Project Summary Report 0-4418-S
Project 0-4418: Bridge Slab Behavior at Expansion Joints

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PROJECT SUMMARY REPORT

Development of New Bridge Deck Details at Expansion Joints

The Texas Department of Transportation (TxDOT) currently uses, for most of its bridges, the "IBTS" standard detail for bridge slab ends at expansion joints (Figure 1). That detail has enabled TxDOT to eliminate the use of diaphragms at slab ends by increasing the thickness at slab ends. Slab ends are deepened by 2 in. and the reinforcement spacing is reduced. The origin of this detail is unknown, but has been used successfully by TxDOT for years. Currently, TxDOT uses a combination of prestressed concrete deck panels as stay-in-place formwork and cast in place concrete topping for the interior portion of bridge decks.

All bridges in Texas are designed according to AASHTO provisions. However concerns from trucks operating beyond their legal weight limits and increased truck traffic as a result of the North American Free Trade Agreement (NAFTA) have led many TxDOT districts to increase their design loads.

Prior to this research project, the capacity and behavior of the IBTS slab end detail under applied AASHTO design loads had not been verified by tests. This research is intended to show how loads are carried at free ends of slab; how skew affects behavior at free ends; how serviceability and capacity are affected by the use of the IBTS detail and the elimination of diaphragms; and how this behavior can be modeled for design purposes. In addition to understanding the behavior of the slab end with the IBTS detail, alternate end details, including a cast-in-place detail with a uniform thickness of 8 in. (UTSE-Figure 2) and a detail including the stay-in-place precast prestressed concrete

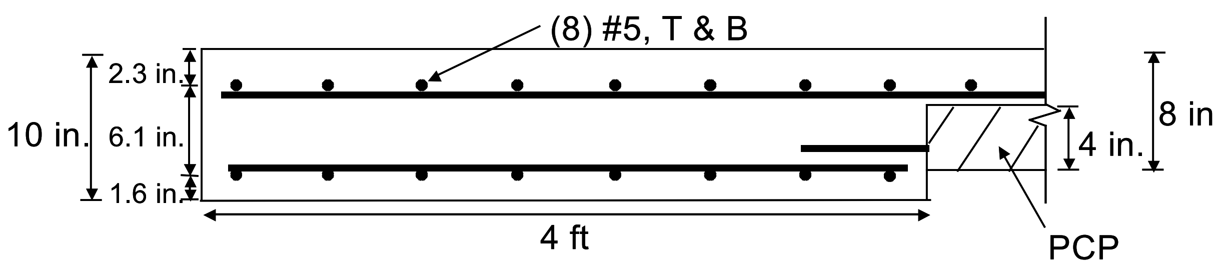

Figure 1: Cross-sectional view of IBTS detail

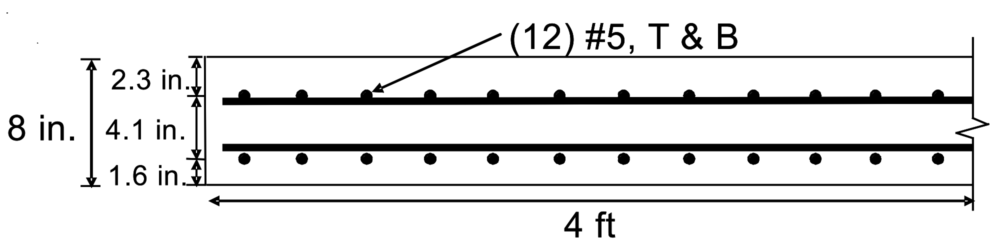

Figure 2: Cross-sectional view of UTSE detail

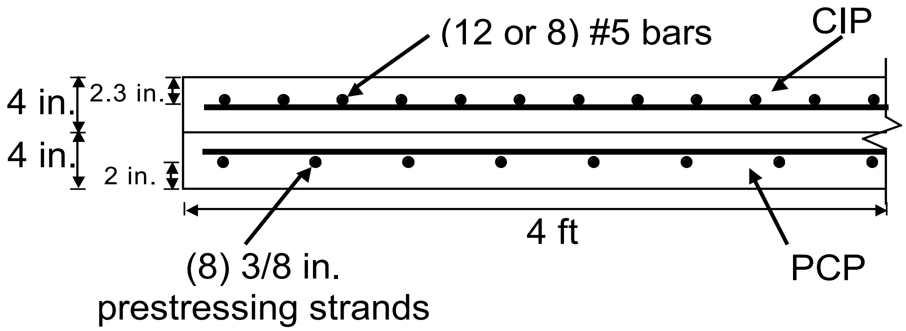

Figure 3: Cross-sectional view of PCPE detail

panels (PCPE –Figure 3) were also developed and investigated.

