Using IT to enhance slope safety

CIVIL ENGINEERING DEPARTMENT

Sunday, June 18, 1972 was a black day for Hong Kong. News broadcasts were loaded with heart-breaking scenes of families crying and screaming in anguish. The territory seemed to be covered in a black veil of grief.

That day, a 40-metre-high road embankment collapsed on Sau Mau Ping Estate in Kowloon and took away 71 lives. The catastrophe caused by a downpour of 232mm of rain did not end there. A few hours later, a hillside above a steep temporary excavation site below Po Shan Road, Mid-Levels on Hong Kong Island collapsed, triggering another fatal landslide that demolished a 12-storey building. Another 67 lives were lost.

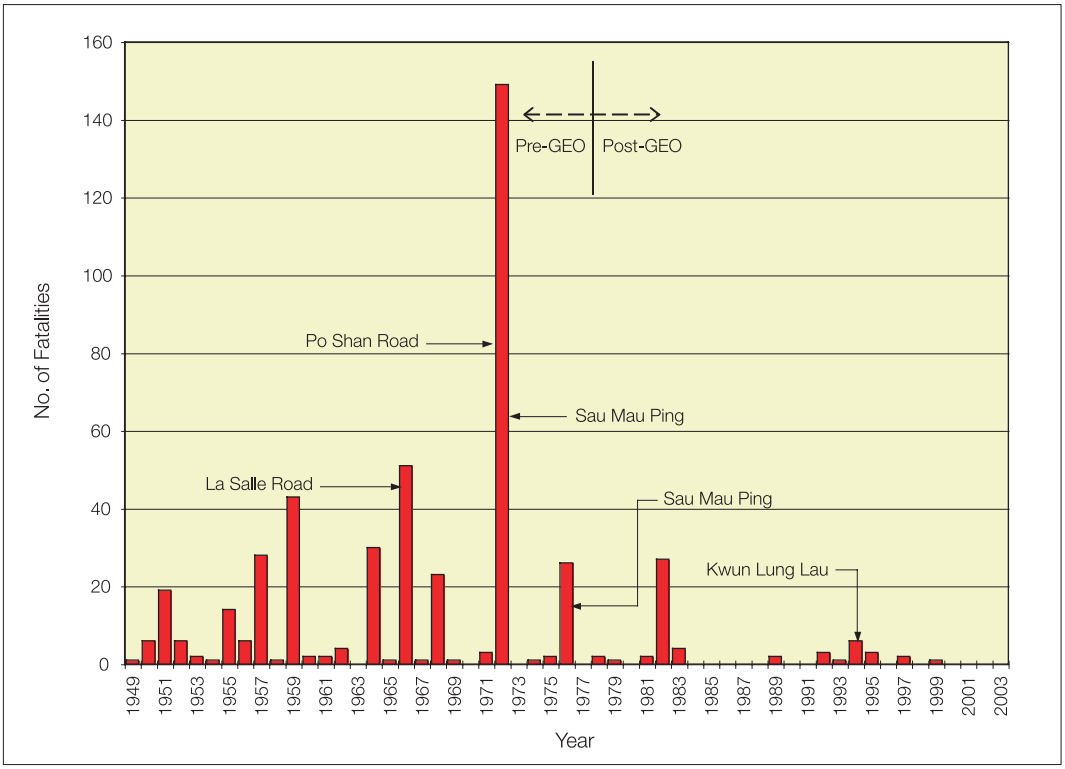
Two tragic landslides occurred on June 18, 1972 leaving 138 dead.

Landslide risk reduced by half

In August 1976, another fill embankment at Sau Mau Ping failed and killed 18 of the residents in the housing block below. Consequently, the government formed the Geotechnical Control Office under the then Public Works Department (renamed the Geotechnical Engineering Office (GEO) under the Civil Engineering Department (CED) in 1991) to enhance slope safety in Hong Kong. This shows the government's ongoing commitment to end the history of tragic landslides that has claimed 470 lives in 50 years.

The GEO has been hard at work implementing measures to ensure Hong Kong's slope safety. It is continually making improvements and meeting new challenges. Over time, a comprehensive slope safety system has evolved. This includes setting world-class geotechnical standards, checking new engineering works, identifying and upgrading old substandard slopes, assessing the need for rehousing squatters on steep hillsides, ensuring that all slopes are regularly maintained, operating a Landslip Warning system in collaboration with the Hong Kong Observatory, and educating the public on slope safety issues. The reduction in landslide problems over the years shows that the government's investment in slope safety is bearing fruit.

Risk-assessment calculations indicate that the overall landslide risk arising from old substandard man-made slopes has been reduced to about 50% of the risk that existed in 1977. The demanding, but achievable, objective is to further reduce the landslide risk from old man-made slopes to below 25% of the 1977 level by 2010. However, steep hillside covers over 60% of the total land area of Hong Kong. This topographical characteristic, coupled with the intensive torrential rainfall and dense development close to steep hillsides, means that landslide risk in Hong Kong can never be reduced to zero and the community must remain vigilant against the potential landslide risk.



Known landslide fatalities in Hong Kong.

Worldwide recognition of Hong Kong's Slope Information System

Prevention begins with information. The GEO's work in improving slope safety in Hong Kong is greatly enhanced by the use of information technology to collect and disseminate slope information. This includes its Hong Kong Slope Safety website, which hosts the Slope Information System.

