DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Seismic Performance of Precast Bridge Decks in Accelerated Construction

Develop and design a prefabricated precast bridge deck panels that can be used seismic zones.

Structure/Seismic

MAY 2019

Project Title:
Seismic Performance of Precast Bridge Decks in Accelerated Construction

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WHAT IS THE NEED?

Accelerated bridge construction (ABC) offers a viable alternative to cast-in-place construction since significant construction time can be reduced by using prefabricated deck for new bridge construction and for deck replacement. The main challenges of using fulldepth deck panels are: 1) how to connect the deck panel to the longitudinal girder and achieve a 'full' composite action and 2) how to connect the panels to each other's transversely and longitudinally so it will act as one unit. These prefabricated deck panels are attractive for bridge construction since they eliminate the need of 1) deck overlays and 2) post-tensioning the precast deck elements.

WHAT WAS OUR GOAL?

The primary objective of this study was to develop and design a prefabricated precast bridge deck panels that can be used seismic zones.

WHAT DID WE DO?

The study conducted literature review on anchors and shear connectors used in precast bridge decks. Information on grout materials, connections between precast panels and superstructure, and rapid replacement of precast deck panels, was collected and summarized. Experimental and analytical investigations were conducted in this study. The experimental work investigated the shear and pull-out behavior of headed anchors using various grout type, anchor head area, and anchor group effect. The ultimate shear, axial capacity and the stiffness of anchors were determined. The test results of the anchors were used in computational models to perform nonlinear seismic analysis of a two-span bridge. The objective of these analyses were to determine the seismic response of the precast deck and the seismic demand forces on anchors when subjected to large ground motions. The AASHTO LRFD seismic provisions used for CIP decks were utilized for the seismic design of precast bridge decks.

WHAT WAS THE OUTCOME?

The results of the experimental and analytical investigations can be summarized as:

- The failure mode of all shear specimens was the fracture of the headed anchor at the interface between the deck and the girder.
- The type of grouts and anchor head area had negligible effect on the ultimate capacity and the stiffness of the anchor.
- The shear capacity of the headed anchors increased linearly when the number of anchors increased indicating no group effect.
- The failure mode for all pullout tests was the fracture of the anchor at the top of the grout indicating adequate embedment length.
- The type of grout and the anchor head area had no effect on the pullout strength and the stiffness of the headed anchor.
- Out of six types of grouts, Latex Concrete had the least amount of time to be removed.
- Polyester Concrete and UHPC were the most difficult grout to be removed.
- Based on the time required and the ease in removing the grout, 1428 HP, EucoSpeed, conventional concrete and latex concrete are recommended to be used for future deck replacement.
- The ultimate shear strength of the tested anchors were similar to the AASHTO Section 6 anchor shear capacity equation.
- The design provisions in AASHTO Section 6 for cast-in-place construction were found to be applicable to precast construction.
- Using the experimental results of the anchor stiffness in gravity load analysis showed that precast bridge decks were not able to achieve full composite action.
- The analytical investigation showed no difference in the overall seismic response of pockets spaced at 4 ft and 6 ft.
- The results of the nonlinear seismic analysis showed all anchors stayed within their elastic range.

WHAT IS THE BENEFIT?

The ultimate capacity and the stiffness of anchors are now available to be used in the seismic design and analysis of precast bridge decks. Information on various grout types and their removal time is available. Nonlinear seismic analysis showed that the anchors of precast decks designed to the current provisions of AASHTO for CIP decks stayed within their elastic range. The overall bridge seismic response was not affected when using pockets spaced at 4 ft and 6 ft.

LEARN MORE

To view the evaluations:

