



# Design of Long Span Bridges Using Spliced Girders

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## Spliced Girder

- Straight Spliced Girder and Curved Spliced U Girder
  - Precast sections
  - Cast in Place splices
  - Post-tensioned together



Precast segment

Closure joint

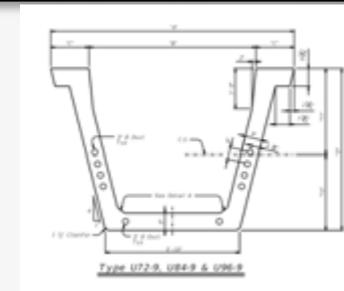
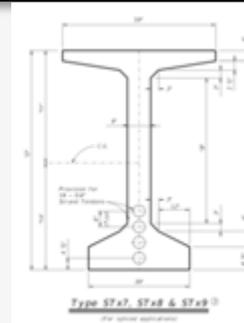
## When to Consider Spliced Girder

- Main span length over 150'
- Span lengths > transportation limit
- Thinner section depth with continuous span
- In salt water adjacent areas



## Applicability of Spliced Girder

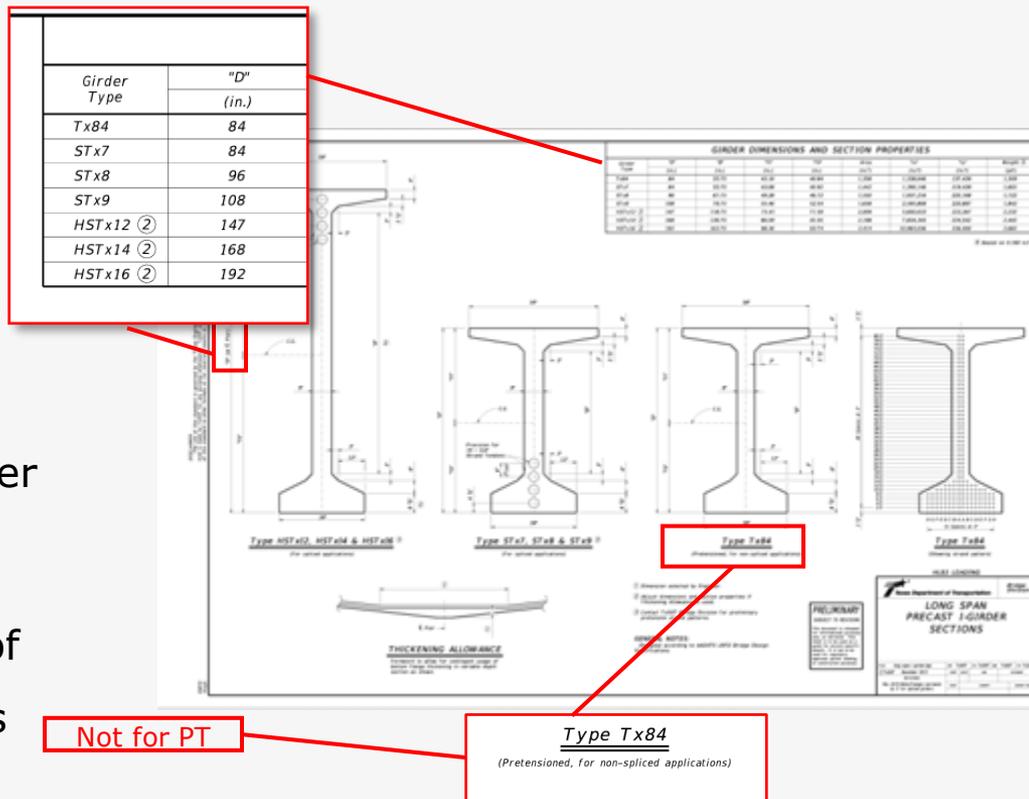
- Main span options in the range of 170' to 325' (Contingent to conditions)
- STX8 up to 245' and for STX9 up to 250' (Prismatic)
- Haunched variable section depth available for longer spans



