Illinois Department of Transportation
Memorandum

To:	ALL BRIDGE DESIGNERS	24.2
From:	Jayme F. Schiff	
Subject:	Full Depth Precast Bridge Approach Slab	
Date:	March 15, 2024	

Due to the propensity of cracks in the concrete wearing surface (CWS) over our current partial depth precast bridge approach slabs, the Department (IDOT) investigated the potential merits of full depth precast bridge approach slabs. Details from the Illinois State Toll Highway Authority (ISTHA) and surrounding states were studied and evaluated for performance, leading to the development and implementation of IDOT's new Full Depth Precast Bridge Approach Slabs.

IDOT primarily sees two types of cracks on precast bridge approach slabs. The first is reflective cracking in the CWS, occurring along joints between approach slab beams. The second type occurs on skewed bridges, where cracks appear in the CWS perpendicular to the backwall across the acute corners of the bridge approach slab.

Additionally, ISTHA performed a crack survey for bridge approach slabs in 2016 with similar crack observations. This survey resulted in the development of full depth precast approach slabs with Ultra-High Performance Concrete (UHPC) shear keys. While relatively new for ISTHA, the full depth slabs with stronger UHPC shear keys appear to have reduced the reflective cracking, and additional reinforcement in the corners of skewed beams have reduced the perpendicular cracks to the backwall.

Summary of Improvements

1. Created full depth precast bridge approach slabs with UHPC connections. This is intended to eliminate the reflective cracking that was observed in the CWS above the partial depth precast bridge approach slabs.
2. Provided transverse reinforcement protruding out of the precast beams and developed them into the connecting full depth UHPC shear keys for continuity.
3. Updated the transverse and top longitudinal reinforcement to be consistent with the policies of the Bridge Manual Section 3.2.11. However, the top transverse reinforcement was placed parallel to the skew and the spacing was reduced to match the bottom transverse reinforcement spacing. This provides better constructability and easier placement of the precast beams. It also eliminates the need for additional reinforcement in the fascia beams under the parapets.
4. Provided additional development utilizing 90° bends in the top longitudinal reinforcement at the abutment end to reduce cracking near the beam ends.

5. Require Bridge Deck Smoothness Grinding for the full depth precast bridge approach slabs and the structure deck. This will remove discrepancies in the precast beam heights and the raised UHPC shear keys and provide a smooth profile grade.

The full depth precast bridge approach slabs, similar to partial depth precast bridge approach slabs, will still maintain an overall length of 30', a finished thickness of 1'-3", and will be applicable on both ends of the bridge when the longest distance from the centroid of stiffness of the structure to the back of integral or semi-integral abutments is greater than 130'. The application of full depth precast bridge approach slabs shall be similar to partial depth Precast Bridge Approach Slabs as described in the Bridge Manual Section 3.2.12.

Design Assumptions

- 2020 AASHTO LRFD Bridge Design Specifications, 9th edition, HL-93 Loading and the design provisions from Section 3.2.11 of the 2023 Bridge Manual
- Transverse reinforcement is placed parallel to the skew.
- f'_c of beam = 5 ksi
- f'_{ci} of beam = 4 ksi
- f'_c of Ultra-High Performance Concrete = 14 ksi minimum
- f'_c of cast-in-place bridge approach footing concrete = 3.5 ksi
- f'_c of cast-in-place parapet concrete = 3.5 ksi
- Estimated concrete beam with reinforcement density = 0.153 kcf
- f_y = 60 ksi
- Approach Slab Design Span Length = 26'-0"
- Designed loading for 44" constant slope concrete TL-5 parapet. Detailed for 39" constant slope concrete TL-4 parapet.
- Minimum Out to Out Parapet Width = 33'-10"
- Slab thickness for design loading = 1'-3¼"
- Slab thickness for capacity = 1'-3"
- Skew Angle ≤ 45°

Special Provision and Guide Bridge Special Provisions (GBSPs):
"Ultra-High Performance Concrete (UHPC) Joints" (Available upon request)
GBSP 59 "Diamond Grinding and Surface Testing Bridge Sections"
GBSP 79 "Bridge Deck Grooving (Longitudinal)"

Details

Beam Layout
A 12' lane is achieved with two standard width interior beams and the connecting shear keys. This standard width was developed to position the longitudinal joints at the center and edge of the lane, away from direct wheel load path. The table below shows the interior beam widths for 12' lanes. Consult with the Bridge Office when using a lane width other than 12'. Shoulder widths vary, therefore exterior beams do not have standard widths.

