

Spread Box and Slab Beams

John M. Holt, P.E.



BRG Webinar

June 2011



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

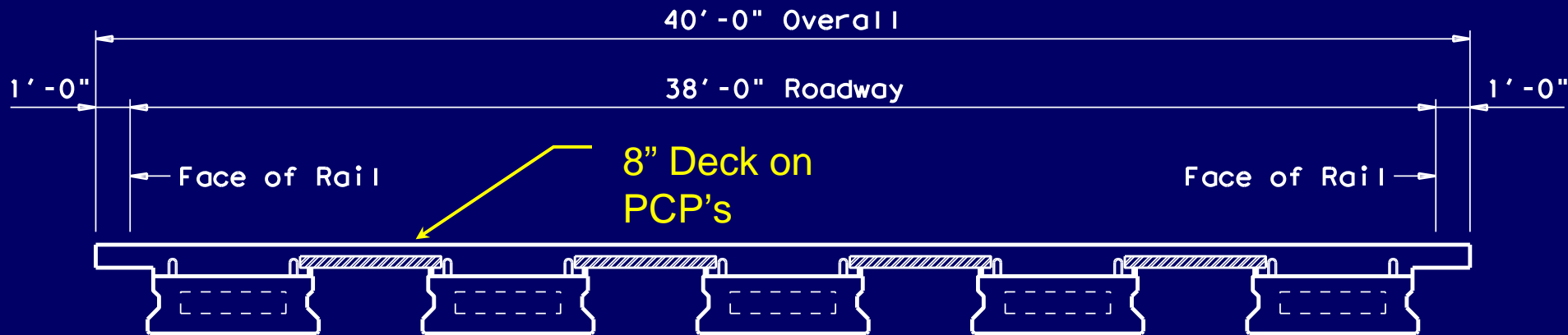
Spread Box Beams—Benefits

- 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



Spread Framing—3 less beams
needed

Conventional Box Beam Span

38' Roadway, 80' Span

Item	Est. Quantity and Avg Bid May 2011 Avg's	Approx Avg Bid Cost
CL S Conc (Slab)	56.8 CY \$479.52/CY	\$27,200
CL S Conc (Shear Key)	30.0 CY \$219.97/CY	\$6600
Type 5B28	636.00 LF \$140.42/LF	\$89,300
		\$123,100 Total

Spread Box Beam Span 38' Roadway, 80' Span

Item	Quantity and Avg Bid May 2011 Avg's	Approx Avg Bid Cost
Reinf Conc Slab	3200 LF \$8.19/SF	\$26,200
	(Note: Less total CIP concrete needed)	
Type 5XB28	397.50 LF \$175/LF (Est)	\$69,600
		\$95,800 Total

\$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 T_x 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

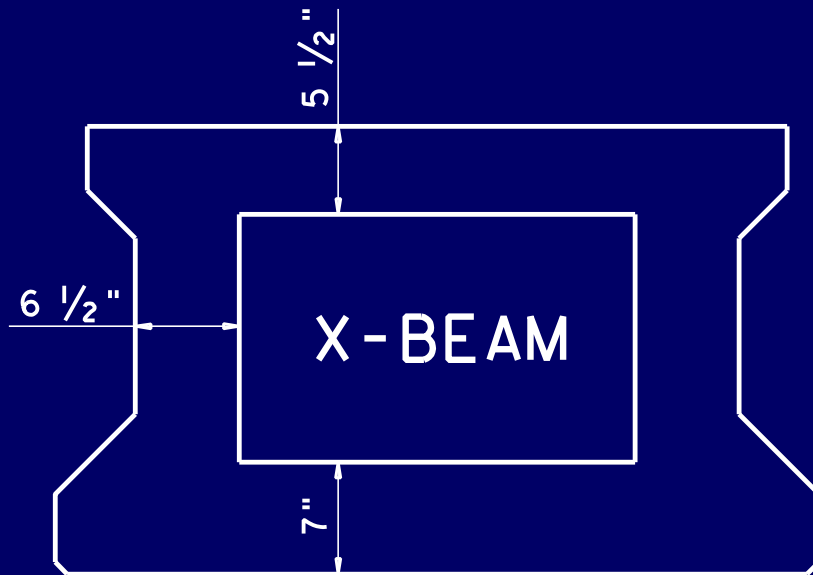
	Spread Boxes	Adjacent Boxes
Horiz curves	Yes	No
Superelevation	Yes	No
Width changes	Yes	No

