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An artificial neural network approach to support physics-based generation of broadband earthquake ground motions

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The Probabilistic Seismic Hazard Analysis (PSHA) traditionally bares on the use of Ground Motion Prediction Equations (GMPEs). Nevertheless, the latter approach resulted to be poorly constrained when near-source conditions are verified and data only partially account for the rupture process [2]. This weakness arises also in case of seismic wave propagation in complex three-dimensional (3D) geological configurations. Numerical simulations potentially provide a large and representative set of scenarios, that can be exploited to constrain classical PSHA predictions. Nonetheless, this approach partially bypass the problem: the intrinsic simplified assumptions of the model and the limited computational resources restrain the reliability of numerical predictions to the region of long natural periods[3]. The range of the numerical simulations is often enlarged to produce broadband wave-forms, by considering hybrid approaches where high-frequency source and path effects are either modelled by stochastic or semi-stochastic processes or random processes are introduced within a deterministic model to provide a realistic frequency-dependent spatial incoherency of ground motion. Albeit the increased performances, hybrid approaches do not reproduce accurately the ground motion spatial correlation at short distances [1]. In this paper, an alternative strategy to produce reasonable wave-forms at short epicentral distance is presented. The key points are: (1) numerical simulation of the strong ground motion scenario, to predict deterministic long-period records at the engineering bedrock; (2) hybrid extension of the resulted wave-forms, by means of standard stochastic approaches; (3) simulation of realistic broad-band (i.e. 0-25 Hz) artificial records by using Artificial Neural Networks (ANN) combined with spectral matching techniques. With this procedure we aimed to overcome most of the shortcoming of traditional methods presented so far, towards a more realistic site response analysis and prediction.

References

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