



# Integral Abutment Connection Details for Accelerated Bridge Construction

tech transfer summary

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## RESEARCH PROJECT TITLE

Integral Abutment Connection Details for Accelerated Bridge Construction

## SPONSORS

Iowa Department of Transportation  
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The Bridge Engineering Center (BEC) is part of the Institute for Transportation (InTrans) at Iowa State University. The mission of the BEC is to conduct research on bridge technologies to help bridge designers/owners design, build, and maintain long-lasting bridges.

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The integral abutment connection tested as part of this research is a viable option for incorporation into ABC projects to improve the durability, constructability, and efficiency of bridges in Iowa.

## Objective

The objective of this research was to perform laboratory tests to aid in the planning, design, and construction of the integral abutment connection detail when used in accelerated bridge construction (ABC) projects.

Three connection details were developed for investigation in this Phase II project. Two were a revised design of the two mechanical coupler connection details tested in Phase I, and the third was a new connection detail designed through the Iowa Department of Transportation (DOT) to be used on an upcoming bridge project.

## Problem Statement

The integral abutment connection is appealing to bridge designers because it eliminates the expansion joint that is a common location of structural deterioration.

## Background

ABC has become a useful bridge construction procedure utilized by many bridge engineering agencies around the world, and in the US. ABC is being analyzed and formalized to replace conventional bridge construction in more and more projects due to the significant decrease in construction time and traffic impact, as well as the increase in bridge element quality and worker and public safety.

ABC differs from conventional bridge construction by utilizing prefabricated bridge elements and systems (PBES) and other technologies to lift, slide, and rotate parts of a bridge, or at times the entire bridge, into position. Once in position, connections are made to join the precast elements into one cohesive bridge system. These connections have been, and still are being, researched and tested for many locations within a bridge to improve their durability, constructability, and efficiency.



*Completed integral diaphragm of the joint specimen before aggregate finish exposed under the form retarder, completion of the connection, and pouring of the UHPC into the joint*

One detail still being researched and tested is the integral abutment. An integral abutment is a connection composed of combined shear and moment connections between the bridge superstructure and substructure.

## Project Description

To advance the use of integral abutments with ABC, rather than relying on a closure pour, three connection details were designed to be constructed full-scale and tested in the structures laboratory to monitor overall strength and durability of each connection detail. The design philosophy of the connection detail was to be able to complete adequate structural connections in a matter of a few days while maintaining the structural integrity and response present with the closure pour connection.

The strength and durability of the connection details were evaluated through full-scale laboratory testing that applied simulated thermal loads and live loads. Strain gauges were used to capture the development and strength of the specimen and connecting materials, and displacement transducers monitored the propagation and magnitude of precast joint openings between the integral diaphragm and pile cap to evaluate the durability and serviceability of the connection details. The results of these tests were compared to the control specimen tested in Phase I.

The ultra-high performance concrete (UHPC) joint design utilized a “notched” cross section formed into the integral diaphragm with protruding reinforcing bars from the integral diaphragm and pile cap. The void between the two precast elements was filled with UHPC. The UHPC joint connection detail was a design created through the Iowa DOT to be used on an upcoming bridge construction project.

The connection detail was successfully constructed and documented in detail, specifically concerning any issues that arose during the construction process. The connection was evaluated based on not only strength and durability but also constructability.

## Key Findings

The results from the testing suggest this connection detail is a viable option for creating a strong, durable, and constructible integral abutment bridge in an advanced bridge construction setting.

The laboratory testing of the UHPC joint showed that the connection would be able to resist high-magnitude cold joint cracks, and consequently, prevent infiltration of deteriorating chemicals and water. Since the failure mechanism seen in the laboratory specimen was the web buckling of the beam, it can be assumed the connection detail is most comparable to the closure pour connection detail for integral abutments.

## Implementation Readiness and Benefits

- The construction of the precast elements was not difficult and should be achievable for experienced fabricators. It is important that the fabricator ensure the required protrusions for the reinforcing bars to provide adequate development length within the UHPC joint, which can be accomplished through proper quality control procedures.
- Prior to casting the joint, UHPC mixing procedures and equipment should be prepared such that the entire joint can be filled with UHPC in one continuous pour to eliminate the possibility of layered sections within the joint.

Incorporating these connections into ABC projects could improve the durability, constructability, and efficiency of bridges in Iowa.

## Recommendations for Future Research

Further investigations about integral abutment connection details for ABC applications should be conducted to provide more literature on the subject. Such investigations would be further revisions to the designs of the connection details and field monitoring of real-world applications of the connections.

Another investigation could focus on the following:

- Revision of the UHPC joint connection detail with the notch of the front face of the integral diaphragm being transferred to the front face of the pile cap. This would allow the protruding coupling bar from the pile cap to be lowered enough to not cause an issue with the beam during slide-in construction, yet have enough length for proper development within the UHPC. By making this revision, formwork for the bottom of the integral diaphragm could be simplified but would require another round of research to verify.
- Cyclic loading of the connection details.
- Analysis of real-world applications of the connection details through field monitoring.