Spread Box Beams—Standards

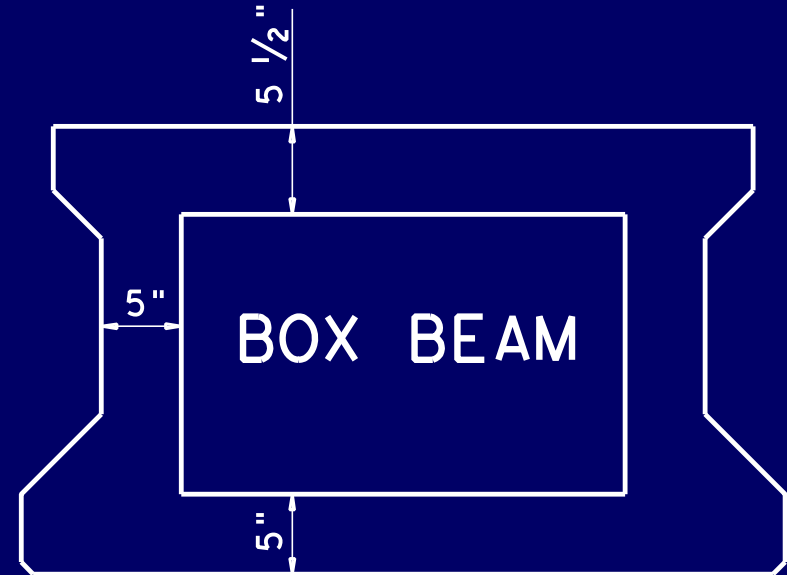
- 32-, 38-, 40-, and 44-ft roadway widths
- Max span of 110'
- Same no. of beams used per span as Tx girder standard spans
- All bents detailed with round columns; no trestle bent details yet

- Issued June 2011

Spread Box Beams—Features



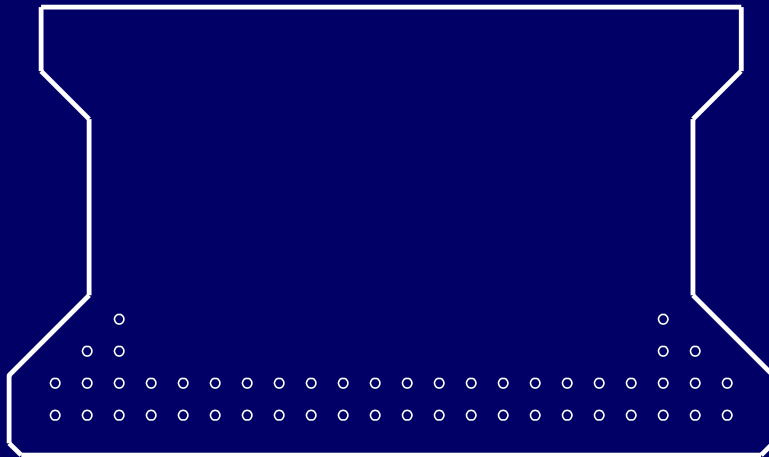
Webs are thicker to prevent web cracking under service loads



