Numerical models for earthquake ground motion and seismic risk assessment

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Physics-based numerical simulations of earthquake ground motion can be used to better understand the physics of earthquakes, improve the design of site-specific structures, and evaluate the seismic hazard, a key step for the reliable assessment of seismic risk. The distinguishing features of a numerical method designed for seismic wave propagation are: accuracy, geometric flexibility and parallel scalability. High-order methods ensure low dissipation and dispersion errors. Geometric flexibility allows for complicated geometries and sharp discontinuities in the mechanical properties. Finally, since earthquake models are typically posed on domains that are very large compared to the wavelengths of interest, scalability allows to efficiently solve the resulting algebraic systems featuring several millions of unknowns. In this talk we present an overview on numerical modelling of the ground motion induced by seismic waves based on employing high-order Discontinuous Galerkin methods. We also present two new approaches to couple the ground motion induced by earthquakes with the structural damages of buildings. The first one is based on empirical laws (fragility curves) whereas the second one employs physics-based linear and non-linear differential models. To validate the first approach we study the seismic damages in the Beijing area as a consequence of ground motion scenarios with magnitude in the range 6.5–7.3 Mw. To validate the second approach we consider the 1999 Mw6 Athens earthquake and study the seismic response of the Acropolis hill and of the Parthenon. The numerical results have been obtained using the open-source numerical code SPEED.

References:

[1] https://speed.mox.polimi.it

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