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New observations on directivity phenomena in the dynamic response of slopes to seismic shaking

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A four year-long accelerometric monitoring of 5 sites distributed in a 6 Km2 area prone to landsliding at Caramanico Terme (Central Italy) has provided evidence of phenomena of directivity in the dynamic response of slopes to seismic shaking. In particular, on occasion of low to moderate seismic events, one site on a mudstone slope mantled by a quiescent landslide and another site on fractured limestone on the rim of a steep gorge, showed maxima of shaking energy, parameterised by Arias intensity, systematically directed according to main, local topographic and/or geologic features (e.g. maximum slope or gorge rim direction). On average these maxima differed from the minimum values, observed in directions normal to those of the maxima, by a factor of 2 and 3 in the two sites, respectively, but occasionally maximum exceeded minimum even by one order of magnitude. These two sites appeared also affected by a significant local amplification. In comparison, two other sites located in the same study area, one on a mudstone slope not involved in mass movements and the other on a gentle, limestone slope, did not show similar phenomena. Extending the observations to data derived from several stations of the Italian National Accelerometric Network, we found similar directivity phenomena in sites located on steep rock slopes. In these cases, however, the directivity was not associated to local amplification, probably because the sites are near the base of the slopes. A spectral analysis of the accelerograms recorded in all the examined stations showed that, whereas in the two Caramanico stations the combination of directivity and amplification appears related to a sort of “directional resonance” with energy concentration on few site specific directional spectral peaks, in the other sites, where directivity was not associated to amplification, spectral energy appeared distributed throughout a wider band of frequency. These findings point to complex interactions between litostratigraphic

and topographic factors that control local slope seismic response and, under certain conditions, determine phenomena of directional amplification. This in turn implies a significant impact on the seismic susceptibility of slopes.

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