Spliced Precast Concrete Girder Developments

TxDOT Transportation Short Course
October 17, 2012
Agenda

• Need for Spliced Girder Technology
• Previous History in Texas
• Recent Texas and National Developments
• Texas Implementation
Long Span Bridges On and Off System

748 Bridges in Texas over 150 ft Span

Number of Bridges

Span Length (ft)

150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050 1100
Long Span Bridges On and Off System
Plate Girders
Direct Connector
Curved Plate Girders
Steel Trap Girders
Segmental: Precast Span-by-Span
Segmental: Precast Balanced Cantilever
Segmental:
CIP Balanced Cantilever

250 ft H

73 ft V
Cost vs. Weight Tangent Plate Girder

Average = $54.86 per SF
Span Length vs. Weight
Curved Plate Girder

Weight (psf)

Span Length (ft)
Span Length vs. Cost
Curved Plate Girder

Average = $100.81 per SF
Span Length vs. Weight
Trapezoidal Girder

Weight (psf) vs. Span Length (ft)
Span Length vs. Cost
Trapezoidal Girder

Cost of Steel per SF

Span Length (ft)

Average = $124.37 per SF
Standard TxGirders

**TYPE Tx28, Tx34 & Tx40**

**TYPE Tx46 & Tx54**

**TYPE Tx62 & Tx70**
## TxGirders: Simple Span Capabilities

<table>
<thead>
<tr>
<th>Girder</th>
<th>Span Length at Min Girder Spa</th>
<th>Span Length at Max Girder Spa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tx28</td>
<td>78</td>
<td>67</td>
</tr>
<tr>
<td>Tx34</td>
<td>92</td>
<td>79</td>
</tr>
<tr>
<td>Tx40</td>
<td>107</td>
<td>91</td>
</tr>
<tr>
<td>Tx46</td>
<td>120</td>
<td>103</td>
</tr>
<tr>
<td>Tx54</td>
<td>135</td>
<td>120</td>
</tr>
<tr>
<td>Tx62</td>
<td>149</td>
<td>128</td>
</tr>
<tr>
<td>Tx70</td>
<td>161</td>
<td>139</td>
</tr>
</tbody>
</table>
Previous TxDOT Methods for Increasing Span Length: Loy Lake Road Bridge at US 75
Previous TxDOT Methods: Drop-In

DOUBLE END CANTILEVER BEAMS
Drop-In: 190 ft Span Cypresswood over RR (HOU)
Drop-In

- Heavily Reinforced Corbels
- Non-Continuous, Less Redundancy
- Multiple Harping Locations in Strands
Spliced Girder Bridges

- Popular in SE & NW US
- Main Span Up to 250 to 325 ft
- 2 Texas (non-TxDOT) projects DART & City of Fort Worth
- 1st TxDOT Project let in Dallas July 2011
Spliced TxGirders

- Spliced precast bulb tees have main span lengths of up to 325 ft
- Competitive with steel plate girders and segmental concrete
- Two TxDOT research projects underway
  - Project 6651 at TTI/TAMU: Continuous PS Conc Bridges
  - Project 6652 at CTR/UT: TxGirder Splices
- Three construction projects underway
DART Orange Line at Trinity River

- First Modern Application in Texas
- Modified Tx82 Sections
- Variable Depth Pier Section

DART at Trinity River

Tx82+ 145’ – 260’ – 145’
Variable Depth Section:
Max Depth = 10’-10”
DART Spliced Girders
DART Spliced Girder

http://aspirebridge.com/magazine/2012Fall/DART.pdf
Clearfork Main Street Bridge, Fort Worth TX

• 165’-220’-165’
• Type VI Mod Girders
• Parabolic Haunch (10’-0” max depth)

From: Hamilton Forms, “Form and Function”, Winter 2010
Dallas Trinity River (Sylvan Ave)

- Two 3-span continuous PT units
  - 171’-200’-171’ (constant depth)
  - 201’-250’-201’ (variable depth)
  - Tx82 Mod 10” thick web
  - Max depth 10’-10”
- 9 Bidders
  - $99 to $112 per SF overall cost
  - $40 per SF for beams and post-tensioning
Projects on the Horizon
FM 1495 Over Old Brazos River River
Freeport, TX
FM 1495 Freeport

- 140’-180’-140’’ min over Old Brazos River
- 192’ min over Dow Chemical RR Yard
Bijou Street Bridge, Colorado
Erection of Span over Rail Yard
FM 457 over ICWW
Sargent Beach, TX
Matagorda Segmental

- Matagorda FM 2013 over GIWW
- 180 ft – 320 ft – 180 ft
- $212 per SF
- Most aesthetic
SH 105 at Brazos River

235’-300’-235’ Proposed Span Arrangement
Spliced Concrete U-Girders
Prestressed U-Beams

- 54” and 40” Beam Depths
- Wider Beam Spacing
- Sloped Sides
- Aesthetic Solution for Grade Seps
Curved Spliced U-Girders: National Efforts

• **Concept Genesis: Colorado**
  - Built 10 projects, 2 under construction
  - Over 800,000 SF deck, 41,000 LF beams in service