Long Span Precast Sections

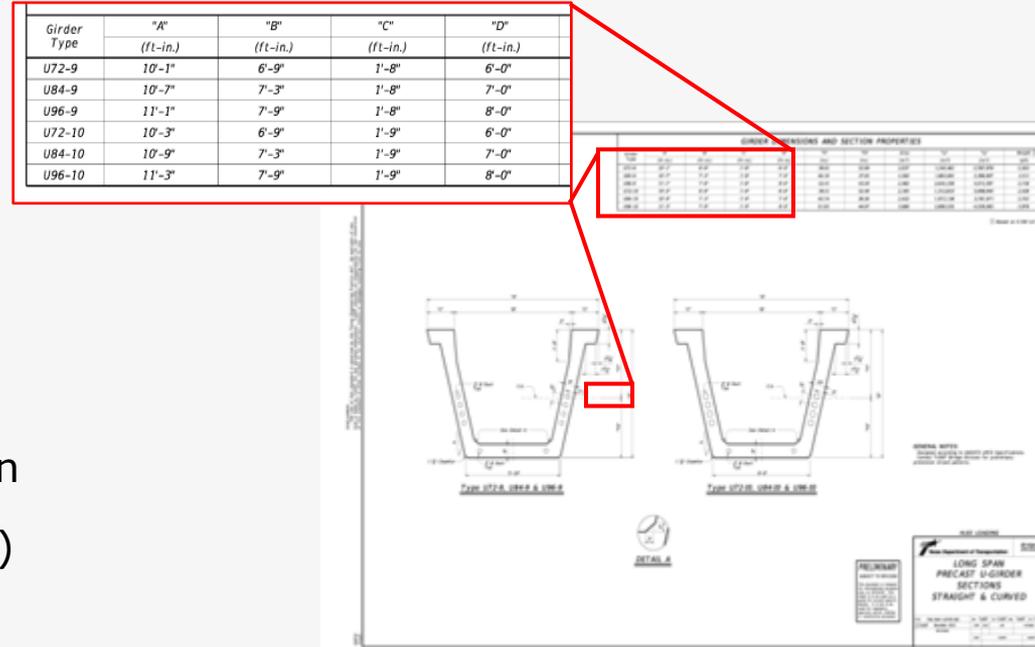
## TxDOT Extended Span

- I-Girders working drawing available for designers
- STx used as drop-in section for long span
- HSTx Girders are haunch section over pier caps
- Use 0.160 kcf due to the presence of rebars/ducts/tendons/miscellaneous



# TxDOT Extended Span

- U-girders working drawing available for designers
- Web/flange thickness may be increased internally to satisfy demand/larger size duct
- Three-four 12-0.6" strand tendons in each web (depends on beam height)
- Minimum web thickness of 9"



## Advantages of Spliced Girder

- Familiarity with TxDOT girder shape
- Deck could be replaced
- Used on horizontally curved alignments
- Overcoming transportation limitation
- Continuity



## Considerations for Spliced Girder

- Splice locations are constrained by several factors
  - Design for 100 tons lifting weight per segment  
(Offer opportunities for more bids)
  - Transportation limit 150' (allows more fabricators participation)
  - Closure joints near inflection points to minimize stresses at closure joints



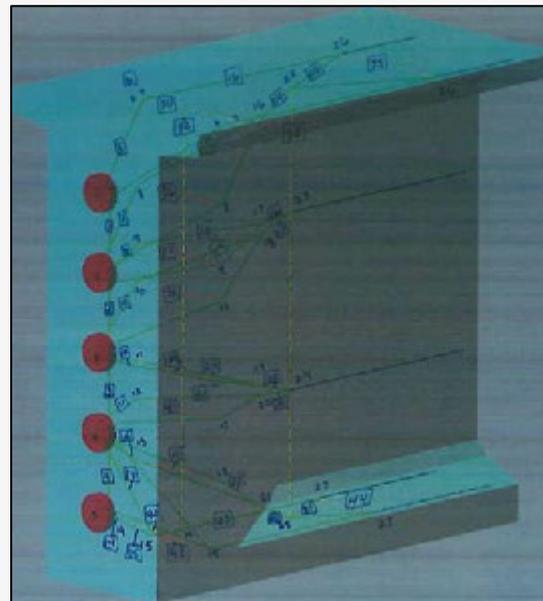
## Considerations for Spliced Girder

- Means and Methods
  - Shore towers or strong-backs change how the load is distributed along the beam and when the load is applied during the construction sequence



