Spread Box and Slab Beams

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BRG Webinar
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Outline

• Spread Box Beams
  – Benefits
  – Standard drawings issued
  – Features
  – Standard spans
  – Custom spans

• Spread Slab Beams
  – Features
  – Development status

• Summary
Spread Box Beams

• Have we used these before?
  - U-beam bridges are classified as spread box beams
  - We’ve used regular box beams in spread framing, but extremely limited in number

• Two recent spread box designs:
  - Grimes Co, May 2010 letting
  - Upshur Co, June 2011 letting, uses X-beams
Spread Box Beams—Benefits

- Will—on average—cost less than adjacently framed box beam spans
  - The span with the fewest beam lines costs the least, on average.
  - Spread boxes should use 30 to 50 percent fewer beam lines

- Comparing the two systems for an 80’ span, 38’ roadway...
Spread Box Beam Bridges

Normal, Adjacent Framing—8 beam lines in this example

5” Deck and Shear Keys

Spread Framing—3 less beams needed

8” Deck on PCP’s
## Conventional Box Beam Span
### 38’ Roadway, 80’ Span

<table>
<thead>
<tr>
<th>Item</th>
<th>Est. Quantity and Avg Bid May 2011 Avg’s</th>
<th>Approx Avg Bid Cost</th>
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</thead>
<tbody>
<tr>
<td>CL S Conc (Slab)</td>
<td>56.8 CY</td>
<td>$27,200</td>
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<tr>
<td></td>
<td>$479.52/CY</td>
<td></td>
</tr>
<tr>
<td>CL S Conc (Shear Key)</td>
<td>30.0 CY</td>
<td>$6600</td>
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<td></td>
<td>$219.97/CY</td>
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<tr>
<td>Type 5B28</td>
<td>636.00 LF</td>
<td>$89,300</td>
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<tr>
<td></td>
<td>$140.42/LF</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>$123,100 Total</td>
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## Spread Box Beam Span
### 38’ Roadway, 80’ Span

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity and Avg Bid</th>
<th>Approx Avg Bid Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>May 2011 Avg’s</td>
<td></td>
</tr>
<tr>
<td>Reinf Conc Slab</td>
<td>3200 LF $8.19/SF</td>
<td>$26,200</td>
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<tr>
<td>(Note: Less total CIP concrete needed)</td>
<td></td>
<td></td>
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<tr>
<td>Type 5XB28</td>
<td>397.50 LF $175/LF (Est)</td>
<td>$69,600</td>
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</table>

**Total:** $95,800

$27,300 less than adjacently framed box beam span
Spread Box Beams—Benefits

- More complete inspection of the beams is possible
- Not mixing box widths in a span—an efficiency in fabrication
  - 5’ boxes are the default width; 4’ box details are provided but have limited application
- Can better handle staged construction
- Unique rail anchorage details are not required
Spread Box Beams—Benefits

• We shouldn’t have this
Spread Box Beams—Benefits

• Can span as far as conventional box beams, but they do have a thicker deck

• Span about 10’ to 15’ further than an equivalent depth Tx girder, if the same number of beams are used
Spread Box Beams—Benefits

• Better live load distribution
• Example 38’ Roadway, 80’ Span:
  – Type 5XB28, LLDF = 0.57 (2.85 lanes total)
  – Type 5B28, LLDF = 0.36 (2.88 lanes total)
  – Type Tx34, LLDF = 0.69 (3.45 lanes total)
Spread Box Beams—Benefits

• More on live load distribution:

  – For 3 X-beams on a 24’ roadway, LLDF by equation is less than $N_L / N_B$
  – With their efficiency in distributing live load, always verify that the LLDF does not drop below $N_L / N_B$
## Spread Box Beams—Benefits

Handles Challenging Roadway Geometry

<table>
<thead>
<tr>
<th></th>
<th>Spread Boxes</th>
<th>Adjacent Boxes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horiz curves</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Superelevation</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Width changes</td>
<td>Yes</td>
<td>No</td>
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</table>
Spread Box Beams—Standards

- 32-, 38-, 40-, and 44-ft roadway widths
- Max span of 110’
- Same no. of beams used per span as Tx girder standard spans
- All bents detailed with round columns; no trestle bent details yet

- Issued June 2011
Spread Box Beams—Features

- Webs are thicker to prevent web cracking under service loads.
- Bottom slab is thicker to accommodate the 2nd layer of strands.