Beam Width at		
Top	Core	Bottom
5'-4"	5'-2½"	5'-5"

Within the shear key, the minimum required spacing between the reinforcement of adjacent panels shall be 1⅛" to provide adequate clearance for up to ¾" maximum long steel fibers in the UHPC mix. This minimum spacing will also allow room for concrete dimensions and reinforcement placement tolerances.

The maximum out-to-out beam width, including protruding reinforcement, is limited to 8'-6". Wider beam widths require an oversize and/or overweight permit for truck transportation. For bridge layouts requiring smaller or larger interior beam widths, consultation with the Bridge Office is required. The minimum exterior beam core width is 3'-8" at the abutment end and transitions to 2'-9" at the footing end due to the parapet to curb transition.

Beams can be flared in width to accommodate bridge geometry provided the reinforcement follows the spacing guidelines and the shear keys are a constant width.

Exterior Beams

The exterior beams decrease in width halfway through the total slab length to accommodate the parapet to curb transition, an 11" change in width. Additional #4 hooked bars are detailed at the top and bottom of this slab transition to reduce potential cracking.

In cases where the parapet spans the full length of the bridge approach slab, the #4 hooked bars may be omitted due to the elimination of the transition and the beam dimensions shall be adjusted accordingly.

The dowel rod spacing for exterior beams may be adjusted to better fit the beam width. The centerline of the dowel rod closest to the parapet shall be a minimum of 4" away from the inside face of the parapet and a maximum of 1'-1".

Staged Construction

The staged construction line should ideally coincide with the crown of the road. This may be difficult to achieve or impractical, therefore the staged construction line can be placed as necessary and as approved by the Bureau of Bridges and Structures provided the interior panel core width is not less than 3', nor greater than 8'.

Expansion Blockout

The beam ends shall be cast for a strip seal joint with a blockout parallel to the skew as detailed on the base sheets. Straight coil loop inserts and coil rods are used to connect the beams to the blockout. The length of the ¾" diameter coil rod shall be as recommended by the manufacturer. Bridge Manual Figure 2.3.6.1.6-1 sets the Department's policy on maximum expansion length with respect to skew for strip seal joints.

The distance from the centerline of the closest insert to the nearest corner is 3" minimum and 12" maximum. The straight coil loop inserts shall be spaced to miss the studs from the preformed joint strip seal. As the skew increases, designers must verify the edge distance chosen will provide 1½" of cover at the end of the straight coil loop inserts in the beam and in the expansion blockout. When checking the cover of the straight coil loop insert, assume the end of the straight coil loop insert is 7" away from the vertical face of the expansion blockout and is 2" in diameter.

Bridge Deck Smoothness Grinding
The beams require smoothness grinding to meet the final profile grade. Designers should reference Bridge Manual Section 3.2.1.2 for design guidelines.

Implementation

Full Depth Precast Bridge Approach Slabs will be implemented on select projects as coordinated between the Central Office Bureau of Bridges and Structures and the District offices. The Department will monitor their performance with the intention of eventually replacing the partial depth precast bridge approach slabs.

New base sheets have been developed and will be available at the primary IDOT CADD page for selected projects.

The Pay item for this work is Full Depth Precast Bridge Approach Slab, Sq. Ft. and the pay code is X5040101.

Please direct questions and comments to Kevin Riechers, Policy, Standards, and Final Plan Control Unit Chief, by email at dot.bbs.comsuggest@illinois.gov.