EXPANDING THE USE OF PRECAST CONCRETE IN TEXAS BRIDGES

Graham Bettis, P.E.
TxDOT Bridge Division – Construction & Maintenance
Just the Facts

- Total Number of On-System Bridges (Excluding Culverts): 21,686
- Total Number with Prestressed Concrete Superstructures: 11,037 (that’s 51%)
- About 90% of New Bridges Built with Prestressed Concrete Superstructures: 92% in FY 2013
Standard I-Beam Construction
Standard U-Beam and Deck Panel Construction
Precast Concrete - How Do We Love Thee?

- Owner’s Perspective
  - Inexpensive
  - Fast
  - Durable
  - Redundant

- Contractor’s Perspective
  - Fast
  - $$$*

* Sometimes difficult for Primes to let go of cast-in-place.
Concrete Production in Texas

- Cement
  - Lots of Limestone
  - 10 Cement Producers
- Coarse Aggregate
  - River Rock
  - Limestone
- Fine Aggregate
  - River Beds (Sand)
  - Manufactured Sand (Limestone)
- Fly Ash

Coal Plants in Texas
## Major Prestressed Member Fabrication Plants (Multi-Project)

<table>
<thead>
<tr>
<th>Producer Code</th>
<th>Fabricator</th>
<th>Location</th>
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<tbody>
<tr>
<td>98296</td>
<td>Atesvi US</td>
<td>Irving, TX</td>
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<td>Bexar Concrete Works I, Ltd.</td>
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<td>Texas Concrete Partners, L.P., Waco Division (formerly Texas Prestressed Concrete, Inc.)</td>
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</tr>
<tr>
<td>99437</td>
<td>Valley Prestressed Products, Inc.</td>
<td>Eagle Lake, TX</td>
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</tbody>
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- **Precast Concrete Fabricators – Major Prestressed**

  - Expanding the Use of Precast Concrete in Texas Bridges

  - PCMA
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<td>99425</td>
<td>CXT, Inc.</td>
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<td>99973</td>
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<td>98236</td>
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<td>99666</td>
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<td>99707</td>
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Average Bridge Costs – FY 2013

- **Structural Steel***
  - Plate Girders: $126/SF
  - Trapezoidal Tubs: $153/SF

- **Prestressed Concrete**
  - Tx Girders (Bulb Tees): $65/SF
  - U54 Beams: $52/SF

* Must take into account that almost all steel spans are long and continuous, raising the construction cost significantly. But still...
Expanding the Use of Precast Concrete in Texas Bridges

Durability

- Extremely Low Permeability
  - Fly Ash
  - Steel Form Finish

- Produced in Controlled Environment
  - Self-Consolidating Concrete
  - Low Water-to-Cement Ratio
  - Moist Curing
  - QC/QA
  - Repair and Rejection – Plant vs. Job Site
Permeability

Standard Test Method for Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration

This standard is issued under the fixed designation C1202; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

**TABLE X1.1 Chloride Ion Penetrability Based on Charge Passed (1)**

<table>
<thead>
<tr>
<th>Charge Passed (coulombs)</th>
<th>Chloride Ion Penetrability</th>
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<tbody>
<tr>
<td>&gt;4,000</td>
<td>High</td>
</tr>
<tr>
<td>2,000–4,000</td>
<td>Moderate</td>
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<tr>
<td>1,000–2,000</td>
<td>Low</td>
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<tr>
<td>100–1,000</td>
<td>Very Low</td>
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<tr>
<td>&lt;100</td>
<td>Negligible</td>
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Not All Concrete Cracks
Conventional Concrete Deterioration
Conventional Concrete Deterioration
Conventional Concrete Deterioration
Conventional Concrete Deterioration
Conventional Concrete Deterioration
Structural Steel Deterioration
Structural Steel Deterioration
High Performance Concrete

