Geophysical Research Abstracts, Vol. 9, 01366, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-01366

Monitoring of the Hungtsaiping Landslide of Nantou, Taiwan

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The Hungtsaiping (HTP) landslide of Nantou County in Central Taiwan covers an area of over 100 *ha*. HTP landslide is located between Shuilikeng and Shuangtung faults which are mostly underlain by Miocene sedimentary rocks. The constitutive material of the HTP landslides is expected to be a colluvial deposit from morphological evidence. The area has a long history of slow movement with a complicated mechanism. It is believed that the most recent sliding was triggered by the Chi Chi Earthquake of September, 1999. The morphological features at HTP landslide include crown, tension crack, main scarp, steps of scarp, depression, hummocky ground surface, and an accumulation zone at the toe. The estimated maximum horizontal ground displacement is 32.0 $m$according to digital aerial photogrametry. The authors conducted a series of field geological survey, soil/rock sampling, laboratory testing and numerical analysis to determine the mechanisms of HTP landslide and safety factors against further sliding. Attempts were made to use DEM created by satellite/aerial photo images as a basis of establishing the mechanism as well as the status of HTP landslide. Numerical techniques of Fast Normalize Cross Correlation (FNCC) and Particle Image Velocimetry (PIV) were used in the analyses of the satellite/aerial photo images. An optic Fiber Bragg Grating Segmented Deflectometer (FBG-SD) system developed by the authors was installed in the boreholes to investigate the possibility of using FBG-SD as a means to detect ground movement and provide early warning of upcoming landslide event. The satellite/aerial photo image techniques have a resolution of a few meters, but can be used to monitor large areas such as the HTP landslide from the ground surface. The FBG-SD, on the other hand, can detect ground movements in

terms of millimeters in depths of well over 90 m. However, the FBG-SD is effective only for the location of the borehole. The two systems compliment each other well. This paper provides details in the implementation of the various monitoring schemes and experiences gained from the exercises.