Accelerated Bridge Construction Design

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ABC

- ABC reduces the impact to traveling public
- Prefabricated elements have been a part of TxDOT’s ABC approach
  - Less Formwork/Reduce Risk
  - Faster Construction
  - Tighter Inspection (Quality due to controlled environment)
  - Typically Safer
  - Repeatable Construction
ABC

- Prefabricated Elements
  - Steel Piling
  - Concrete Piling
- Prefabricated Elements
  - Steel Girders
Prefabricated Elements
- Concrete Girders
Prefabricated Elements
- Deck Slab Beams
Prefabricated Elements
- Precast Deck Panels
Prefabricated Elements

- Precast Abutments
Prefabricated Elements
- Precast Bent Cap
Prefabricated Elements
- Full Depth Panels
- SPMT – Fort Worth West 7th
Modular Units
- **Loop Concrete Joint**
  - Wider closure pour
  - Rapid setting concrete with steel fibers

- **UHPC Joint**
  - Narrow longitudinal closure pour
  - Utilize Ultra-high Performance Concrete
- Lateral Slide
Prefabricated Elements Bridge
Misc. Standards for Substructure Elements

- PBC-P Precast Conc. Bent Cap
  Opt. for Conc. & Steel Piles

http://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/bridge-e.htm
Prefabricated Elements Bridge
Misc. Standards for Substructure Elements

http://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/bridge-e.htm
Prefabricated Elements Bridge Misc. Standards for Substructure Elements

- PPBC-RC Prestressed, Precast Bent Cap Option for Round Columns

http://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/bridge-e.htm
Prefabricated Elements Bridge
Prestressed Concrete I-Girder Standards
- PCP(O) Precast Conc. Panels for Overhangs

http://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/bridge-e.htm
Prefabricated Elements Bridge
Prestressed Concrete I-Girder Standards
- PCP(O)FAB Precast Conc. Panels for Overhangs Fab Details

http://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/bridge-e.htm
Contract Consideration of Time
- Calendar Day
- Work Week Definition
- A+B Bidding
- Incentives/Disincentives
- No excuse bonus
- Lane Rental
General Guidelines TxDOT Accelerated Construction Guidelines

- Road User Costs $18.00 per user-hour
- TxDOT Administrative Costs of $450 to $2000 a day
- Max Incentive 8% of Project Cost
- Tighten Schedule (but not overly so)
Project Overview

- 5 Bridge Replacements
- Rural highways with long detours (SH15 and US83)
- 10 calendar day closure time per bridge
- West Fork Horse Creek Bridges need to be built at the same time
- Utilize Accelerated Bridge Construction (ABC) concepts to reduce traffic impact
- Sought contractor input on foundation options, superstructure concept, and access/timeframe issues
- Milestone incentives
Project Overview
Project Overview

- West Fork Horse Creek Bridges will have a built detour
- All SH 15 bridges will have built haul road only
- Temporary construction license to build detour(s)
- Approach roadway work 150’ ~ 200’
Project Overview

- Original bridges built in the 1930’s on timber piles and steel beams
- Widened in the 60’s and 70’s with steel piles
- Structures need to be replaced
- **Milestone incentives for each bridge will be available for timely completion of construction**
Project Overview

- US 83 West Fork Horse Creek (North)
Project Overview

- US 83 West Fork Horse Creek (South)
Project Overview

- SH 15 Farwell Creek
Project Overview

- SH 15 Palo Duro Creek
Superstructure Concept

- SH 15 Ivanhoe Creek

Haul Road
Superstructure Concept

- Cast Deck with Tx-Girders off site
- Pick 1 or 2 girder systems at a time
- Cast closure pour with UHPC or Rapid Setting Fiber Reinforced Concrete (RSFRC)
Superstructure Concept

- Guidance from AGC:
  - Maximum desirable transportable load over long distance ~ 100 Tons
  - Maximum desirable lift load (assuming two crane lift) ~ 150 Tons
- Widths over 10 – 12 ft become problem for long distance transportation
### Superstructure Concept