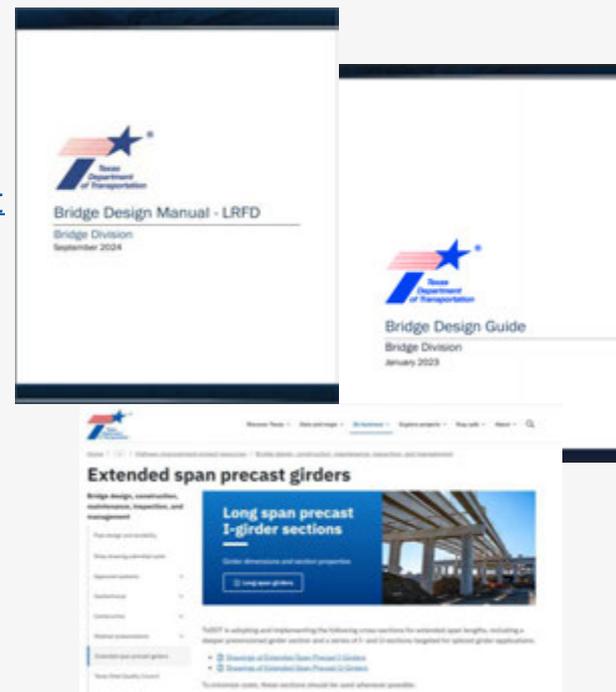
## Considerations for Spliced Girder

- End Zone
  - Combine requirements for pre-tensioning and post-tensioning
  - Constructability is difficult given the congested rebars



# TxDOT Requirements for Spliced Girder

- AASHTO LRFD Specifications
- Bridge Design Manual (BDM) - Chapter 3: Section 16
  - <https://onlinemanuals.txdot.gov/TxDOTOnlineManuals/txdotmanuals/lrf/lrf.pdf>
- Bridge Design Guide - Chapter 3 : Section 11
  - <https://crossroads/content/dam/crossroads/divisions/bridge/documents/bridge-design/bridge-design-guide-january-2023.pdf>
- Extended span precast girders
  - <https://www.txdot.gov/business/resources/highway/bridge/extended-span-precast-girders.html>



## TxDOT Requirements for Spliced Girder: Materials

- Precast elements can have concrete strength up to 10 ksi
- Cast-in-Place elements can have concrete strength up to 6 ksi



## TxDOT Requirements for Spliced Girder: Materials

- Post tension system provided following TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, & Bridges
- BDM (exceptions from item 426 in Standard Specs):

Environment	Protection Level
Non-Severe Corrosive	1B
Severe Corrosive	2

- Stressed tendons in finished structure must be grouted
- Permanent tendons stressed at precast yard before transport must be grouted



fhwa.gov

## TxDOT Requirements for Spliced Girder: Geometric Constraints

- Minimum number of girders in any roadway width
  - I-Section
    - 3 or 4 girders (if the span is over a lower roadway and the vertical clearance is less than 20 ft)
  - U-Section
    - 2 girders



## TxDOT Requirements for Spliced Girder: Analysis

- Staged construction
- Addition and removal of temporary supports
- Locked in forces
- Staged post tensioning
- Secondary forces due to post tensioning
- Torsion due to horizontally curved alignments
- Superstructure-Substructure interaction
- Temperature variation



## TxDOT Requirements for Spliced Girder: Design

- Evaluate principal tensile stresses; account for duct in grouted/ungROUTED conditions
- Evaluate bending stress limits based on Bridge Design Manual
- Decks are required to be designed as non-stress elements to allow future redecking
- The duct must be smaller than  $0.54 * (\text{Web width})$  (AASTHO 5.4.6.2)



## TxDOT Requirements for Spliced Girder: Design

- Minimum of two tendons per web
- Provide a full depth diaphragm at all splice and anchorage locations
- Diaphragms may be eliminated if specific criteria are met
- Intermediate diaphragm use is not mandatory



