Quantitative Assessment of Soil-Structure Interaction Effects on Seismic Performance of Bridges with ABC Connections

Quarterly Progress Report
For the period ending August 31, 2020

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ABC-UTC
Florida International University
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In this report, we provide a summary of our progress for the project tasks.

Task 1: Baseline finite element model for the tested two-span bridge system

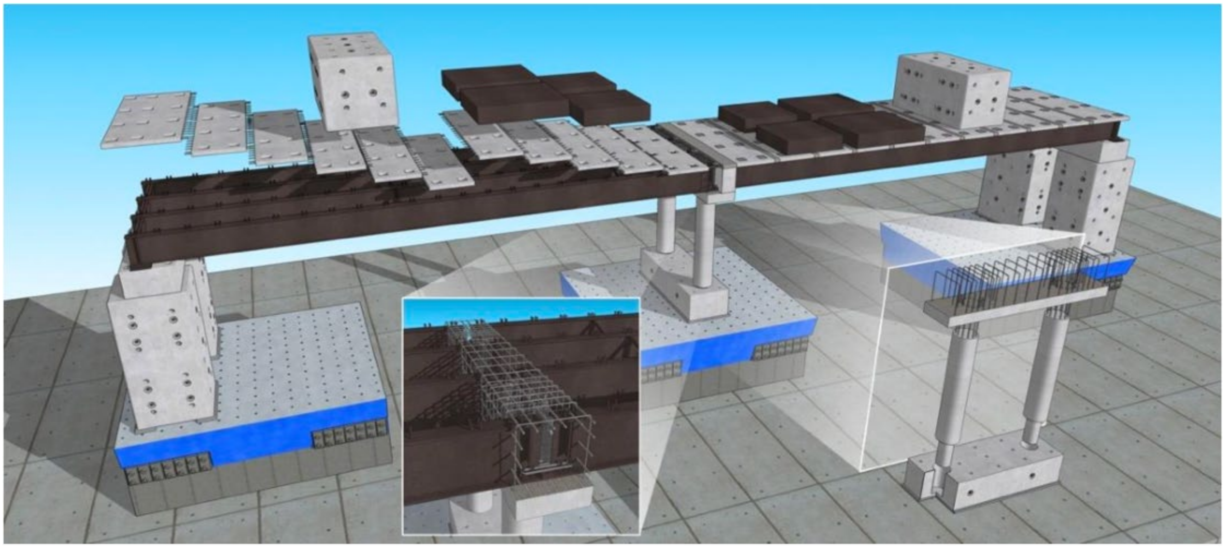

Figure 1: Three-dimensional view of the tested bridge model (Shoushtari et al. 2019).

Recently, a series of shake table testing were completed at the UNR. The experiments–supported by ABC-UTC and Caltrans–consisted of three different two-span bridge systems at the 0.35-scale and with six ABC connection types (Shoushtari et al. 2019). The considered ABC connections including column-to-footing rebar hinge pocket connection and column-to-hybrid cap beam grouted duct connection. Figure 1 shows the bridge model which was tested to failure on three shake tables under successive bi-directional motions simulating scaled versions of the 1994 Northridge-Sylmar earthquake with peak ground accelerations ranging from 0.1 to 1.2 g. Results of this experiment demonstrated that the performance of the bridge model was comparable to cast-in-place bridges as columns underwent 6.9% resultant drift ratio in a ductile manner while cap beam, deck, footing, and four ABC connections in the superstructure responded as capacity protected elements. The main objective of this task is to create the baseline finite element model of the tested bridge.

Progress: The baseline finite element model is developed in Opensees using the design details of the two-span bridge system. The columns, girders, and deck are modeled as force-based beam-column elements. The model uses the recorded shake table acceleration in the x-direction and y-direction as the input for the base excitation. All experimental data are tapered, base line corrected and filtered using a bandpass Butterworth filter. Figure 2 shows examples of processed base excitations for a low amplitude base excitation compared to the original unprocessed data. Figure 3 shows the map of installed accelerometers, which is used to define the node recorders in the OpenSees model. Figure 4 shows an example of comparing computed acceleration at ACC03 to the experimental data. Currently, we work on verifying different aspects of the baseline finite element model.

