

# Evaluation on Influences of Inertial Mass on Seismic Responses and Structure-soil Interactions of Pile-soil-piers

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## Research Article

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# Abstract

This research is to assess the influences of the inertial mass from the girder on the dynamic characteristic, dynamic response, and structure-soil interaction of a pile-soil-pier subsystem in a scale-model of a cable-stayed bridge. Therefore, both connection configurations between the pile-soil-pier and girder, including the sliding and fixed connections, were designed to present various inertial mass from the superstructure delivered to the pile-soil-pier. The pile-soil-pier supported by a 3×3 pile-group in mixed soil placed in a shear box was tested using shaking tables. The dynamic characteristics, seismic responses, inertial interactions, and pile group effects of the pile-soil-pier between the sliding and fixed connections were analyzed under three input motions with different shaking amplitudes. These results showed that more inertial mass from the girder significantly increased the reinforcement strain and bending moment at the column bottom and pile top, displacement at the column top, inertial interaction effects, and pile group effects of the pile-soil-pier due to the sliding connection changing to the fixed connection. The inertial mass increment from the girder noticeably decreased the peak accelerations of the column of the pile-soil-pier when subjected to three input motions with different amplitudes. However, the inertial mass insignificantly affected the accelerations of the pile and free-soil. Therefore, the corresponding kinematic interaction effects were almost unaffected by the inertial mass. Additionally, the evident pile group effects were observed in the sliding and fixed connections between the pile-soil-pier and girder. 24 The numerical model could approximately reproduce the macroscopic seismic responses of the pile-soil-piers with sliding and fixed connections and capture the typical response variations induced by the connection configuration change.

## Full Text

This preprint is available for [download as a PDF](#).

## Figures

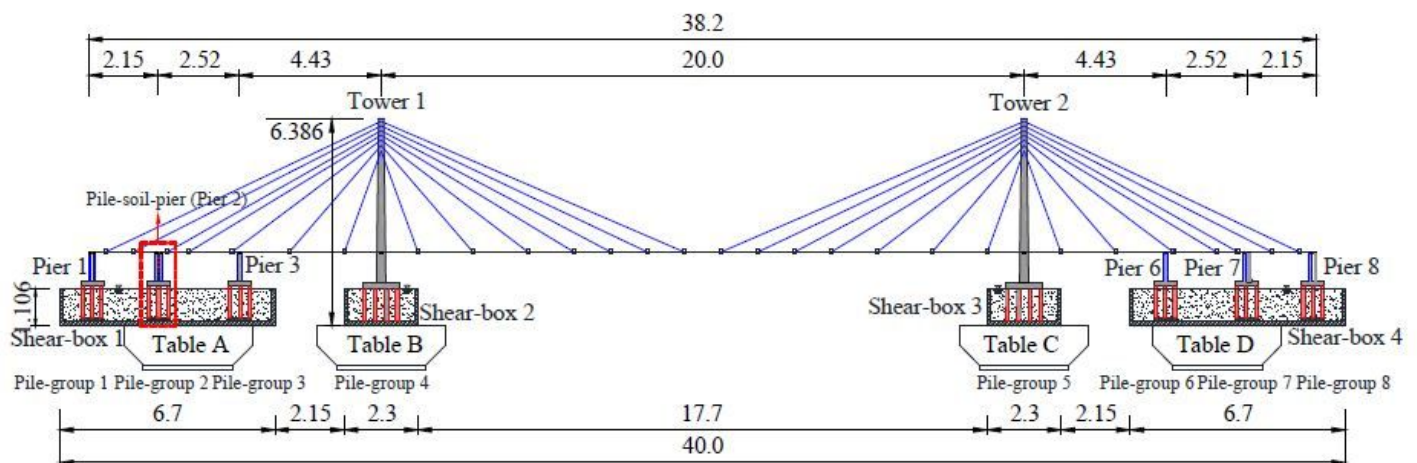


Figure 1

Elevation view of cable-stayed bridge model (Units: m)

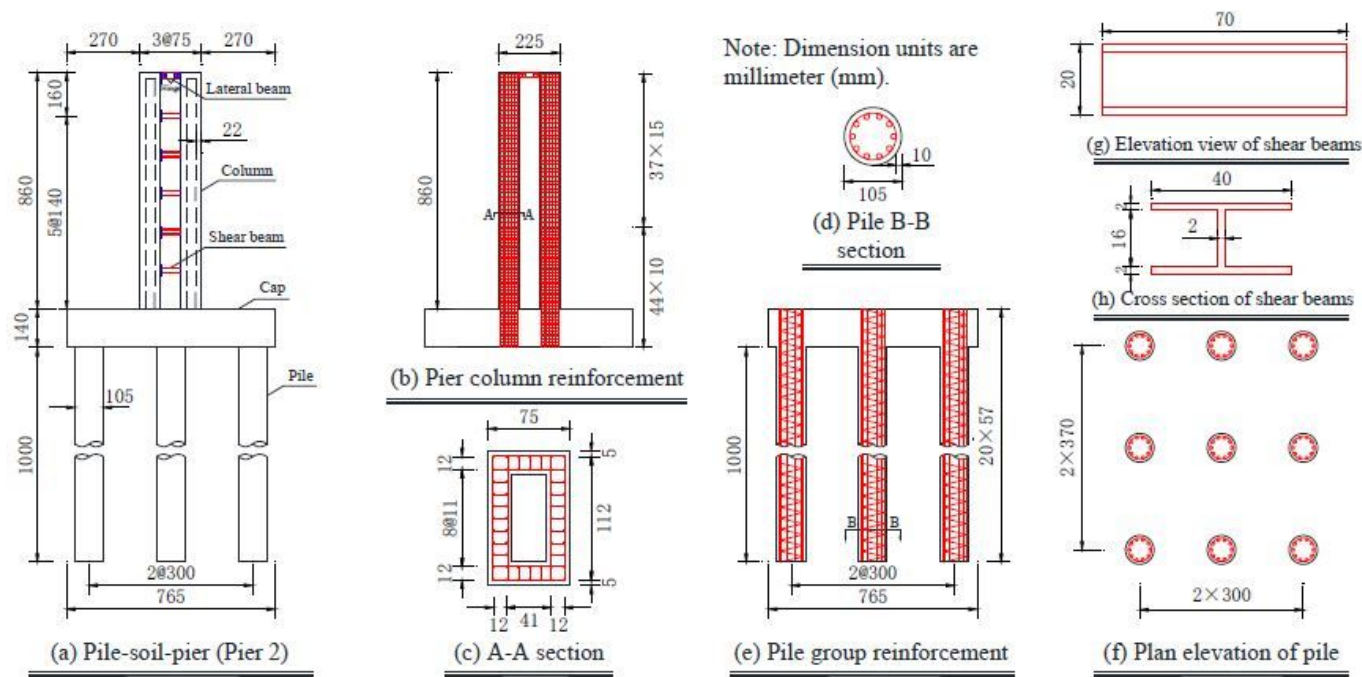
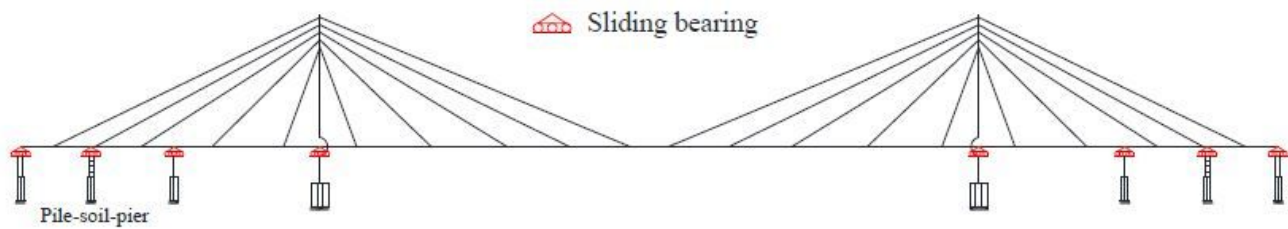
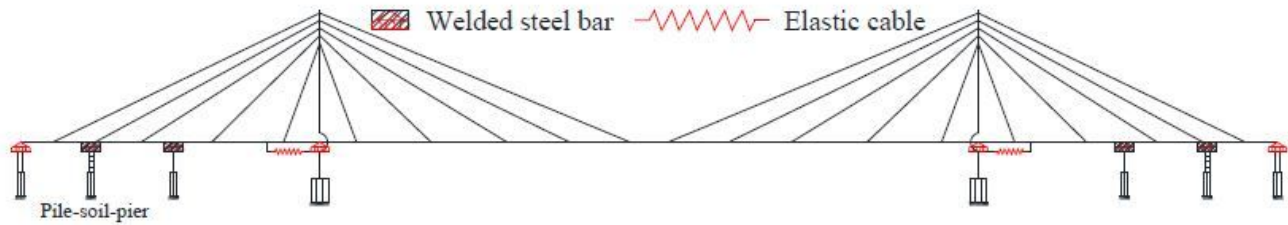


Figure 2

Size dimensions and rebar arrangements of pile-soil-pier



(a) Schematic of sliding connections between the pile-soil-pier and girder in the floating structural system



(b) Schematic of fixed connections between the pile-soil-pier and girder in the supporting pier structural system