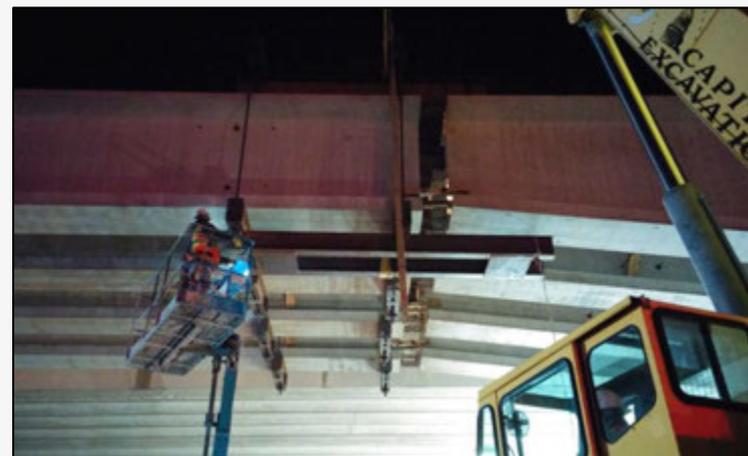
## TxDOT Requirements for Spliced Girder: Others

- Plans require assumed Construction Sequence with:
  - Shore tower locations and shore tower loads
  - Lifting / support points of precast members
  - Final girder elevation points
  - Post tensioning sequence
  - Jacking stresses for prestressing strand and post-tensioned tendons
- Require contractor to provide a temporary bracing plan of girders
- Require contractor to provide shoring and erection plan



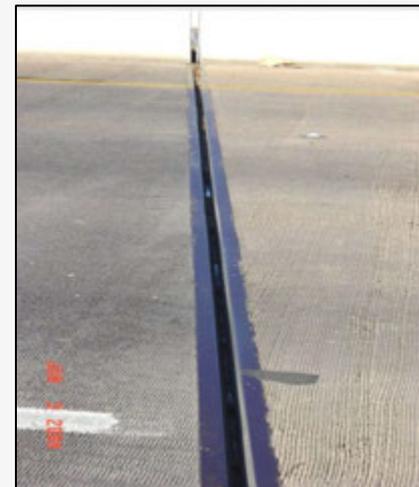
## TxDOT Requirements for Spliced Girder: Others

- Design temporary construction equipment and falsework
  - Consider lateral loads
- Temporary bracings must resist rolling, provide stability, limit torsional stresses and deflections
- Torsionally brace and support girder segment ends on shore towers, prior to releasing any significant load from erection equipment



## TxDOT Requirements for Spliced Girder: Others

- SEJ-B or SEJ-M (depending on traffic), finger joints, or modular joints
- Elastomeric bearing or HLMR bearings



## Texas Spliced Girder Bridge Inventory

- Projects from 2011-2024 across the state
  - FM 78 (New Braunfels St) & UPRR, Guadalupe County
  - IH-53N OVERPASS at UPRR, Williamson County
  - Sargent Beach, Matagorda County
  - SH 249 NB to SH99-WB DC (Ramp C), Harris County
  - FM 1495 over Old Brazos River, Brazoria County (Ongoing)
- Max main span range: 215'-300'
- 1 Curved U-beam spliced girder in Houston



