DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Improved Bridge Columns for Seismic Areas

Advanced materials in precast bridge columns speed up construction time, improve resiliency, and reduce post-earthquake damage

Seismic

DECEMBER 2014

Project Title:
Next Generation of Bridge Columns for Accelerated Bridge Construction in High Seismic Zones

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Task Manager:
Peter Lee
Research Contract Manager
plee@dot.ca.gov

WHAT IS THE NEED?

The majority of bridges and their components in California are cast in place, which is a time-consuming construction method that can take months. To shorten onsite construction time, an alternate approach is to implement Accelerated Bridge Construction (ABC), a technique that uses prefabricated structural elements that can be rapidly assembled at the construction site. ABC offers many other advantages, such as less impact on traffic, improved work zone safety, more durable bridges because of the use of quality precast members, and potentially lower overall cost. ABC is already a routine technique for some bridge components, such as bent caps, but precast columns have been rarely applied in moderate and high seismic zones because of the absence of performance data and lack of confidence in the connections.

WHAT WAS OUR GOAL?

The goal was to develop a new generation of precast concrete bridge columns and connections with seismic performance that is equal to or better than columns built using conventional cast-in-place technology.

WHAT DID WE DO?

Caltrans, in partnership with the University of Nevada, Reno, constructed eight different half-scale column models to test precast column connections. One column was a cast-in-place model to provide a benchmark for comparing the seismic performance of the other columns. The researchers developed and evaluated different types of connections, some using couplers to connect reinforcing bars and others using grouted ducts. To enhance the columnsâ€™ seismic performance, the researchers incorporated advanced materials known to have superior strength.

One goal was to develop and proof-test connection and column designs that incorporated ultra high-performance concrete, a durable, super-concrete with high strength, a fiber-reinforced grout that can bend without falling apart, and bars made with nickel and titanium, which have the ability to bring the bridge back to its original position as it sways back and forth. The team assessed the advantages and disadvantages of each model to help engineers decide which type to use for a particular design.

WHAT WAS THE OUTCOME?

The research developed several types of proof-tested, practical precast bridge columns and connections, enabling engineers to choose optimal columns for a particular bridge to resist seismic forces. Connections using grouted ducts instead of couplers as a means to simplify construction were added to the list of reliable choices.

WHAT IS THE BENEFIT?

Incorporating innovative materials instead of conventional steel and concrete allow bridge engineers to design for higher standards. Most of the new generation of precast bridge columns have a seismic performance that is equal to or better than traditional cast-in-place columns. Using precast columns decreases construction time, traffic impact, and potentially cost. The precast columns are built with advanced materials that enhance bridge resiliency, substantially reduce post-earthquake damage and repair costs, and lessen the vulnerability of bridge columns to permanent side movements that render the bridge useless. Bridges can remain open to traffic, even after strong earthquakes. These unique features help ensure life-time serviceability of highway bridges in high seismic regions.

LEARN MORE

To view the complete report:
http://wolfweb.unr.edu/homepage/saiidi/caltrans/nextgen.html

IMAGES

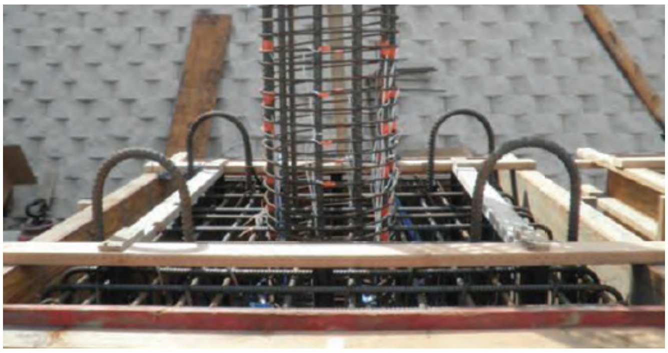

Figure 1: A cast-in-place footing ready for casting concrete is used as a benchmark.

Figure 2: Completed cast-in-place column model