DESIGN GUIDELINES FOR ABC COLUMN-TO-DRILLED-SHAFT FOUNDATION CONNECTIONS IN HIGH SEISMIC ZONES

Quarterly Progress Report
For the period ending May 31, 2020

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Submitted to:
ABC-UTC
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1. Background and Introduction

Precast columns have the potential to be very cost- and time-efficient for ABC, but they must be connected effectively to the foundation, particularly in regions of moderate or high seismicity. Most of the relevant research on column-to-foundation connections has been conducted for spread footings, but in many applications, drilled shafts are preferred, most commonly with a diameter larger than that of the column. Little research has been performed on connections between precast columns and enlarged drilled shafts.

Discussion with the Washington State Department of Transportation (WSDOT) and California Department of Transportation (Caltrans) indicate that drilled shaft foundations are being used with increasing frequency for bridges. Drilled shafts are often needed to support a bridge when the soil conditions, or limited space, make it difficult or impossible to use spread footings. Speed and simplicity of construction, which are essential to ABC, require adequate construction tolerances, and these are most easily achieved if the shaft diameter is larger than that of the column.

Figure 1. Tran Tests of Connection Between Precast Column and Enlarged Drilled Shaft

2. Problem Statement

The current AASHTO ABC design recommendations for shafts are based on the results of cast-in-place column behavior and a single cyclic test of a column-to-shaft subassembly. This research will use experimental data from a past study and data from a PEER-funded study to calibrate strut-and-tie and finite-element models of connections between precast columns and cast-in-place drilled shafts. The calibrated models will then be used in a parametric study, whose results will make it possible for the research team to develop/revise design recommendations for such connections.

3. Objectives and Research Approach

UW researchers will develop guidelines for the design of ABC connections between precast columns and enlarged, cast-in-place drilled shafts in seismic regions. These guidelines will be based on the results of three tests conducted previously (Tran 2015), and one or two additional tests to be conducted with PEER funding. The team will perform a parametric study using strut-and-tie models and finite-element models, which will have been calibrated with the test results, to consider a wide range of column and shaft properties.

4. Description of Research Project Tasks

The following is a description of tasks carried out to date.

PEER –Funded Research.

One or two additional tests of column-to-drilled shaft connections will be performed with the support of the Pacific Earthquake Engineering Research center (PEER). These tests were delayed by laboratory closures due to Covid-19, but the laboratory is now open for research. Graduate student researcher Michelle Chang has already constructed some of the formwork and reinforcement cages for her specimen, and she plans on casting the base of her specimen in late July. Figure 2 shows a photo of Michelle Chang's specimen under construction.

Figure 2. Photo of Specimen Under Construction

Task 1 – Analysis of Data from Tran Test and New Test.

All of the data collected by Tran (2015) has been preserved, but it is necessary to re-analyze the data, so that the data processing methodology for the new tests will be consistent with that used for the new, PEER-funded tests. This analysis will also make it possible to design the new test specimens to so that they will be most useful in developing new design recommendations.

Researcher Michelle Chang has reproduced the calculations performed by Hung Tran. These analyses were used to select an additional specimen to test. Ms. Chang is constructing that specimen now, as discussed earlier

Task 2 – Development/Calibration of Analytical Models

Strut-and-tie and finite-element models will be calibrated using the data available from Tran and the PEER-funded tests. Figure 3 shows the initial form of a strut-and-tie model that could be used in this application.

No progress has yet been made on this task.

Task 3 – Parametric Study

The developed models will be used in a parametric study to evaluate the effects of key design variables, including the depth of embedment of the precast column, the relative diameters of the column and shaft, as well as the details of the longitudinal and transverse reinforcement.

No progress has yet been made on this task.

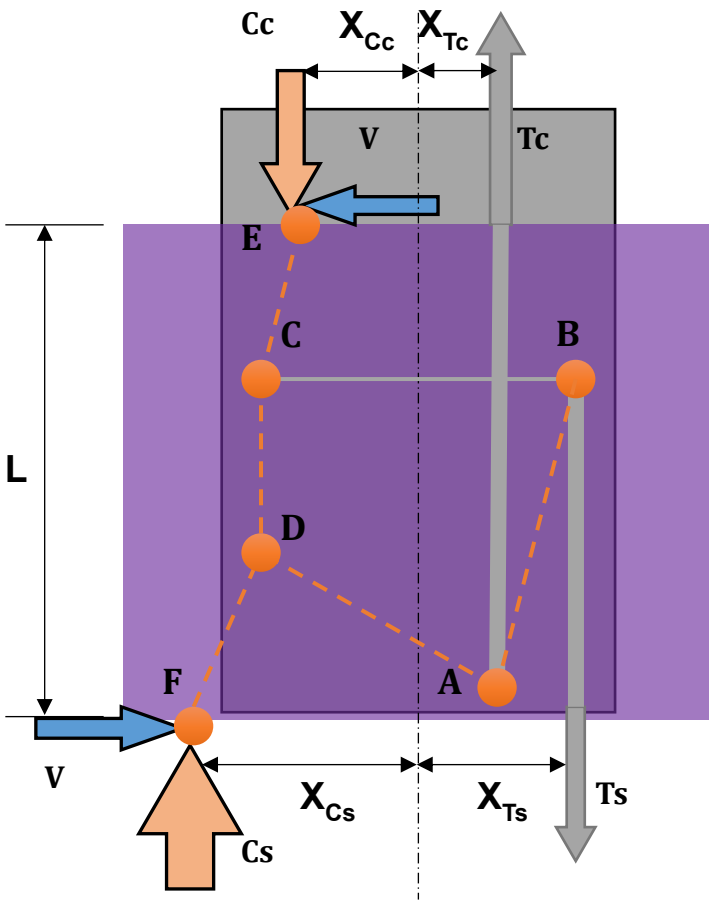

Figure 3. Initial Strut-and-Tie Model for Connection.

Task 4 – Development of Design Recommendations

The results of the parametric study will be used to develop design recommendations that would be suitable for practice. These recommendations will be reviewed by bridge engineers from California and Washington states to verify that the form is appropriate.

No progress has yet been made on this task.

5. Expected Results and Specific Deliverables

The main deliverable will be a report that summarizes:

- Results of the parametric study,
- Calibrated models of the connection, and
- Design recommendations.

6. **Schedule**

This cycle 3 project just started at the University of Washington. Progress of tasks in this project is shown in the tables below.

Item	% Completed
Percentage of Completion of this project to Date	10%

Table 1. Schedule

Research Task	2020								2021								
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
Task 1 – Analysis of Tran Test Data.																	
Task 2 – Development of Analytical Models																	
Task 3 – Parametric Study																	
Task 4 – Development of Design Recommendations																	
	Work Performed																
	Work to be Performed																