CEE AT ILLINOIS
Department of Civil and Environmental Engineering

EERI

GESO
GEOTECHNICAL ENGINEERING STUDENT ORGANIZATION AT UIUC

CEE 595F - Geotechnical Seminar w/ Earthquake Engineering Research Institute

Friday, Dec 6, 2019 | 11:00 AM, Newmark Lab 3310 | open to all CEE

Numerical Simulations of Site Response and Seismic Settlements at Kashiwazaki-Kariwa Nuclear Power Plant, Japan

Alvin Parande Bayudanto, M.S. Student

Faculty Advisor: Prof. Youssef M.A. Hashash

Department of Civil & Environmental Engineering,
University of Illinois at Urbana Champaign

Abstract: Constructed on the west coast of Japan, the Kashiwazaki-Kariwa Nuclear Power Plant was strongly shaken by Mw 6.6 Niigata-ken Chuetsu-oki earthquake in 2007. Significant seismic settlements were observed in dry sand deposits at both the free-field site and around the power plant structure components. These total and differential settlements were reported to be the main reasons for water and oil leakage, which eventually led to flooding and fire. This study focuses on three-dimensional, soil-porewater pressure coupled numerical modeling of multi-directional shear and volumetric response of Service Hall free-field site and Arahama Site on which the reactor and turbine buildings, as well as the transformer house are located using a newly developed soil-constitutive model in LS-DYNA. The Service Hall site consists of claystone overlain by loose sand whereas Arahama site has dense sand deposits on top of claystone. The comparison of measured and computed responses at the Service Hall vertical array site showed that the simulations captured the spectral responses. In addition, the simulation with multi-directional loading provided best estimates for seismic settlements and showed significant amount of settlements occurred in the dry sand deposits. The free-field model was then extended to three-dimensional soil-structure interaction (SSI) model to investigate the seismic response of soil under and adjacent the Unit 1 reactor and Unit 3 turbine buildings at Arahama Site. The soil-structure interaction models successfully captured the measured response spectra at the base of Unit 1 reactor building and the surface response around Unit 3 turbine building, which was significantly greater than the surface response calculated from the simplified free-field simulations. Computed seismic settlements at the ground surface adjacent to the reactor, turbine building, and transformer house were consistent with field observations of ground subsidence, whereas the settlements of the structures themselves were negligible. These results demonstrate that the developed three-dimensional simulations of seismic soil-structure interaction provide reliable estimates of the potential effects of differential settlements which cannot be represented using free-field simplifications.