Bottom slab is thicker to accommodate 2nd layer of strands

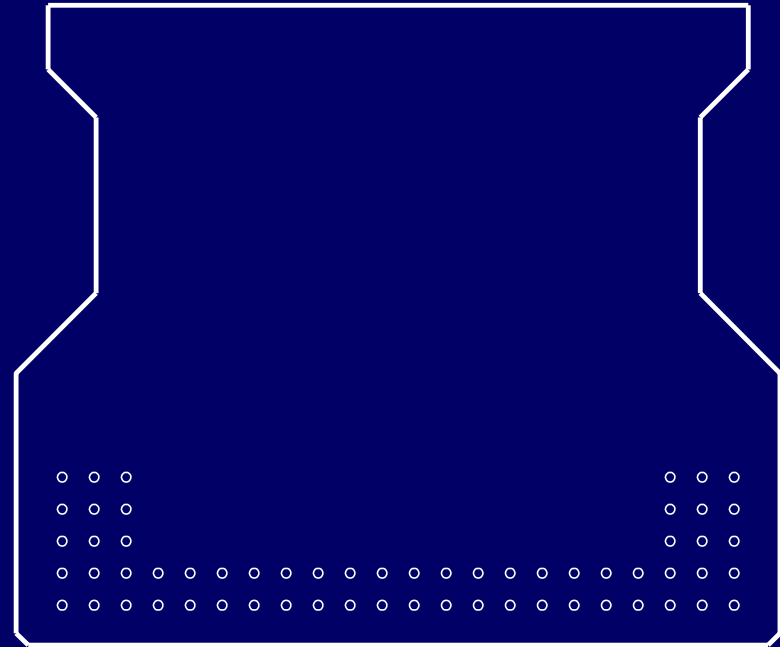
Heavier beams result

Spread Box Beams—Features



20" and 28" Boxes

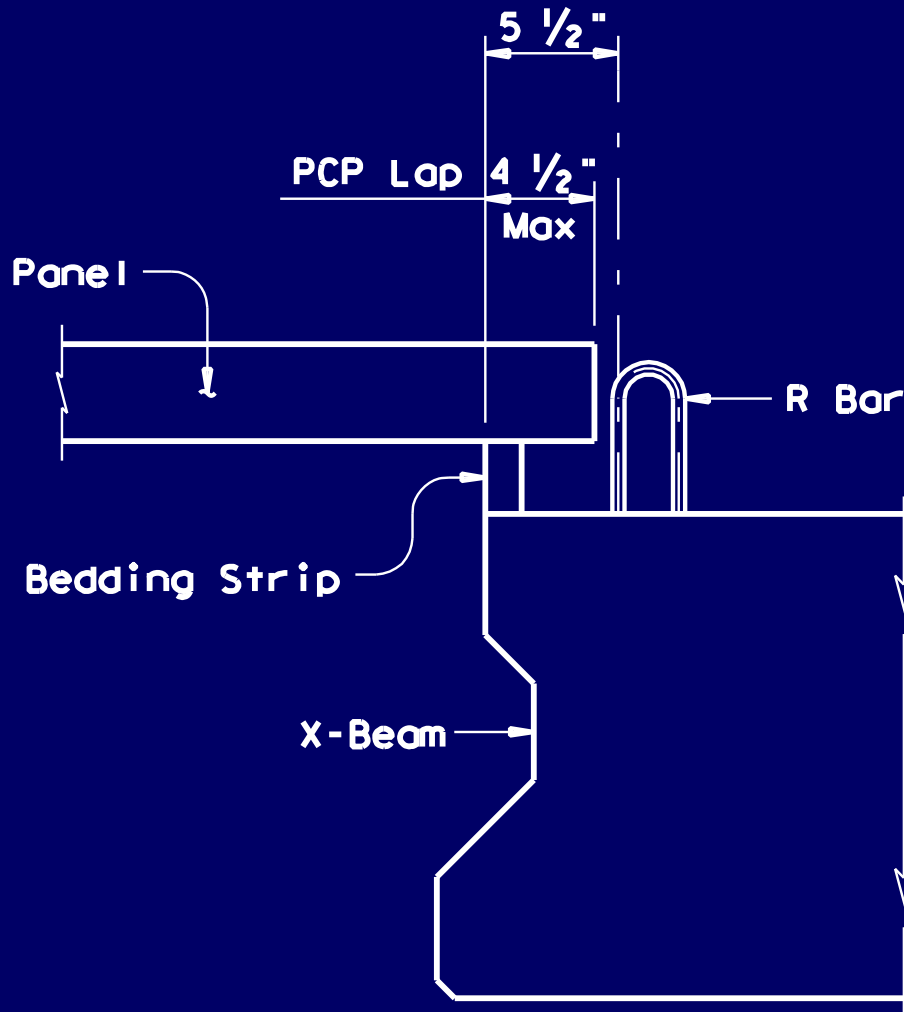