Photo by Modjeski and Masters

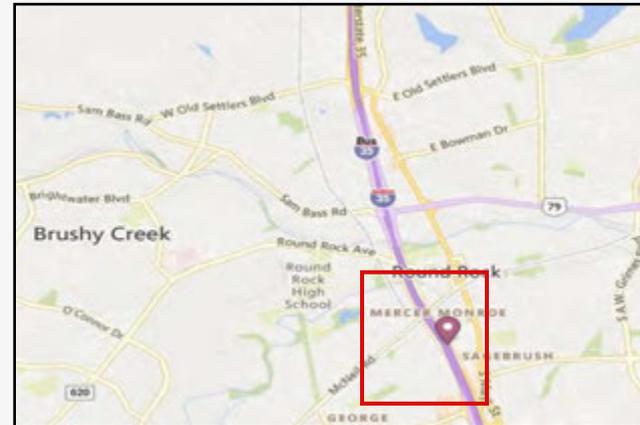
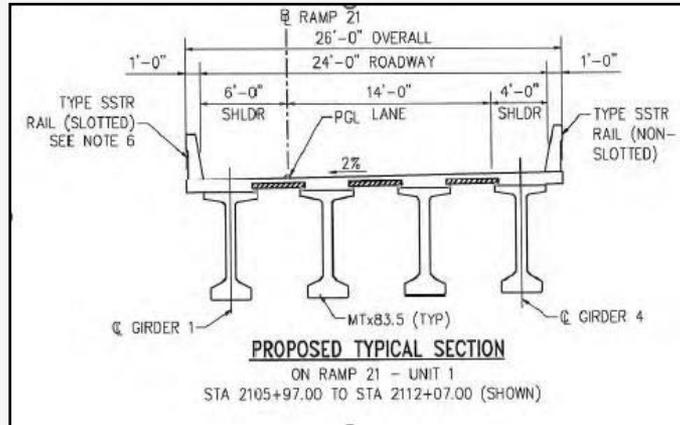
## Project Highlight: FM 78 (New Braunfels St) & UPRR, Seguin

- 438'-0" concrete spliced girders I-beam unit with main span of 200' over UPRR
- 33'-0" overall width with varying skew over UPRR
- Internal strong back for I beams



## Project Highlight: IH-35N OVERPASS AT UPRR, Williamson County

- 610' Concrete Spliced Girder I-beam Unit with main span of 250' over UPRR
- 26'-0" overall width with a mild horizontal curvature of 7876' radius
- Haunched sections over the supports and drop in sections over UPRR



## Project Highlight: IH-35N OVERPASS AT UPRR, Williamson County

- Modified TxDOT standard girder with 83.5" depth for drop in section and 120" haunched sections over the interior supports
- Segments are straight but kinked at splices to accommodate curvature
- Deck was chorded to accommodate curvature (might not work on tight curve)



## Project Highlight: IH-35N OVERPASS AT UPRR, Williamson County

- Temporary steel cap on concrete columns used for stability during erection
- Strong backs used for drop in sections

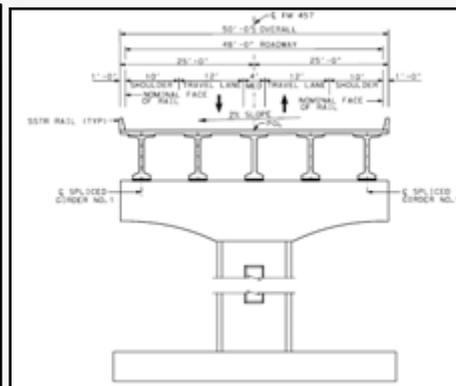


## Project Highlight: Sargent Beach, Matagorda County

- 690' Concrete Spliced I-beam Unit with a main span 300' over Sargent Beach
- 50'-0" overall width used to allow truck to navigate the corkscrew ramps with horizontal curve
- Utilized slab beams for approaches



Photo by Modjeski and Masters



## Project Highlight: Sargent Beach, Matagorda

- Haunched sections over the supports
- Segments are straight but approach spans are curved
- Shoring towers and internal strong backs used for erection stability



