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Expected signature of nonlinearity for strong ground motion parameters: a statistical study using Kik-net synthetic downhole accelerograms

G. Pousse (1,2), L.F. Bonilla (1), F. Cotton (2)

(1) Institut de radioprotection et de sûreté nucléaire, 92262 Fontenay-aux-Roses, France, (2) Laboratoire de Géophysique Interne et de Tectonophysique, 38000 Grenoble, France, (guillaume.pousse@irsn.fr)

Recent earthquake studies have demonstrated that nonlinear behavior of soft soil can be significant during strong ground motion. Thus, degradation of the soil rigidity has been observed, and in some special cases it may remain irreversible. In this study, we are interested in predicting when sediment nonlinearity becomes a first-order effect. In this sense, we first study the uncertainty of the input ground motion and its effect when a nonlinear soil column is considered. The soil column corresponds to soil types C and D following the Eurocode 8. In a second step, we also vary the mechanical properties of the soil column in order to have the full range of uncertainty on the nonlinear soil response. The input ground motion corresponds to several hundred synthetic accelerograms, generated to represent rock ground motions at 100 m depth. These accelerograms are calibrated using the Kik-net Japanese downhole data, and reproduce natural non-stationary of strong motion. The complete seismogram is treated as if it were purely SH motion, and the nonlinear rheology is taken into account by the multishear mechanism developed by Towhata and Ishihara (1985), and Iai et al. (1990). In this work, we investigate in particular the dependency of the Acceleration Response Spectra, the Peak Ground Acceleration, the Strong Motion Duration, and the Arias Intensity with respect to the nonlinear properties of the medium as well as the uncertainties in the downhole ground motion. Preliminary results show that the high frequencies of the response spectra are mostly affected by the nonlinear effects. Yet, some amplification is still observed for moderate events, which is of great importance in regions of moderate seismicity and same soil conditions, where linear effects can still be largely dominant.