ERECTION PLANS
UT-BRIDGE & UT-LIFT

Kevin R. Pruski, PE
July 27, 2017
Specification Controls for Erection

- **Item 5 – “Control of the Work”**
  - Table 1 includes Erection Drawings
  - Requires submittal with PE Seal
  - Does not require TxDOT Approval
    - Unless plan could impact public safety
    - TxDOT may require PE of Erection plan to review shoring
Worthy of a Look by the PE

Shore Tower placed Close to Culvert Inlet

Shore Tower Foundations Submerged
Shore Tower Concern
Specification Controls for Erection

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- **Item 7 – “Legal Relations and Responsibilities”**
  - Section 7.2.4. Public Safety and Convenience
    - Never allow lifting girders over live traffic
    - Always protect shore towers from live traffic
  - Section 7.16. Hauling and Loads on Roadways and Structures
    - Section 7.16.1. Overweight Construction Traffic Crossing Structures
    - Section 7.16.2 Construction Equipment Operating on Structures
    - Section 7.16.3 Loads on Structures
Item 441 – “Steel Structures”, Section 3.1.6.1

- Requires Erection Drawings for RR Underpasses, Field-spliced Girders, etc.
- Does not require Erection Drawings for rolled I-beams.
- Specifies to prepare drawings in accordance with AASHTO/NSBA Steel Bridge Collaboration S10.1 (Section 2.2) and Lists the minimum required information.
- Specifies to perform girder erection analyses using TxDOT provided software UT-Lift and UT-Bridge when applicable, or use other suitable commercial software.
- Clarifies that any changes to previously approved erection drawings/procedures requires re-approval.
Steel Bridge Erection Guide Specification

AASHTO/NSBA Steel Bridge Collaboration

Section 2
Erection Procedures

2.1 General
The Contractor shall submit a detailed erection procedure to the Owner for each bridge structural unit, prepared under the supervision of a licensed Professional Engineer qualified in steel erection. The procedure shall address all requirements for erection of the structural steel into the final designed configuration and satisfy all written Owner comments prior to the start of erection. The procedure, as a minimum, shall include the following information:

Commentary
The qualifications of the engineer preparing the erection plan are evidenced by knowledge, training, and experience in steel erection and having demonstrated the ability to resolve problems related to steel bridge erection. Complex or monumental structures (see commentary to Section 1.2) should have specific erection requirements noted in the Contract. The erection procedure should be submitted as soon as possible after Contract award. Erectors are encouraged to attend prebid and preconstruction meetings. Projects that involve complex erection or multi-agency review can be expected to require additional time for review of the submitted erection procedure.

Commentary
Other parameters also may need to be shown on the plan of the work area, such as right-of-way.

2.2 Drawings:
   a) plan of the work area showing permanent support structures (piers and abutments), roads, railroad tracks, waterways (including navigational channel), overhead and underground utilities, and other information pertinent to erection
   b) erection sequence for all members noting any temporary support conditions, such as holding crane positions, temporary supports, falsework, etc. Member reference marks, when reflected on the erection plan, should be the same as used on shop detail drawings;
   c) primary member delivery location and orientation
   d) location of each crane for each primary member pick, showing radius and crane support (barges, mats, etc.)
   e) capacity chart for each crane configuration and boom length used in the work
   f) center of gravity locations for primary members

Erection sequence should indicate specific cross frames or lateral bracing required by stability calculations.

For operations on navigable waterways, the configuration of the barge(s), loading sequence, stability provisions (tie downs, piles, etc.), and calculations.
Bridge “Standards” Controls for Erection

**Steel Beams – MEBR(S)**

- To be used a guide for Erection Drawings
- Shows minimum Bracing Requirements
- Specifies minimum amount of supplement support based on beam curvature
- Does not dictate lifting points
Steel Girder Erection/Construction Analysis Tools

- **UT Curved Girder Analysis Tools (UTCGAT)**
  - Free to Download off TxDOT Website (Engineering Software)
  - [http://fsel.engr.utexas.edu/facilities/software/software](http://fsel.engr.utexas.edu/facilities/software/software) (for the latest version)

- **UT Lift**
  - Excel Spreadsheets
  - Input steel member information, lift points, and presence of cross-frames
  - Check on beam stresses/twist during erection (single beam)

- **UT Bridge – 3D Finite Element Analysis**
  - Windows Based Software/Analysis
  - Input steel member information, permanent and temp. support locations, and presence of cross-frames
  - Check on beam(s) stresses/deflections/rotations during erection
  - Check cross frame forces
  - Includes lateral loads
  - Deck placing sequence checks
Behavior of Curved Girder During Lifting

- $L_1$: Length of Section 1
- $L_2$: Length of Section 2
- $W_1$: Weight per Unit Length of Section 1
- $W_2$: Weight per Unit Length of Section 2
- $\theta_1$: Internal Angle from the Beginning of the Girder to the End of Section 1
- $\theta_2$: Internal Angle from the Beginning of the Girder to the End of Section 2
- $s$: Cross Frame Width
- $L_x$: Length along the Girder to X-Frame 3
- $R$: Radius of Curvature of the Girder

Girder Input:
- Project: Example Problems
- Girder #: Example Girder 1

Number of Cross Sections:
- $N_{cross_sections} = 2$

Radius of Curvature (ft):
- $R = 1000$ ft

Material Constants:
- $E = 29000$ ksi
- $G = 11154$ ksi
- $p = 490$ lbs/ft

Cross Frame Input:
- Number of Cross Frames Locations:
- Uniformly Cross Frames Weight: Constant X-Frame Weight

Uniformly Spaced Cross Frames:
- Spacing: 12.5 ft
- Location of the 1st Cross Frame:
- 1st X-Frame Loc.: 0 ft

Cross Frame Location along centerline (CL) of the Girder (ft):
- $L_x$

Weight of One Cross Frame (lbs):
- $W_x$

Inside of Curve, Outside of Curve or Both (I, O, or I/O):
- I/O

Internal Angle from Beginning (deg):
- $\theta_x$

Cross Frames:
- on the Inside: I
- on the Outside: O

TxDOT Bridge Webinar
July 27, 2017
Steel Girder Erection/Construction Main Concerns of Owner

- **Safety**
  - Has a PE designed a plan that will not put public safety at risk?
  - Has lateral loading been considered?
  - Are traffic control issues clearly defined?
  - Site conditions have an influence on the thoroughness of our review.
  - Is the plan being followed?

- **Member Integrity**
  - Does the plan seem reasonable (past experience of similar work) to avoid issues
  - Do the analysis results verify no permanent distortion
  - Is the plan in accordance with plans and specifications
  - We factor in that the erector/contractor are not out to have a problem

- **Inspection**
  - Does the plan include step by step procedures?
  - Are temporary supports clearly documented?
  - Are the intermediate steps described (ie. % of fasterners in splices, number of diaphragms installed, etc)
Shore Tower Concern
Shore Tower Concern
Traffic Concern
Traffic Concern
Stand Back and Watch the Professionals
Stand Back and Watch the Professionals
Stand Back and Watch the Professionals
Often a Problem Area
Useful Documents

- TxDOT Project 0-5574: Curved Plate Girder Design for Safe and Economical Construction


- Publication No. FHWA-NHI-15-044: Engineering for Structural Stability in Bridge Construction

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