


ERECTION PLANS UT-BRIDGE & UT-LIFT

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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

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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

Specification Controls for Erection (Continued)

- 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.

AASHTO/NSBA Steel Bridge Collaboration S 10.1

AASHTO/NSBA Steel Bridge Collaboration

S 10.1 - 2007

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.

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

Commentary

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

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

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

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.)

For operations on navigable waterways, the configuration of the barge(s), loading sequence, stability provisions (tie downs, piles, etc.), and calculations.

e) capacity chart for each crane configuration and boom length used in the work

f) center of gravity locations for primary members

Bridge “Standards” Controls for Erection

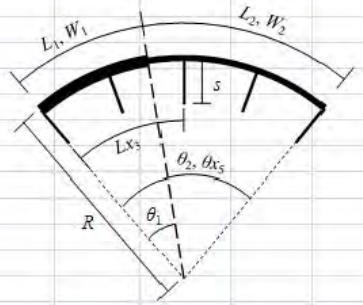
- Steel Beams – MEBR(S)
  - To be used a guide for Erection Drawings
  - Shows minimum Bracing Requirements
  - Specifies minimum amount of supplement support based on beam curvature
  - Does not dictate lifting points

Steel Girder Erection/Construction Analysis Tools

- UT Curved Girder Analysis Tools (UTCGAT)
  - http://www.txdot.gov/inside-txdot/division/information-technology/engineering-software.html
  - Free to Download off TxDOT Website (Engineering 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

TxDOT – Steel Girder Erection Software – UT Lift

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

$\theta_0 = 0$
θ_1: Internal Angle from the Beginning of the Girder to the End of Section 1
θ_2: Internal Angle from the Beginning of the Girder to the End of Section 2

s: Cross Frame Width
Lx_3: Length along the Girder to X-Frame 3
θx_3: Internal Angle from the Beginning of the Girder to X-Frame 3

R: Radius of Curvature of the Girder

Girder Input:

Project :	Example Problems
Girder # :	Example Girder 1

Clear Input

User Input
Notable Results

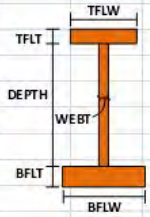
Number of Cross Sections:		
NUMSECTIONS =	2	
Radius of Curvature (ft): R		
R =	1000	ft

Girder Scale Factor:		
$S.F._{girder}$ =	1.10	

Material Constants:		
E =	29000	ksi
G =	11154	ksi
ρ =	490	lbs/ft³

Page 1

	Section 1	Section 2
TFLW	24	24
TFLT	1.25	2
DEPTH	72	72
WEBT	0.75	0.75
BFLT	1.25	2.5
BFLW	24	24



	Section 1	Section 2
L_i =	65	70
W_i =	426.7	606.4
θ_i =	3.72	7.73

Girder Input | C.G. & Ideal Lift | Calculated Behavior | Graphs

Cross Frame Input:

Number of Cross Frames Locations:		
NUMXFRAMES =	11	
Cross Frame Width: s		
s =	8.00	ft

Uniformly Cross Frames Weight:		
Weight =	250	lbs

Constant X-Frame Weight

Uniformly Spaced Cross Frames:		
Spacing =	13.5	ft
Location of the 1st Cross Frame:		
1st X-Frame Loc. =	0	ft

Constant X-Frame Spacing

All Cross Frames on Inside of Curve, Outside of Curve, or Both

All I | All O | All I/O

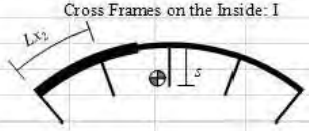
	X-Frame 1	X-Frame 2	X-Frame 3	X-Frame 4	X-Frame 5	X-Frame 6	X-Frame 7	X-Frame 8	X-Frame 9
Lx_j =	0	13.5	27	40.5	54	67.5	81	94.5	108
Wx_j =	250	250	250	250	250	250	250	250	250
I/O	I/O	I/O	I/O	I/O	I/O	I/O	I/O	I/O	I/O
θx_j =	0.000	0.773	1.547	2.320	3.094	3.867	4.641	5.414	6.188

	X-Frame 10	X-Frame 11
Lx_j =	121.5	135
Wx_j =	250	250
I/O	I/O	I/O
θx_j =	6.961	7.735

