



Rock avalanche dynamics evidenced by near-field strongmotion seismogram

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Giant landslides have been argued to have some distinctive physical properties such that they can achieve high speed sliding and long runout distance. Although estimating their physical properties is difficult, it is nevertheless crucial for landslide assessments. The idea assessments are from direct measurements when they are at motion. However, due to their scarce occurrences and short flowing durations, they have rarely been instrumentally recorded. In Tsaoling area, Taiwan, there have been historically documented four giant landslides since the late 19th century because of its unique geological condition and, therefore, seismological equipments have been installed around the area since the 90s to monitor the regional seismic activities and its topographic amplification effects. In 1999, Chi-Chi earthquake triggered the fifth major landslide, with a scar volume 0.125 km³. Due to its volume and site locality to the seismic instrument array, the landslide induced ground motion was expected to be captured. We cross examine the records of the surrounding seismic stations and find that only the nearest station, CHY080, exhibits distinguished signatures which may be associated with the landslide. We use the Ensemble Empirical Mode Decomposition (EEMD) to decompose the signals which identify a series of peculiar wave packets. Based on it, a simple rigid sliding model is deployed to analyze the sliding process for physical quantities of the landslide. The results reveal that with the sliding distance 1994 m, the maximum velocity reaches ~ 78 m/s, and the mass generates a large collision impact against the riverbed and the steep slope on the other side of the river. The friction angle of the sliding surface could be estimated and suggested as low as 6.9° so as to achieve a high velocity sliding. These results are agreeable with kinematic simulation of the landslide and provide evidence that the landslide induces seismic ground motion. The revealed results provide a solid evidence and create a new high record for the massive and high speed landslide.