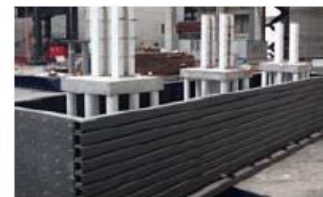
(c) Sliding connections between pile-soil-pier and girder



(d) Fixed connections between pile-soil-pier and girder



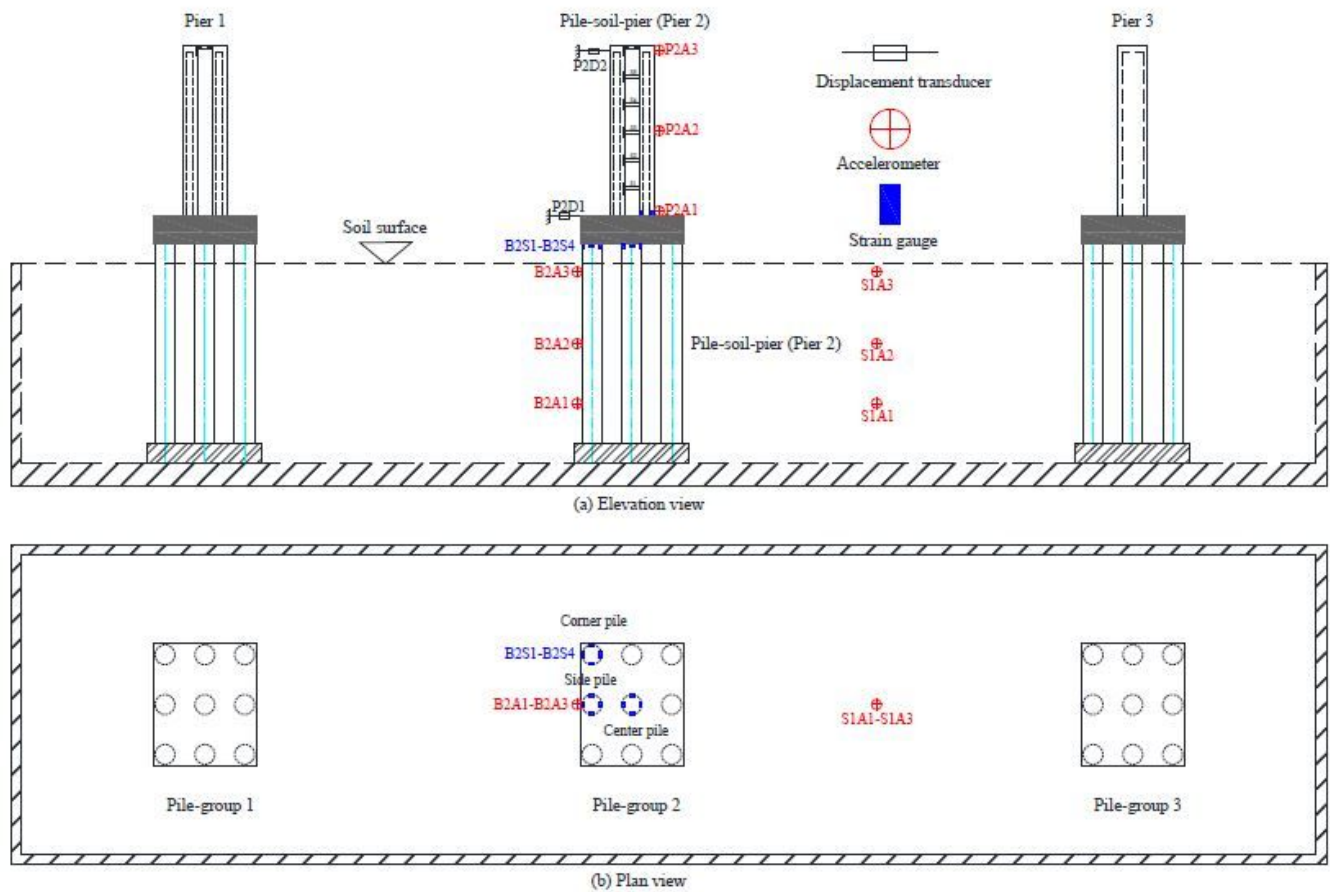
(e) Connections between pile tips and shear box



