Project Summary
Texas Department of Transportation

0-5367: Development of Simple Bridge Deck Details at Expansion Joints

Background

The Texas Department of Transportation (TxDOT) has, in recent decades, dedicated considerable resources to improving bridge construction methods. Evolving from this effort is the current practice of using prestressed concrete panels in bridge decks. The use of these panels eliminates the majority of formwork for concrete bridge decks, decreases construction time, and reduces construction costs. Skewed expansion joints in bridge decks present a unique challenge for precast panel bridge deck systems. Precast (PC) panels are generally rectangular in shape and leave trapezoid-shaped gaps at the end of the deck adjacent to the expansion joint. Current bridge construction practices call for the use of stay-in-place sheet metal forms or timber forming methods to construct the IBTS detail at the end of the bridge deck.

What the Researchers Did

The purpose of research project 0-5367 was to evaluate the fatigue performance of precast panels used in bridge decks with and without skew. For skewed PC panels, the work done earlier on non-skewed expansion joints (research project 0-4418) was extended to skewed edges so that panels could be used throughout the length of a bridge deck. In consultation with fabricators, contractors, and bridge engineers, details of skewed (trapezoidal) panels were developed and evaluated and guidelines for the implementation of skewed panels prepared.

What They Found

The PC panels for 0° and 45° skew bridge decks exhibited excellent fatigue response. The specific responses of bridge deck specimens with 0° skew are:

- Service-Level Fatigue Behavior
  - The overall system response (load vs. deflection) and the measured strain response remained linear throughout the fatigue test and did not change appreciably with increasing fatigue cycles.
  - The stiffness of specimens was lower after being subjected to static overload, but the fatigue response did not change appreciably with increasing fatigue cycles.
  - No delamination or deterioration was observed along the interface of the PC panel and the cast-in-place slab during the fatigue tests.

Research Performed by:

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- Design-Level Fatigue Behavior
  - The overall system response (load vs. deflection) and the measured strain responses remained linear throughout the fatigue tests, and did not change appreciably with increasing fatigue cycles.
  - The stiffness of specimens reduced after the static overload test (three times the design wheel load), but the fatigue response did not change appreciably with increasing fatigue cycles.

One of the major research findings relates to the fabrication and use of trapezoidal prestressed concrete panels. The research team for project 0-5367 demonstrated that trapezoidal prestressed panels can be used as stay-in-place formwork at skewed expansion joints. Important observations from bridge deck specimens with 30° and 45° skews are:

- The orientation (fanned or parallel) of the strands in the precast panel did not influence the strength or stiffness of the test specimens. However, parallel strand panels were found to be much simpler to fabricate.
- Even though the length of the free end of skewed panels is greater than that of rectangular panels, the skewed panels exhibited similar strength and stiffness to rectangular panels, provided that the surface roughness was sufficient to prevent delamination of the panel from the topping slab.
- Test specimens with a 45° skew angle exhibited maximum load carrying capacities four times greater than the 21.3-kip Design Wheel Load for the HL-93 Design Truck, and they failed in diagonal shear at the short side support.
- The overall system response remained linear throughout the duration of the fatigue loading at service level loads, and no delamination or reduction of stiffness was observed with increasing fatigue loading.
- Fatigue loading did not significantly affect overall system stiffness or the maximum load carrying capacity for the specimens compared to specimens with no previous load history.
- In two tests of 30° panels, the topping slab delaminated from the panels. Because of the delamination, the maximum load carrying capacities were only 2.5 times greater than the Design Wheel Load. Panel surface roughness was likely the cause of panel delamination. When the same tests were repeated in two 30° specimens with panels having a rough surface, maximum applied loads were 3.7 times the Design Wheel Load, a strength that better correlates with the 45° specimens.

What This Means

The results of this research project demonstrate that precast concrete panels can be used adjacent to expansion joints in bridges with skew angles between 0° and 45° and panel widths up to 9 ft 6 in. without compromising the strength or fatigue performance of the bridge deck. The research results further show that producing trapezoidal precast prestressed panels can be economical while accommodating a wide range of geometries.

For More Information:

0-5367-1 Recommendations for the Use of Precast Deck Panels at Expansion Joints

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