DRISI

Caltrans Division of Research, Innovation and System Information

Research Notes

Evaluate the Development Length for Headed Steel Reinforcing Bars

Investigate soil-structure interactions of buried structures with Caltrans standard installations to test the applicability of the proposed methods for buried structures by the National Cooperative Highway Research Program (NCHRP) Report 611.

Seismic / Structures

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Project Title:
Seismic Design Details for Improved Bridge Performance

Task Number: 2560

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WHAT IS THE NEED?

In the event of a major earthquake, Caltrans requires slab bridges, like other bridge types, be designed such that plastic hinges form in substructure elements, which can be reinforced concrete pile extensions, columns, or pier walls, rather than in the superstructure. In order for this to occur, a substructure element can be pin-connected to the deck slab or the vertical reinforcement from a substructure element extended into the slab. For the latter case, slab thickness determined in accordance with current design standards will result in a thicker and costlier slab to develop the vertical reinforcement with standard hooks. The use of headed deformed bars can significantly reduce the required embedment length. Currently, there is no data to show that this is possible or to determine whether sufficient shear reinforcement could be put in a column-slab joint to make it possible.

WHAT ARE WE DOING?

The proposed research will develop reinforcing details for column-slab joints that will allow headed bars to develop their full tension capacity with an embedment length of ten times the bar diameter or whatever minimum development length that is practically feasible, and to develop design guidelines for this purpose.

The research has four main tasks. The first two tasks will consist of numerical studies based on finite element models to develop the necessary insight to the anchorage behavior of headed bars with different design details and to assist the development of design guidelines. Results of these studies will guide the design of the experimental study that will be carried out in Task 3 to validate the finite element models and design details developed in Task 2. Task 4 will focus on the development of design guidelines.

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WHAT IS OUR GOAL?

The objective of the proposed research will develop design guidelines, including reinforcing details for column-slab joints that allow headed bars to develop their full tension capacity without a significant increase in slab thickness.

WHAT IS THE BENEFIT?

There are several situations where a smaller rebar development length would make it possible to obtain better seismic performance without a significant increase in cost. For instance, in order for columns to form plastic hinges, the vertical reinforcement must be fully developed into the superstructure and the footing. Of particular concern is the development of the main substructure reinforcement into slab bridges. Caltrans Office of Earthquake Engineering has written new seismic requirements for slab bridges in MTD 20-7 that include the use of more ductile pile extensions, shaft extensions, and pier walls. However, Structures Design would like to keep these requirements from greatly changing what has been an inexpensive bridge to build and an easy bridge to design.

If testing shows that headed reinforcement requires a smaller development length than hooked and straight rebar, Caltrans will be able to use them in slab bridges without having to make the slab deeper, providing a drop bent cap, or changing what has been a very inexpensive bridge to design and build. There are many other locations (in footings, stirrups for pier walls, etc.) where there is not enough room for the typical requirement for straight bars where considerable savings could be obtained if testing proves headed reinforcement requires shorter development at ultimate stresses

WHAT IS THE PROGRESS TO DATE?

The first column-slab assembly has been constructed and tested. The test data was analyzed. The second column-slab assembly was designed and analyzed.

The next step is to modify MTD 20-7 to reflect new design guidance based on this research.