Steel Bridge Fundamentals

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Texas Department of Transportation

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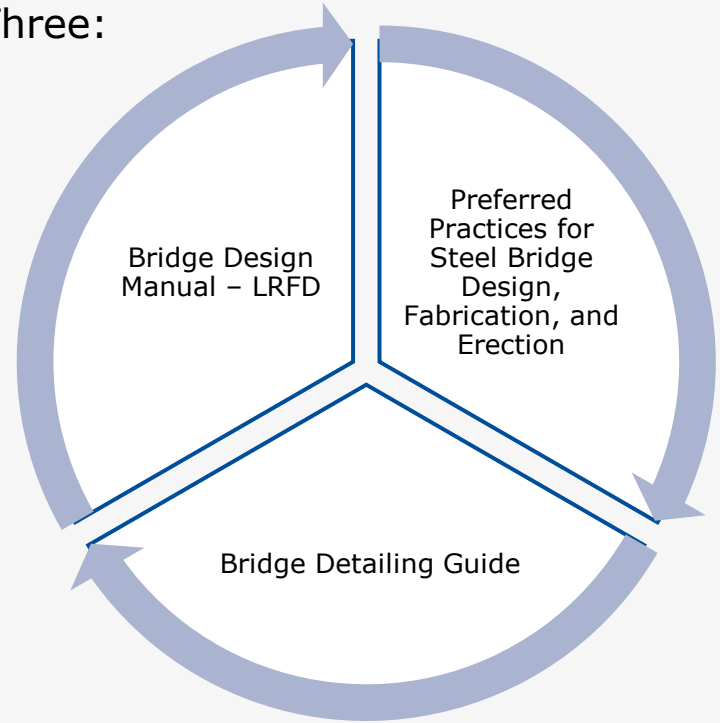
When to Consider Steel

- Commonly for longer spans (~150’+)
- Significant horizonal curvature
- Complex geometry
- Weight savings
- Can also offer advantage for short spans
  - Increase vertical clearance/hydraulic opening
  - ABC options
  - Light weight can reduce crane requirements

Design/Detailing Resources

The Big Three:



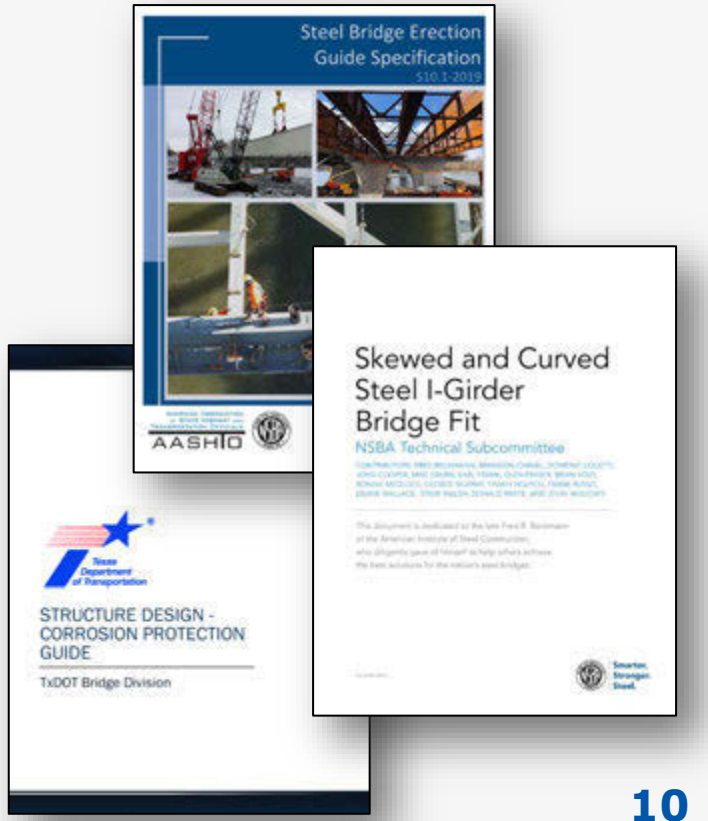
Design/Detailing Resources

Other important references:

- Bridge Design Guide
- Corrosion Protection Guide
- NSBA Guide/Specification Documents

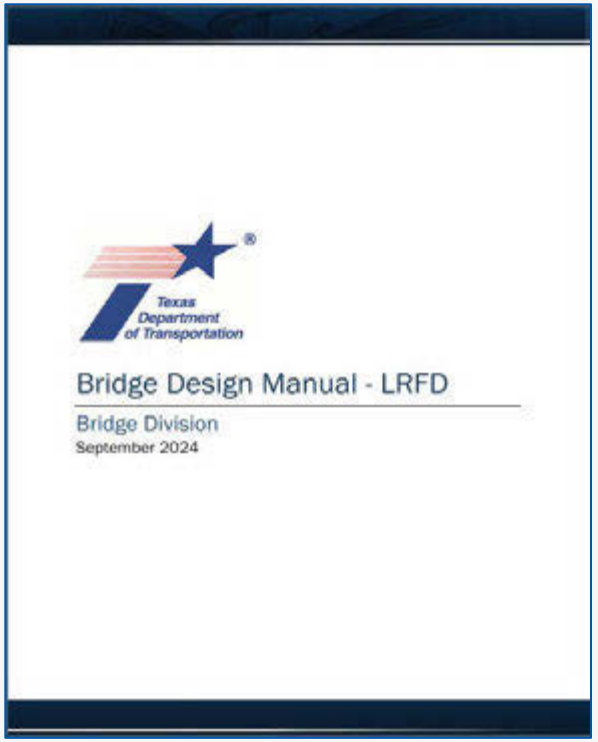
https://www.txdot.gov/business/resources/highway/bridge/bridge-publications.html