Heavier beams result.
Spread Box Beams—Features

- 20” and 28” Boxes
  - 62 strand positions for 5XB

- 34” and 40” Boxes
  - 74 strand positions for 5XB
Extra web width coupled with the R-bar detail allows space for PCP lap.

Lap dimensions are the same as those for Type C beams.
These are the “standard” dimensions from slab edge to beam CL.
Spread Box Beams—Features

Beam corner break fits into a 2’ backwall break

A smaller overhang with corner breaks requires modification
Pedestals, similar to those for U-beams, are used. Dowels are used instead of shear keys, earwalls, etc.

Dowel is galvanized—it is exposed at 2-pad end
Spread Box Beams—Features

• Deck drainage can be handled as is done with I-beams

New BD-3 shown with Tx girder; will work with X-beams
Standard Spread Box Beam Spans

• To simplify calculation of bearing seat elevations and bearing pad tapers, these are not permitted with standard spans:
  – Vertical curve combined with a skew
  – Change in cross-slope
  – However, a bridge designer can take care of this geometry with a standard span on a custom basis
Standard Spread Box Beam Spans

• All use 5’ wide X-beams

• Standard designs were developed using non-standard cross sections in Prestress14 and with a 50 percent limit on no. of strands debonded, both per row and section
Standard Spread Box Beam Spans

- Beams are set with the roadway cross-slope.
- Investigated setting beams plumb on level bearing seats, but this creates other complications:
  - “Split-level” bearing seats at 2-pad ends if spans are skewed.
  - Haunch dimensions around 4” max.
  - Bearing pad issues.
Standard Spread Box Beam Spans

• Use STD-BRG.xls for geometry
  – Calculates and provides bearing seat elevations and bearing pad taper report

• Should read X-beam section in “Guide to Bridge Standard Drawings” prior to using them
Custom Spread Box Beam Spans

- Geometry calculations similar to U-beams
  - Pedestal and bearing pad slopes
  - Haunches
  - No limit on skew plus vertical curves OR cross-slope changes
- 30-degree skew limit
- Sections are in PGSuper
Custom Spread Box Beam Spans

- Beams can be placed plumb if addressed adequately in the plans, but not recommended for skews.
- One pedestal width per beam width.
- Recommend a minimum clear distance between top beam corners of 2.83’, so the prestressed panels can be prestressed.
Spread Slab Beam Bridges
Spread Slab Beam Bridges

- Same concept with spreading box beams—mainly to lower bridge construction cost

- Very similar to decked slab beam bridges, but without slab overhangs.
  - Contractors showed strong preference for no overhangs
Spread Slab Beam Bridges

- LLDF’s used are based on those for spread boxes, but use a beam depth of 18”, which is the lower bound for the equations.
- Quite a bit more shear reinforcement is required with spread slab beams because $\Phi Vc$ is not quite double $Vu$.
- Both issues are scheduled to be researched beginning in September.
Spread Slab Beam Bridges

Normal, Adjacent Framing—8 beam lines in this example

Spread Framing—3 less beams needed
Spread Slab Beam Bridges

• Development Status
  – Spans are 90 percent complete
  – Substructure is being developed
  – Standard drawings could be issued this year
  – Same roadway widths and skews as spread box beams
Summary

• Spread box beams provide a new tool for providing economical bridge spans

• Spread slab beam standard drawings will be available soon and will provide the same benefits
Send Questions to:

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• 512-416-2212