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REGIONALLY ADJUSTED GMPES INCLUDING SOURCE STRESS PARAMETER SCALING FOR SMALL MAGNITUDE EVENTS

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Ground-motion prediction equations (GMPEs) are a fundamental ingredient in seismic hazard assessment. In empirical GMPEs the scaling of ground motion with source properties is typically accounted by the earthquake magnitude, the style-of-faulting and, in some cases, other parameters related to the earthquake depth or to the fault geometry (e.g., dip angle). One of the most important source parameter, that is rarely accounted for in the empirical GMPEs, is the stress parameter (i.e., Brune's stress drop). Nevertheless, the stress parameter is often cited as one of the possible causes of the larger scatter of high-frequency between-event residuals for small magnitudes with respect to large magnitude events, observed in several studies (e.g., Youngs et al.,1995; Boore et al., 2014).

The main reasons for neglecting the stress parameter in empirical GMPEs are that its estimation is typically characterized by relevant uncertainties and that the stress parameter value for future events is usually unknown and thus difficult to use in seismic hazard assessment. However, several studies have shown that differences may exist in the average values of stress parameters for different regions. This is the case, for instance, of France and Switzerland where it has been shown that stress parameters for the French and Swiss Alps are generally lower that the ones obtained in the Rhine Graben or in the Pyrenees (Drouet et al., 2010; Edwards & Fah, 2013). This information can be accounted for in median ground-motion prediction if stress parameter scaling is included in the GMPEs.

In this study we use the Reference Database for Seismic Ground Motion in Europe (RESORCE), developed within the SIGMA research and development project, to derive empirical GMPEs that cover the moment magnitude range 3-7.6 and distances smaller than 200 km. The selected dataset contains about 300 earthquakes and 1700 records at the shortest spectral periods. The dataset is mostly composed by Italian, Turkish and Greek earthquakes for Mw > 4.5 whereas for smaller magnitude French and Swiss events dominate. We first define an appropriate functional form to model the spectral amplitudes over the considered magnitude and distance ranges. A quadratic magnitude scaling and a magnitude-dependent distance scaling are included in the model. The linear site amplification is modelled through Eurocode8 site classes (A, B, C and D) as the Vs30 is available only for a limited number of stations. The fault mechanism is considered in terms of strike-slip, normal and reverse classes. The regressions are performed applying a random effect approach, that allows to determine the between-event and the within-event components of the standard deviation.

The between-event and the within-event residuals distribution are investigated in order to assess the performance of the model. The short-period between-event residuals for French and Swiss events show a larger variability with respect to other region events. The French and Swiss between-event residuals are then correlated with stress parameters provided by Drouet et al. (2010) and Edwards & Fah (2013) and a positive correlation is found for short spectral period. Based on such results, we develop a stress parameter model that we include in the GMPE functional form. The inclusion of the

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stress parameter model allows to explain part of the between-event variability observed for small-magnitude events and to reduce the standard deviation of the GMPE. Moreover, the stress parameter model significantly affect the median ground motion prediction and allows to account for the stress parameter scaling in the estimation of ground motion for future events.

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