ESC2016-636, 2016
35th General Assembly of the European Seismological Commission

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4–10 September 2016 Trieste

Towards the definition of reference motions (1000 < Vs < 3000 m/s): analysis of the KiK-net data and correction of the local site effects

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A key scientific component in Probabilistic Seismic Hazards Analysis (PSHA) is the assessment of a local hazard with reference to a hard rock site (1000<Vs30<3000 m/s), either for applications to installations built on this site category, or as an incident motion for site effect computation. Within the context of PSHA, empirical ground motion prediction equations (GMPEs) are the traditional basis for estimating shaking intensities and Vs30, the time-averaged shear-wave velocity in the upper 30 meters from the surface, is the basis to account for site conditions. The current GMPEs, however, are not well constrained for Vs30 larger than 1000 m/s (only a few records on high Vs30 sites are included in the main accelerometric databases), and so it cannot be used directly. In this study, we ask: what methods can we use to alternatively define seismic reference motions (1000< Vs30<3000 m/s) that do not include site-effects?

We explore methodologies to obtain a prediction for reference motions (1000<Vs30<3000 m/s) by using the "rock" Japanese KiK-net sites with 500<Vs30<1350 m/s. Each site presents the advantages of having a two sensors (one at the surface, and one installed in a borehole at depth between 100 and 200 m for most sites and up to 2000 m) and geotechnical characterization (P- and S-wave velocity profiles) of the surface and down-hole sensor. Firstly, the "rock" transfer functions are estimated in two ways: empirically (spectral ratios between surface and depth records) and theoretically (linear SH1D simulation). These two approaches are compared to validate the input parameters and also to select the stations for which the 1D approximation is verified. Then, two new accelerometric datasets characterizing hard rock sites (1000< Vs30 < 3000 m/s) in free surface condition are developed:

1. Records made at depth are corrected by the depth correction factor developed by Cadet et al. (2012),
2. Records observed at the surface are corrected by an amplification factor (surface / outcrop rock) defined theoretically for each station to eliminate the site effects.

Simple GMPEs function of Vs30 (assumption that Vs30 is similar to Vs measured in depth) are then developed for each dataset and the results are compared for a specific scenario to the result obtained with the traditional approach of the host-to-target adjustment. For the second dataset, sensitivity tests are applied on the way to define the site response and their impacts on the GMPE results are analyzed.