# Keller Lake, Minnesota, Accelerated Bridge Construction Case Study

tech transfer summary

**August 2019**

**RESEARCH PROJECT TITLE**
Contracting of ABC Projects: Case Studies and Consensus Building

**SPONSORS**
Accelerated Bridge Construction University Transportation Center
U.S. Department of Transportation
Office of the Assistant Secretary for Research and Technology

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The Accelerated Bridge Construction University Transportation Center (ABC-UTC) has assembled an experienced, knowledgeable, and engaged group of bridge academics and engineers who collectively provide the transportation industry with the tools needed to effectively and economically utilize the principles of ABC to enhance mobility and safety and produce safe, environmentally friendly, long-lasting bridges.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the project sponsors.

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**The construction of this trial ABC pre-cast bridge element project on TH 36 over Keller Lake in Maplewood, Minnesota, included bridge decks with and without fiber reinforcement and was procured using design-bid-build; this summary includes key take-aways from the project.**

## Project Description

The Minnesota Department of Transportation (MnDOT) replaced two side-by-side bridges on Minnesota Trunk Highway (TH) 36 over Keller Lake, in Maplewood, Minnesota, north of Saint Paul.

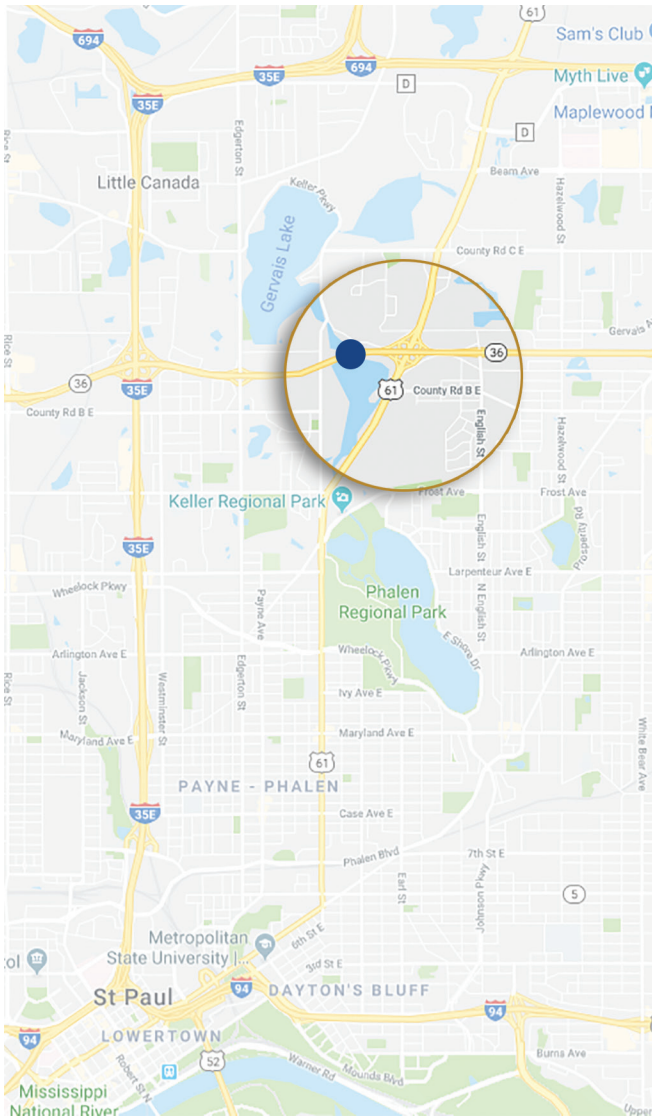
MnDOT utilized accelerated bridge construction (ABC) techniques. The project was used as a trial for MnDOT to test several innovative technologies, including precast bridge elements and an inverted T-beam system. The inverted T-beam technology had been identified for possible ABC by the former state bridge engineer on a scanning tour and had been undergoing non-accelerated trial installations since 2005.

## Why ABC

The project was chosen for ABC because the construction season was limited for these bridges, and TH 36 in this area is a high-volume route and re-alignment of the route for off-line bridge construction was not an option. This was combined with the fact that MnDOT was planning to replace two bridges in the area at the same time, leading to dense construction activity. In addition, there was a bald eagle nest in the vicinity of the project that limited construction activities between August 1 and January 15 to avoid unwanted impact to the nest.

