DRISI
Caltrans Division of Research,
Innovation and System Information

Research Results

Testing the Performance of Grouted Couplers for Bridges

Precast columns assembled with grouted couplers pass seismic tests

Seismic

MARCH 2014

Project Title:
Seismic Performance of Precast Bridge Columns with Grouted Couplers

Task Number: 2290

Start Date: July 11, 2011

Completion Date: May 31, 2012

Task Manager:
Peter Lee
Research Contract Manager
peter.s.lee@dot.ca.gov

WHAT IS THE NEED?

Accelerated bridge construction (ABC), which relies on prefabricated structural elements that can be rapidly assembled at the construction site, has gained momentum as an alternative to traditional cast-in-place construction. ABC can speed up construction, thereby reducing costs and lessening the impact on the environment and traveling public. Despite the advantages, ABC has not been widely implemented in areas prone to seismic activity because of the uncertainty of how the connections used to join precast elements, particularly the column connections, perform during an earthquake. After an earthquake, the columns must be able to maintain the stability of the bridge for public safety.

Grouted couplers have been successfully used to join precast elements for more than 30 years in high-rise building construction in Asia. A grouted coupler consists of a ductile cast-iron sleeve that is filled with high-strength grout and joins two reinforcing bars placed within the sleeve. Precast column members with grouted coupler connections have great potential for ABC projects in high-seismic zones because they can be assembled rapidly, and the reinforcement details are similar to conventional bridge columns. However, research on how these connections perform under seismic loading in bridge columns designed with U.S. standards is not available.

WHAT WAS OUR GOAL?

The goal was to determine whether grouted couplers used to join precast column elements can withstand the loads and deformations that occur in a strong earthquake.

WHAT DID WE DO?

Caltrans, in partnership with the University of Nevada, Reno Center for Civil Engineering Earthquake Research, constructed

three bridge column specimens to test under cyclic loads until they failed. Two columns were fitted with grouted coupler connections in a plastic hinge at the column-footing joint. The third column, used as the benchmark, consisted of conventional reinforced concrete. The researchers tested various grouted coupler devices to failure under static and dynamic uniaxial loading. They used the results to develop computer simulation models to evaluate the behavior of the connections.

WHAT WAS THE OUTCOME?

The results indicate that columns with grouted coupler connections behave similar to reinforced concrete columns. The grouted coupler devices changed the stiffness and strength to the area of the column, altering the overall behavior of the column member. Although the mode of failure was the same, the failure locations differed between grouted coupler and conventional columns, indicating that the presence of the grouted coupler devices changed the plastic hinge formation in the precast columns. The couplers themselves sustained no damage. The computer models developed to calculate the response of the grouted coupler columns supported the experimental results.

WHAT IS THE BENEFIT?

Accelerated bridge construction has the potential to offer numerous advantages, from minimizing traffic delays and mitigating noise and air pollution, to cutting costs and enhancing construction site safety. This research shows that precast columns utilizing grouted couplers can achieve ductile response in seismically active areas. However, they might not be as resilient as cast-in-place columns. Caltrans is continuing to research ways to improve ABC connection methods to maximize ductile design and resiliency of ABC bridge systems.

LEARN MORE

To view the complete report:
www.dot.ca.gov/hq/esc/earthquake_engineering/Research_Reports/vendor/un_reno/Final_Report_ 65A0425.pdf

IMAGES

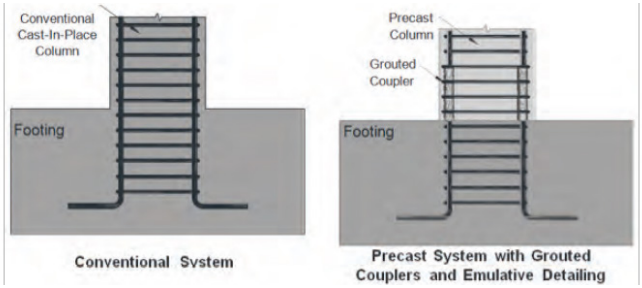

Figure 1: Comparison between conventional and precast systems with grouted coupler connections

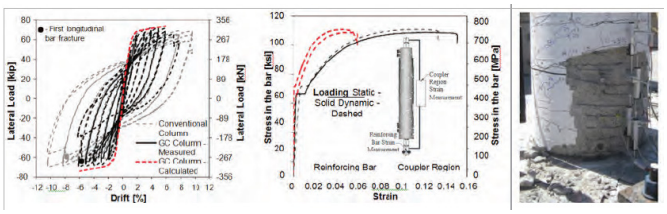

Figure 2: Behavior of grouted couplers and their connections (left to right): Force-displacement response of conventional and grouted coupler columns; tensile stress-strain response from individual couplers; damage of a grouted coupler column-footing connection at 6% drift