Geotechnical Engineering Seminar
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A simplified methodology for Fault-Rupture Soil-Structure Interaction effects in engineering design

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ABSTRACT:

The design and retrofit of critical facilities in the immediate vicinity of active faults, and the development of associated methodologies to be integrated in building code provisions for seismically active regions, has been a debatable topic in the past decade. As an example, Greek seismic code provisions established prior to 1980 prohibited the construction of critical structures in the near vicinity of active faults. The 1995 Aegio Earthquake in Southern Greece triggered the scientific community's interest on the effects of fault-rupture soil-structure interaction (FR-SSI), and research results have been incorporated in updated versions of the Greek building code. As a result, the new generation of provisions allows construction of critical facilities near active faults, conditioned on the conduction of a thorough […site-specific seismological, geological, geotechnical and structural investigation…] to verify the adequacy of design on a case-to-case basis, while there exists no clear description of the recommended investigation procedure. Addressing the lack of quantitative criteria for this problem, Anastasopoulos (2005) conducted numerical analyses to simulate the effects of FR-SSI and successively benchmarked results by comparison with centrifuge experiments. These analyses were shown to capture accurately phenomena such as rocking and uplifting of the structural foundation, as well as deviation of the fault plane from its original direction of rupture propagation upon the presence of strong impedance contrast between the soil and the structure at the surface exposure of the fault plane. These analyses, however, were computationally intensive and required advanced engineering expertise for realization and interpretation. To overcome the drawbacks of elaborate numerical analyses, a simplified methodology is here developed to simulate the effects of FS-SSI by means of a beam on Winkler foundation-type model. Dimensional analysis of the problem is initially performed, followed by a parametric investigation for different values of soil depth H, foundation width B, original position of surface rupture s and imposed loading q, for the case of dense sand and normal faulting at a $\alpha = 60^{o}$ dip that is commonly encountered in Greece. Bearing interaction and bearing stress redistribution diagrams are developed based on the numerical simulations, and utilized in the simplified analyses. Comparison of the proposed methodology to the finite element simulations shows excellent agreement. Nonetheless, effectiveness of the method is conditioned on the availability of bearing stress redistribution diagrams, which thereafter need no further calibration for implementation in the proposed Winkler-based design methodology.

BIO:

Alexandros Kalos received his BS in Civil Engineering from the National Technical University of Athens (Athens, Greece) in 2006. He has worked as an intern at the Ministry of Environment, Physical Planning and Public works on projects involving underground structures for two semesters. His primary research interests are in numerical methods and nonlinear dynamic soil behavior and he is currently pursuing a PhD degree at the School of CEE at GATech, under the supervision of Dr. D. Assimaki.