Containing catalogued information on 57,000 sizeable man-made slopes and retaining walls in Hong Kong, including digital images, the computerised system provides engineers as well as the general public with useful and updated technical slope information through the website (http://hkss.ced.gov.hk). This is one of the largest and most comprehensive databases of its kind in the world and is highly regarded by geotechnical practitioners and natural-hazard managers worldwide.

The world-acclaimed "Geospatial Achievement Award".

In 2003, the system was awarded the "Geospatial Achievement Award – Certificate of Merit" by the Intergraph Corporation, a worldwide leader in Mapping and Geospatial Solutions. The award recognises the GEO's extraordinary contribution to

the application and implementation of geospatial technology and solutions for dissemination of slope information online.

The Head of the Geotechnical Engineering Office, Mr Raymond Chan Kin-sek, said: "We aim to provide a transparent system that is completely accessible to the public. The slope information system illustrates this spirit well. Other examples include the layman's guides, "Slope Maintenance" and "Landscape Treatment of Man-made Slopes and Retaining Walls". These are also available free of charge.

"The bilingual Slope Information System is user-friendly. The public can make searches using a number of criteria, including building names, street addresses and slope numbers.

"Last year, we upgraded the system and launched the 'Slope Safety Island' presenting slope information with loads of graphics, pictures and videos. There is also a teach-yourself course – 'Slope Safety College' – on slope maintenance. We also make instant announcements on precautionary measures while Landslip Warnings are in force, Mr Chan said.

"We understand that no matter how well we do our job, the landslide risk reduction could not be effectively achieved without public support. There are 18,000 private slopes, about one-third of the total, which need the private owners' co-operation in maintaining safety. Slope owners' participation is vital in the prevention of landslide disasters.

"The vigilance of the general public is equally important in helping to reduce the risks. Alert residents and workers can take precautions to protect themselves and their families from landslide risks when the Landslip Warnings are in force."

Annual surveys have been conducted since 1997 to gauge public awareness of slope safety. The results show that both public awareness of Landslip Warnings and public understanding of owners' maintenance responsibilities had been increasing up to 2002. A drop in awareness was registered in 2003, probably as a result of the recent quiet years leading to less vigilance in the community. This is the next challenge facing the GEO.

"We have done a lot of solid work in our Landslip Preventive Measures Programme," Mr Chan said. "Each year, the GEO spends about $870 million to upgrade the old substandard government slopes under the programme. In 2003, upgrading works on 260 government slopes and safety screening of 320 private slopes were completed."

Mr Chan also noted that every year, the seven departments involved in building and infrastructure works spend about $600 million to maintain all government slopes. "Poorly maintained slopes may deteriorate to a point where they may become dangerous and fail during heavy rain. Regular maintenance costs much less than repairing a failed slope, and casualties can be avoided," he said.

To achieve landslide risk reduction and ensure long-term safety, the department also reviews the adequacy of the design and construction of all geotechnical works by the private sector, public authorities and government departments. In 2003, it checked almost 14,000 geotechnical design proposals and inspected over 2,900 active construction sites.

Since the mid-eighties, the government has rehoused over 74,800 squatters living in flimsy structures on steep hillsides. This has been most effective in reducing landslide fatalities in squatter areas.

Advanced geotechnical equipment world-acclaimed

Hong Kong's subtropical climate, heavy seasonal rain and steep hilly terrain make the territory prone to risk from landslides. Apart from public education and technical enforcement work, landslide risk assessment also plays a vital role in preventing the occurrence of disasters.

To facilitate engineering fieldwork, the department developed a groundbreaking "mobile mapping" application system for assessing Hong Kong's hillsides. The mobile system involves the innovative integration of state-of-the-art mobile computing technologies, wireless telecommunication technologies, Global Positioning System (GPS), and mobile Geographical Information System (GIS) into a handheld package.

Advanced technology allows for efficient field work.

Using a pocket personal computer and mobile phone technologies, data in GIS, GPS and communication with the office can be integrated. The system allows engineers and geologists from the GEO to navigate digitally in real time in the field, even in remote areas in the New Territories and outlying islands, thus allowing them to work faster and with a degree of accuracy not possible before. This is particularly useful in decision-making relating to public safety, especially under emergency situations such as in the case of a serious landslide.

The world-acclaimed "Special Achievement in GIS Award".

The Civil Engineering Department, chosen from more than 100,000 organisations, was honoured for its innovative use of GIS technology. It was awarded the "Special Achievement in GIS Award" in 2002 by the Environmental Systems Research Institute, the world leader in GIS software.

Moreover, the Slope Safety System developed by the GEO has drawn the world's attention. More than 30 delegations from places such as Mainland China, Malaysia, Japan, Canada, Germany, Italy, and the United States have visited the department since 2000.

Mr Chan said that this kind of experience sharing was essential for the department to excel. "Our achievements in landslide risk management are highly regarded by the international geotechnical community.

"We also contribute to international forums, through participation in conferences and serving on technical committees. For example, a member of our GEO staff has been invited to serve as one of the five core members of the Technical Committee on risk assessment and risk management of the prestigious International Society of Soil Mechanics and Geotechnical Engineering."