https://www.aisc.org/nsba/design-and-estimation-resources/aashto-nsba-collaboration/aashtonsba-steel-bridge-collaboration-documents/



Bridge Design Manual (BDM)

- Documents bridge design policy in Texas
- Assists Texas bridge designers in applying provisions of AASHTO LRFD Bridge Design Specifications, to which designers should adhere unless directed otherwise by BDM
- Chapter 3 Superstructure Design
  - Section 2: Concrete Deck Slabs on I-Girders, U-Beams, Steel Plate Girders, and Steel Tub Girders
  - Section 13: Straight Plate Girders
  - Section 14: Curved Plate Girders



BDM Ch. 3, Sec. 2: Concrete Deck Slabs

Overview

Provides TxDOT concrete deck design policy information for slab-on-stringer type superstructures.

Some Important Points

- Material selection should be based on corrosion protection requirements
- Decks less than 8.5” thick are not permitted
- Empirical deck design (with some modifications) is to be used where applicable
- Continuous girders have unique reinforcement requirements

BDM Ch. 3, Sec. 13: Straight Plate Girders

Overview

Provides material, geometry, analysis, and design requirements for straight steel plate girder units.

Some Important Points

- Specify fit condition when necessary (see AASHTO 6.7.2) and Steel Dead Load fit whenever possible
- Investigate a feasible erection sequence
- Specify continuous deck placement when possible and staged placement only when necessary

BDM Ch. 3, Sec. 14: Curved Plate Girders

Overview

Provides material, geometry, analysis, and design requirements for curved steel plate girder units.

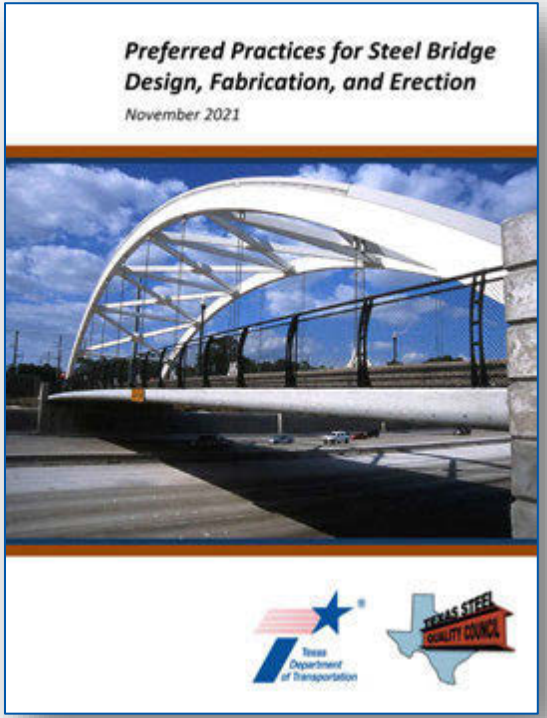
Some Important Points

- Similar to the straight plate girders but with some more strict requirements:
  - Min flange width (0.25D vs. 0.20D)
  - Min flange thickness (1in vs. 0.75in)
  - Max cross-frame spacing (20ft vs. 30ft)

Preferred Practices for Steel

The *Preferred Practices for Steel Bridge Design, Fabrication, and Erection* document provides guidance to help steel bridge designers working on TxDOT projects to achieve optimal quality and value in steel bridges.

