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Experimental approach for estimating seismic amplification effects at the top of a ridge and their implication on ground motion predictions: the case of Narni (Central Italy).

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From March to September 2009 a dense velocimetric network was installed in correspondence of Narni, a little village in central Italy, built on the top of a massive limestone ridge. The network was planned with the aim to investigate possible local site effects due to the morphology of the ridge, characterized by slopes ranging from 22° to 35° and a maximum difference of quota between top and bottom of 230 m. Three stations were installed at the base of the hill and other 7 monitored the crest. A remarkable dataset was obtained, composed by about 700 earthquakes, the great amount of which occurred after the 06th April 2009, Mw 6.3, L'Aquila earthquake.
Site amplifications related to the ridge morphological features were investigated through empirical techniques with and without reference site, computing Spectral Standard Ratio, SSR and Horizontal to Vertical spectral ratio, HVSR. Directional spectral analyses were also performed .
The agreement between the results coming from HVSR and SSR techniques allows us to assess with reliability a clear amplification effect for frequencies ranging between 3 and 5 Hz for all stations installed on the crest: in particular, SSR results show an amplification level with respect to the reference station up to 4.5. The highest amplification level (almost double) were observed when the direction perpendicular to the main elongation of the ridge is taken into account. Finally, considering the L'Aquila events with Mw > 4.5 and merging the information coming from the reference and non-reference site techniques, it was possible to recognize further amplification effects, at frequency lower than 1 Hz, probably related not to the morphology of the area but to source and/or polarization effects. Bidimensional numerical simulations were then computed in order to compare the results coming from the experiment with those obtained through numerical modeling. A hybrid finite-boundary element method based on code named HYBRID has been used for modeling. The model has been excited by SV and P Ricker wavelet in order to extract transform functions. The medium assumed to have a linear elastic constitutive behavior. All calculations were performed in time domain using direct boundary element method. The amplification patterns both in time and frequency domain were derived and similarities and discrepancies between the results were discussed.
At last, considering only local events (epicentral distance R <= 30 km), empirical ground motion predictive equations, calibrated for maximum horizontal peak ground acceleration, PGA, velocity, PGV, and acceleration response spectra (SA, 5% damping) up to 1s, were carried out with the only aim to estimate topographical corrective coefficients. The results show significant corrective term values (between 0.35 and 0.48 in logarithmic scale) for the spectral ordinates between 0.2 s and 0.3 s. These results, in agreement to those obtained from the spectral analyses, suggest that the introduction of a topographic site class in the calculation of predictive models might probably reduce the inter-station variability for stations installed in correspondence of topographic irregularities, often included in reference-rock classes.