

# Nonlinear Dynamic Soil-Structure Interaction in Earthquake Engineering

## Abstract

THE present work addresses a computational methodology to solve dynamic problems coupling time and Laplace domain discretizations within a domain decomposition approach. In particular, the proposed methodology aims at meeting the industrial need of performing more accurate seismic risk assessments by accounting for three-dimensional dynamic soil-structure interaction (DSSI) in nonlinear analysis.

Two subdomains are considered in this problem. On one hand, the linear and unbounded domain of soil which is modelled by an impedance operator computed in the Laplace domain using a Boundary Element (BE) method; and, on the other hand, the superstructure which refers not only to the structure and its foundations but also to a possibly region of soil exhibiting nonlinear behaviour. The latter subdomain is formulated in the time domain and discretized using a Finite Element (FE) method.

In this framework, the DSSI forces are expressed as a time convolution integral whose kernel is the inverse Laplace transform of the soil impedance matrix. In order to evaluate this convolution in the time domain by means of the soil impedance matrix (available in the Laplace domain), a Convolution Quadrature-based approach called the Hybrid Laplace-Time domain Approach (HLTA), is thus introduced. Its numerical stability when coupled to Newmark time integration schemes is subsequently investigated through several numerical examples of DSSI applications in linear and nonlinear analyses. The HLTA is finally tested on a more complex numerical model, closer to that of an industrial seismic application, and good results are obtained respect to reference solutions.