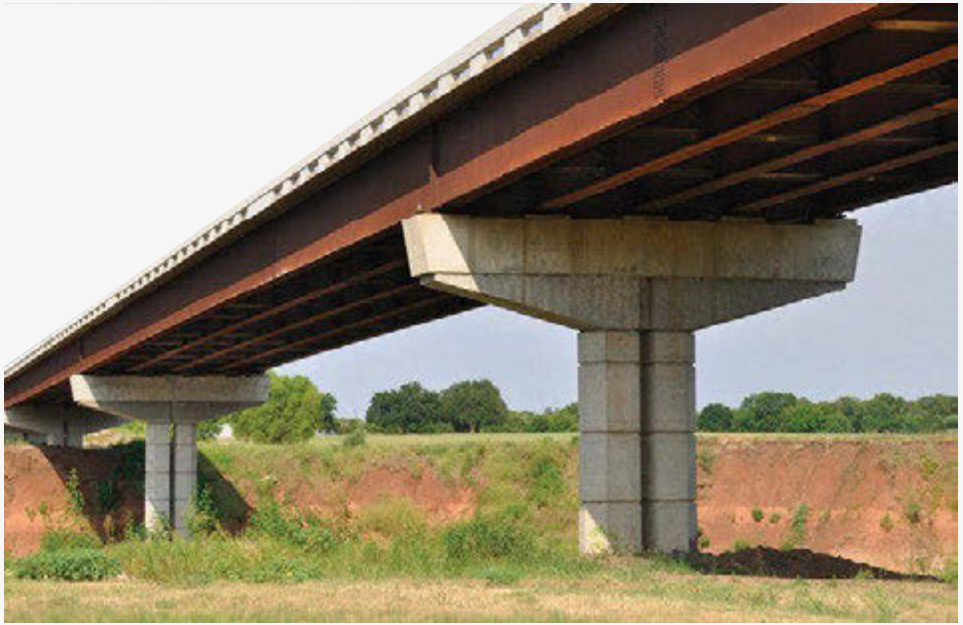
- To be used as a companion to the Bridge Design Manual (per BDM Sec.1)
- Documents the best practices identified by the Texas steel bridge industry (TxDOT, fabricators, erectors, contractors, academics, etc.)
- Maintained by the Texas Steel Quality Council (TSQC)
  - https://www.txdot.gov/business/resources/highway/bridge/texas-steel-quality-council.html



Preferred Practices for Steel: Design

Preliminary Design Considerations

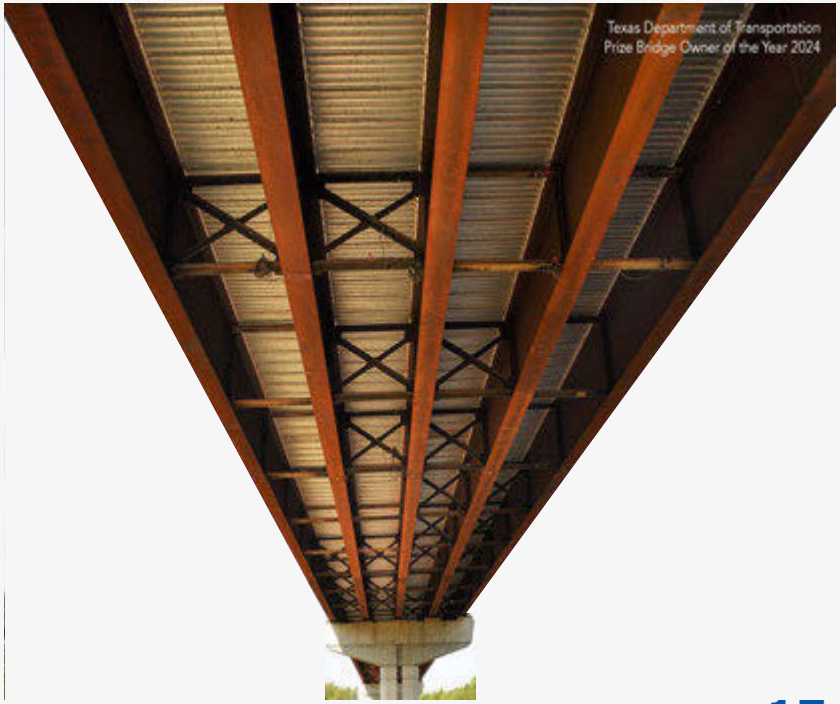
- Steel Grade Selection
  - A709 Grade 50W (unpainted) is BRG preference
  - Some districts prefer painting, so obtain approval for painting system and steel type
- Span Configuration
  - 3 and 4-span are preferred, 1 and 2-span acceptable
  - Interior span(s) should be about 20 to 30 percent longer than the end spans



Preferred Practices for Steel: Design

Preliminary Design Considerations

- Expansion Joint Considerations
  - Try to limit expansion lengths to allow the use of standard expansion joints
  - Avoid modular/finger joints if possible
- Girder Spacing
  - Should be limited to a max of 10 feet
- Minimum of 4 girders in a span is preferred



Preferred Practices for Steel: Design

Plate Girder Design

- Flange sizing limits
- Web sizing limits and dapping considerations
- Stiffener sizing and details
- Shop and field splice locations
- Field section geometry requirements

Preferred Practices for Steel: Design

Cross-Frame Design/Detailing

- General TxDOT philosophy
- Member selection considerations
- Spacing and orientation guidance
- Special considerations for stage construction
- Fit condition references
- Lean-on bracing references

Preferred Practices for Steel: Design

Bolted Connections

- Bolt size limitations (only 1in and 7/8in)
- Edge distance requirements (1/4in + AASHTO min)
- Strength check erection bolts for curved and unusual geometry
- Do not specify tension control bolts
- Galvanizing requirements

Preferred Practices for Steel: Design

Other Design Topics

- Rolled Beams
  - Section selection, bearings, camber
- Tub Girders
  - Geometric control, section considerations, bracing, splices, and bearings
- Box-Girder Sections

Preferred Practices for Steel

Other Topics

- Fabrication
  - Shop drawing review/distribution
  - NDT and cleaning & painting
- Erection
  - Consider erection sequence in design
  - Shipment of bolts
  - Condition of weathering steel