http://wolfweb.unr.edu/homepage/saiidi/caltrans/nonlinear.html

http://wolfweb.unr.edu/homepage/saiidi/caltrans/bridgedeck.html

IMAGES

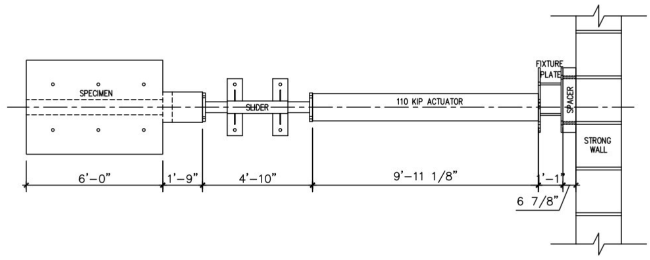

Image 1: Plan View

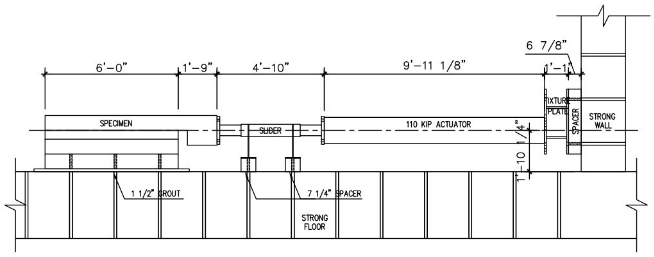

Image 2: Elevation View

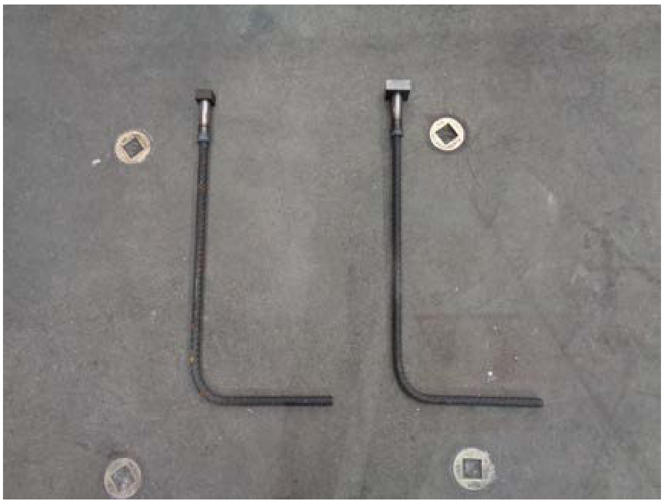

Image 3: Headed anchors used in the study (Left: Head Area = 4Ab; Right: Head Area = 9Ab)

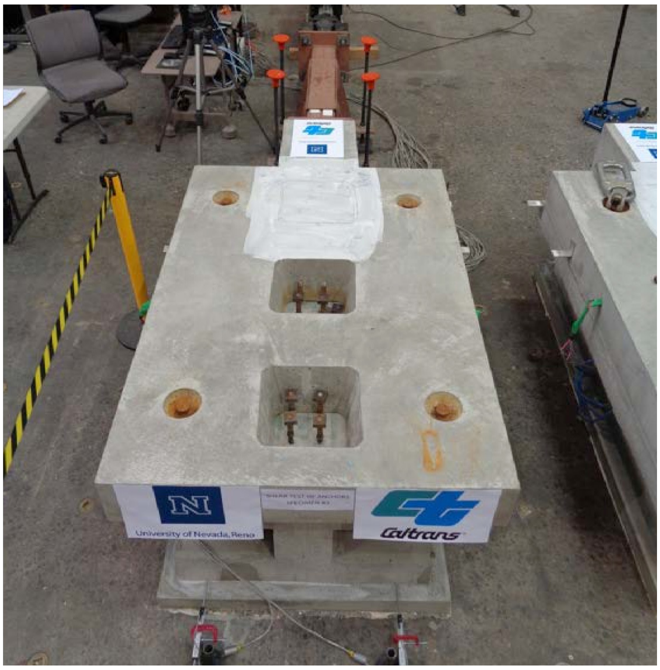

Image 4: Sher test setup

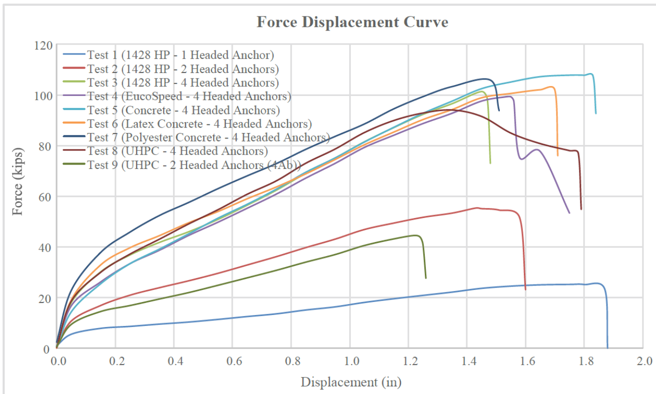

Image 5: Test results of shear force displacement response for all specimens

Image 6: Pullout test setup

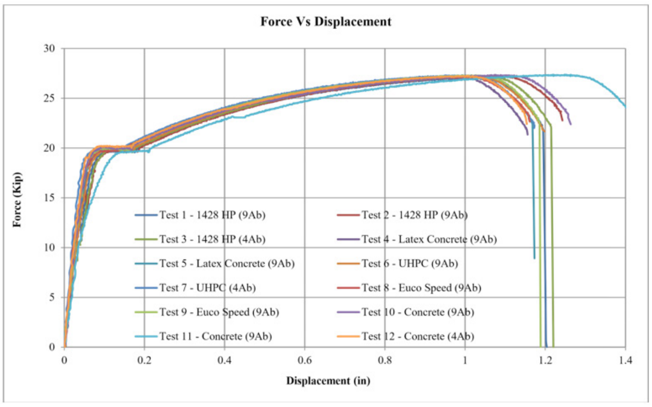

Image 7: Test results of pullout axial force displacement response for all specimens