<table>
<thead>
<tr>
<th>Regular Weight Concrete (150 pcf)</th>
<th>Lifting Weights (kips)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60 Foot Span</td>
<td>70 Foot Span</td>
</tr>
<tr>
<td>Single Girder</td>
<td>89</td>
<td>104</td>
</tr>
<tr>
<td>Single Girder w/ Rail</td>
<td>112</td>
<td>130</td>
</tr>
<tr>
<td>Two Girder</td>
<td>134</td>
<td>156</td>
</tr>
<tr>
<td>Two Girder w/ Rail</td>
<td>156</td>
<td>183</td>
</tr>
</tbody>
</table>

- **Single Girder** assumes 7’ deck width
- **Two Girder** assumes 8’ deck width

<table>
<thead>
<tr>
<th>Light Weight Concrete (120 pcf)</th>
<th>Lifting Weights (kips)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>60 Foot Span</td>
<td>70 Foot Span</td>
</tr>
<tr>
<td>Single Girder</td>
<td>79</td>
<td>92</td>
</tr>
<tr>
<td>Single Girder w/ Rail</td>
<td>101</td>
<td>118</td>
</tr>
<tr>
<td>Two Girder</td>
<td>122</td>
<td>143</td>
</tr>
<tr>
<td>Two Girder w/ Rail</td>
<td>145</td>
<td>169</td>
</tr>
</tbody>
</table>
### Superstructure Concept

#### UHPC vs RSFRC

<table>
<thead>
<tr>
<th></th>
<th>Proprietary UHPC</th>
<th>RSFRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Cost</td>
<td>~$5000/cyd</td>
<td></td>
</tr>
<tr>
<td>Compressive Strength (28 day)</td>
<td>&gt;17000+ psi*</td>
<td>-</td>
</tr>
<tr>
<td>Compressive Strength (7 day)</td>
<td>-</td>
<td>~6000 psi</td>
</tr>
<tr>
<td>Compressive Strength (4 day)</td>
<td>~14000 psi</td>
<td>-</td>
</tr>
<tr>
<td>Compressive Strength (4 hours)</td>
<td>-</td>
<td>~3000 psi</td>
</tr>
<tr>
<td>48 hour Pull-Out Strength (% of yield)</td>
<td>100 @ 4 days (or 14ksi compressive strength)</td>
<td>75</td>
</tr>
<tr>
<td>Familiarity</td>
<td>Limited</td>
<td></td>
</tr>
</tbody>
</table>

*Minimum defined by ASTM C1856 for UHPC classification

**UHPC TxDOT SS 4119**


**RSFRC TxDOT SS 4144**

Superstructure Concept

- Lift decked girders into place
- 2 girder systems to reduce number of closure pours

- Cast closure pours with minimal reinforcement placement
- Use full length galvanized reinforcement
- Original deck 9” to included 0.5” mill to ensure smooth riding surface
Superstructure Concept

Due to geometric complexities:

- Bridge girders need to be installed in the plumb condition, but the deck needs to be cast with the roadway cross slope inherent.
- Because of girder camber, a variable haunch will be needed to achieve the intended profile grade.
- Because of the use of “full depth” precast units, the risks of differential cambers may require the beams to be built on simulated bearing seats and the precast deck cast with all girder lines in place to ensure achieving goal of correct grades.
## Substructure Concept

<table>
<thead>
<tr>
<th>Option</th>
<th>Foundation Type</th>
<th>Foundation Loads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option #1</td>
<td>Drilled Shaft</td>
<td>340 Tons/DS</td>
</tr>
<tr>
<td>Option #2a</td>
<td>Concrete Piles</td>
<td>90 Tons/Pile</td>
</tr>
<tr>
<td>Option #2b</td>
<td>Steel ‘H’ Piles</td>
<td>90 Tons/Pile</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bridge</th>
<th>Estimated Pile Length</th>
<th>Estimated DS Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH 15 at Farwell Creek</td>
<td>52</td>
<td>72</td>
</tr>
<tr>
<td>SH 15 at Palo Duro Creek</td>
<td>53</td>
<td>58</td>
</tr>
<tr>
<td>SH 15 at Ivanhoe Creek</td>
<td>72</td>
<td>92</td>
</tr>
<tr>
<td>US 83 at West for Creek (north)</td>
<td>55</td>
<td>65</td>
</tr>
<tr>
<td>US 83 at West for Creek (south)</td>
<td>52</td>
<td>67</td>
</tr>
</tbody>
</table>
Substructure Concept

