

Geotechnical -  
Structures

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Project Title:  
Development of Effective  
Accelerated Bridge Construction  
(ABC) Methods for Bridge Abutment  
Design and Construction

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## Development of Effective Accelerated Bridge Construction (ABC) Methods for Bridge Abutment Design and Construction

This task will develop an accelerated bridge construction method to construct bridge abutments using cost-effective and lightweight modular components.

### WHAT IS THE NEED?

The growing need for new infrastructure solutions to meet current and future demands of the economy has driven the need for innovative construction methodologies that can deliver bridge projects rapidly and efficiently. A significant portion of the nation's bridge inventory has been found to be structurally deficient or functionally obsolete, and is in urgent need of repair, rehabilitation, or complete replacement. However, the conventional approach to bridge construction is not always able to provide the efficiency required to address that issue.

Given their advantages over conventional construction techniques, Accelerated Bridge Construction (ABC) methods have been increasingly used not only for the rehabilitation/replacement of existing structures but also for the construction of new structures. Such methods can greatly reduce on-site construction time, improve safety of the traveling public and workers, improve bridge components quality, as well as the longevity of the overall bridge structure. As a result, several State Departments of Transportation (DOTs) have developed and implemented ABC procedures for select components of a bridge system when rehabilitating or replacing a bridge. In California, as in other states, attempts at implementing ABC techniques for substructure systems have been met with challenges stemming from the use of post-tensioning and Cast-in-Drilled-Hole (CIDH) shafts, and the inability to continue construction until in-situ concrete/grout reaches adequate strengths. Moreover, the development of ABC for substructure systems, especially abutments, requires careful consideration of seismic performance and Soil-Foundation-Structure interaction.



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In a recent research project funded by the Iowa Highway Research Board (IHRB), Cheng and Sriharan (2019) developed connection details for a bridge column-pile-footing system. The performance of the connections was successfully verified in a large-scale outdoor field test that was able to account for the important effects of SFSI, which laboratory tests fail to accurately capture.

## WHAT ARE WE DOING?

To develop and experimentally verify an ABC method to construct abutments in a seismic region using prefabricated elements and properly designed connections, the following sub-tasks are envisioned:

- Review of available studies as well as design and construction specifications relevant to ABC using prefabricated abutments elements;
- Develop prefabricated prototype abutment elements to meet the functionality of standard abutment designs used by Caltrans as well as robust connections that take advantage of unique properties of prefabricated elements;
- Develop analytical models to predict the structural behavior of the new systems;
- Construct and test a large-scale unit at an outdoor site in natural ground conditions to evaluate the performance of the connections and system;
- Analyze the test data to evaluate the performance of the prefabricated substructure elements and their connections; and lastly
- Develop design and construction guidelines for implementation of the methodology.

## WHAT IS OUR GOAL?

Considering the aforementioned challenges and utilizing the knowledge acquired through the successfully completed study, the goals of this research are to:

- Develop a cost-effective and lightweight prefabricated bridge abutment modular system;
- Develop simple and reliable connections that allow fast assembly in the field of the abutment system; and that will
- Perform satisfactorily under both service and seismic loading; and require minimal repair after a seismic event.

## WHAT IS THE BENEFIT?

This research supports the California Bridges & Structure Strategic Direction #8: Balance performance, lifecycle cost, time, delivery, and risk to optimize total value. Deliverables from this work include design details, design guidelines with examples, construction specifications and quality control plan to rapidly construct cost-effective abutments that also minimize maintenance costs. These results will help Caltrans optimize capital, operating, and maintenance costs by establishing lifecycle cost analysis procedures and developing a more flexible, range-based estimating system for structures and improve the decision-making process and tools to help identify “best value” outcomes for structures.

## WHAT IS THE PROGRESS TO DATE?

Recent work supported by Iowa DOT has resulted in a method to rapid construct a pile footing – column connection. The intent is to extend this technology to develop a method to rapidly construct bridge abutments.