MnDOT

*Completed Keller Lake bridge on TH 36 in Maplewood, Minnesota*




Map data © 2019 Google, https://www.google.com/maps/@45.0111804,-93.0685791,2014m/data=!3m1!1e3

*Location of the Keller Lake bridges on TH 36, in Maplewood, Minnesota, north of Saint Paul*

## ABC Procurement and Bidding

The project was procured using design-bid-build (DBB). MnDOT detailed several precast elements as part of this project, including precast substructures and precast full deck panels. In using all precast elements, the precast pick weights and corresponding crane reach were investigated in an attempt to balance the equipment needs to complete construction.

All precast elements were required to be cast in a Precast/Prestressed Concrete Institute-certified (PCI-certified) plant because of the tight tolerances. After the job was completed, the contractors also noted that they would have been reluctant to self-perform precasting due to increased risk should MnDOT reject the product or impose penalties on the project with such a tight schedule.

## Contracting

The contract that was awarded included disincentives of $7,500 per calendar day. The bridge construction cost was approximately $2.1 million for 10,615 square feet, which translates to roughly $195 per square foot. In comparison, conventional precast beam bridges with cast-in-place (CIP) substructures in 2013 were averaging between $110 and $130 per square foot without the time constraints. Typical bridge construction duration for three-span slab spans without time constraints is between 3.5 and 5 months.

## ABC Construction

Several innovative technologies were utilized in this trial project. The project utilized substantial precast elements: precast piles, precast pile bent caps, precast stub abutments, and precast inverted T-beams, which serve as a permanent form for a CIP deck with a single layer of reinforcing steel.

The inverted T-beam is a prestressed beam that fully forms the underside soffit and eliminates the need for significant forming over water. Precast piles were utilized in this project because of both aesthetics and the perception that pile driving noise would be minimized to avoid disturbance of the nearby eagle nest.

This project was completed using staged construction. The prestressed concrete piles for the abutments and piers were driven, followed by setting precast abutments and pier caps on temporary brackets to establish the bearing seat grade. The piles extended into the precast substructure through full-depth openings and were grouted with a conventional substructure concrete mix with smaller aggregate.

After grouting the substructure units, the inverted T-beams were placed for the three-span bridge using a crane. The beams were set on narrow elastomeric pads that extended the full length of the substructure.

MnDOT

*Keller Lake precast bridge construction*

MnDOT

*Precast abutment setting over piles with projecting, hooked, reinforcing steel bars*

MnDOT

*Precast abutment set showing pile grout pockets with wingwalls that consisted of a permanent sheetpile wall with a CIP facing and top coping*

MnDOT

*Keller Lake Bridge view from trail under bridge*

## Key Takeaways

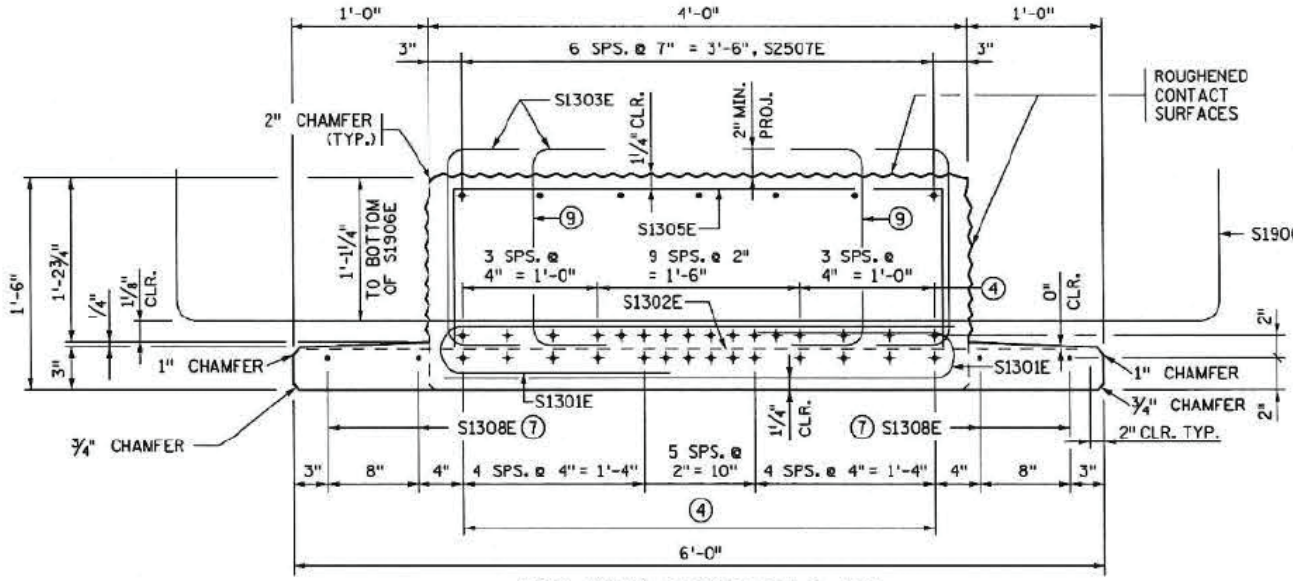
- Contractors would prefer CIP elements over precast elements for heavy substructure components. Precast stub abutments weren't found to add much acceleration value.
- Precast substructure elements can lead to higher bids for the work, or fewer bids if it is a limiting factor for contractors.
- Shifting risk to contractors during the bidding process tends to increase bid dollar amounts.
- The most successful component of the bridge was the inverted T-beam system in combination with non-metallic fibers.
- Non-metallic fibers resulted in reduced deck cracking and are now used in most deck placements statewide in Minnesota.