- Substructure Option #1
  - Remove 2 exterior girders on each side and clear substructure as needed
  - Drill and pour shafts and columns
Substructure Concept

- Substructure Option #1
  - Close and demo bridge
  - Lift pre-cast abutment and bents into place
  - Lift decked girders into place and cast closure pours
  - Use temporary barriers while casting new traffic rail
Substructure Concept

- Substructure Option #2
  - Piles
Substructure Concept

- Move Traffic Control over
- Finish Driving Piles and close up holes
Construction Schedule

10 Calendar Day Road Closure

- Demo – 2 Days*
- Earthwork and placing bent/abut caps – 3 Days*
- Placing Pre-Decked Beams and Casting Closure Pours – 3 Days*
- Closure Pour Curing – 2 Days*

(*Estimated)

Cast bridge rail after road is reopened

CONSTRUCTION SEQUENCE:

1. Drill and pour exterior abutment drilled shafts and bent drilled shafts outside of the roadway/bridge limits.
2. Drill and pour interior abutment drilled shafts in conjunction with lane closures and provide temporary steel plate cover.
3. Construct I-girders and precast sections. Exterior deck sections shall be precast with T223 rail L and U bars.
4. Remove existing structure.
5. Install precast abutments and bent caps and grout closure pockets.
6. Place decked girder sections and slab sections and pour UHPC closures.
7. Diamond grind deck to remove discontinuities. Place temporary port ctb (fur & inst) (SGL SLOPE) TY1 and open to traffic. Cast T223 rail section.
8. Remove temporary barrier.
9. Contractor shall submit accelerated bridge construction (ABC) assembly plan for approval prior to commencing work. At a minimum, assembly plan shall include method for creating, lifting and transporting precast units and assembly of the structure including erection and bracing requirements. Lifting, bracing and erection plans and calculations shall be sealed and signed by a licensed Texas professional engineer.*
10. Contractor shall account for vertical alignment when casting superstructure units.
Plan Details

- Details for superstructure
- Re-evaluate the use of the drop in deck pieces due to fabrication and handling concerns
Plan Details

TYPICAL TRANSVERSE SECTION
Plan Details
Plan Details

Abutment & Bent Details

- Drilled shafts will be placed off the critical path
Plan Details

- Ducts for drilled shaft to cap connection
- Precast Concrete Bent Cap
- Option for Round Columns

SECTION B-B

Stirrups around ducts not shown for clarity

Ducts. See standard “PBC-RC” (MOD) for additional information not shown
Plan Details

- Backwall at the back of the cap
- Wingwall cast-in-place
Plan Details

ELEVATION SECTION

TRANSVERSE SECTION
Alternate Designs SOP

- There is increasing interest in utilizing prefabricated elements in all facets of bridge design and construction.
- Precast alternate not always included in plans.
- Developed a Standardized Method to allow Contractors to propose alternate to Cast-in-Place (CIP) Construction or to propose alternate to ABC method as detailed in the plans.
Alternate Designs SOP

- Will be an update to existing Alternate Prestressed Bent/Abutment SOP
- New Precast and Accelerated SOP
- Communication of the SOP will not be enough, it will need to be in the plans.
Conclusion

- Precast options offer more Accelerated Bridge Construction (ABC) solutions
  - Many options
  - Considerations for site location and shipping
  - Ask for contractor input
  - Allow for innovations
  - Must include non-traditional precast bridge standards in the plan set
- Thorough planning
- Great communication is key to success
- Must offer milestone incentives to offset the cost and risk to the contractor