What We Did…

A total of three full-scale bridge deck specimens were constructed and tested. Two of the full-scale specimens, 0˚ (Figure 4) and 45˚ (Figure 5) skews, were constructed to test the effect of skew on the IBTS and UTSE details. Test results showed that at design load levels, skew had no significant effect on the behavior of the two details, particularly under typical design loads. All test areas failed in shear, predominantly punching shear. The UTSE detail failed at slightly lower load levels than the IBTS detail due to a 2 in. difference in section depth. However, both details had ultimate capacities at loads well above the design load levels.

It was originally intended to test a numerous amount of IBTS beam spacings and skews. However, since both the UTSE and IBTS details exhibited tremendous capacities in an extreme condition (10-ft spacing and 45˚ skew) it was decided to test an alternate detail using the stay-in-place PC panels in the end regions was developed and tested. The use of PC panels in the end regions eliminates special formwork construction and reduces safety concerns associated with such formwork construction at heights. The third full-scale bridge deck specimen was built with the PCPE detail (Figure 6.) Some sections of the slab ends were cast with expansion joint rails.

What We Found…

Bridge slabs designed with the IBTS, UTSE and PCPE details performed well under AASHTO LRFD Design Tandem Load. For bridge slabs constructed with girder spacing less than 10 ft and skews less than 45˚, cracking can be as-

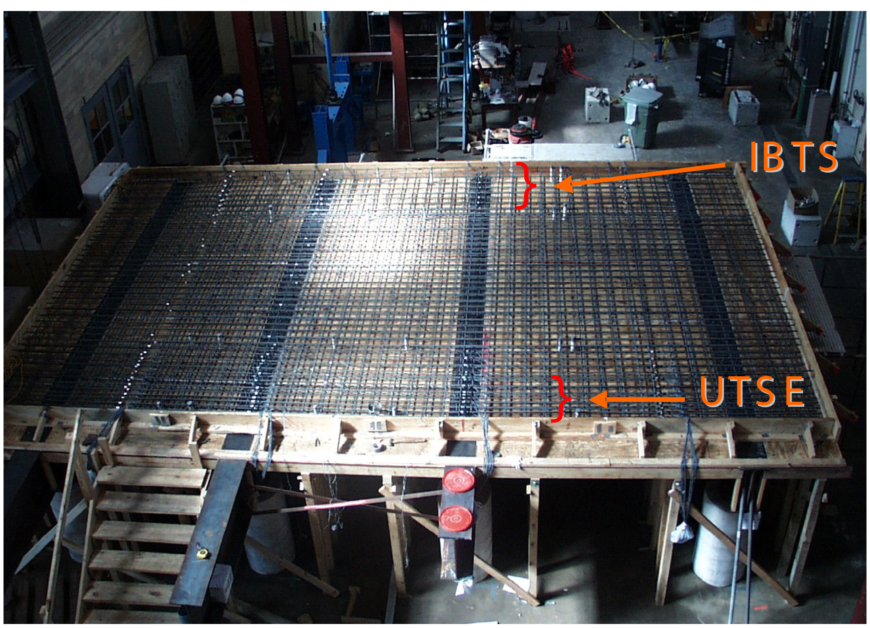

Figure 4: Full-Scale Test Specimen with 0º skew

sumed to be minimal or non-existent under AASHTO LRFD Design Tandem Load. When slab ends are subjected to overloads, cracking was minimal (lengths were less than 24 in. and widths smaller than 0.01 in.) until approximately 1.5 x AASHTO LRFD Design Tandem Load. The smallest ultimate capacity in any of the 11 tests was 55 kip. / wheel.

For bridge slabs constructed with expansion rails, results showed that expansion rails contribute significantly to the behavior and capacity of slab ends. However, excluding the contribution from the expansion rails is a conservative approach.