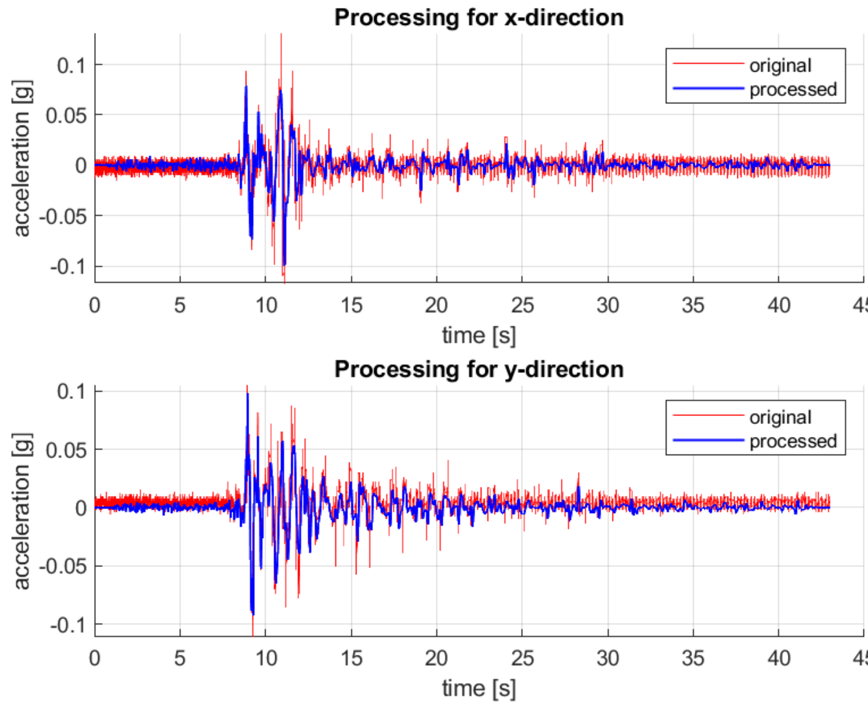

Figure 2: Results from data processing for the base excitation.