62 strand positions
for 5XB



34" and 40" Boxes

74 strand positions
for 5XB

Spread Box Beams—Features

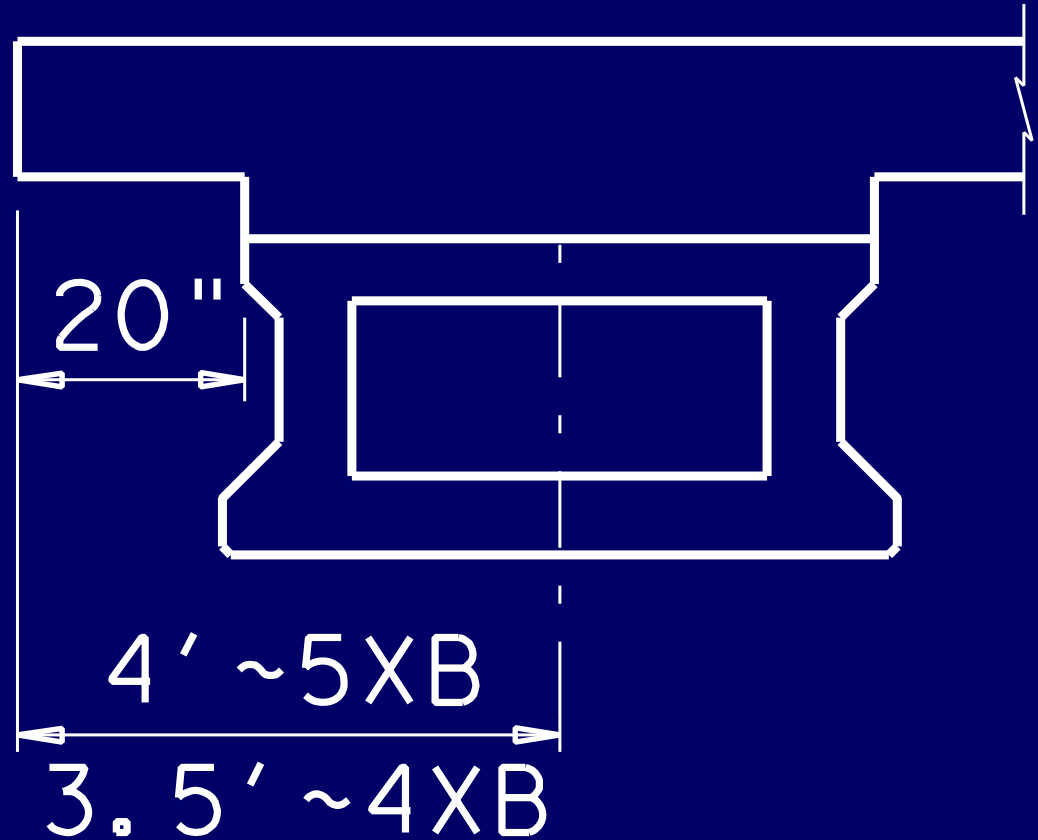


Extra web width coupled with the R-bar detail allows space for PCP lap.