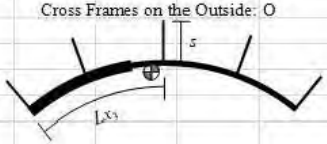
Page 2

Cross Frame Location along centerline (CL) of the Girder (ft): Lx_j
Weight of One Cross Frame (lbs): Wx_j
Inside of Curve, Outside of Curve or Both (I, O, or I/O): I/O
Internal Angle from Beginning (deg.) : θx_j

Cross Frames on the Inside: I



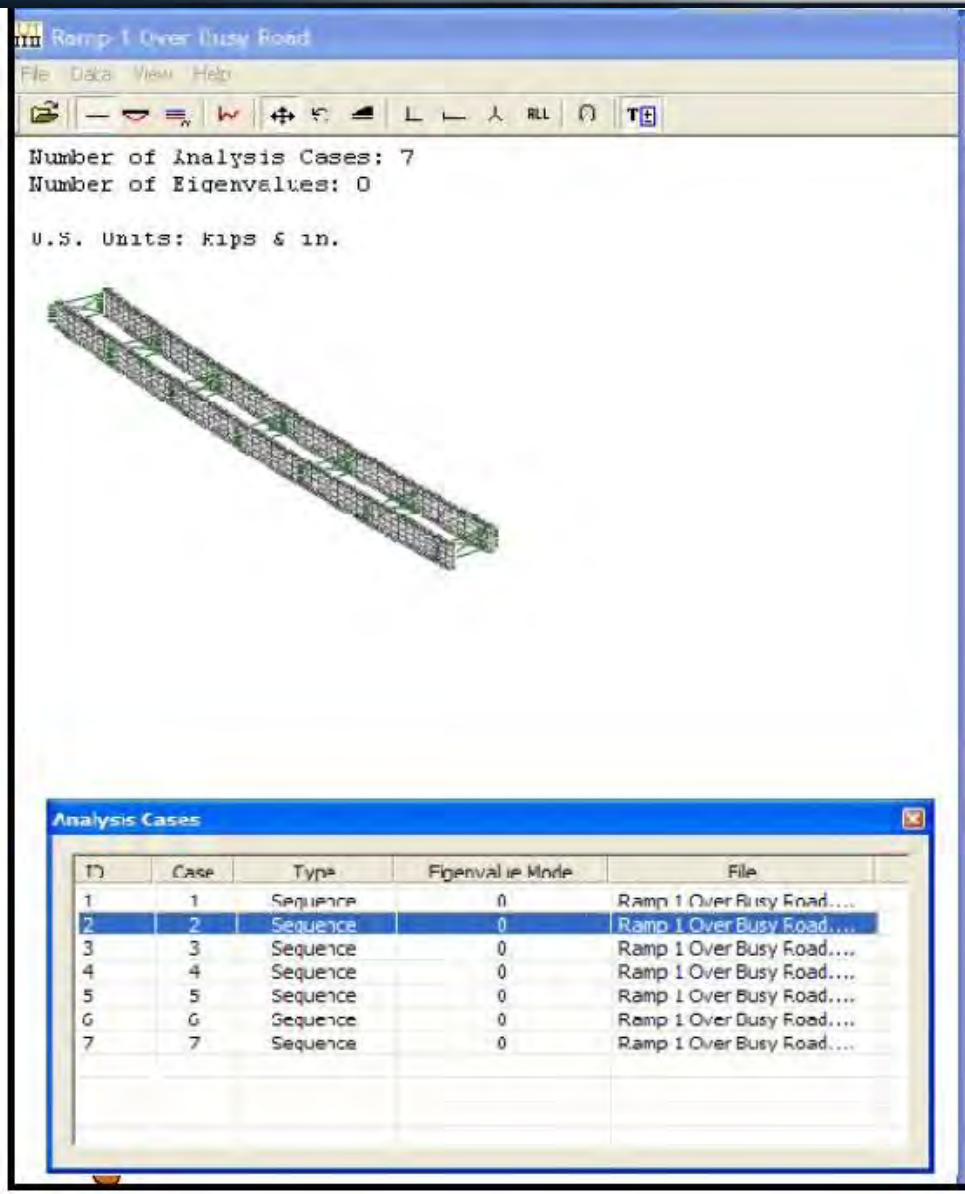
Cross Frames on the Outside: O

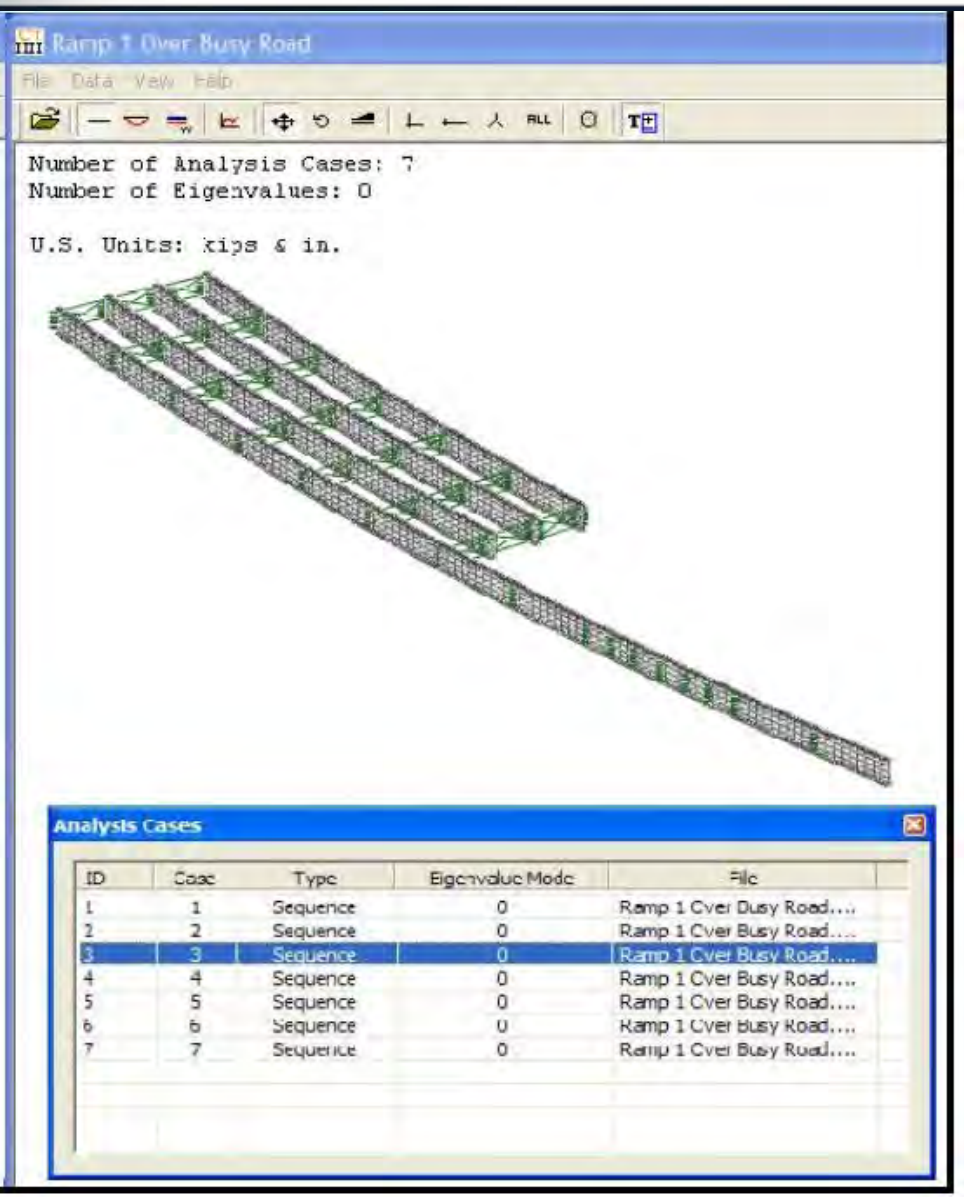


Cross Frames on Both Sides: I/O

