Soil-Foundation-Structure Interaction during Near-Fault Ground Motions

Chia-Han Chen, Assistant Researcher

National Center for Research on Earthquake Engineering

Extensive foundation failures have been found in all major disaster earthquakes, such as the 1964 Niigata Earthquake, 1989 Loma Prieta Earthquake, 1995 Kobe Earthquake, 1999 Chi-Chi Earthquake, 2011 Christchurch Earthquake, and the 2011 Great East Japan Earthquake. The major causes of the failures are soil liquefaction, lateral spreading, and intense ground motions. Studies on soil-pile interactions have been conducted to understand the mechanism of the dynamic loading on foundations, predict the seismic responses, and develop effective countermeasures. Various approaches, including analytical analysis, numerical simulations, physical modeling, and field monitoring, have been adopted. The numerical simulations and physical modeling are the two major tools.

However, due to the forward directivity and fling effect characteristics of the near-fault ground motions, the ground responses under the near-fault ground motions are significantly different from those far-fault ones in terms of the loading rate, amplitude level, and duration. The physical modeling of the near-fault effects on SFSI or SSI is limited due to the capacities of facility and equipment. With the support of the long-stroke shaking table and the biaxial laminar shear box, the 1-g physical model test can be conducted to investigate the near-fault effect on free-field ground responses as well as the SFSI under the near-fault ground motions. The test results can be used to calibrate the constitutive law of soil and sophisticated finite element model, provide useful information on performance criteria for aseismic design of structure foundations, and develop countermeasures.