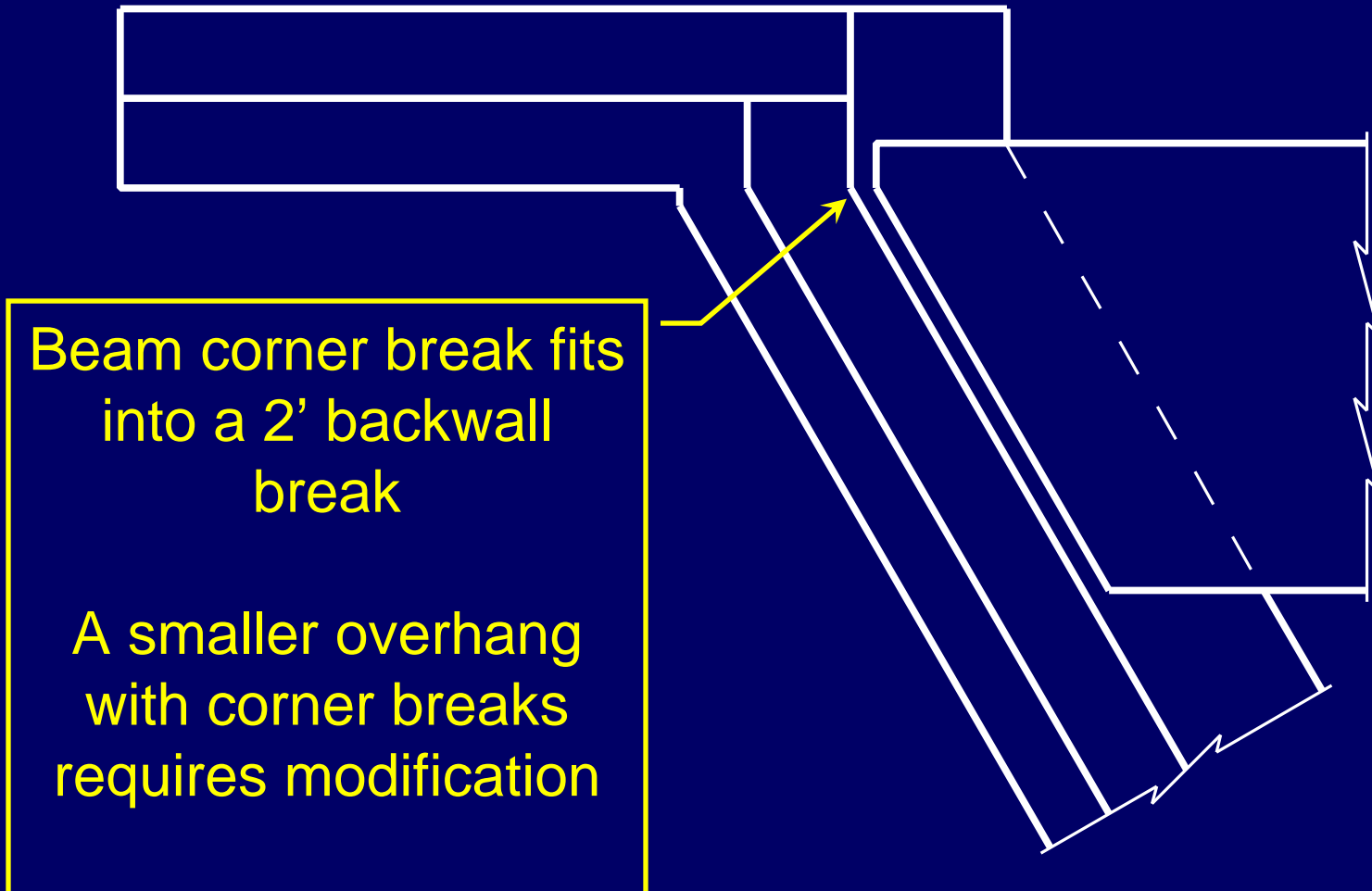
Lap dimensions are the same as those for Type C beams