Girder Input | C.G. & Ideal Lift | Calculated Behavior | Graphs

TxDOT – Steel Girder Erection Software – UT Bridge





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

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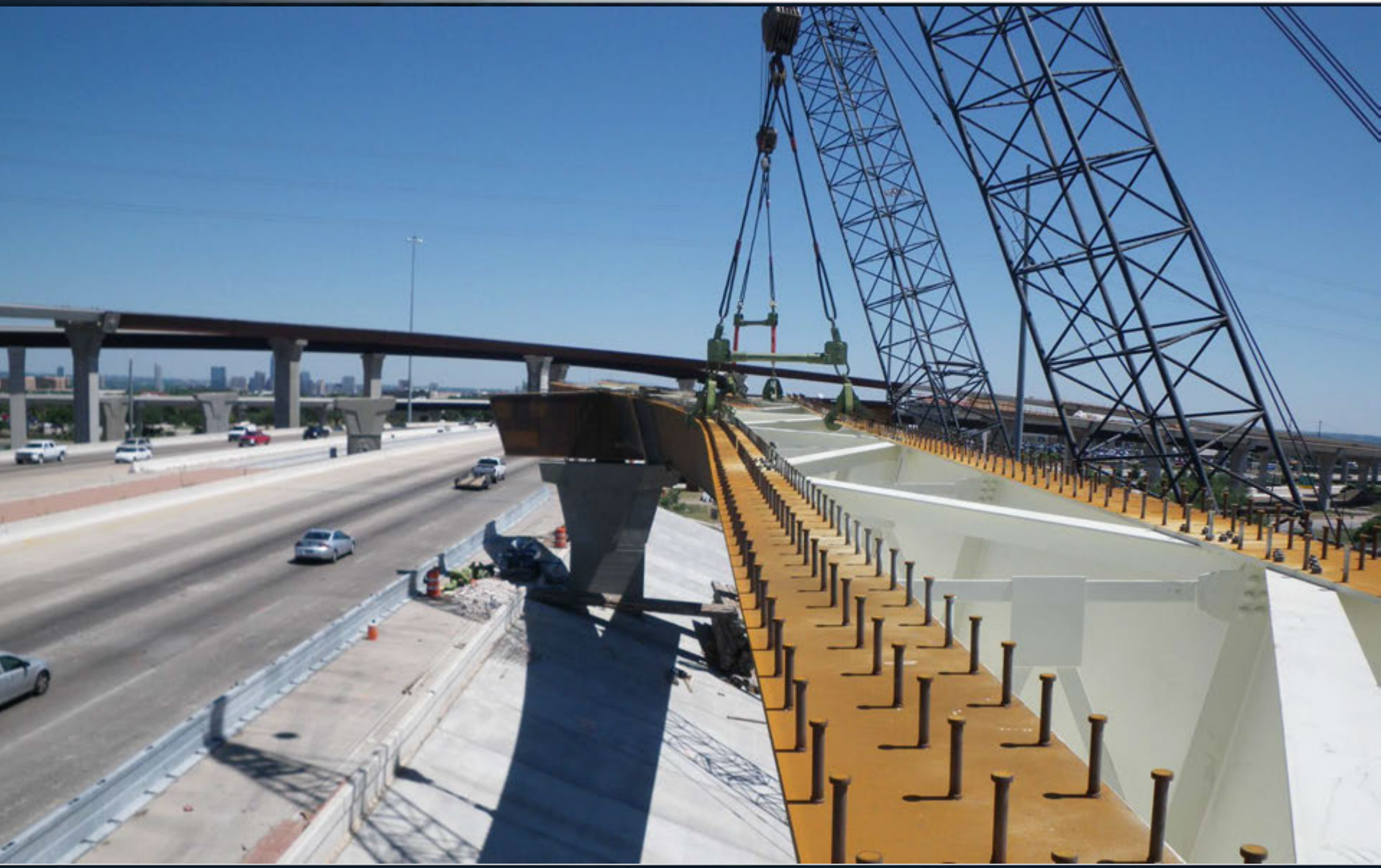
Traffic Concern



Traffic Concern

Stand Back and Watch the Professionals

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Stand Back and Watch the Professionals – Really?

Often a Problem Area

Useful Documents

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

- AASHTO/NSBA Steel Bridge Collaboration, S 10.1 – 2007: Steel Bridge Erection Guide Specification

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

- TxDOT Preferred Practices for Steel Bridge Design, Fabrication, and Erection February 2015: http://ftp.dot.state.tx.us/pub/txdot-info/library/pubs/bus/bridge/steel_bridge.pdf

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