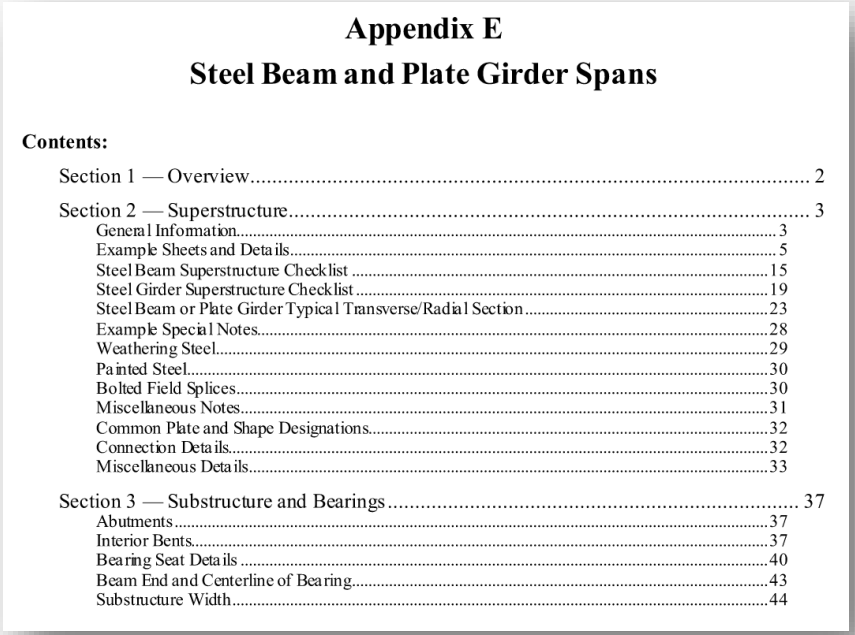
Preferred Practices for Steel

Appendices

- Appendix A – TxDOT Painting Practices
  - Overview of steel coating systems and recommendations
- Appendix B – Paint Durability Questionnaire
  - List of questions to be presented to the paint supplier to ensure that TxDOT is getting a durable colorfast product

Plan Preparation: Bridge Detailing Guide, Appendix E

Appendix E of the **Bridge Detailing Guide** is intended as a reference; facilitating the general detailing practices with respect to plan sheet production, when considering bridges with steel beam/plate superstructures.



Appendix E

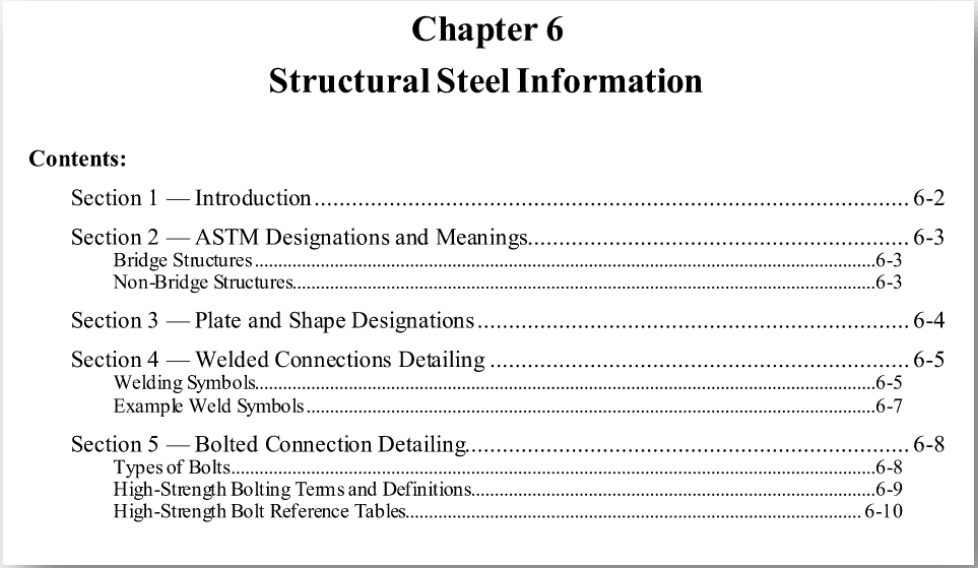
Steel Beam and Plate Girder Spans

Contents:

Plan Preparation: Bridge Detailing Guide, Chapter 6

This chapter offers a quick reference for structural steel specific detailing elements.

- ASTM Material Designations
- Plate and Shape Designations
- Welding Detailing
- Bolted Connection Detailing



