Abstract: SMiRT 25
Charlotte, NC, USA, August 4-9, 2019
Division III

Soil-Structure Interaction Analysis of Conventional and Base-Isolated Structures using MASTODON

Sai Sharath Parsi[1], Swetha Veeraraghavan[2], Chandrakanth Bolisetti[2] and Justin Coleman[3]

Abstract

Recent advances in computing have made the simulation of nonlinear soil-structure interaction (NLSSI) including soil, structural and foundation-soil interface nonlinearities, much more feasible. The Facility Risk Group at Idaho National Laboratory has been developing an open-source software, MASTODON (Coleman et al., 2017), to perform NLSSI simulations. MASTODON uses the finite-element method and is highly parallelizable for very large-scale problems.

This talk provides a step-by-step procedure on modeling and simulation of NLSSI problems using MASTODON. A representative pressurized water reactor building is considered for the purpose of this demonstration. The numerical model of the containment and the internal structure are idealized as stick-mass models and the model parameters are obtained from an example in the SASSI2000 user manual (Ostadan, 2006). The stick mass model is connected to a circular basemat which is in contact with the soil underneath. For this demonstration, the response of both the structure and the soil are assumed to be linear elastic. The only nonlinearity in this model arises from the geometrically nonlinear effects caused by the soil-structure interaction. Two different contact types are considered for this demonstration: (i) tied contact, and (ii) thin-layer contact between the soil and structure. Tied contact is modeled by the basemat and soil sharing nodes at the contacting surface. Thin-layer contact is modeled by placing a thin layer of nonlinear soil, using the ISoil material model (Numanoglu, 2018) implemented in MASTODON, the properties of which, are chosen such that the stress-strain hysteretic behavior of the thin soil layer approximates that of a Coulomb friction model.

---

[1] Graduate Student Researcher, Department of Civil, Structural and Environmental Engineering, University at Buffalo, SUNY, Buffalo, NY. (saishara@buffalo.edu)

[2] Scientist, Facility Risk Group, Idaho National Laboratory, Idaho Falls, ID, USA

[3] Facility Risk Group Lead, Idaho National Laboratory, Idaho Falls, ID, USA

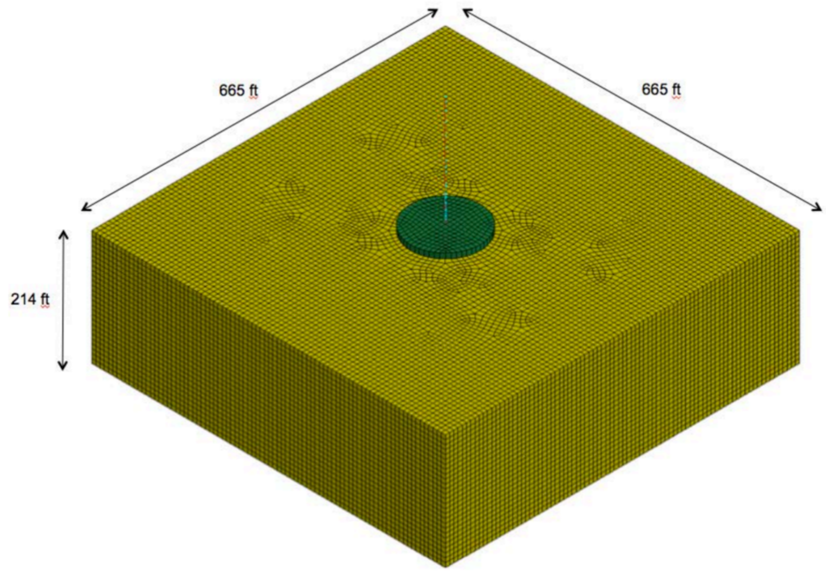

Figure 1. Stick-mass model of a nuclear power plant attached to a circular basemat, which is in contact with the soil underneath [reprinted from Bolisetti et al. (2015)].

The demonstration will also include SSI simulation of the same structure with seismic base isolation. MASTODON includes verified and validated numerical models for simulating lead-rubber bearings and friction-pendulum bearings developed by Manish et al (2015a) and Manish et al (2015b), respectively, and these models will be employed in the demonstration.

References

Bolisetti, C., Coleman, J., Talaat, M. and Hashimoto, P. (2015). “Advanced seismic fragility modeling using nonlinear soil-structure interaction analysis.”, INL/EXT-15-36735, Idaho National Laboratory, Idaho Falls, ID.

Coleman, J., Slaughter, A., Veeraraghavan, S., Bolisetti, C., Spears, R., Hoffman, W. and Kurt, E. (2017). “MASTODON theory manual”, Idaho National Laboratory, Idaho Falls, ID.

Numanoglu, O. A. (in progress). *Ph.D Thesis.* University of Illinois at Urbana Champaign, Urbana-Champaign, IL.

Ostadan, F. (2006). "SASSI2000: A System for Analysis of Soil Structure Interaction - User's Manual." University of California, Berkeley, CA.

Kumar, M., Whittaker, A. S., and Constantinou, M. C. (2015a). “Seismic Isolation of Nuclear Power Plants using Elastomeric Bearings.” MCEER-15-0008, Multidisciplinary Center of Earthquake Engineering Research, Buffalo, NY.

Kumar, M., Whittaker, A. S., and Constantinou, M. C. (2015b). “Seismic Isolation of Nuclear Power Plants using Elastomeric Bearings.” MCEER-15-0008, Multidisciplinary Center of Earthquake Engineering Research, Buffalo, NY.