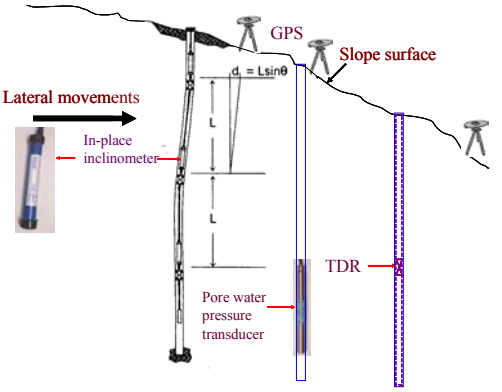
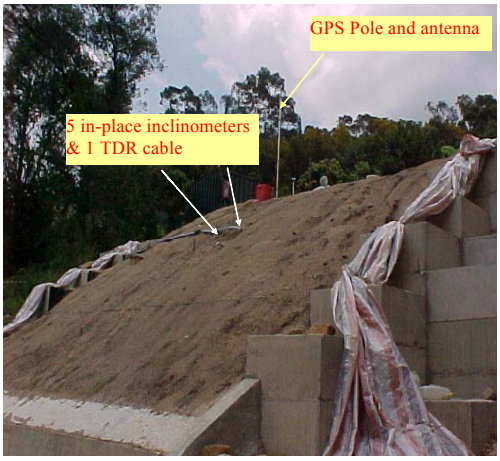
AN INNOVATIVE INTEGRATED SYSTEM FOR MONITORING MOVEMENTS OF SLOPES

J-H. Yin, Centre for Ground Engineering and Technology (C-GET), Department of Civil and Structural Engineering (CSE), The Hong Kong Polytechnic University (HK PolyU), Hong Kong, China
X-L. Ding, C-GET, Department of Land Surveying and Geo-Informatics, HK PolyU, Hong Kong, China
Y-W. Yang, C-GET, Department of Civil and Structural Engineering, HK PolyU, Hong Kong, China

Abstract

An innovative integrated system for monitoring and warning of landslides has been developed by the authors in Hong Kong. The system consists of an automatic conventional slope monitoring package and a multi-antenna accurate Global Positioning System (GPS) package. The system can be set up at a slope site and used to measure sub-surface ground movements and pore water pressures and surface ground movements. The data from the packages can be transferred to an office computer, processed and analyzed together. A database has been developed for interpretation of all information from the system. This system has been used to monitor a soil slope in Hong Kong. The assessment of results has demonstrated that the integrated system is reliable, accurate and effective for monitoring slope movements and warning of any potential slope failure.





A schematic view of the field installation of the integrated system (top figure) and (b) monitoring a loose fill slope in Hong Kong (bottom photo)

EXTENDED ABSTRACT

Hong Kong is a hilly region with heavy rainfalls in the summer normally. Heavy rainfalls can easily induce slope failures or landslides. Other factors such as human activities, rock weathering and rising ground water may also contribute to the landslides. Landsides still pose a great danger to human life and property, despite considerable effort in slope maintenance and stabilization measures. In Hong Kong, many buildings, factories and important facilities are either very close to or on the hillside. During a landslide, life and property may be at risk. Therefore, any pre-warning of slope failure will allow time for people to evacuate and take other preventive measures. Many landslides in Hong Kong have a deep-seated slip and noticeable displacement may occur prior to failure. Sometimes, the landslide is progressive in nature. It is possible to forewarn a landslide by monitoring any pre-failure displacement. Therefore real-time slope monitoring may potentially play an important role in landslide warning and prevention. An automated integrated slope monitoring and warning system has been developed by the authors in Hong Kong. The integrated system consists of (a) a conventional slope monitoring-warning package and (b) a multi-antenna Global Positioning System (GPS) package. The conventional package includes (i) in-place inclinometers, (ii) piezometers, (iii) rain gauges and (iv) a Time Domain Reflectometer (TDR). The multi-antenna GPS package is a special technology newly developed for monitoring surface movements of a slope. The integrated system has a remote data acquisition/control unit connecting an office computer to a data-logger at the site for both the conventional package and the GPS package separately for data communication and control with visual software. In this approach, the two packages can work jointly or independently to monitor a slope. When working together, the two packages are set up at the same slope site and used to collect data of sub-surface ground movements, pore water pressures, rain falls, surface ground movements. The data from the two packages are then transferred to the same office computer, processed and analyzed together. The integrated data can be automatically retrieved, temporarily stored and transmitted from the two packages. Software can perform data download, storage, analysis and real-time display. All data from the two packages are integrated and analyzed using a database developed by the authors. The integrated system was installed at and used to monitor a full-scale test loose fill slope site at The Kadoorie Agriculture Research Centre, Hong Kong from April 2002 to November 2002. The slope was loaded to failure. The system monitored the entire slope loading and failure process and collected valuable data. The analysis of data has shown that the integrated system is reliable, accurate and effective for monitoring slope movements and warning of any potential slope failure.