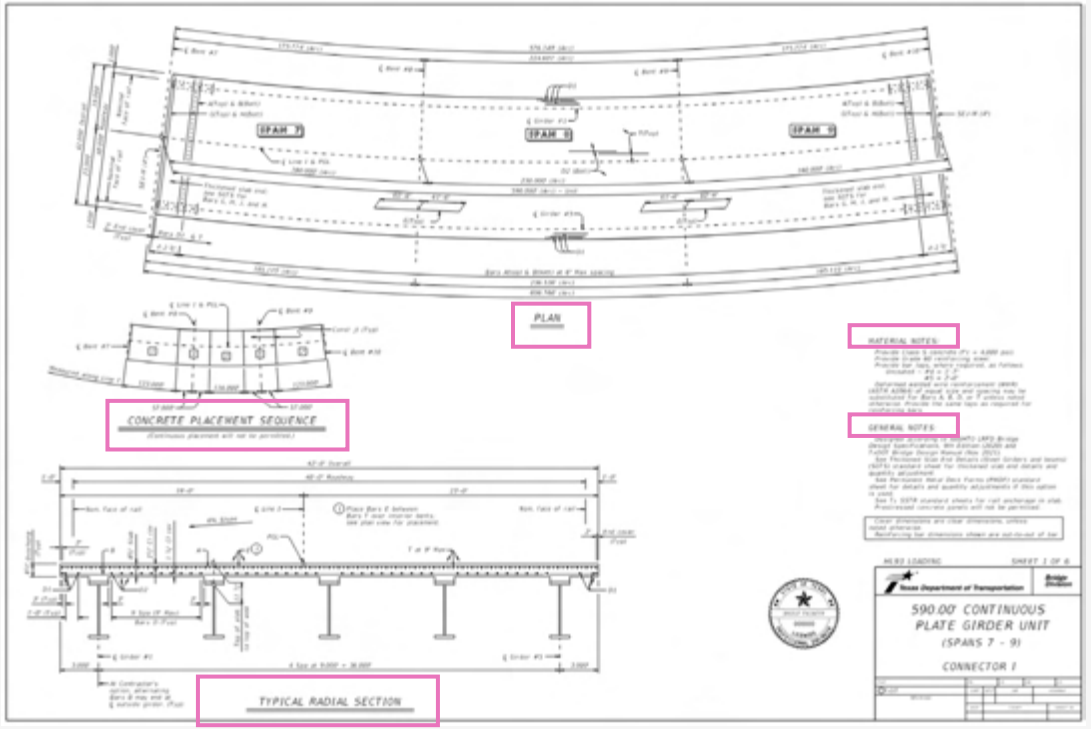
Chapter 6
Structural Steel Information

Contents:

Plan Preparation: Typical Steel Unit Details

Typical Sheet 1

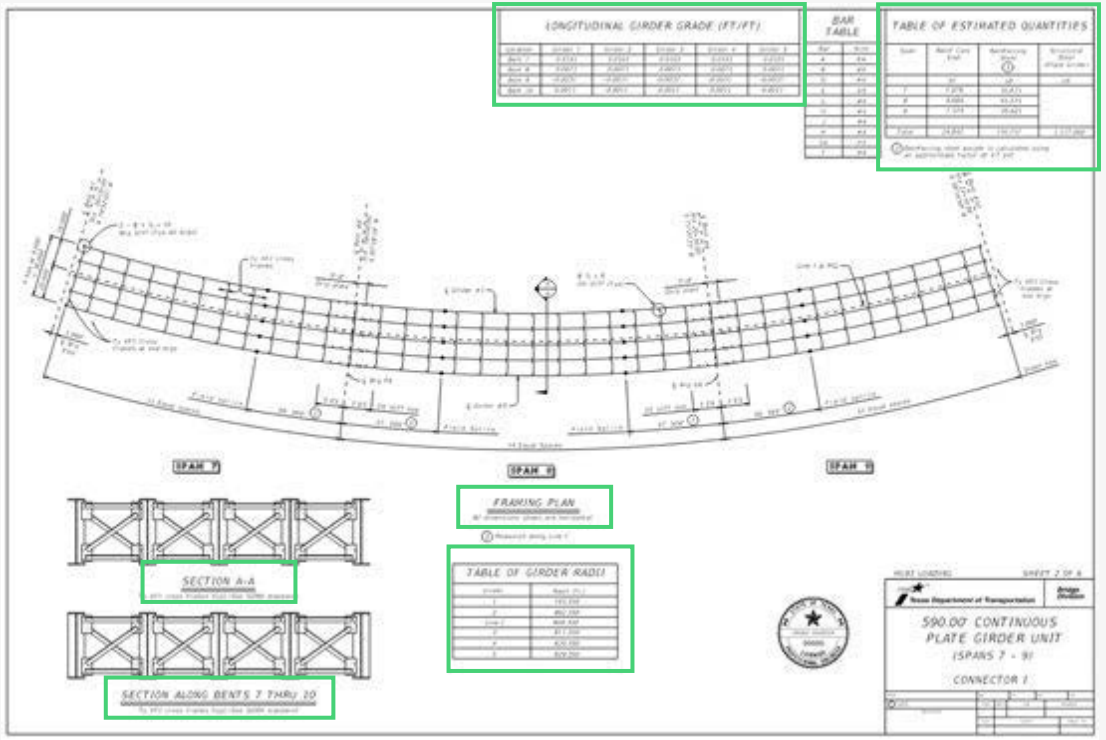
- Plan View
- Typical Section
- Concrete Placement Sequence
- General Notes
- Material Notes