## Acknowledgments

This case study was prepared by the Bridge Engineering Center and the Construction Management and Technology program at Iowa State University's Institute for Transportation, which provided match funding for this project through their related work for Kiewit Infrastructure Co.

The authors would like to thank the sponsors for funding this work and MnDOT for their contributions and participation to produce this case study tech transfer summary. Paul Pilarski with MnDOT contributed significantly to the creation of this document and his time is greatly appreciated.

# Keller Lake, Minnesota, ABC Plan Details

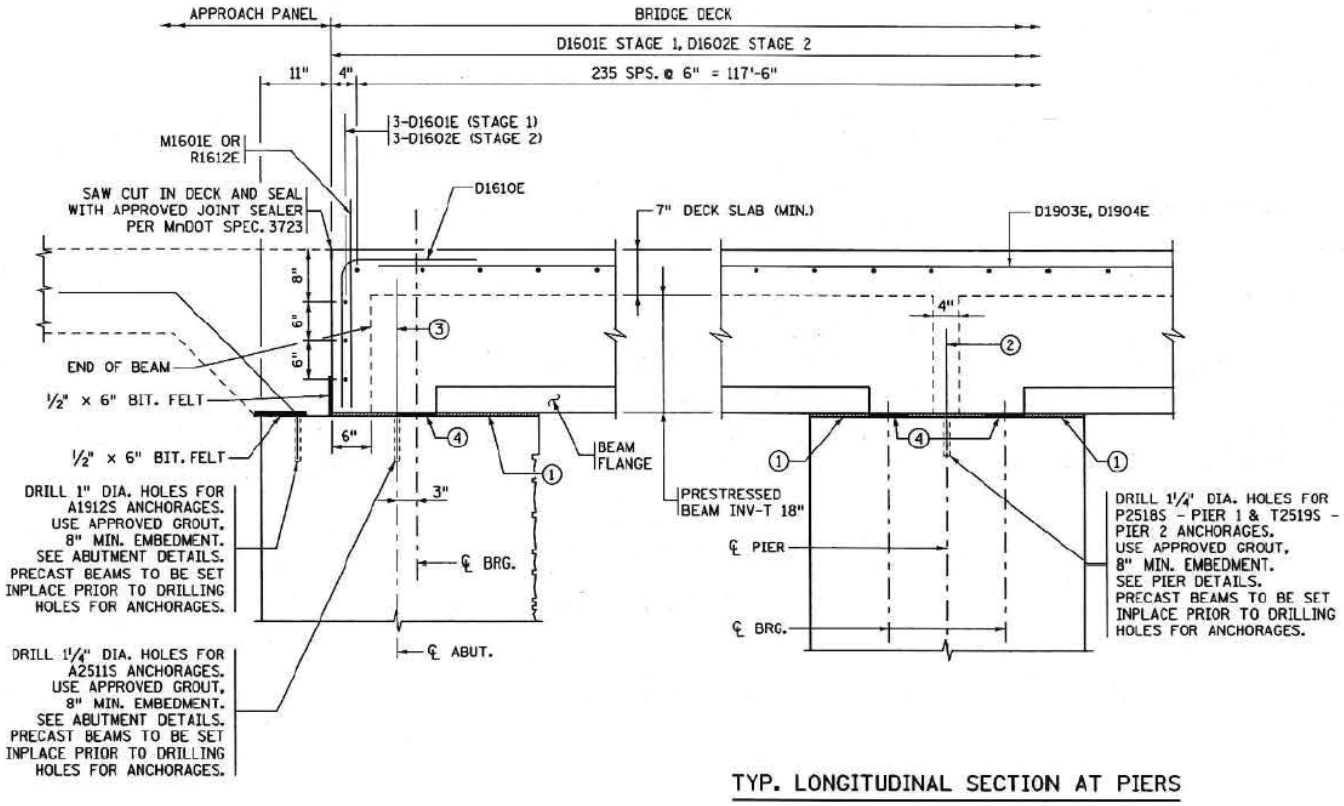



END VIEW BEAMS B5 & B7

CUT STRANDS FLUSH WITH CONCRETE. PAINT ENDS WITH AN APPROVED GRAY EPOXY EXCEPT AS NOTED.
(BEAMS B5 = 6 REQUIRED THUS, BEAMS B7 = 6 REQUIRED THUS)

MnDOT

*Interior inverted T-beam details showing flanges are coped over supports to enable substructure connectivity*




TYP. LONGITUDINAL SECTION AT PIERS

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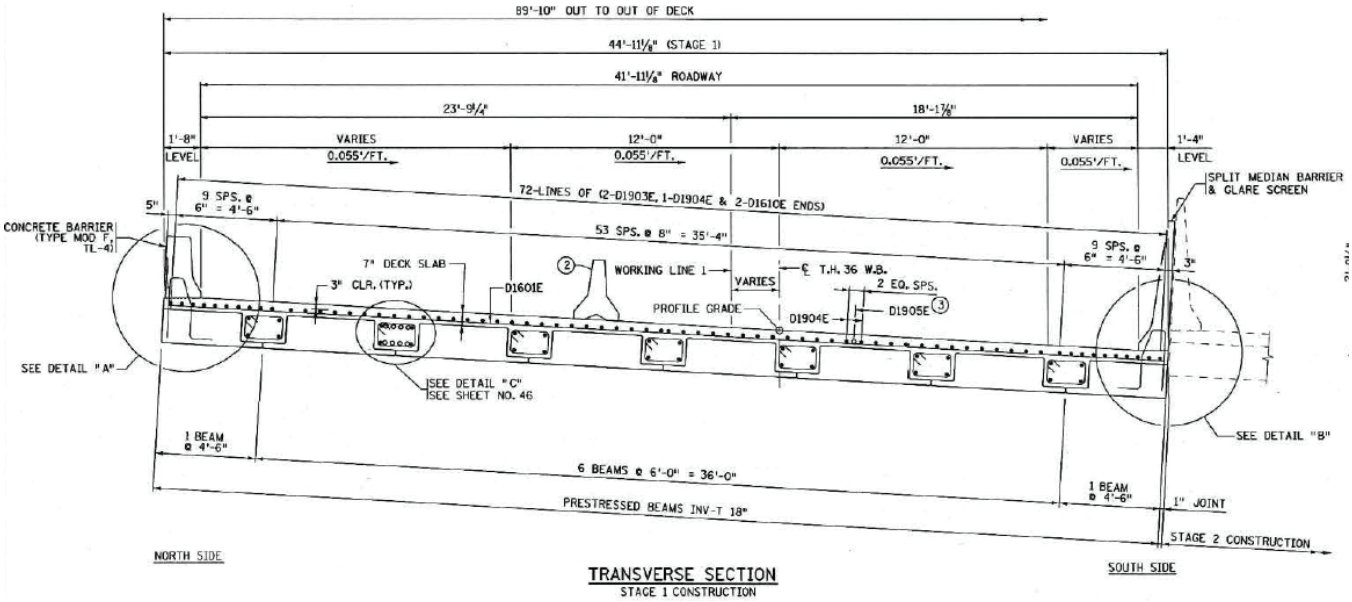
*Longitudinal section showing bearings (Circle 4), anchoring dowels (Circle 3), and single layer of deck reinforcement*