(f) Connections between shear box and table

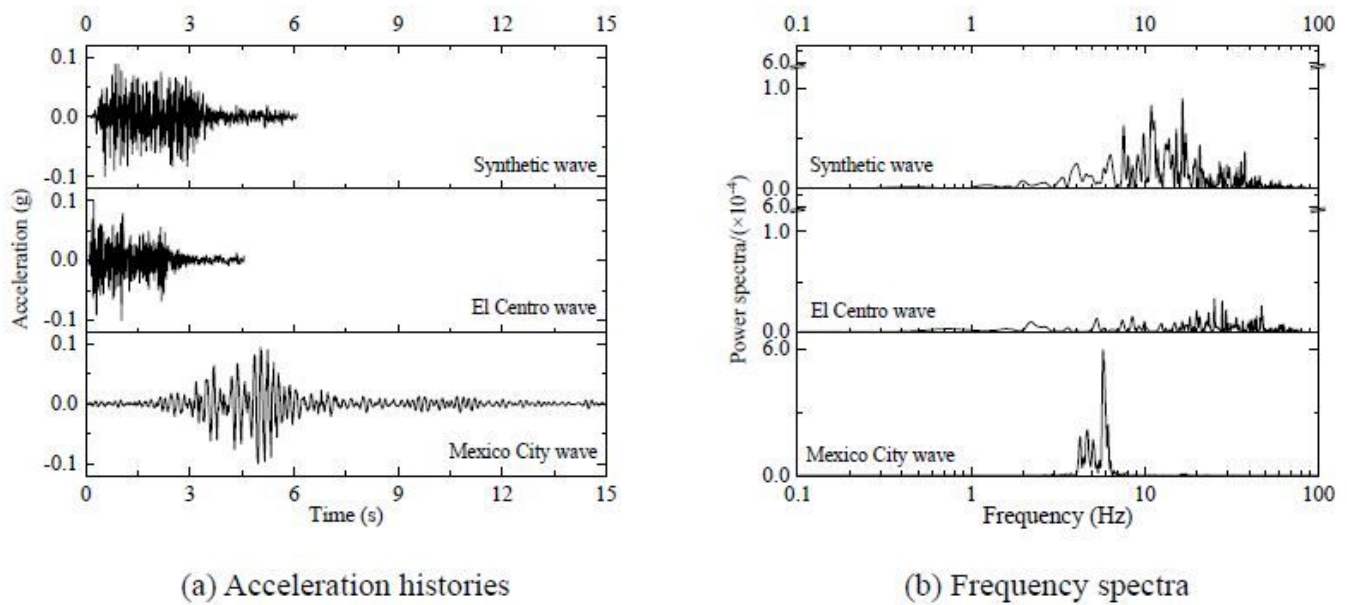
**Figure 3**

Connection configurations between the pile-soil-pier and girder



**Figure 4**

Instrumentations of pile-soil-pier in Shear-box 1



**Figure 5**



Acceleration histories and frequency spectra of three input motions

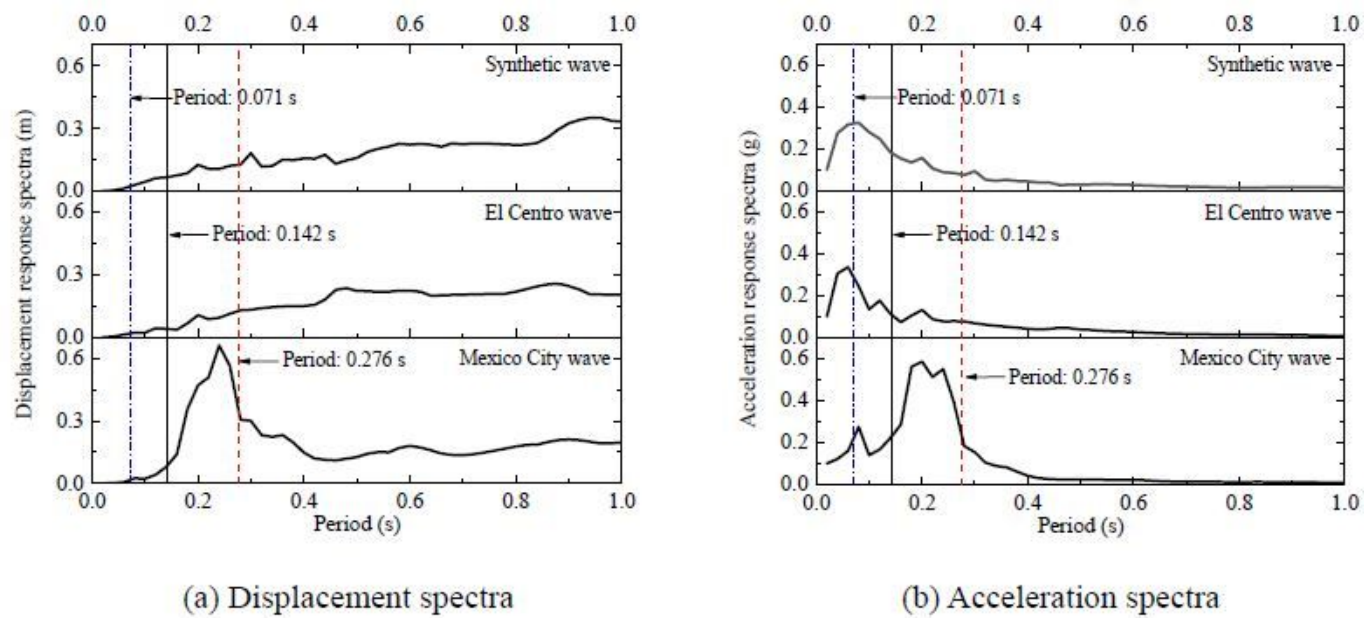


Figure 6

Displacement and acceleration spectra of three input motions

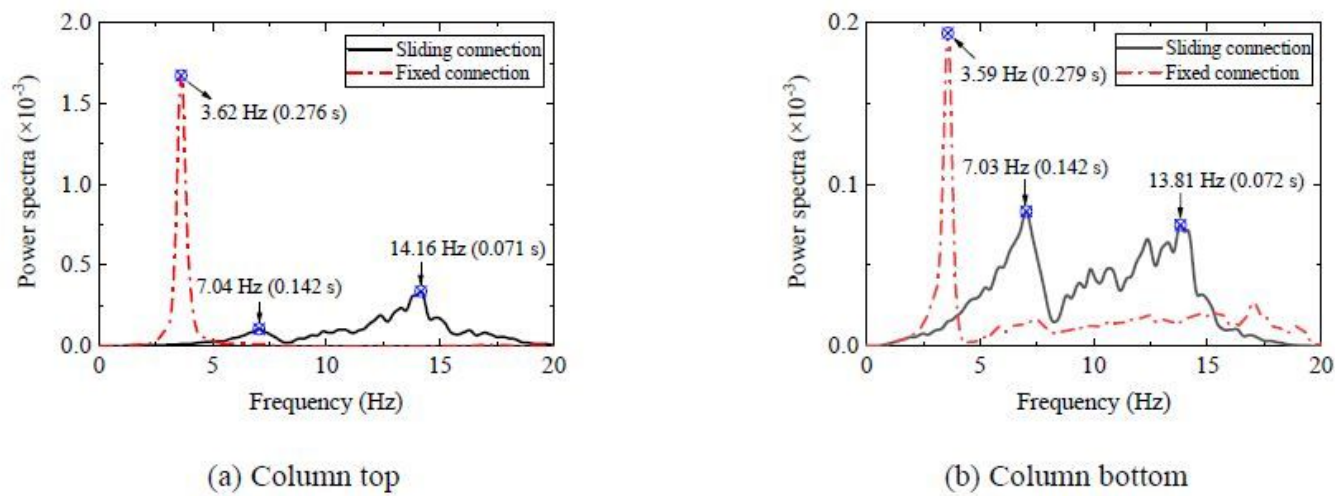
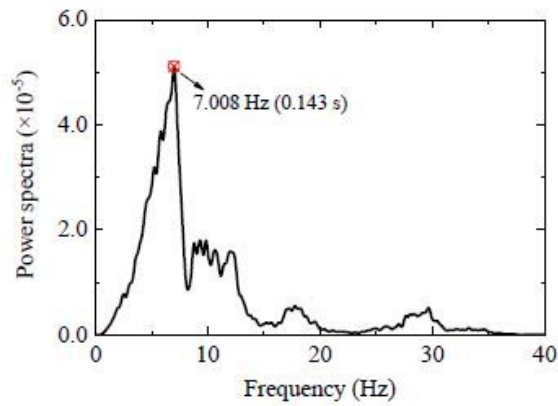
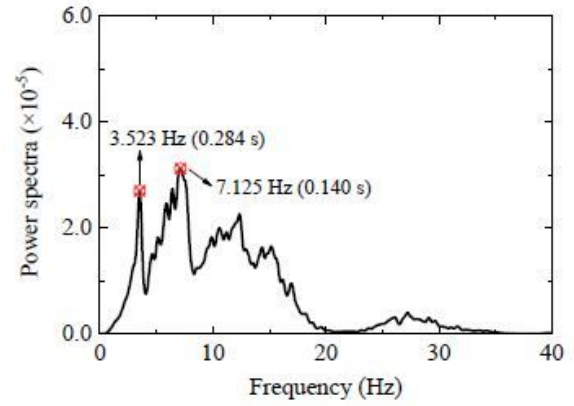


Figure 7

Dominant frequencies of pile-soil-piers with sliding and fixed connections



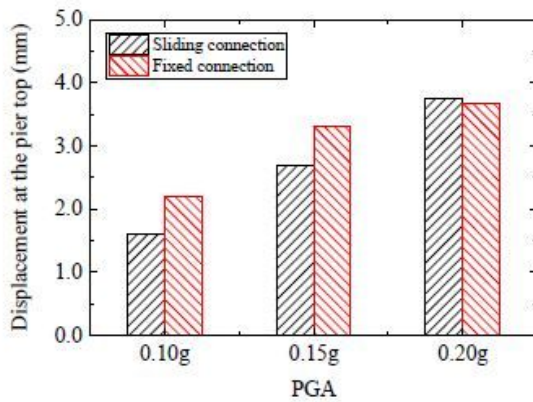
(a) Pile-soil-pier with sliding connections



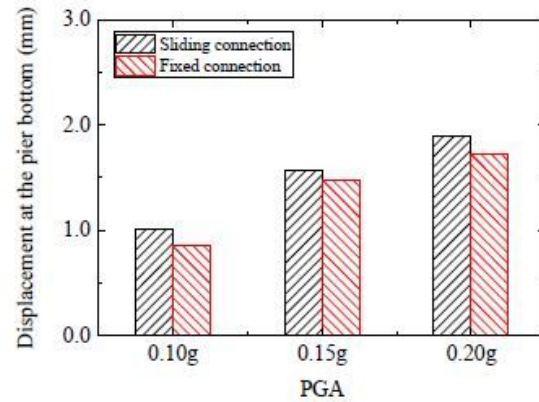
(b) Pile-soil-pier with fixed connections

**Figure 8**

Frequency characteristics of free-soil in Shear-box 1 for pile-soil-piers with sliding and fixed connections



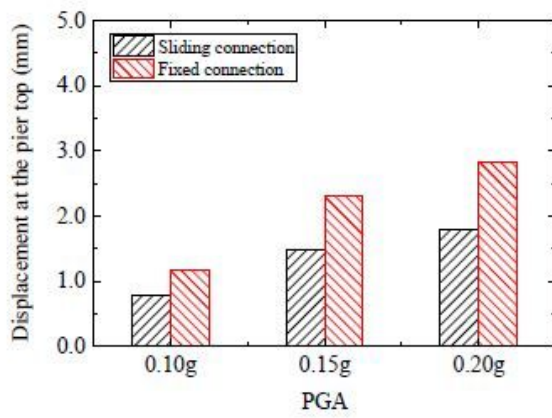
(a) Column top



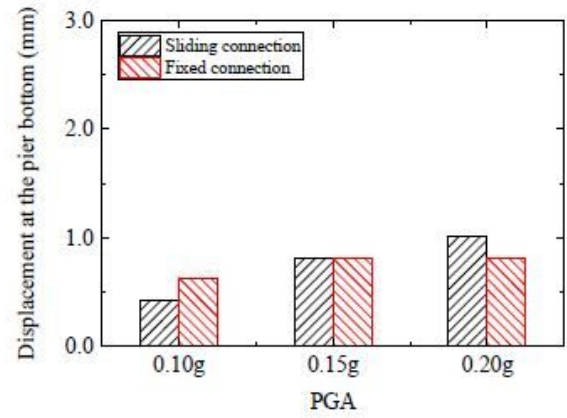
(b) Column bottom

**Figure 9**

Peak displacements of the column of the pile-soil-pier with sliding and fixed connections under the synthetic wave



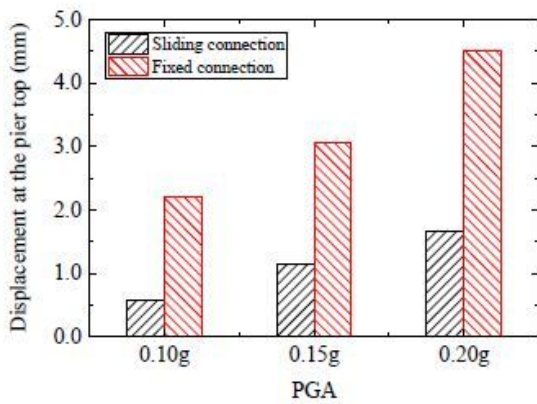
(a) Column top



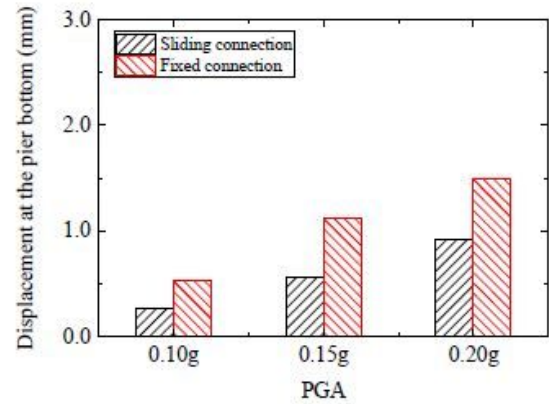
(b) Column bottom

**Figure 10**

Peak displacements of the column of the pile-soil-pier with sliding and fixed connections under the El Centro wave