Plan Preparation: Typical Steel Unit Details

Typical Sheet 2

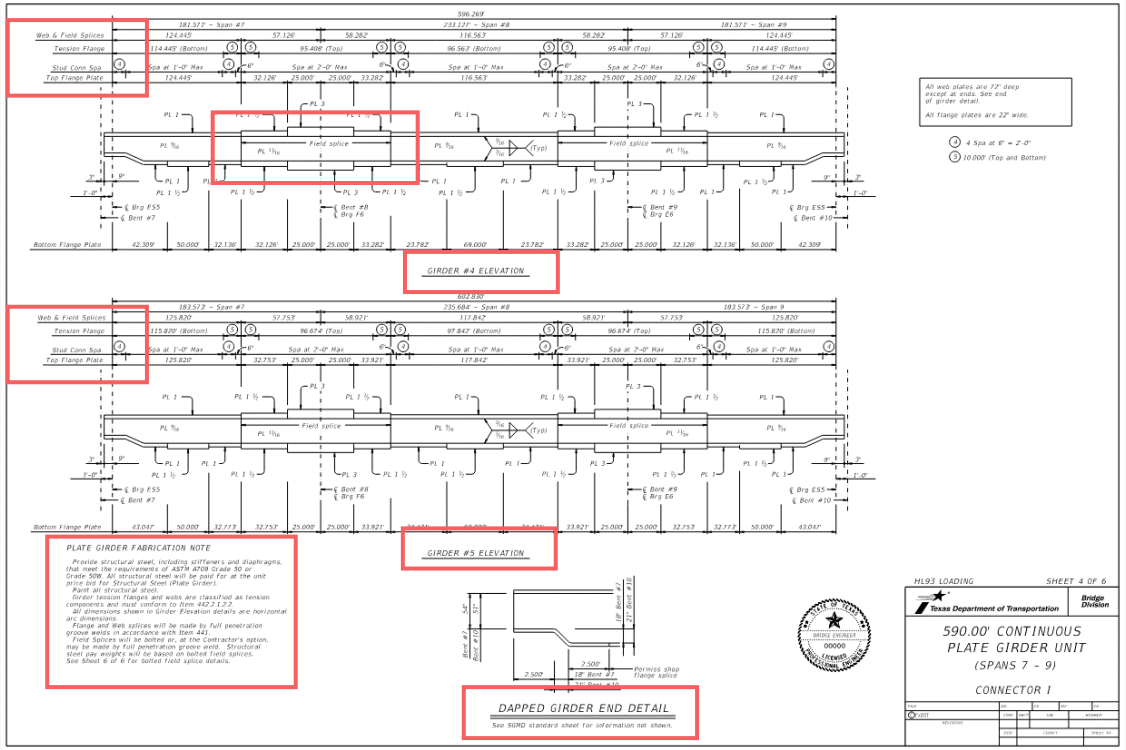
- Framing Plan
- Cross-frame Sections
- Girder Geometry Tables
- Girder Grade Table
- Estimated Quantities



Plan Preparation: Typical Steel Unit Details

Typical Sheets 3-4

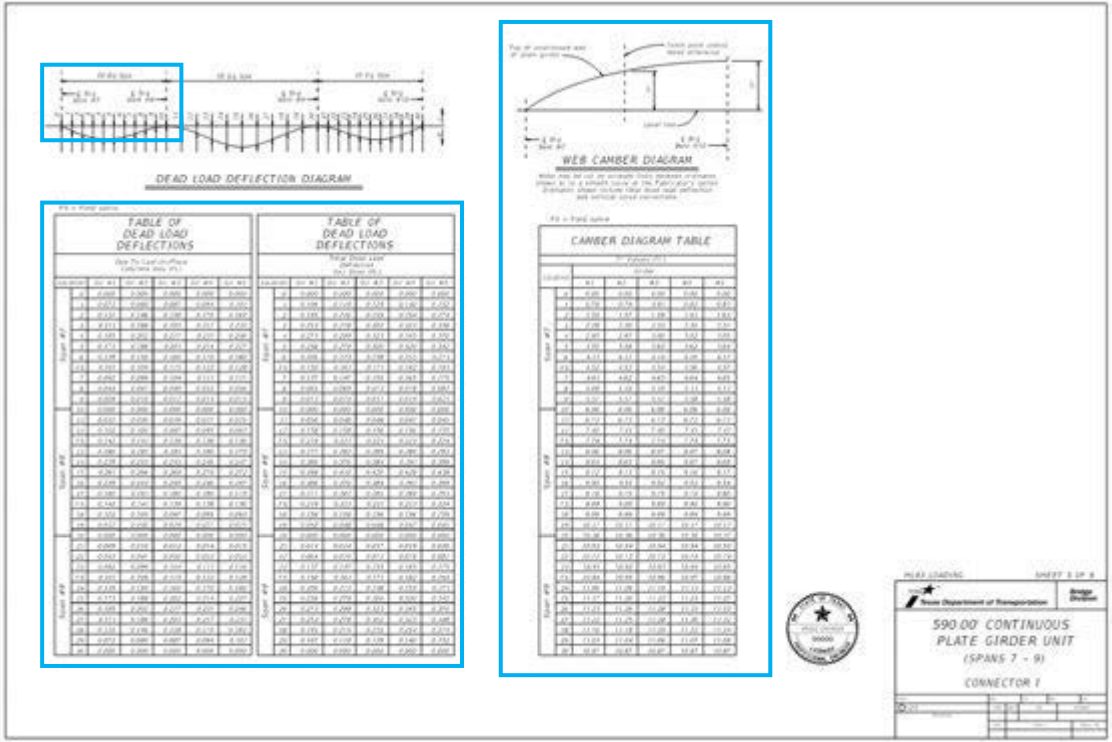
- Girder Elevations
  - Describes individual girder designs
  - Locates field splices
  - Identifies tension components
  - Describes dapped end geometry
  - Specifies girder fabrication requirements