Photo by Modjeski and Masters

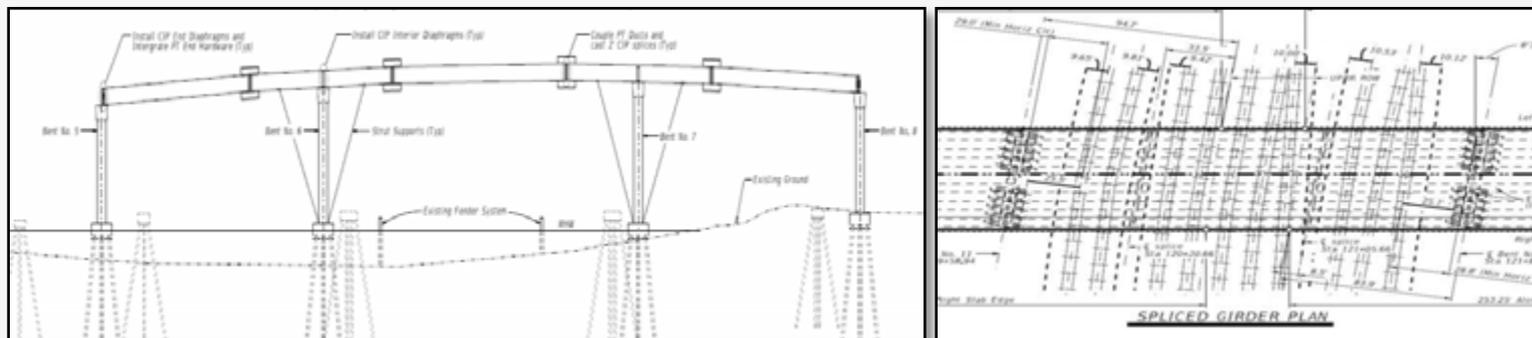
## Project Highlight: SH 249 NB to SH99-WB DC (Ramp C), Harris County

- 1,228' curved spliced girder U-beam
- 32'-5" overall width with horizontal curvature 920' radius
- Internal strong back for U beams
- Welded steel to the forms to control curvature in U beams



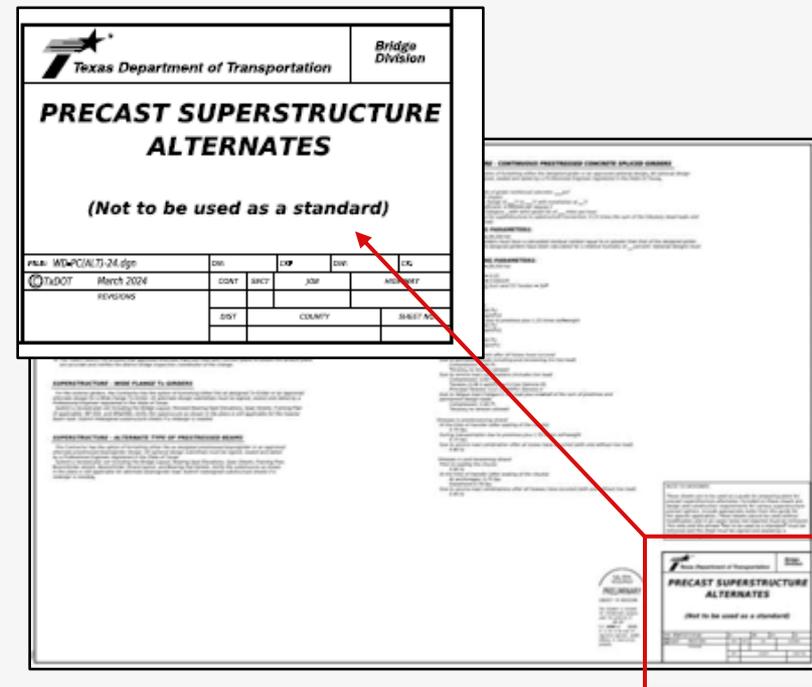
## Project Highlight: FM 1495 Over Old Brazos River, Freeport

- 537' Concrete Spliced Girder I-beam Unit with 215' main span
- 451' unit with 192' main span over multiple railroad tracks at 9° skew
- 63'-0" overall width, no horizontal curvature
- Use a combination of strong backs, strut supports and shoring systems



## Alternate Design

- Project plans need to specify possibility of alternate design
- Contractor runs analysis and chooses alternate
- Alternate design increases competitive bid
- If approved the alternate design will be included with as-built plans for accuracy
- <https://ftp.dot.state.tx.us/pub/txdot-info/cmd/cserve/standard/bridge/MS-PCA-SUP-24.pdf>



## Summary

- Spliced girder in Texas
- When projects should consider spliced girder as an option
- Bridge Division will review all concrete spliced girder bridge plan sheets designed by consultants at all major project milestones (30%, 60%, 90%, & 100%) to:
  - Minimize use of inefficient and insufficient design details
  - Help avoid project delays after letting

# Thank you!

Questions?

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