SYNTHESIS: A DATABASE TO ARCHIVE AND DISTRIBUTE SYNTHETIC WAVEFORMS

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Empirical models for the prediction of the ground motion as a function of magnitude, distance from the source and site conditions, are worldwide employed in the generation of shaking scenarios and in seismic hazard assessment. Such approaches have taken advantage in the last decades of the increasing quantity of instrumental observations available from several recording networks operated by different national and international institutions. Several empirical Ground Motion Prediction Equations (GMPEs) have been proposed but, notwithstanding the increasing complexity of the models and the use of qualified strong-motion datasets, they are still representative of the average characteristics of the ground motion from earthquakes recorded in large regions at different sites (Bindi et al., 2014; Campbell et al., 2014; among others). GMPEs are still far from capturing the observed features of site-specific ground motion, especially in the near-fault range (with effects such as directivity, radiation pattern, etc.), mostly due to the paucity of recordings from large to moderate events at short source-to-site distances.

Numerical simulations, can provide a realistic representation of site-specific ground motions through a detailed modelling of the seismic source process, waves propagation and local site response. Synthetic ground motions can also be used to constrain several elements in the derivation of empirical GMPEs, such as magnitude and hanging-wall scaling. Moreover, the use of numerical approaches are also suitable for engineering purposes which require the use of complete time series for the dynamic analysis of seismic structures.

In the light of the abovementioned issues, in this work we propose a tool to archive and distribute synthetic waveforms through a web repository, with the aim to create a database of synthetic signals to integrate observed data in several applications related to seismic hazard evaluation, risk assessment and seismic microzonation.

The SYNTHEtic SeISmograms database (SYNTHESIS 0.1) is composed of more than 10000 accelerograms simulated by stochastic (EXSIM, Motazedian and Atkinson, 2005), deterministic-stochastic (DSM, Pacor et al., 2005) or hybrid methods (HIC, Gallovič and Brokešová, 2007). The scenario events included in the SYNTHESIS database are the case histories of the M6.9 1980 Irpinia earthquake (Ameri et al., 2011) and the M6.3 2009 L'Aquila earthquake (Ameri et al., 2012). Data

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coming from the MASSIMO project (Monitoraggio in Area Sismica di SIstemi Monumentali, Cultural Heritage Monitoring in Seismic Area) are also included. This project is devoted to the assessment of the seismic response of some test buildings which are relevant from the cultural heritage conservation point of view. Simulations have been performed at the bedrock for three class of magnitude (M7.0, M6.0, M5.0) and for fault distances less than 15 km.

The dissemination of synthetic waveforms and related metadata is performed through the web portal http://synthesis.mi.ingv.it/, where a fully relational database is stored. The structure and the tables are based on those of the Italian strong motion database ITACA (http://itaca.mi.ingv.it), aimed to distribute strong-motion data recorded in Italy. SYNTHESIS can be explored through three groups of user-friendly interfaces, which allow performing queries on selected scenarios, stations and waveforms parameters. Each group can be explored specifying search key fields: 11 for the scenarios, 13 for the stations, and 10 for the synthetic waveforms. The synthetics are distributed as ASCII files, whose name contains the information on the virtual grid of receivers, the site code, the type of simulation, the site conditions, and the ground motion component. The ASCII files have a header of 55 rows, where the main information describing the synthetic waveforms are included (hypocentral location, magnitude, simulation technique, frequency range, etc.), followed by a column with ground motion amplitudes. The waveforms resulting from specific queries can be downloaded in a compressed file format, which contains unprocessed and processed acceleration, velocity, displacement time-series and acceleration response spectra. An image gallery is also included in the web portal to quickly display and download pictures related to seismic scenarios (PGA, PGV, PGD or SA maps) or earthquake photo collections for historical events.

Moreover, since a single event can be simulated through several scenarios parameters producing thousands of waveforms, we have established a selection criterion to facilitate and retrieve a sub-set of synthetic seismograms on the base of the statistical distribution (i.e. mean, median, percentiles, etc.) of the ground motion parameters.

The SYNTHESIS database has been designed to be a useful tool for scientific research or practical applications in seismology and earthquake engineering fields. The waveforms and the associated information included in SYNTHESIS can be used in a variety of applications, such as constraining ground motion prediction equations, defining damage scenario for seismic risk mitigation and seismic inputs for site response or structural response analyses.

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