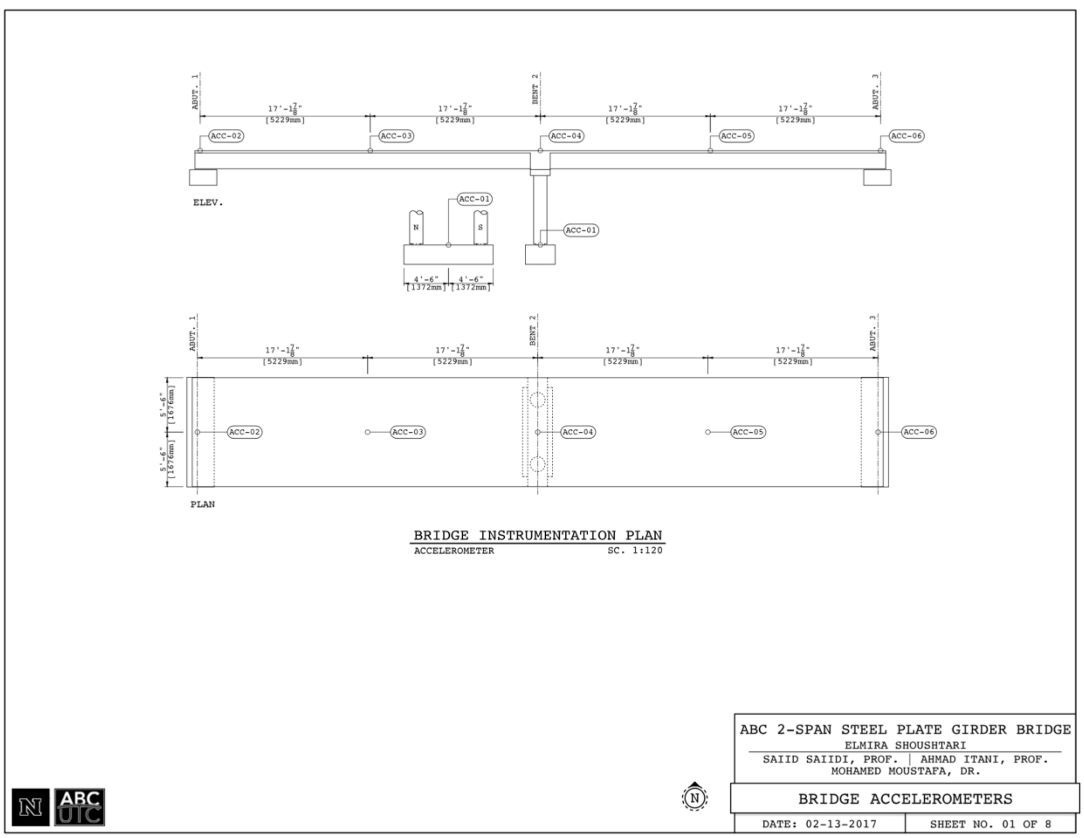

Figure 3: Locations of installed accelerometers.

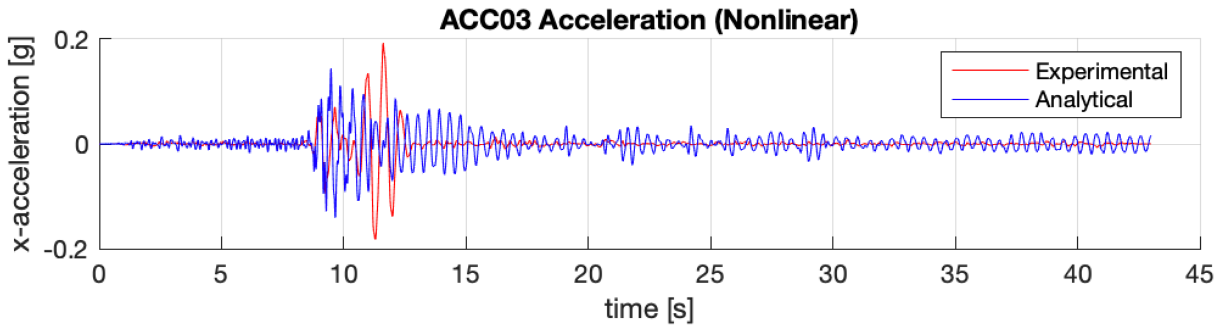

Figure 4: Comparison of numerically computed and experimental acceleration data in x-direction at ACC03 (Figure 3).

Task 2: Data assimilation and nonlinear model calibration

The main objective of this task is to improve the predictive capability of the finite element model in capturing the experimental results of the recently completed shake table test.

Progress: Not started

Task 3: Direct modeling of SSI effects

The main objective of this task is to couple the bridge model with the surrounding soil. Our plan is to use the direct modeling approach to model the near-field soil.

Progress: We have started modeling the near-field soil domain and far-field boundary conditions in OpenSees. These boundary conditions are used to model vertically propagating shear waves in an elastic half-space.

Task 4: Quantitative assessment of SSI effects on seismic performance of ABC connections

Our plan is to use the developed model in Task 3 to perform a series of numerical experiments to quantitatively assess the SSI effects on two considered ABC connections for the bridge column. To this end, we will determine the extent to which seismic demands in ABC connections and global response of the bridge are correlated with the input motion characteristics and the soil. We anticipate spending 3 months on this task.

Progress: Not started.

1. TIME REQUIREMENTS

To allow for the completion of all the project tasks, the study will be conducted over a period of 12 months (4 quarters) following this schedule:

Task	Status	Quarter 1	Quarter 2	Quarter 3	Quarter 4
1	In Progress				
2	Not Started				
3	In Progress				
4	Not Started				

Percentage of Work Completed = 20%

Percentage of Work Remaining = 80%