Spread Box Beams—Features

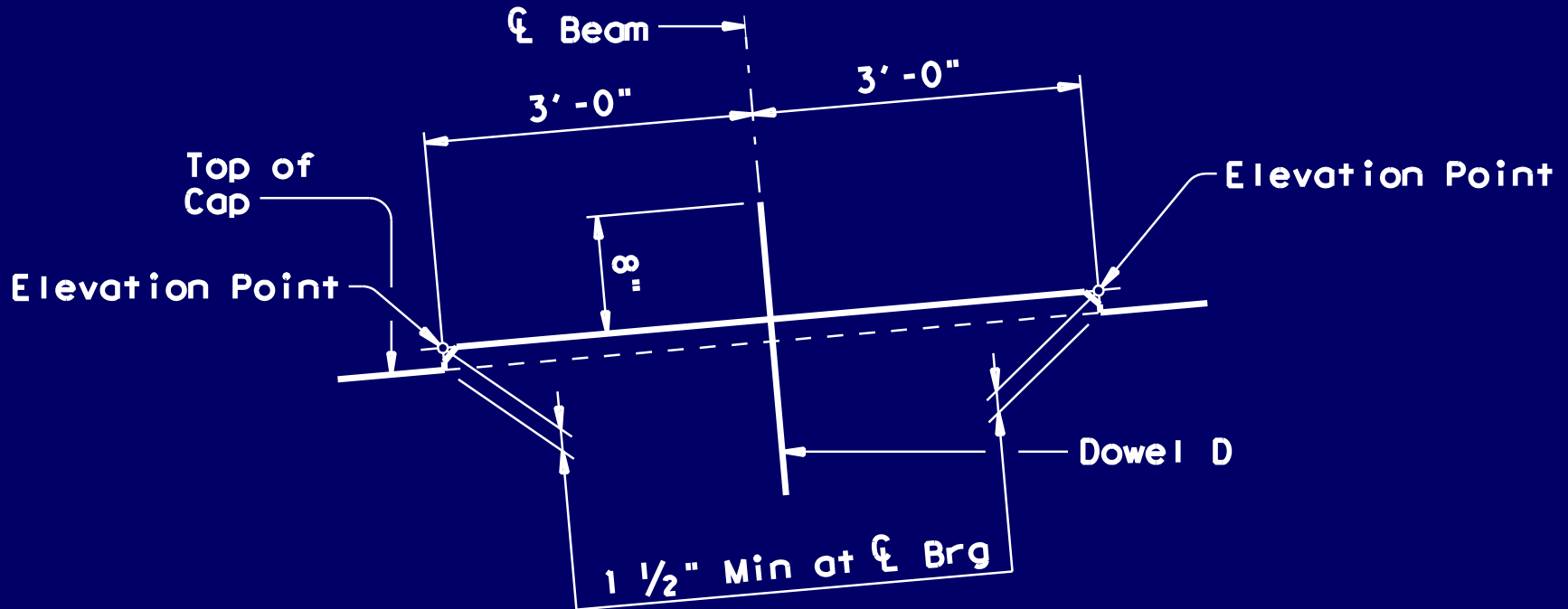
These are the
“standard”
dimensions
from slab edge
to beam CL



