2015 T.H.E. Conference

Short Span Bridge Design Alternatives

By: Jack Elston, P.E.,
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AGENDA

• Introduction
• Bridge Planning Alternatives
• Design Comparisons
• Summary
Pragmatic Comparison of Rural Bridges  40 – 120 ft

- Precast Prestressed Concrete Deck Beams
- Cast-in-Place Concrete Slabs
- Concrete Slab on Steel Beams
- Concrete Slab on Precast Prestressed Girders
- Culverts / 3 Sided Structures <40 ft
Precast Prestressed Concrete Deck Beams

- Span Lengths: 40 ft to 100 ft
- Predominant on County & Township Inventories
- Quick Fabrication and Erection
- Salt and heavy loads deteriorate shear keys
- Concrete and HMA & A-3 overlays improve ride quality
Bridge Planning Alternatives

Cast-in-Place Concrete Slabs

• Max Span length ~ 45 ft
• Requires Piers in channel
• Thin superstructure depth
• Long life span / Low maintenance
• High labor costs - Regional
Concrete Slab on Steel Beams

- Single Span Lengths: 60 ft to 120 ft
- Weathering Steel / Integral Abutments
- Long Life Span and Low Maintenance
- Suitable for Rehabilitation/ Deck Replacement

Structural Steel Prices have remained competitive
Concrete Slab on Precast Prestressed Concrete Beams (PPCI)

- Single Span Lengths: 60 ft to 135 ft
- Long Life and Low Maintenance
- Less Competitive Than Steel: Span to Beam Depth Ratio

New PPC-IL Shapes planned for release
Box Culverts

- Single and Double Boxes are most cost effective
- Long Life and Low Maintenance
- Labor Intensive Construction
- Intrusive Instream Work & Permitting / Debris
3 Sided Structures

- Provide quick construction and natural bottom
- Applications can be limited by foundation material
- Evaluate Scour Potential
Design Comparisons

Span Length
Life Expectancy

Construction Costs
Instream Work
Maintenance Needs

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Design Comparisons

Determine Design Span Length

• Site Layout – Channel Width
• Highwater & Hydraulic Capacity
• Superstructure Construction Depth
• Set Approach Roadway Grade
Design Comparisons

Optimize Constructability

• Reduce Instream Work
• Allow Equipment Access to Superstructure
• Ensure Material Delivery & Logistics

• Reduce Closure Time
• Allow Future Rehabilitation
• Salt Usage?
### Average Bridge Cost Comparisons

<table>
<thead>
<tr>
<th>Material</th>
<th>Span Type</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIP Concrete Slabs</td>
<td>3 span</td>
<td>154 $/sf</td>
</tr>
<tr>
<td>PPC Deck Beams</td>
<td>3 span</td>
<td>165 $/sf</td>
</tr>
<tr>
<td>PPC Deck Beams</td>
<td>Single span</td>
<td>149 $/sf</td>
</tr>
<tr>
<td>Steel Beams</td>
<td>Single span</td>
<td>173 $/sf</td>
</tr>
</tbody>
</table>

**2014 Lettings**

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Design Comparisons

Case Study: Long Span Structure options

Vermilion County, Township Bridge, 120 ft length

1) Three Span PPC Deck Beam $642,000
2) Single Span PPC Deck Beam $580,000
3) Single Span Steel Beam $653,000

Steel Beams provided longer expected life span

Low Maintenance, Clear of Debris
Case Study: Multiple Span Structure options
Fayette/ Shelby County, C.H. 14 Bridge, 225 ft Length

1) Three Span PPC Deck Beam $1,263,000
2) Three Span Steel Superstructure $1,306,000

Limited Detour Options for Traffic

PPC Beams allow quicker construction
Design Comparisons

Case Study: Medium Length Structure options
McLean County, C.H. 36, 84 ft length

1) Three Span CIP Concrete Slab $774,000
2) Single Plate Steel Superstructure $800,000

Piers Eliminated in Channel
Adequate Freeboard for
Deeper Steel beams

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Case Study: Short Span Structure options

Ford/ Iroquois County, Township Bridge, 68 ft length

1) Three Span PPC Deck Beam $193,000
2) Three Span CIP Concrete Slab $232,000

Concrete Slab provides longer structure life
In Conclusion:

• *Initial Cost* and *Life Expectancy* most often affect structure choice.

• *Communication and Planning* of design factors are critical to find the best solutions.
Questions?

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