(a) Column top

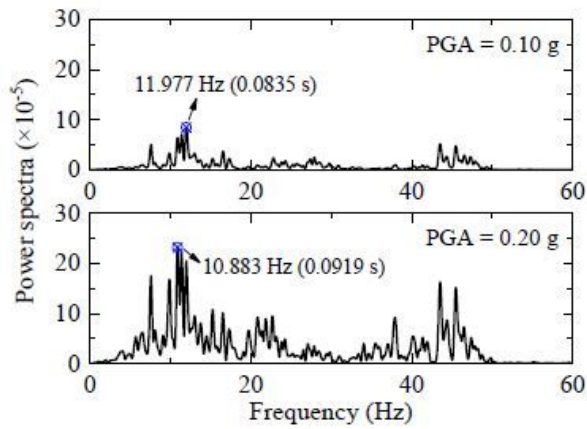


(b) Column bottom

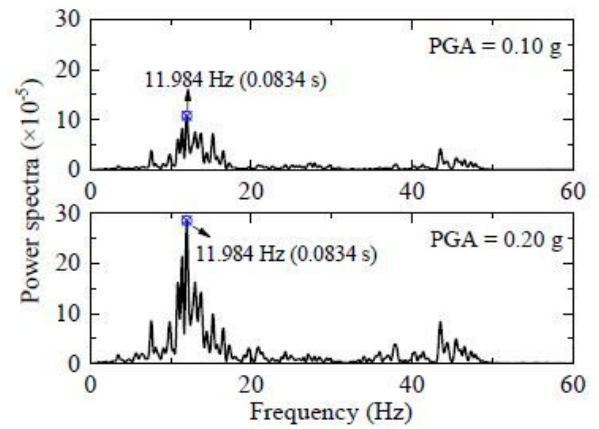
**Figure 11**

Peak displacements of the column of pile-soil-pier with sliding and fixed connections under the Mexico City wave





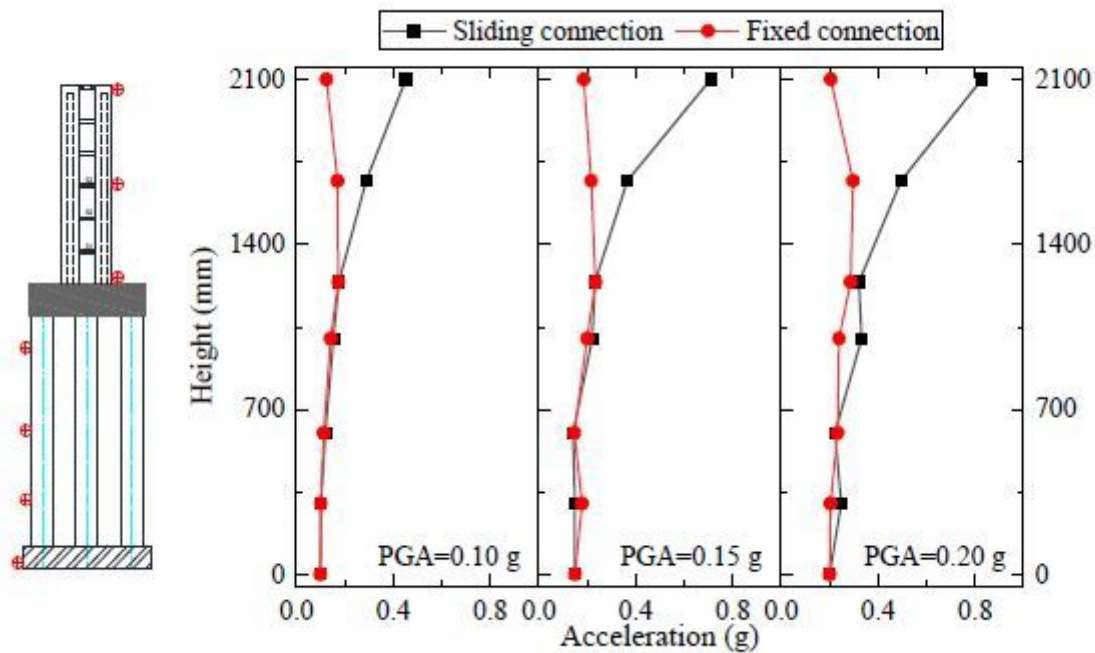
(a) Pile-soil-pier with sliding connections



(b) Pile-soil-pier with fixed connections

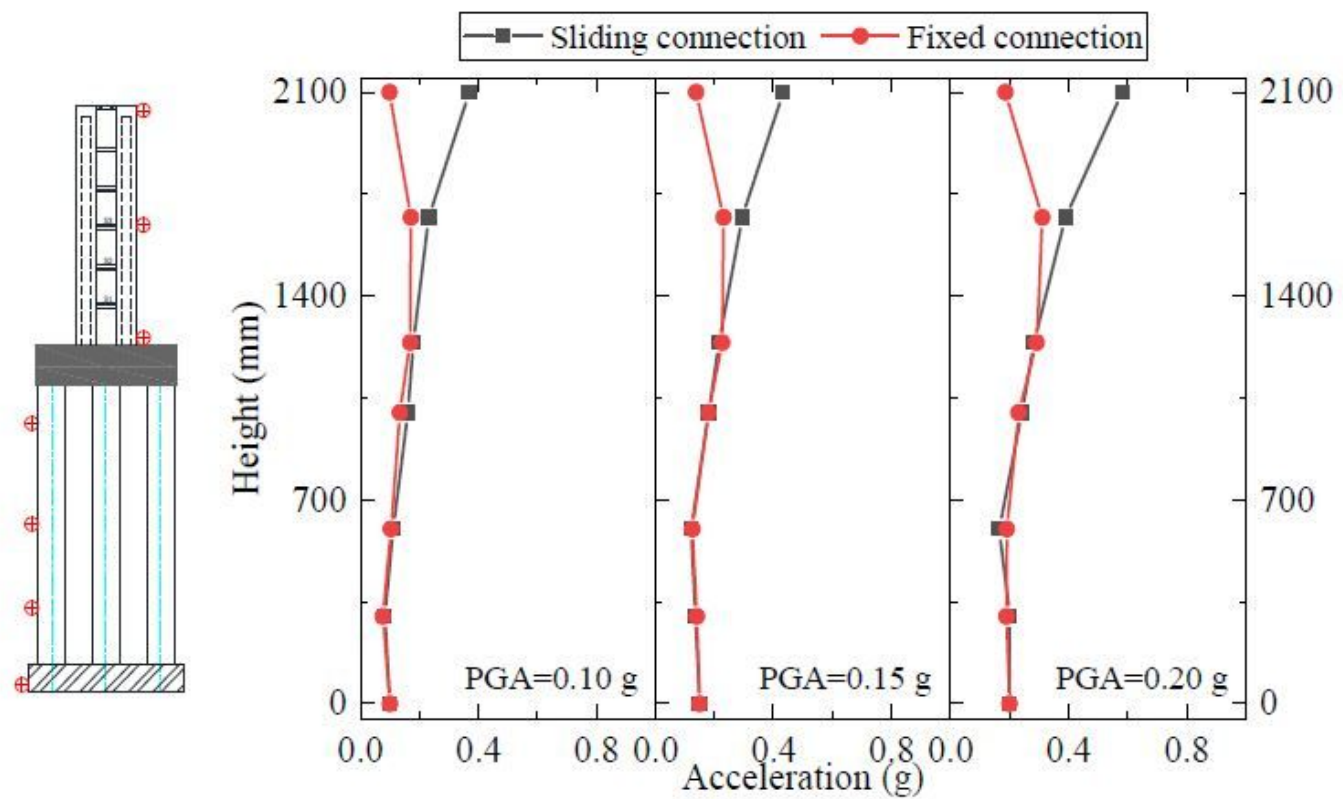
**Figure 12**

Dynamic characteristics of the free-soil of the pile-soil-pier with sliding and fixed connections under the synthetic wave



