SESSION 32- Numerical Simulation of Near-Fault Earthquakes: Modeling Challenges, Ground Motion Features, and Site Effects

Conveners

Silvia Giallini, Institute of Environmental Geology and Geoengineering of the National Research Council (CNR-IGAG), Italy
Raffaele De Risi, University of Bristol, UK
Gabriele Fiorentino, Institute of Environmental Geology and Geoengineering of the National Research Council (CNR-IGAG), Italy
Alessandro Pagliaroli, Department of Engineering and Geology, G. d'Annunzio University of Chieti-Pescara (INGEO Ud'A), Italy

Session Description

Near-fault earthquakes result in ground motions that are fundamentally different from those observed in the far-field, not only in terms of amplitude but also in their physical nature and frequency content. Features such as strong directivity, fling-step effects, pulse-like velocity waveforms, and significant vertical and rotational components have been repeatedly documented in recent earthquakes worldwide, such as the 2009 L'Aquila and 2012 Emilia

events in Italy, and New Zealand (2010–2012). These complex motion patterns can impose seismic demands on structures that differ substantially from those derived from conventional probabilistic seismic hazard analyses (PSHA), which are generally based on far-field assumptions.

Despite growing observational evidence, near-fault effects are still only partially incorporated in most building codes and hazard models. This highlights the need for improved physical understanding and numerical representation of near-fault processes, from fault rupture dynamics to the propagation of seismic waves and their interaction with complex geological and topographic features.

This session aims to bring together studies on the numerical simulation of near-fault earthquakes.

Topics of interest include:

- Dynamic rupture modeling and near-fault ground motion characterization (vertical component, directivity, fling, hanging-wall, rotational effects);

- Advanced numerical approaches (finite/spectral element, finite difference, hybrid, or data-driven methods);
- Modeling of 3D geological structures, topographic amplification, and nonlinear site response;
- permanent ground deformation due to fault ruptures and their effects on lifelines (e.g., pipelines, railways) and foundations
- Integration of numerical simulations with strong-motion, geodetic, and geological data;
- Implications for seismic hazard assessment, building codes (e.g. EC8), and engineering design.

By fostering collaboration among seismologists, computational modelers, and engineers, this session seeks to identify key modeling challenges, share recent advances, and define future directions toward more realistic and physically consistent simulation-based approaches to quantify and mitigate near-fault seismic risk.