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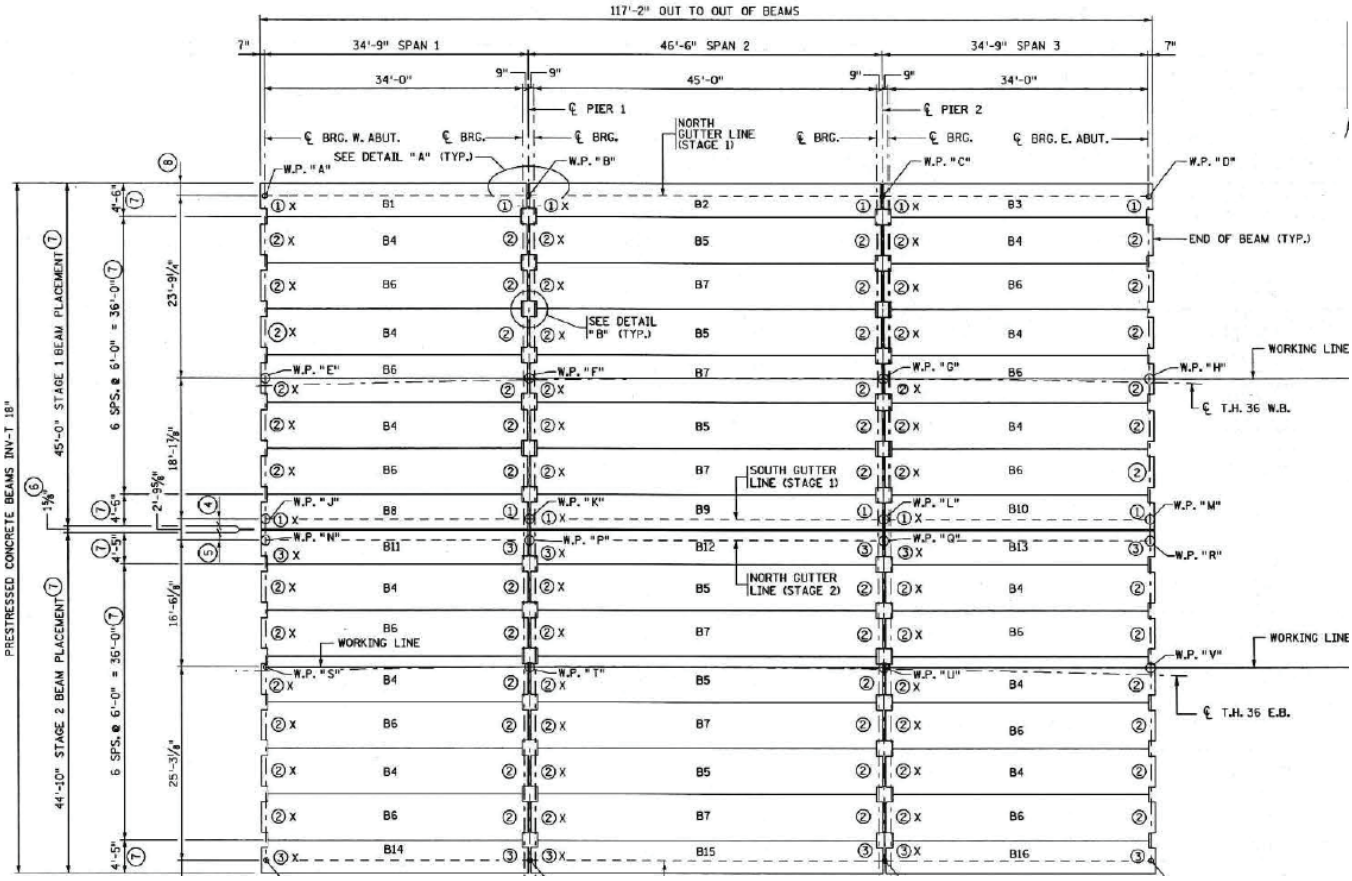
*Superstructure cross-section with deck reinforcement and interconnecting diaphragm reinforcement*

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*Plan view of three spans of inverted T-beams*