Spread Box Beams—Features



Spread Box Beams—Features

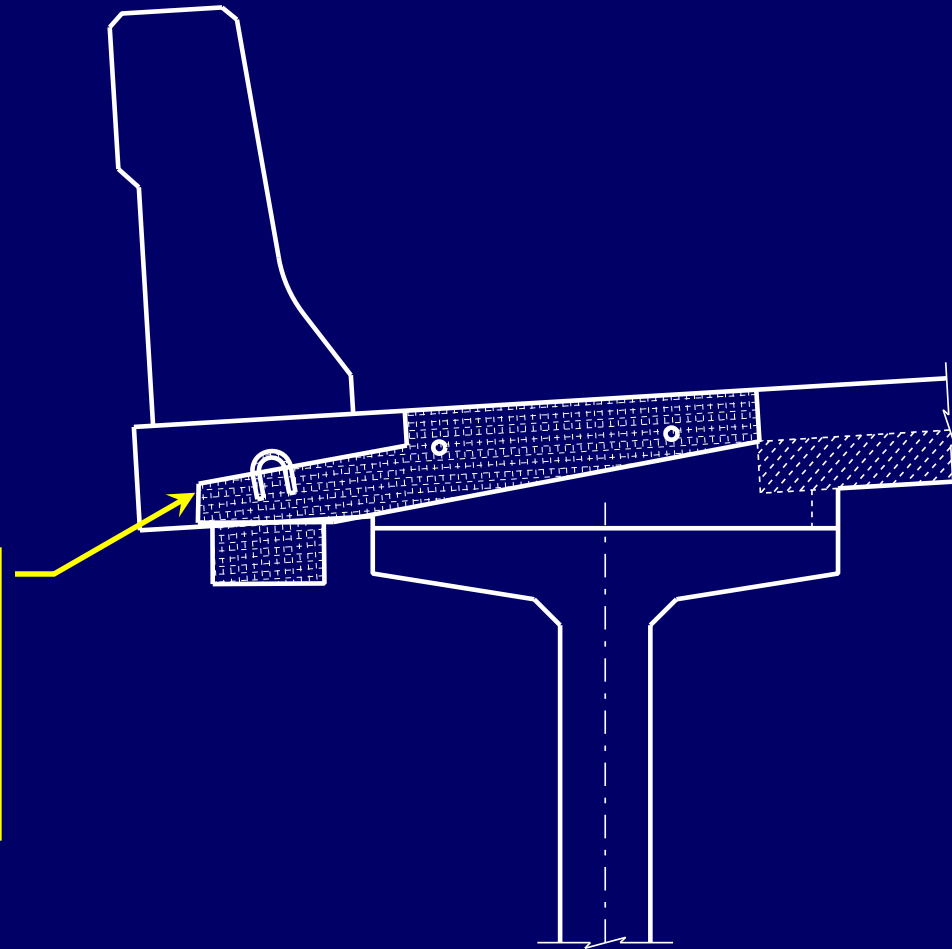


Pedestals, similar to those for U-beams, are used. Dowels are used instead of shear keys, earwalls, etc.

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

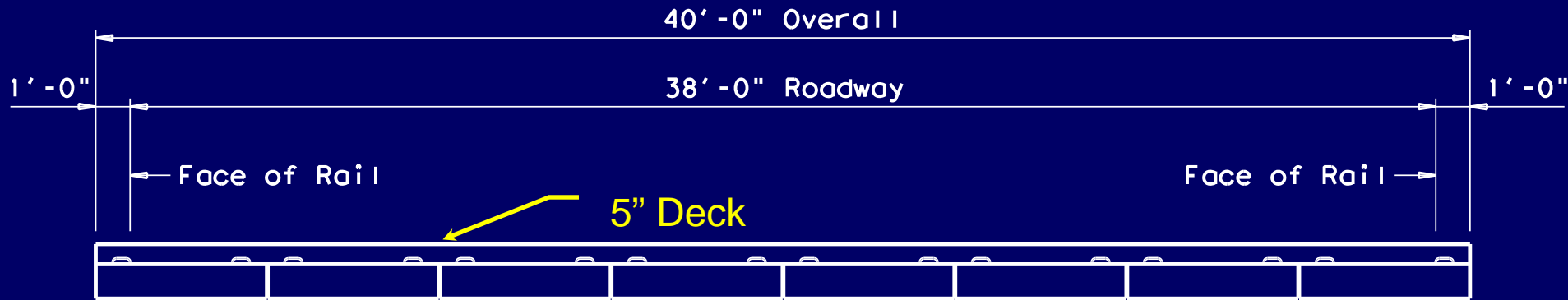
Spread Slab Beam Bridges

- 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

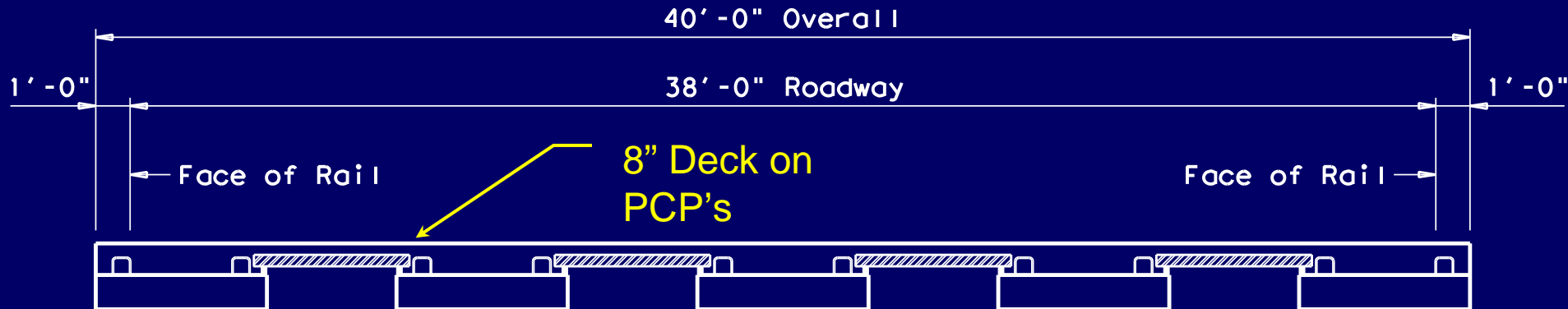
Spread Slab Beam Bridges

- 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 ϕV_c is not quite double V_u
- 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:

- John.Holt@txdot.gov
- 512-416-2212