DRISI

Caltrans Division of Research, Innovation and System Information

Research Notes

Geotech/ Structures

Development of Alternative ABC Substructure Systems

Develop an accelerated bridge construction method to construct a pile footing column connection for seismic regions.

AUGUST 2021

Project Title:
Seismic Details Development for Accelerated Bridge Construction

Task Number: 3672

Start Date: September 1, 2020

Completion Date: June 29, 2022

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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.

Accelerated Bridge Construction (ABC) technologies have gained significant momentum in recent years. Besides their ability to deliver bridge projects rapidly and efficiently, these techniques can significantly improve safety of the traveling public and workers, enhance the quality and durability of bridge components and consequently those of the overall bridge structure. Given these advantages over conventional approach to bridge construction, several Departments of Transportation (DOTs), in collaboration with research institutes, have developed and implemented innovative ABC methods for various substructure systems with the primary goal of reducing on-site construction time of existing or new structures and thus minimize impacts on mobility and related traffic delays.

Attempts at implementing ABC techniques for substructure systems in California and other states have been challenging, owing to certain design practices including the use of post-tensioning and Cast-in-Drilled-Hole (CIDH) piles, and the necessity of in-situ concreting, which delays construction progress until the concrete reaches adequate strength. Moreover, the development of ABC for substructure systems requires careful consideration of seismic performance and Soil-Foundation-Structure Interaction (SFSI).

WHAT ARE WE DOING?

In a recent research project funded by the Iowa DOT, Cheng and Sritharan (2019) developed socket/pocket connection details for a bridge column-footing-pile system. The performance of the connections was successfully verified in a large-scale field test in natural soil that accounted for the important effects of SFSI, which laboratory tests are generally unable to accurately capture. Other unique features of this test included the use of H-piles including four that were battered and the use of an appropriate level of axial load in the column.

Utilizing the knowledge acquired by Cheng and Sritharan (2019), the main objectives of this research are to:

- Develop ABC concepts for column-footing-pile systems for use in California that will utilize lightweight precast modular sections.
- Develop reliable connection details, which will ensure full mobilization of the system design strength and promote full development of the plastic hinge in the column adjacent to the footing.
- Experimentally verify the developed system performance with due consideration of SFSI
- Develop analysis techniques that can quantify the performance of the system, including the developed connection details.
- Develop construction specifications to ensure reliable system performance.

WHAT IS OUR GOAL?

The goal is to develop and experimentally verify a similar system for ABC with new details. The methodology will ensure that the precast elements are as lightweight as possible to facilitate on-site transportation and handling; and that the connections are properly detailed to ensure ease of construction and guarantee performance under all loading conditions including seismic.

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 include design details, design guidelines with examples, construction specifications, and a quality control plan to rapidly construct column – foundation subsystems that also minimize maintenance costs.

WHAT IS THE PROGRESS TO DATE?

Recent work supported by Iowa DOT has resulted in a method to rapidly construct a pile footing – column connection, with the intention to extend this technology to seismic regions.