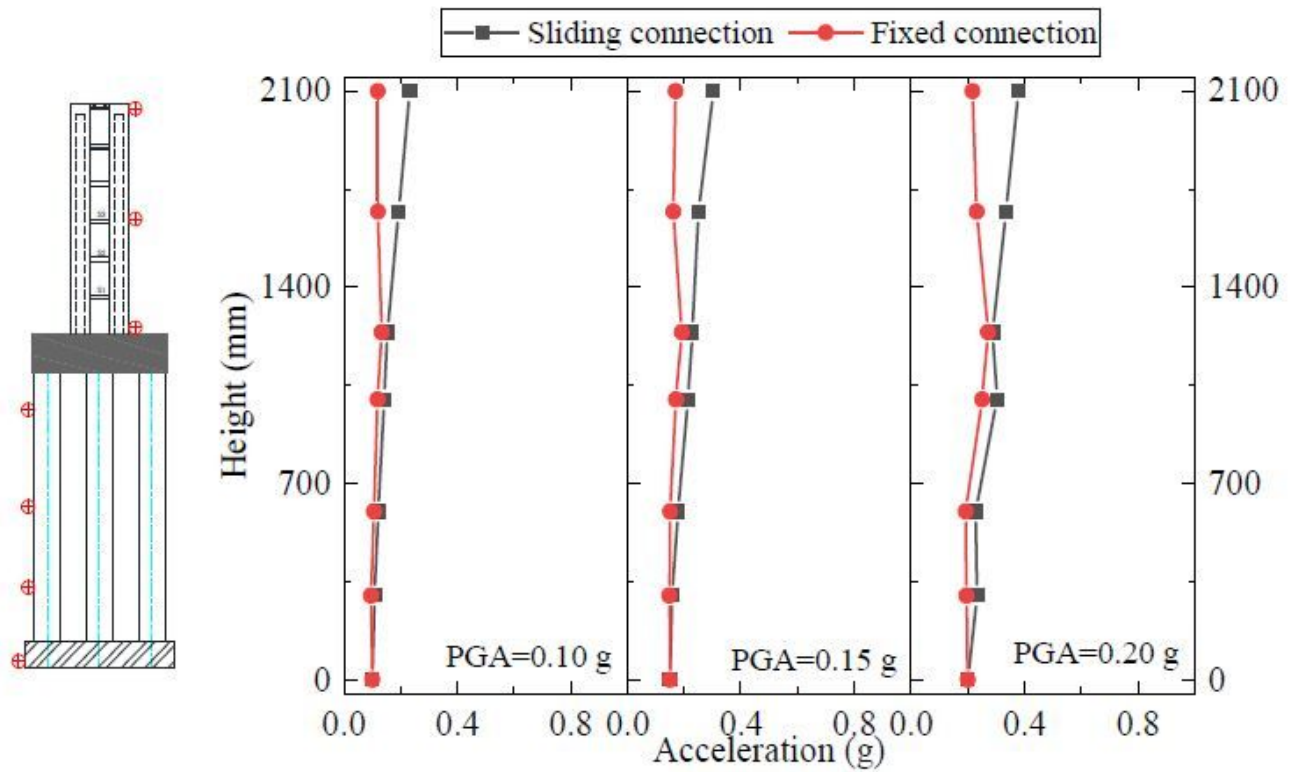
**Figure 13**

Comparisons of peak accelerations of the column and pile between pile-soil-piers with sliding and fixed connections under the synthetic wave



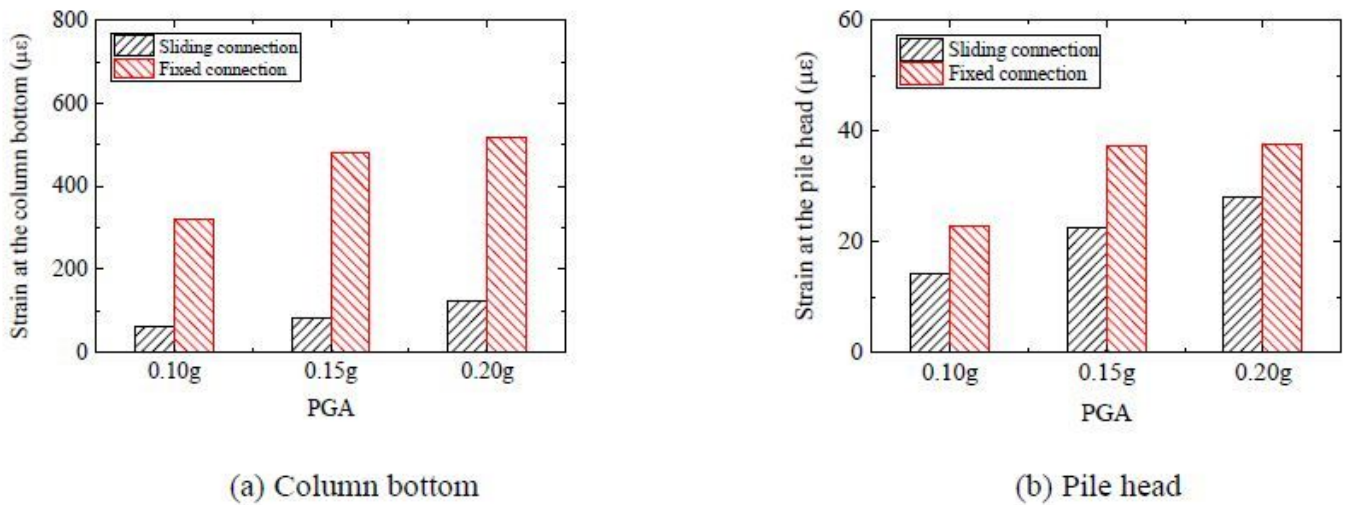
**Figure 14**

Comparisons of peak accelerations of the column and pile between pile-soil-piers with sliding and fixed connections under the El Centro wave



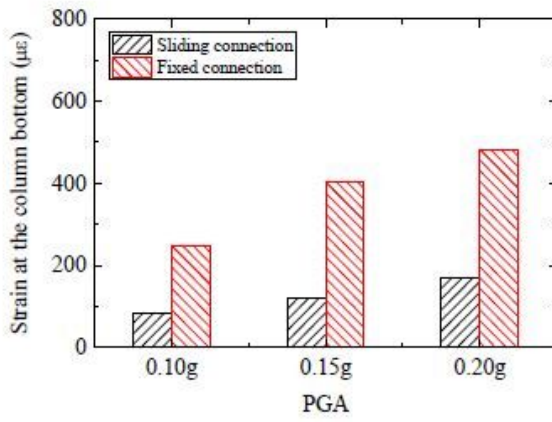
**Figure 15**

Comparisons of peak accelerations of the column and pile between pile-soil-piers with sliding and fixed connections under the Mexico City wave

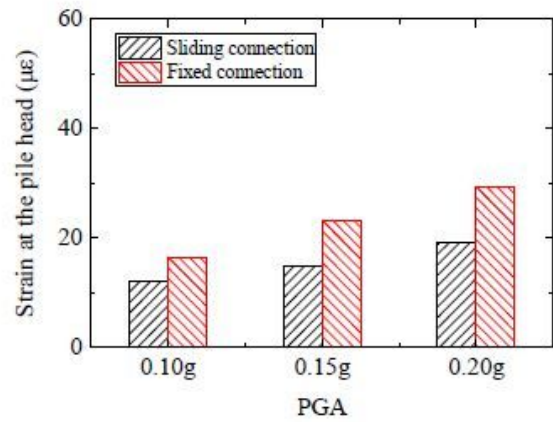


**Figure 16**

Comparisons of reinforcement strain between pile-soil-piers with sliding and fixed connections under the synthetic wave



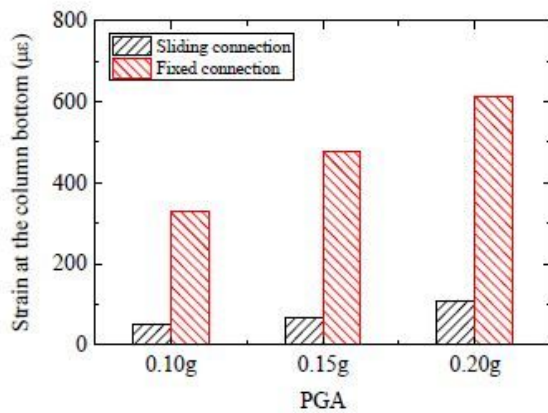
(a) Column bottom



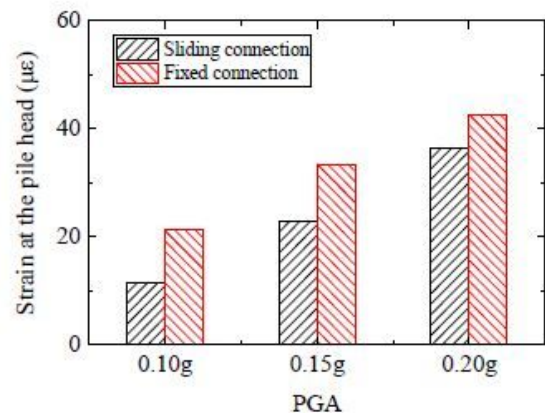
(b) Pile head

**Figure 17**

Comparisons of reinforcement strain between pile-soil-piers with sliding and fixed connections under the El Centro wave