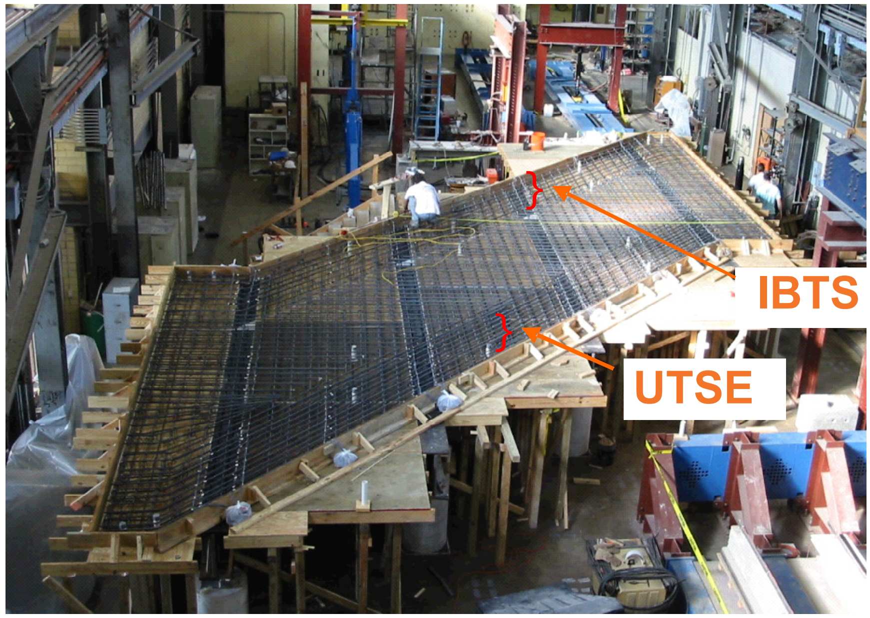

Figure 5: Full-Scale Test Specimen with 45° skew

The Researchers Recommend...

The use of the two new slab end details (UTSE and PCPE) developed in this research project is recommended. Both of the details are simpler than the existing slab end detail (IBTS). Implementation of the end details developed in this study will increase construction speed and result in substantial savings. Based on the promising findings of this project, the development of new PCPE details with skews and fatigue testing of those details are recommended.

TxDOT has already implemented the findings of this project in the Galveston causeway expansion project (Figure 7.)

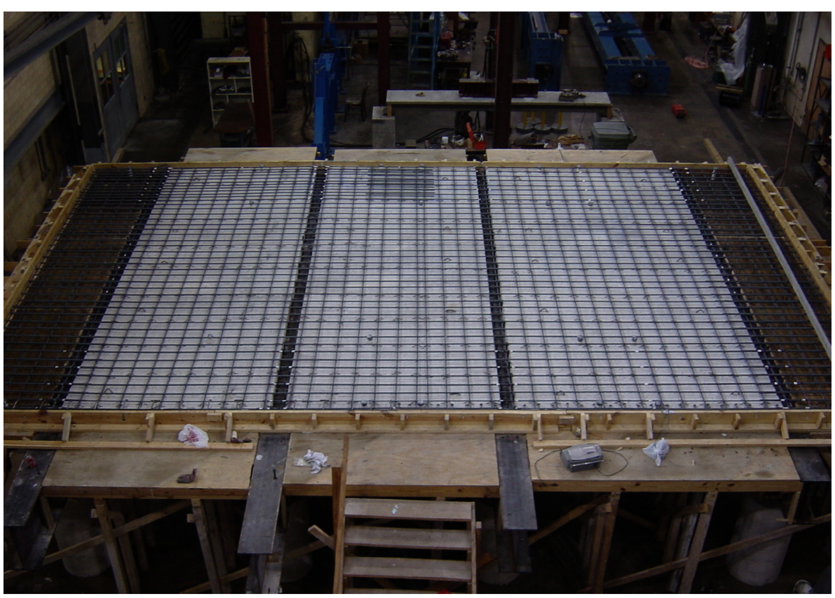

Figure 6: Full-Scale Test Specimen with PCPE detail

Figure 7: Galveston Causeway Expansion Project

For More Details...

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The research is documented in the following report:

0-4418-1 *Bridge Slab Behavior at Expansion Joints*

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