SSA 2010 Annual Meeting Abstract

Session: Numerical Prediction of Earthquake Ground Motion
Schedule: Thu 22 Apr – 1:30 PM
Location: Salon E
Presentation Type: Oral
Presenter: Hollender, Fabrice

EUROSEISTEST VERIFICATION AND VALIDATION PROJECT: AN INTERNATIONAL EFFORT TO EVALUATE GROUND MOTION NUMERICAL SIMULATION RELEVANCE

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Numerical simulations are often used to evaluate local ground motion amplification (site effects). Before using these approaches for civil engineering design purposes, it is necessary to evaluate their reliability. Within the framework of this evaluation effort, an ongoing international collaborative work was organized, jointly by the Aristotle University of Thessaloniki, Greece, the Cashima research project (supported by the CEA and the Laue-Langevin institute), and the Joseph Fourier University, France. We decided to focus the study on a site (1) where the site geometry and geotechnical properties are well known and (2) where accelerometric time histories are available. The EuroseisTest site, located few tens of km East of Thessaloniki, was chosen since it provides a detailed 3D model of the sedimentary basin (about 5 km wide, 15 km long, sediments reach about 400 m depth) and the signals of 8 local earthquakes with magnitude from 3 to 5, recorded on 19 surface and borehole accelerometers. The project involves more than 10 international teams from Europe, Japan and USA, employing different numerical techniques (FDM, FEM, SEM, DGM, PSM, DEM). It consists in computations of different 2D, 3D, linear or non-linear cases. Through these exercises, it is possible to evaluate (1) the accuracy of numerical methods when applied to realistic applications where no reference solution exists (verification) and (2) quantify the agreement between recorded and numerically simulated data (validation). We will present the site, the objectives, the 3D model construction strategy, the different computing cases and main results of this project. The verification work allows us to clearly identify and understand the discrepancies between the predictions of the different simulation methods. The validation work shows surprisingly good agreement for the largest magnitude event, even at high frequencies (up to 4 Hz).

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SSA 2010 Annual Meeting Abstract

Session: Numerical Prediction of Earthquake Ground Motion
Schedule: Wed 21 Apr – PM Poster #38
Location: Exhibit Hall
Presentation Type: Poster
Presenter: Moczo, Peter

NUMERICAL MODELING OF EARTHQUAKE GROUND MOTION IN THE MYGDONIAN BASIN, GREECE: VERIFICATION OF THE 3D NUMERICAL METHODS

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The capability of numerical methods to predict earthquake ground motion is investigated through the ongoing Euroseistest verification and validation project. The project focuses on the Volvi Mygdonian basin (Greece) which has been a subject of extensive geophysical and geotechnical investigations for more than two decades. A new detailed 3D model of the basin (5 km wide, 15 km long, with maximum sediment thickness 400 m and minimum S-wave velocity 200 m/s) as well as recordings of local earthquakes by the Euroseistest instruments provide a reasonable basis for the verification and validation of the numerical methods. Here we present the results of the verification phase of the project for 3D numerical methods.
Numerical-modeling teams from Europe, Japan and USA employ the finite-difference method (FDM), finite-element method (FEM), global pseudospectral method (GPSM), spectral- element method (SEM), discrete-element method (DEM) and discontinuous Galerkin method (DGM). The problem configurations include elastic and viscoelastic rheologies, basin models built from smooth velocity gradients or composed of three homogeneous layers, one hypothetical event and six local events with magnitude between 3 and 5. Numerical predictions for frequencies up to 4 Hz are compared using quantitative time-frequency envelope and phase goodness-of-fit criteria computed at 288 receivers. Solutions are also analyzed with respect to rheology, geometry of the interface and source parameters, and their representations in the computational models. In particular, it is shown that the agreement between numerical predictions of ground motion duration strongly depends on the ability of each method to model accurately the surface waves diffracted off the basin edges and propagating within the basin.

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SSA 2010 Annual Meeting Abstract

Session: Numerical Prediction of Earthquake Ground Motion
Schedule: Wed 21 Apr – PM Poster #32
Location: Exhibit Hall
Presentation Type: Poster
Presenter: Chaljub, Emmanuel

EUROSEISTEST NUMERICAL SIMULATION PROJECT: COMPARISON WITH LOCAL EARTHQUAKE RECORDINGS FOR VALIDATION.

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The ultimate goal of the Euroseistest verification and validation project is to assess the capability of numerical simulation to accurately predict seismic ground motion up to relatively high frequencies . This presentation will focus on the validation step, consisting in comparing numerical predictions with actual recordings up to 4 Hz. The exercise has been performed for 6 local, weak to moderate magnitude events, spanning various azimuths, depth and distances, and recorded by a local array of 19 surface and borehole accelerometers. In general, while the detailed waveforms do not match, the overall amplitude, duration, and spectral shape exhibit a relatively satisfactory agreement. The level of agreement is however found to be event-dependent, as a combined result of the large sensitivity of waveform details to the source location and mechanism, the geometry of the sediment-basement interface, and the internal sediment layering, and of the uncertainties in the source parameters and basin structure. The best agreement is found indeed for the largest – and thus best known- event. In order to remove the errors due to source parameter uncertainties, the instrumental site to reference spectral ratios derived from the available recordings were compared with those derived from 1D and 3D synthetics. The best fit is obtained for 3D simulations, which do account for both the broad band amplification due to lateral reverberations, and the scatter due to the sensitivity of the diffraction pattern to the source location. There is however a trend for underestimating the actual amplification, in probable connection with incorrect estimates of damping and internal sediment layering structure. The next challenge in view of deterministic simulation of ground motion at intermediate frequency thus consists mainly in improving the performance of shallow geophysical investigations.

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