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HETEROGENEOUS ASYNCHRONOUS TIME INTEGRATOR IN NONLINEAR DYNAMICS: SEISMIC NONLINEAR ANALYSIS OF CRANE BRIDGE AND CONCRETE GRAVITY DAMS THROUGH CO-SIMULATION

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The aim of this work is to take full advantage of specialized simulation codes by setting up co-simulation strategies. Among a large variety of applications, the present work is focused on the study of a crane bridge experiencing a lot of impacts during an earthquake excitation as well as the nonlinear response of a concrete gravity dam under earthquake loading. Both problems are dealt thanks to a coupling approach based on domain decomposition methods in linear and nonlinear transient dynamics. The two subdomains may present geometric (incompatible meshes) and algebraic (different shape functions) non-conformity at their interface and use two different time integration schemes and time step sizes, using the HATI framework (Heterogeneous Asynchronous Time Integrator). For the dam application, two software based on appropriate numerical methods are employed for dealing with this complex situation, involving in the same analysis, seismic source and wave propagation in the soil and low-frequency vibrations of the dam. First, the open source EFISPEC3D is developed by BRGM to predict seismograms in complex 3D geological environments. It is based on the spectral element method (SEM), known to be an efficient tool for propagating elastic waves within earth media with a low computational cost. The second software is Code_aster (EDF) or Akantu (Computational Solid Mechanics Laboratory, lsms. epfl.ch), based on the classical finite element method (FEM). In comparison to the SEM method, the finite element method is more suitable for modelling complex geometry like buildings or subsurface soils meshed with small elements and presence of nonlinearities. Co-simulation approach is also set up for the crane bridge application under earthquake loading. The impacts/contacts with friction are dealt, in reduced subdomains of the crane bridge, by an explicit FE code, whereas the main part of the bridge is simulated with implicit FE code with large time steps and different damping formulations.

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