• **PCI-SE (Zone 6) Effort**
  - Developed “standards”
  - [http://www.gcppci.org/index.cfm/technical/products](http://www.gcppci.org/index.cfm/technical/products)

• **FDOT Implementation**
  - [http://www.dot.state.fl.us/structures/Innovation/Ubeam.shtm](http://www.dot.state.fl.us/structures/Innovation/Ubeam.shtm)
  - Orlando-Orange County Expressway Authority Interchanges

• **TxDOT Implementation**
Construction Steps

PHASE 1

SPAN 1
SPAN 2
SPAN 3

Q. BRG PIER 1
Q. PIER 2
Q. PIER 3
Q. BRG PIER 4

APPROX. EXISTING GROUND LINE

PHASE 2

SPAN 1
SPAN 2
SPAN 3

Q. BRG PIER 1
Q. PIER 2
Q. PIER 3
Q. BRG PIER 4

2'-0" SPlice (typ.)

PHASE 3

SPAN 1
SPAN 2
SPAN 3

Q. BRG PIER 1
Q. PIER 2
Q. PIER 3
Q. BRG PIER 4

APPROX. EXISTING GROUND LINE

PHASE 4

SPAN 1
SPAN 2
SPAN 3

Q. BRG PIER 1
Q. PIER 2
Q. PIER 3
Q. BRG PIER 4

APPROX. EXISTING GROUND LINE
PCI-SE: 72” Deep Sections

- Max Main Span Lengths
  - 185’ to 220’ Range Continuous
  - 175’ to 180’ Range Simple Span

- Two Different Sections
  - Type 3 = 9” Webs for 3” Plastic Ducts (12 x 0.6” Tendons)
  - Type 4 = 10” Webs for 4” Plastic Ducts (19 x 0.6” Tendons)

- 2117 and 2271 plf, respectively (U54 = 1167 plf)
PCI-SE: 84” Deep Sections

- **Max Main Span Lengths**
  - 195’ to 265’ Range Continuous
  - 190’ to 200’ Range Simple Span

- **Two Different Sections**
  - Type 3 = 9” Webs for 3” Plastic Ducts (12 x 0.6” Tendons)
  - Type 4 = 10” Webs for 4” Plastic Ducts (19 x 0.6” Tendons)

- 2349 and 2529 plf, respectively (U54 = 1167 plf)
PCI-SE: 96” Deep Sections

• Max Main Span Lengths
  – 205’ to 280’ Range Continuous
  – 200’ to 220’ Simple Span

• Two Different Sections
  – Type 3 = 9” Webs for 3” Plastic Ducts (12 x 0.6” Tendons)
  – Type 4 = 10” Webs for 4” Plastic Ducts (19 x 0.6” Tendons)

• 2581 and 2787 plf, respectively (U54 = 1167 plf)
PCI-SE: Variable Depth

- Max Main Span Length of 300 ft
- Requires 19 x 0.6” Tendons
- Constant Depth Section = U84-4
- Variable Depth Section
  - 11 ft max depth
  - Maintains 4:1 side slope (4’-0” wide, thick bottom flange)
  - Weighs 303 kips
- Requires More Splices
PCI-SE Design Considerations

• Focus
  – 40 ft nominal overall, 37 ft roadway
  – 2 girder system
  – Radius down to 750 ft

• Weight considerations
  – Lifting and shipping weights
  – Loads over 254 kips require special permits in Texas
  – Typical piece lengths will be limited to around 100 ft

• Precast panels not considered “structural”

• Intermediate lid slabs needed for torsional stiffness on longer spans

• Slab usually placed after full PT to allow redecking
Fab Example: Encon CO
Fab Example: Plum Creek CO
Reinforcing Cage in Forms Prior to Casting, CO
Girders in Storage Area, CO
Design Features:
Thickened Bottom Flange over Piers
Varying Web Thickness
Cantilever PT Anchors in Webs
Precast Supports for Strong Back Shoring
Preferences at Anchorage Regions

- Precast blockouts for post-tensinoing hardware at plant
- CIP diaphragm and PT anchorage in the field
- Minimizes weight and hardware coordination
Typical Shoring, CO
Girders spliced, Lid Slab in place and diaphragms cast. Girders ready for post tensioning (CO)
Precast Deck Panels placed between Girders (CO)
Bijou Street Bridge, CO
Erection used Strongbacks exclusively to avoid ground supported falsework
Bijou Street Bridge, CO
Erection of Span 3 over Rail Yard
U-Girders In Service: Colorado
TxDOT Implementation Status

• Construction underway on Sylvan Ave (Tx82 Mod)
• Three Projects in Early Stage of Design
  – FM 1495 Old Brazos River Freeport (HOU) – Spliced U (Tangent)
  – SH 105 Brazos River (BRY) – Spliced I (Variable Depth)
  – FM 457 at GIWW (YKM) – Spliced I (Variable Depth)
• Standardization Effort
  – New I Girder Shape
    • Multi-piece Single Span Post Tensioning
    • Continuous Spans
    • Standardize Variable Depth Practice
  – U Girders (with aid of PCI-SE standards)
• Industry Involvement from PCMA of Texas and AGC of Texas
Questions?