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Synthetic ground motion scenarios for the urban area of the city of Catania (Italy)

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The seismic risk in the Catania area is recognized as being extremely high. Indeed, as suggested by historical studies, the seismicity of the area is characterised by the occurrence of some strong earthquakes, interlagged by long quiescence periods (i.e. 1169 and 1693 earthquakes), and the earthquake reinforced building are by far the minority. The aim of this study is to evaluate the strong ground motion in the municipal area of Catania for a catastrophic earthquake scenario. The selected reference earthquake is the destructive (M 7.2) event of 1693, which is commonly associated to rupture along the Ibleo-Maltese escarpment fault system placed a few kilometres offshore along the Ionian coast of Sicily. This seismic event destroyed about 45 cities and caused as many as 54,000 deaths in Eastern Sicily. The information used for this study consists of borings, geological profiles, pre-interpreted seismic lines, data relative to deep wells, as well as seismological, geological and geotechnical studies regarding Eastern Sicily, particularly in the area surrounding Catania. This aspect is very important in order to construct realistic structural models and include the finest local details, coming from geophysical, geological, and geotechnical data available. By using a deterministic approach to the seismic hazard evaluation, the computation of the expected ground motion in the selected area is performed through the application of two simulation techniques. The first one estimates the ground shaking by solving the 2-D full-wave equation by the Chebyshev spectral element method (SPEM), performing several simulations in order to take into account changes in source position and orientation, and finite extension of the fault along its dip. The second one uses a stochastic approach to simulate high-frequency strong ground motion and implemented in the open-source extended-source simulation algorithm EXSIM by Motazedian and Atkinson (2005). This code was developed for earthquake simulations using stochastic finite-fault modelling and a dynamic corner frequency approach. EXSIM represents a reliable and practical code to simulate ground motion records of moderate and large earthquakes especially in regions where structural damage is expected, but sparse ground motion recordings are available. In order to obtain reliable synthetic scenarios and calibrate the input parameters suitably (above all in terms of crustal model), we computed synthetic seismograms for some recorded seismic events as well, and made the comparison with the instrumental data available for the area. The obtained results, represented by synthetic seismograms and peak ground acceleration values, can be considered useful for practical purposes in terms of evaluation analysis and loss estimates for the urban area and infrastructures of Catania.

References

Motazedian, D. & G.M. Atkinson (2005). Stochastic finite-fault modeling based on a dynamic corner frequency. Bull. Seism. Soc. Am. 95, 995-1010.