(a) Column bottom

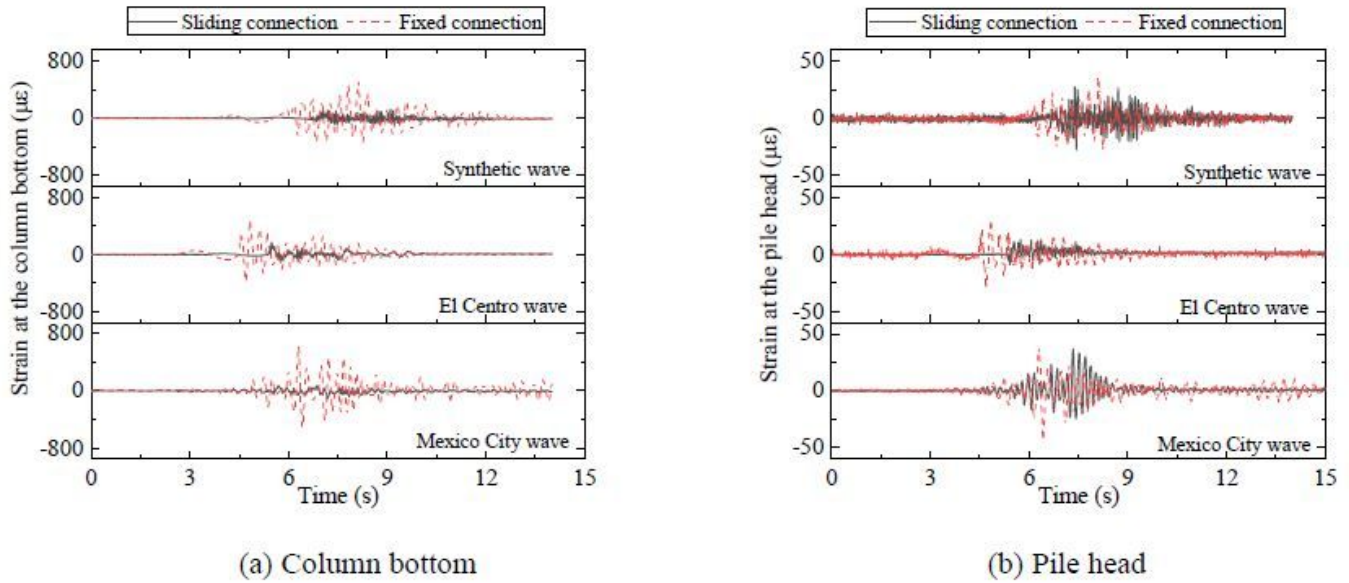


(b) Pile head

**Figure 18**

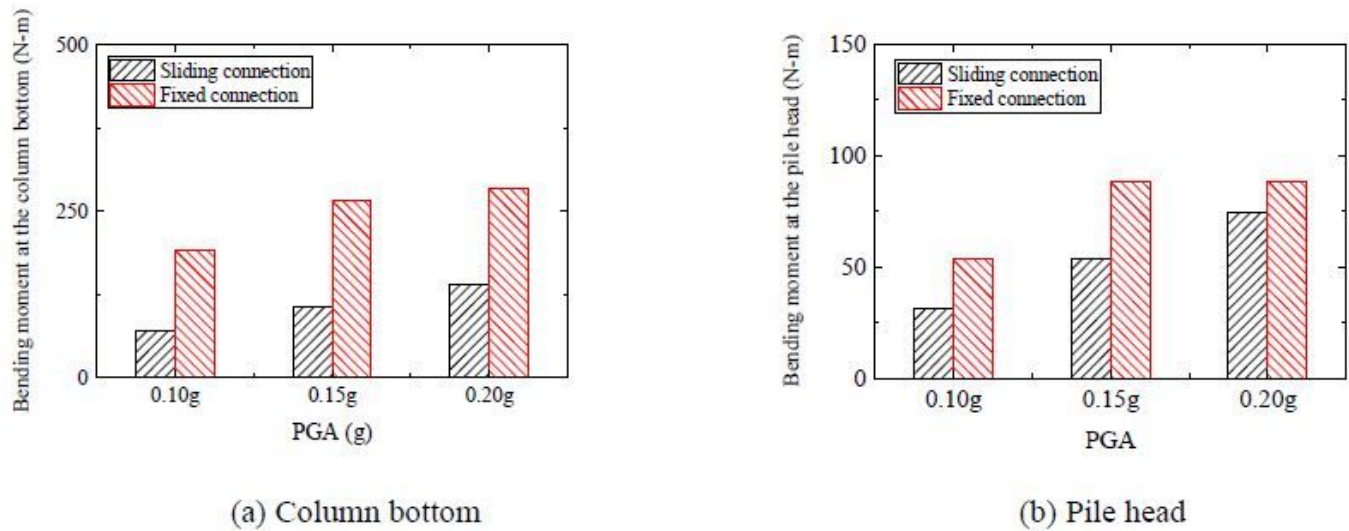
Comparisons of reinforcement strain between pile-soil-piers with sliding and fixed connections under the Mexico City wave

### Mexico City wave



**Figure 19**

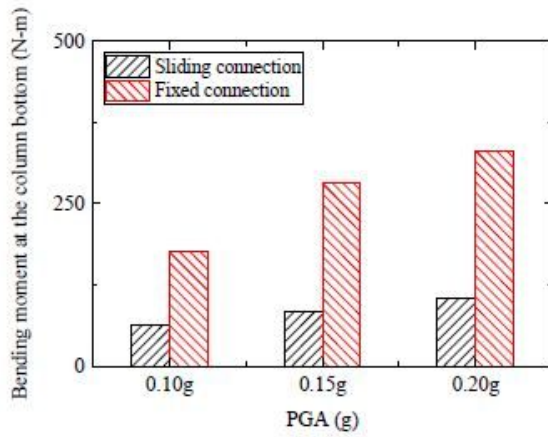
Reinforcement strain histories of pile-soil-piers with sliding and fixed connections under three input motions with 0.20 g



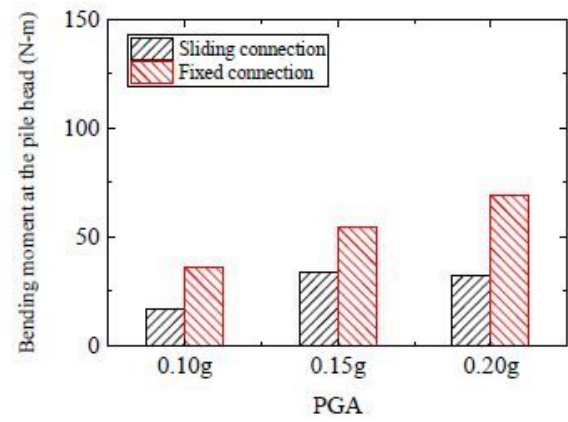
**Figure 20**

Comparisons of bending moment demands between pile-soil-piers with sliding and fixed connections under the synthetic wave





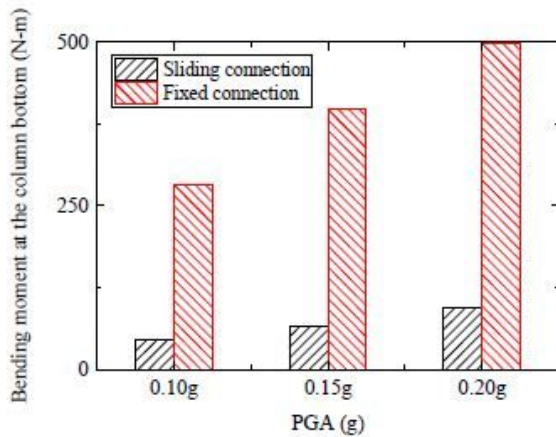
(a) Column bottom



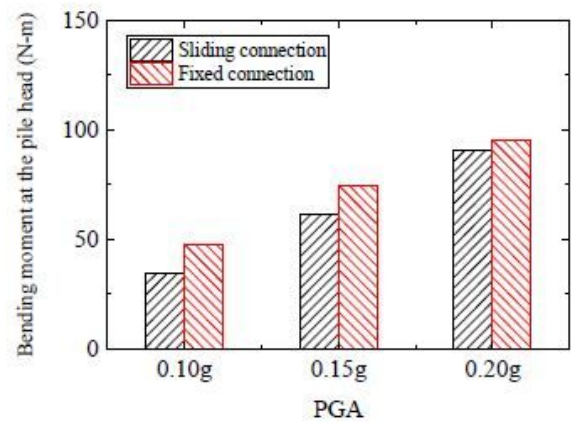
(b) Pile head

**Figure 21**

Comparisons of bending moment demands between pile-s 388 oil-piers with sliding and fixed connections under the El Centro wave



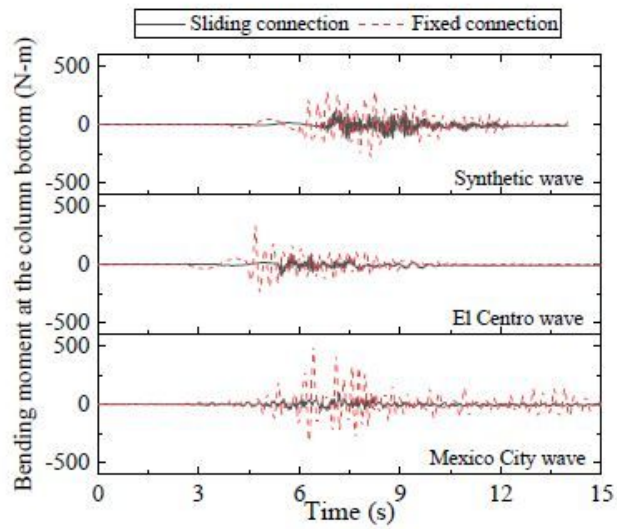
(a) Column bottom



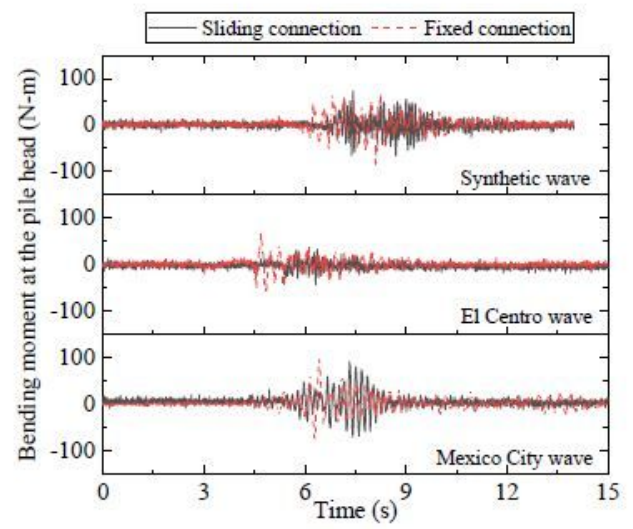
(b) Pile head

**Figure 22**

Comparisons of bending moment demands between pile-soil-piers with sliding and fixed connections under the Mexico City wave



