

Co-simulation of concrete gravity dams by coupling a SEM code with a FEM code

M. Brun, L. Zuchowski, F. De Martin, N. Richart, G. Anciaux, J-F. Molinari

Abstract

The spectral element method (SEM) is known to be an efficient tool for propagating elastic waves within earth media (earthquakes, traffic vibrations), with a low computational cost thanks to its efficient quadrature formulation in comparison to the finite element (FEM) method. On the other hand, the finite element method (FEM) is more suitable for modeling complex geometry like buildings or subsurface soils meshed with small elements. The aim of this work is to take full advantage of both methods by setting up a SEM/FEM co-simulation strategy. The coupling approach is based on domain decomposition methods in transient dynamics. The two subdomains present geometric (incompatible meshes) and algebraic (different shape functions) non-conformity at their interface and use two different time integration schemes (Newmark explicit for SEM and Newmark implicit for FEM) with their own time step size. The spatial coupling between FEM and SEM is managed by a standard coupling mortar approach, whereas the time integration is dealt with an hybrid (explicit/implicit) asynchronous (different times steps) time integrator. A seismic dam analysis is considered in order to validate the SEM/FEM co-simulation. Mesh refinement and time step size for the FEM partition are investigated while keeping unchanged the parameters in the SEM partition. The accuracy and effectiveness in terms of computation time of the hybrid asynchronous SEM/FEM co-simulation are highlighted by comparing to a reference full-SEM simulation.