices between the column and its foundation, meet the requirements of Article 5.11.5.2.1.

Added: Information for Single Column Bents or Piers

Includes Information on:

- Materials
- Geometric Constraints
  - Consider using hollow pier sections where appropriate
- Structural Analysis
- Design Criteria
- Detailing

Questions?

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