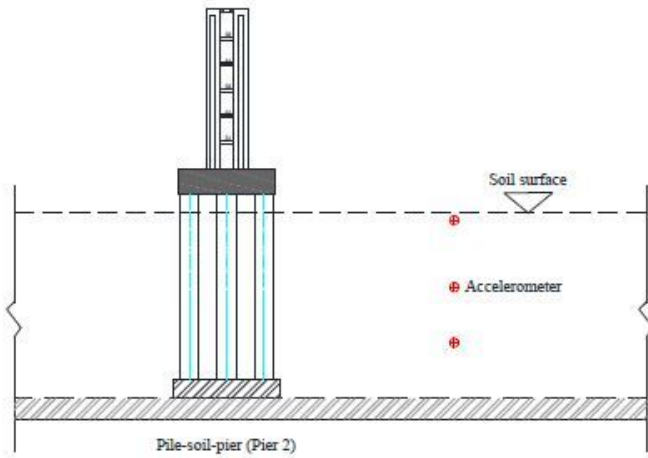
(a) Column bottom



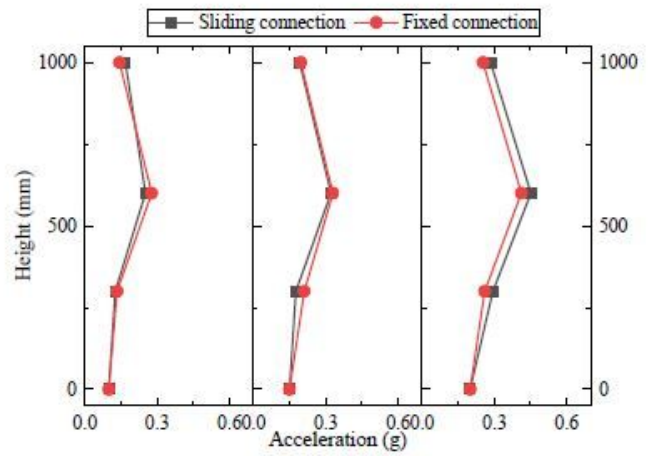
(b) Pile head

**Figure 23**

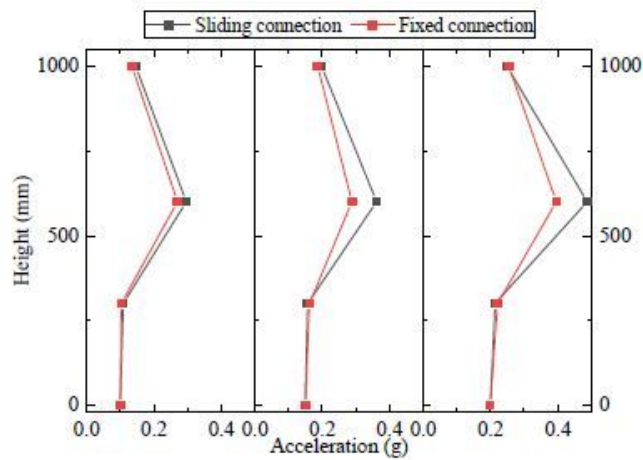
Comparisons of bending moment demands between pile-soil-piers with sliding and fixed connections under input motions with 0.20 g



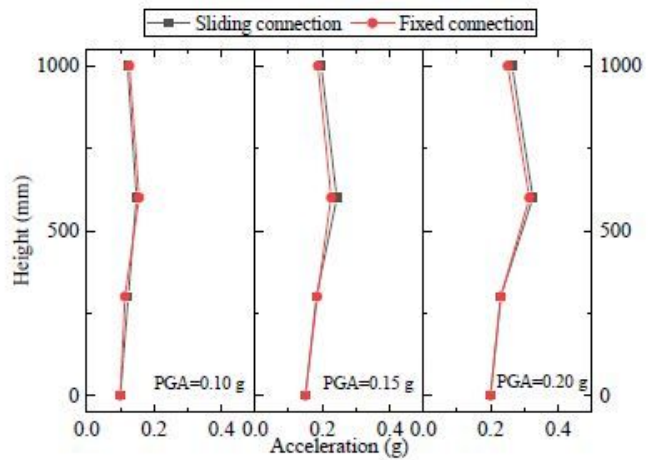
(a) Accelerometers arrangement



(b) synthetic wave



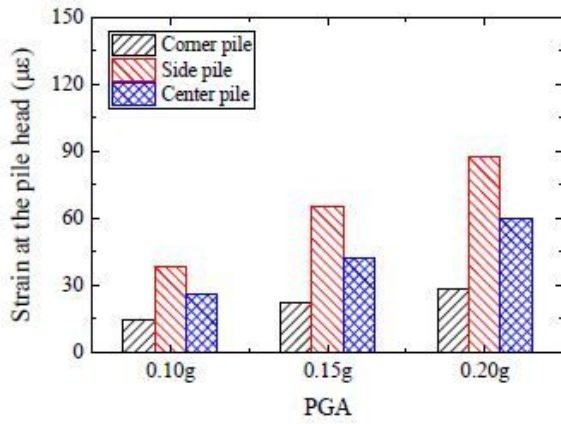
(c) El Centro wave



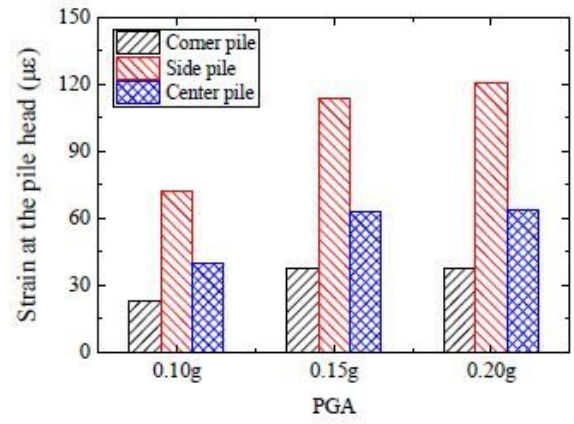
(d) Mexico City wave

**Figure 24**

Comparisons of the peak acceleration of the 415 free-soil between pile-soil-piers with sliding and fixed connections under three input motions



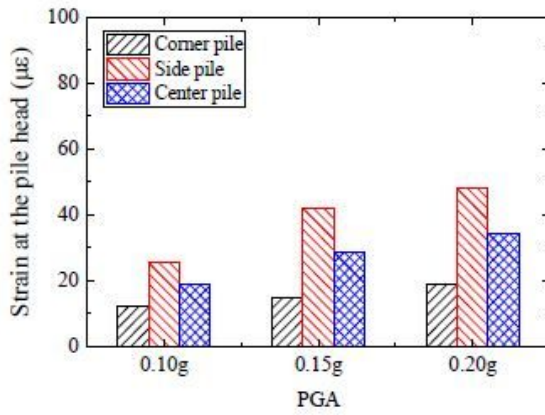
(a) Sliding connection configuration



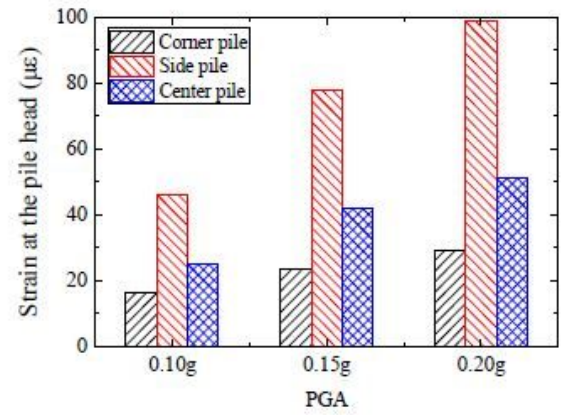
(b) Fixed connection configuration

**Figure 25**

Pile group effects of pile-soil-piers with sliding and fixed connections under the synthetic wave



(a) Sliding connection configuration

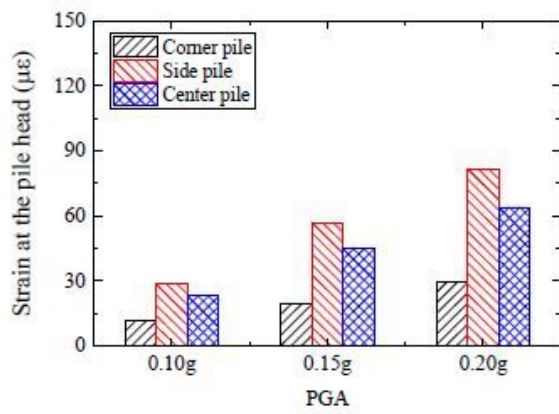


(b) Fixed connection configuration

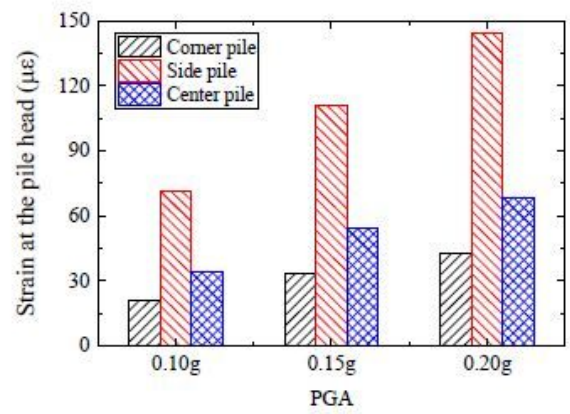
**Figure 26**

Pile group effects of pile-soil-piers with sliding and fixed connections under the El Centro wave





