ABSTRACT
Over the last decade, 1-Hz kinematic Global Positioning System (GPS) has been used as a displacement sensor in earthquake observations and structural health monitoring. Many researchers in both seismology and engineering fields have expressed the desire for higher-rate sampled (10-sample-per-second or even higher) GPS data to acquire high-frequency displacement information. With the major purpose of evaluating the performance of high-rate kinematic GPS, we performed several shake table tests to GPS on 29 April, 2009. We found that the accuracy of high-rate kinematic GPS was independent of the sampling rate of the receivers, while it did depend on the movements of the antennas. The errors in kinematic GPS measurements during the periods of strong shaking were systematically larger than those during the static periods. Furthermore, we found that these large errors were coincident with large accelerations and jerks of the shake table motions. Observation from the 2010 Maule, Chile earthquake and 2011 Tohoku, Japan indicated that significant jerks and/or accelerations may cause a GPS unit temporarily losing tracking on some or all GPS satellites, which will degrade the accuracy of kinematic measurements and even lead to gaps in GPS seismograms. Other factors which lead to instrument and system failures during these large earthquakes are also investigated.

CONCLUSIONS
This study shows that the accuracy of high-rate GPS seismograms from near-fault areas in large earthquakes must be evaluated with caution. In particular, there should be no assumption of uniform accuracy; instead, accuracy can vary even within a single GPS seismogram. The errors during strong-motion periods are likely to be larger than those during periods of weak-motion or repose. The effects of strong shaking on GPS receivers can be partially minimized by installing receivers on seismic isolation devices. We hope to develop an outdoor shake table facility to further study the accuracy of high-rate kinematic GPS measurements.