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Ground-Motion Intensity Inferred From Upthrow of Boulders and Rock Falls during the 2010 Darfield Earthquake, Port Hills, New Zealand

narges khajavi (1), mark quigley (2), kevin furlong (3), amir rezanejad (4), and tim davies (5)

(1) Earth Sciences Department-Canterbury University-New Zealand(narges.khajavi@pg.canterbury.ac.nz), (2) Earth Sciences Department-Canterbury University-New Zealand(mark.quigley@canterbury.ac.nz, (3) Department of Geosciences, Pennsylvania State University, USA (kevin@geodyn.psu.edu), (4) Earth Sciences Department-Canterbury University-New Zealand (Amirrezanejad595@yahoo.com), (5) Earth Sciences Department-Canterbury University-New Zealand(tim.davies@canterbury.ac.nz)

Characteristics of displaced boulders from soil and of rock falls during the Mw=7.1 Christchurch earthquake of September 3, 2010 UT, allow estimates of the accelerations responsible for displacements to be made. Displaced boulders and rock falls that occurred in the old jointed volcanic rocks were generally restricted to a few high ridges in Port Hills, Banks Peninsula, indicating that topography magnified the intensity of shaking. Most of the boulders moved downslope in predominantly NE-SW directions; however; many others moved on a flat ridge crest at 488 m a.s.l. To interpret the observations of the upthrow of boulders and their remarkable displacements, a shattered ridge, and the rock falls, we used field measurements, topo-amplification models with 5% damped acceleration response spectra, and New Zealand response spectrum attenuation relations. Considering maximum vertical and horizontal accelerations of 1.26 g and 0.82g respectively from a very near-fault record, this study used data from two other strong-motion earthquake accelerograms close to the Port Hills to reconstruct the geological setting of the upthrown boulders. Although our observations and data sets indicate that the horizontal acceleration was greater than the vertical acceleration in the study area, the position, shape, materials, subsoil and elevation of the ridges had a significant effect on enhancing the vertical and horizontal accelerations of the boulders, the rock falls and the shattered ridge. The results also demonstrated that higher parts of the ridge with soil underneath of the boulders experienced greater shaking than lower ridges and hills with the same characteristics. Similarly, the location of huge rock falls showed that shaking was greater on top of the high rocky ridges compared with lower elevations.