- Item 421: Hydraulic Cement Concrete
- 8 Mix Design Options
- HPC = Design Options 1 through 5
  - In Reality, HPC = Design Option 1
    - Replace 25% of Cement with Class F Fly Ash
    - Applies to All Precast Concrete
Precast Concrete
Current, Widespread Usage
<table>
<thead>
<tr>
<th>Standard Precast Items</th>
<th>Traffic Barrier</th>
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<tbody>
<tr>
<td>Railing</td>
<td>Decked Slab Beams</td>
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<tr>
<td>Prestressed Piling</td>
<td>Bent Cap for Round Columns</td>
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<tr>
<td>Spread Boxes – X-Beams</td>
<td>Prestressed Deck Panels</td>
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<tr>
<td>End Treatments</td>
<td>Sheet Piling</td>
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<tr>
<td>Tx Girders (Bulb Tees)</td>
<td>Culverts</td>
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<tr>
<td>U-Beams</td>
<td>Reinforced Concrete Pipes</td>
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<tr>
<td>I-Beams</td>
<td>Box Beams</td>
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</tbody>
</table>
Prestressed Piling
Expanding the Use of Precast Concrete in Texas Bridges

Prestressed Piling
Standard I-Girder Shapes

TYPE T×28, T×34 & T×40

TYPE T×46 & T×54

TYPE T×62 & T×70
I-Girders
What We’re Doing Now – Tx Girders
Decked Slab Beams
U-Beams
Precast Deck Panels
Precast Deck Panels
Precast Deck Panels with PMDF
Precast Overhang Deck Panels with Pockets
Expanding the Use of Precast Concrete in Texas Bridges

Precast Overhang Deck Panels with Channel

SHOWING FIELD PLACEMENT OF TOP REINFORCING STEEL

SHOWING PCP(3) EXPOSED REINFORCING STEEL

Blockout required where needed for SEJ. (Typ) 1

Place one full length bar Y at this location 2

End Panel PCP(0)

Interior Panel PCP(0)

Interior Panel PCP(0)

Interior Panel PCP(0)

Interior Panel PCP(0)

Expansion Joint

2Y (Typ)

2 1/2Y (Typ)

A 2

F 12

Showing Option 2 on the PCP standard. Option 1 not allowed.
Precast Overhang Deck Panels with Channel

**TYPICAL TRANSVERSE SECTION**

(Showing Girder Type Tx46)
Full Depth Panels

Expanding the Use of Precast Concrete in Texas Bridges
Full Depth Panels
MSE Panels
Existing Concepts
Desire for Expanded Use
Precast Bent Caps
Precast Bent Caps
Precast Bent Caps

Expanding the Use of Precast Concrete in Texas Bridges
Precast Abutments
Precast Abutments

Expanding the Use of Precast Concrete in Texas Bridges
Expanding the Use of Precast Concrete in Texas Bridges
New Concepts
Current Implementation
Expanding the Use of Precast Concrete in Texas Bridges

Long Spans - Existing

![Bar chart showing the distribution of long spans for existing bridges in Texas. The x-axis represents the span length in feet, starting from 0 to 1,150 feet, in increments of 50 feet. The y-axis represents the number of bridges, ranging from 0 to 180. The chart indicates the number of bridges for each span length category.]
Long Spans – Trending Upwards

Expanding the Use of Precast Concrete in Texas Bridges
Spliced Precast Girders

- Uniform Cross Section (Non-Haunched): 225’ – 240’
- Haunched: 325’
- Curved Tubs: 240’ – 260’
Expanding the Use of Precast Concrete in Texas Bridges

Spliced Precast Girders
Haunched Section
Spliced Precast Girders
Spliced Precast Girders with Haunch
Expanding the Use of Precast Concrete in Texas Bridges

Spliced Precast Girders with Haunch
Post-Tension Anchorage Zones
Expanding the Use of Precast Concrete in Texas Bridges

Post-Tension Anchorage Zones
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Post-Tension Anchorage Zones
Cylinder Piling
Cylinder Piling

Expanding the Use of Precast Concrete in Texas Bridges
Cylinder Piling
Innovation and Unique Applications
Curved Precast Concrete Tubs
Curved Precast Concrete Tubs
Curved Precast Concrete Tubs
Spliced Concrete Tubs
Prestressed Concrete Bent Caps

Conventional Design

Equivalent Prestressed Design

See PBC-RC for duct and additional reinforcing details.

Sym about y Sistrct
Unique Precast Applications – West 7th Street Arch
Expanding the Use of Precast Concrete in Texas Bridges

Unique Precast Applications – West 7th Street Arch
Graham Bettis, P.E.
TxDOT Bridge Division - Field Operations Section
Construction & Maintenance Group
graham.bettis@txdot.gov
Office: 512-416-2526
Mobile: 512-658-1231