Plan Preparation: Typical Steel Unit Details

Typical Sheet 5

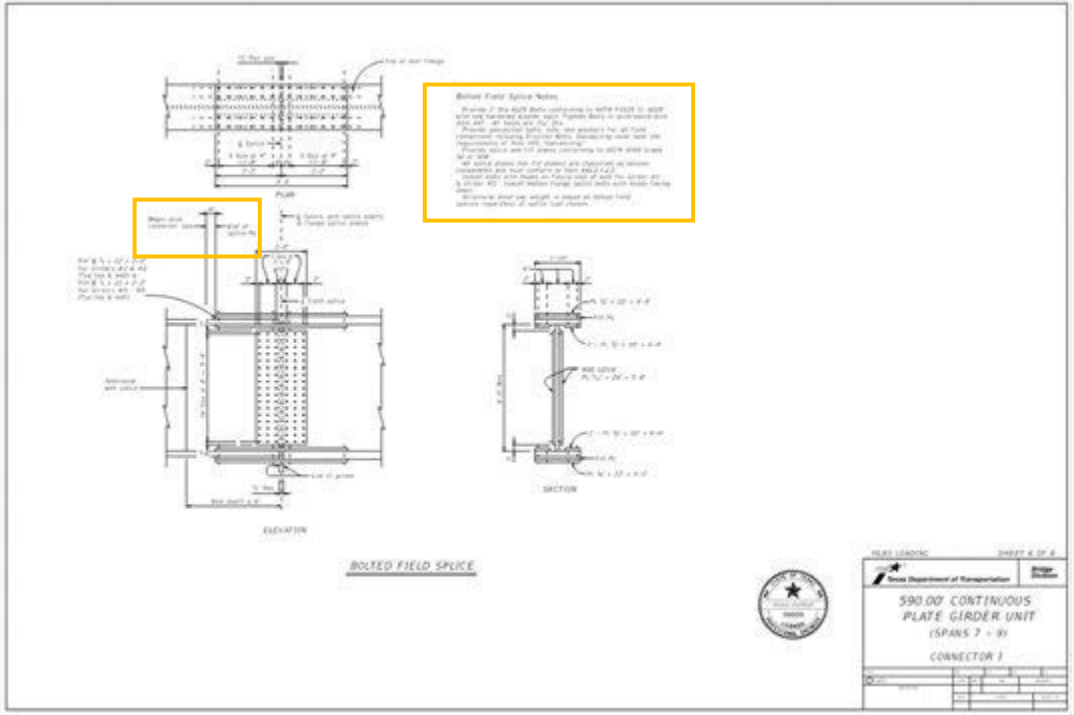
- Deflection and Camber
  - All ordinates are at tenth points and field splices
  - DL deflections separate slab weight and total DL
  - Specify deflections based on critical deck casting
  - Camber includes DL deflections and vertical curve geometry



Plan Preparation: Typical Steel Unit Details

Typical Sheet 6

- Bolted Splice Details
  - Splice-specific notes
  - Specify plate material
  - Identify shear connector adjustments
  - Note that payment is based on bolted (not welded) splices



Submittal Requirements

Steel Bridge Plan Reviews

- All steel bridge plan sheets designed by consultants are required to be submitted to Bridge Division for review at Preliminary Bridge Layout Review (PBLR), 30%, 60%, 90% and 100% submittals.
- Districts should submit each milestone set via ProjectWise in the appropriate % submittal folder.

Thank you!

