PROJECT SUMMARY

Texas Department of Transportation

0-5831: Bursting and Shear Behavior of Prestressed Concrete Beams with End Blocks

Background

In 2007, the Texas Department of Transportation (TxDOT) initiated Project 0-5831 to investigate the behavior of U-beams and box beams at prestress transfer and under shear loading. The primary goal of this project was to simplify the details in the end regions of prestressed concrete beams with end blocks. The steps proposed to achieve this goal were fourfold:

1. Understand the behavior of the end regions of beams with skewed and non-skewed interior voids with skewed ends at release.
2. Understand the behavior of the end regions of beams with skewed and non-skewed voids with skewed ends under shear loads.
3. Use the understanding gained in items 1 and 2 to simplify the design of the end regions of beams with various skew angles.
4. Test the simplified details at release (bursting and spalling study) and under shear loads to ensure satisfactory performance at release, under service loads, and under over-loads.

What the Researchers Did

For the U-beams portion of this project, eight full-scale, Texas U54 prestressed concrete beams were fabricated and tested. Eight end regions were instrumented internally and monitored at prestress transfer, 10 end regions were cured with thermocouples inside the end block, and 11 end regions were load tested.

For the box beams portion of this project, opposite ends of 10 4B28 box beams (28 in. deep and 48 in. wide) were tested under shear loads, resulting in 20 shear tests. In addition, the research team fabricated and tested five 5B40 (40-in. deep and 60-in. wide) box beams. A total of nine shear tests were conducted on the box beams fabricated in-house.

What They Found

The following conclusions were reached for the U-beam portion of this research study:

- The current standard end-block and web reinforcement used in the Texas U-beam is sufficient for controlling stresses and all but minor cracking at prestress transfer.
- When loaded near the beam end, the existing Texas U-beam standard design can fail along the bottom flange-to-web interface at loads well below the calculated shear capacity. The strength can be increased using additional reinforcing bars across the interface and by lengthening the beam end block.
- In U-beams with no skew, loads applied above the webs were distributed evenly to the webs. In beams with one end square and one end skewed to the maximum allowed (45°), the shorter web carried approximately 60 percent of the load in the skewed end; at the square end, loads were distributed evenly. Despite the physical separation that exists between the webs of the Texas U-beam, the assumption that the two webs work as one is acceptable for use in shear capacity calculations, even in beam ends skewed to 45°.

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The following conclusions were reached for the box beam portion of this research study:

- Measured vertical strains at the time of prestress transfer revealed that the vertical forces induced by the prestressing strands at prestress transfer can be controlled successfully through the current standard reinforcement detail suggested by TxDOT.
- Measured horizontal strains at the time of prestress transfer revealed that the horizontal transverse forces cannot be resisted by the current box beam standard reinforcement detail used by TxDOT without exceeding the 20-ksi limit recommended by the American Association of State Highway and Transportation Officials. Modifications to end region reinforcement were developed accordingly.
- In square ends of box beams, it was found that approximately half of the total shear is carried by each web. In skewed ends of box beams, it was found that as much as 60 percent of the total shear is carried by the web corresponding to the obtuse corner of the skewed end. The uneven distribution of the shear to the webs was not sufficiently large to cause unconservative shear capacity calculations.

What This Means

The current and recommended end region details for standardized U-beam construction are shown in Figure 1.

The current and recommended end region details for standardized box beam construction are shown in Figure 2.

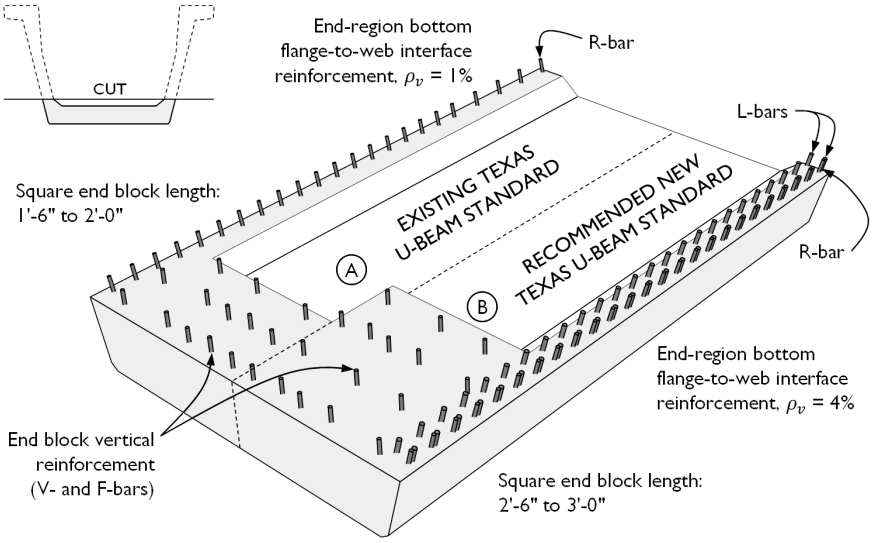

Figure 1. U-Beams: (A) Existing Details and (B) Recommended Details.

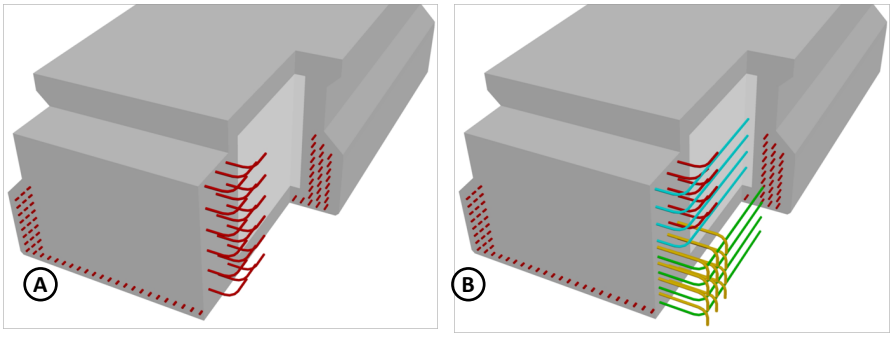

Figure 2. Box Beams: (A) Existing Details and (B) Recommended Details.

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