(a) Sliding connection configuration



(b) Fixed connection configuration

Figure 27

Pile group effects of pile-soil-piers with sliding and fixed connections under the Mexico City wave

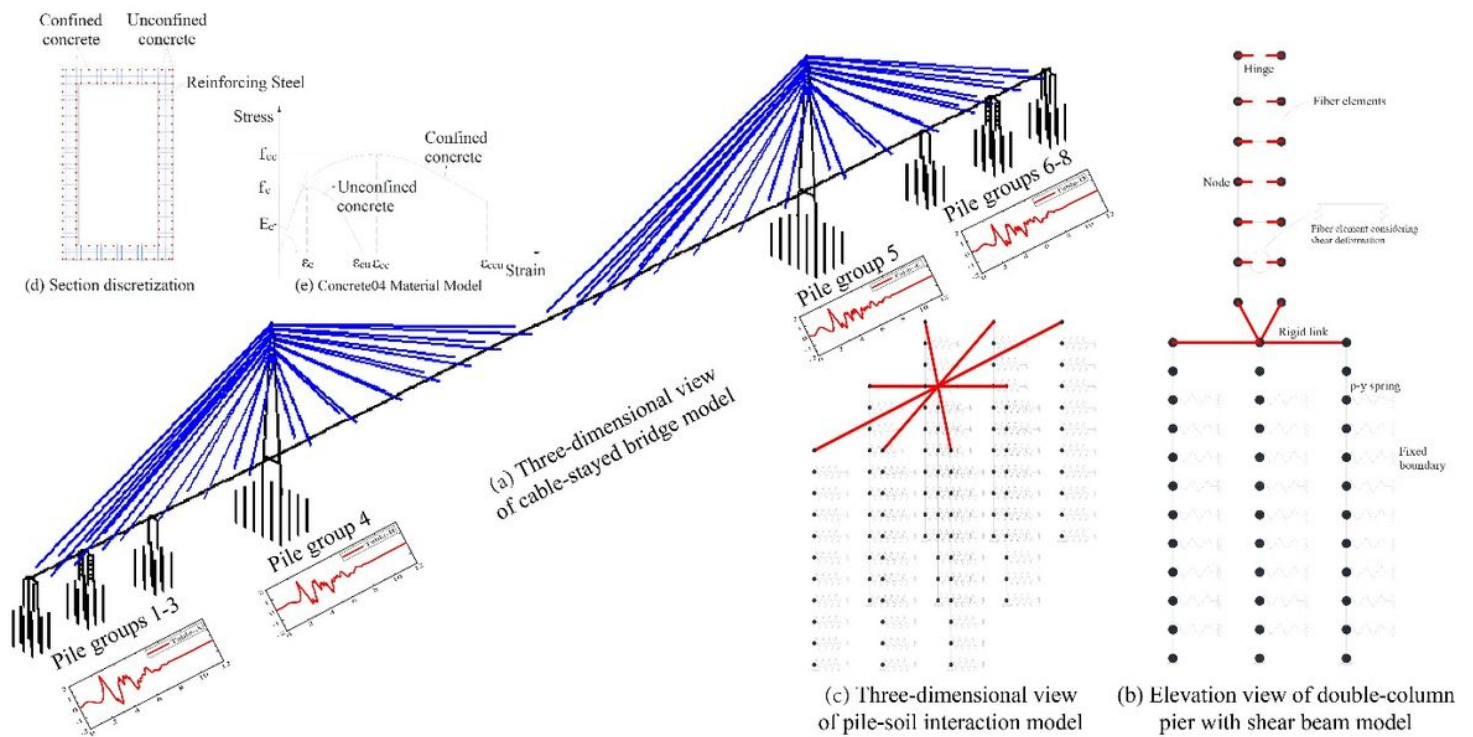
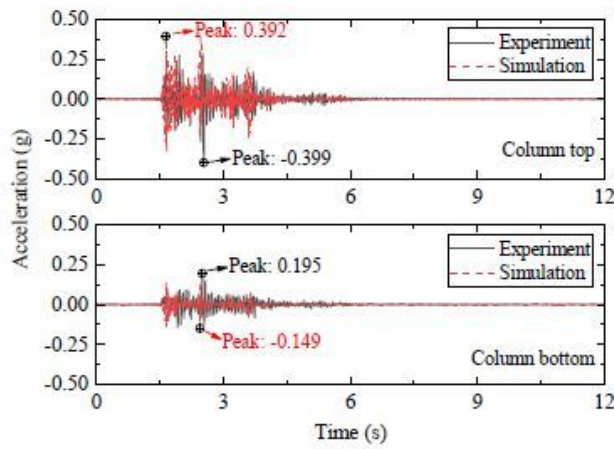


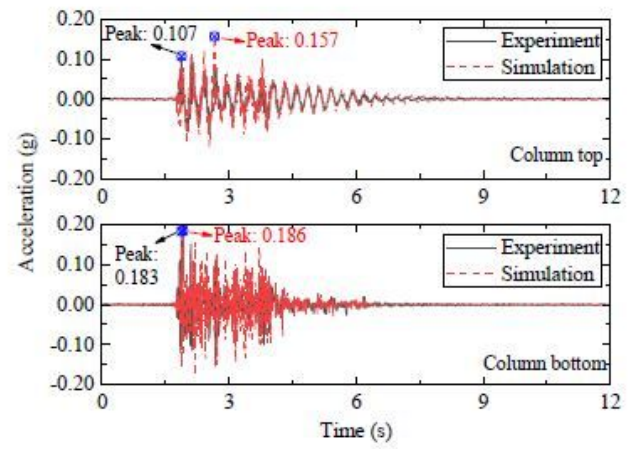
Figure 28

Numerical model of the bridge model including the pile-soil-piers





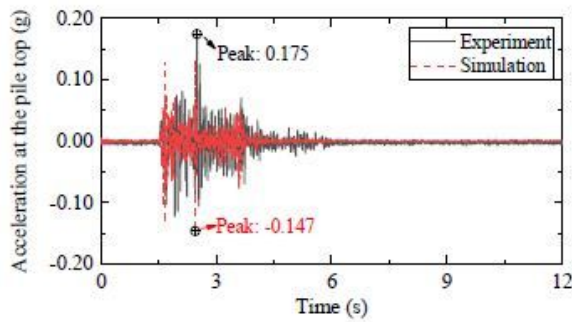
(a) Pile-soil-pier with sliding connections



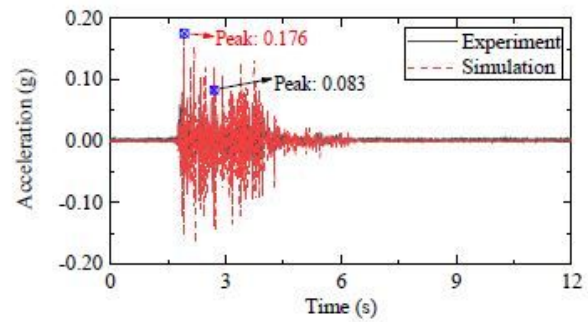
(b) Pile-soil-pier with fixed connections

**Figure 29**

Acceleration responses of the column between the experiment and simulation of the pile-soil-pier with sliding and fixed connections for the bridge model under the 0.10 g El Centro wave



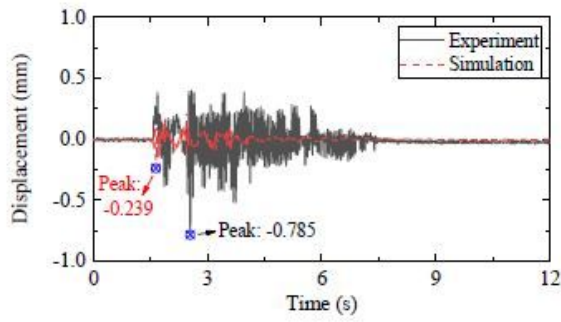
(a) Pile-soil-pier with sliding connections



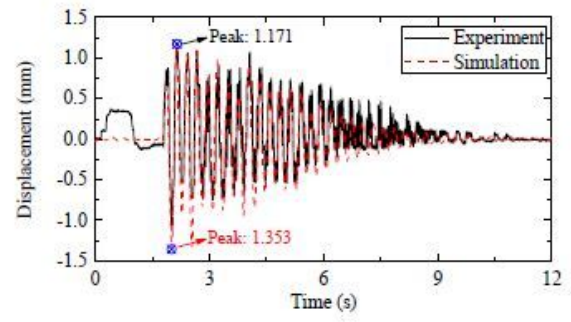
(b) Pile-soil-pier with fixed connections

**Figure 30**

Acceleration responses at the pile top between the experiment and simulation of the pile-soil-pier with sliding and fixed connections for the bridge model under the 0.10 g El Centro wave



(a) Pile-soil-pier with sliding connections



(b) Pile-soil-pier with fixed connections

**Figure 31**

Displacement responses at the column top between the experiment and simulation of the pile-soil-pier with sliding and fixed connections for the bridge model under the 0.10 g El Centro wave