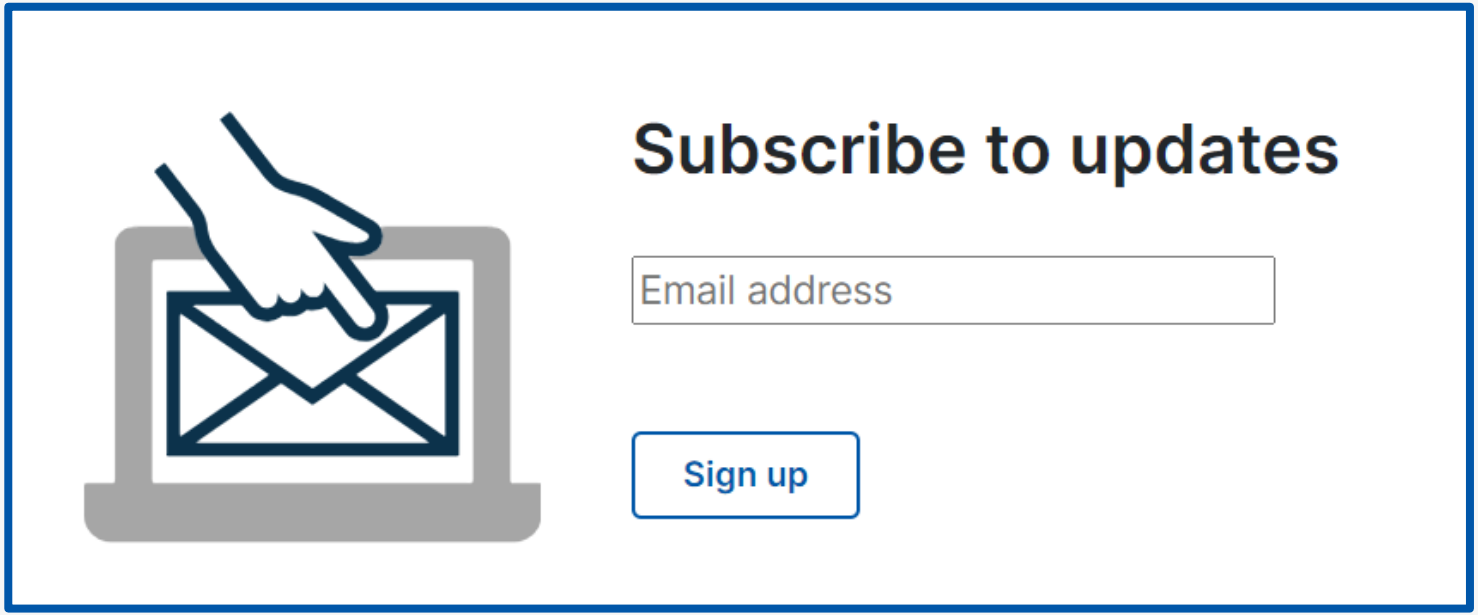
Questions?

https://www.pinterest.com/pin/401242648030614945/

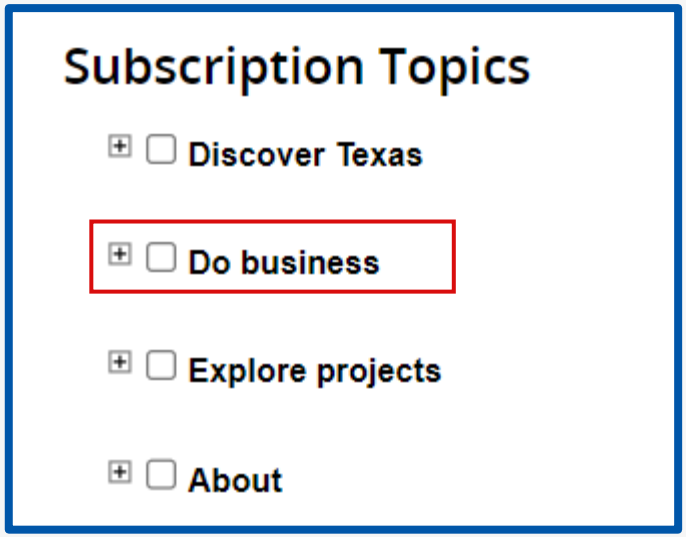
Let's explore TxDOT policies!

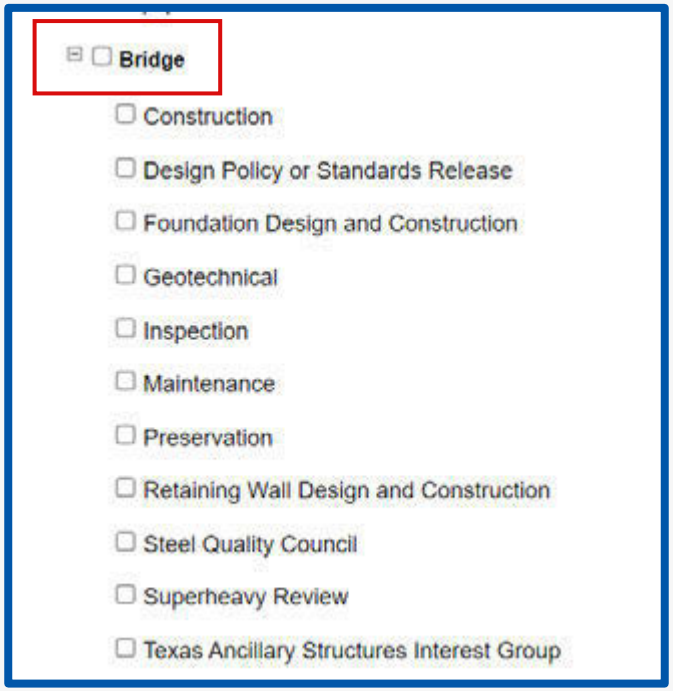
Don’t miss out on other updates!

https://www.txdot.gov/about/divisions/bridge-division.html



Don’t miss out on other updates!





PDH

- Please remember Bridge Division does not provide documentation for TX Board PDH approval. Each engineer should exercise personal judgement when counting webinar topics for their professional development hours. For more info on what qualifies for Continuing Education, please visit https://pels.texas.gov/CEPInfo.htm