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Landslide Studies by the Geotechnical Engineering Office

Key Message: Systematic studies of landslides by the GEO improve the understanding of slope failures in Hong Kong, provide new ideas for reducing landslide risk and innovative design of slopes, and assist in the Government's Landslip Prevention and Mitigation Programme (LPMitP) by identifying areas for improved practice in slope design, construction and maintenance.

Introduction

Since the early 1980s, the Geotechnical Engineering Office (GEO) has been collecting data and conducting annual reviews of rainfall and landslides in Hong Kong. Landslides were selected for detailed study, on the basis either of their serious nature or for purposes of advancing the understanding of landslides in Hong Kong.

Professor N R Morgenstern of the University of Alberta was engaged by the Government to carry out an independent review of the 23 July 1994 Kwun Lung Lau landslide. One of Professor Morgenstern's recommendations was for the Government to supplement its Landslip Preventive Measures (LPM) Programme by a process that involves a more integrated stability assessment through review of landslides. A landslide investigation (LI) methodology was subsequently developed, which was tested in a three-year trial implementation from 1996 to 1999 and was found to be useful. Starting from 2000, landslide investigation work has become part of the LPM Programme to make the best use of the investigation results and supplement the conventional, catalogue-based slope stability assessment process. LI continues to form an integral part of the LPMitP, which was launched in 2010 to dovetail with the LPM Programme upon its completion in that year.

Benefits and Arrangement of Landslide Studies

The benefits of systematic landslide studies include:

(i) identification of slopes in need of early attention under the LPMitP and review of earlier studies,

(ii) provision of forensic evidence in cases of landslides that may involve coroner's inquest, legal action or financial dispute,

(iii) provision of data for reviewing the performance of Government's slope safety system and identifying areas for improvement, and

(iv) improvement in knowledge on the causes and mechanisms of landslides in Hong Kong so as to formulate new ideas for reducing landslide risk and enhancing the reliability of landslide preventive/remedial works.

On average, about 300 landslides are reported to the GEO every year. All landslides reported

to the GEO are examined and screened in order to identify cases that warrant follow-up study. Worthy cases are studied in detail to document the failure and relevant background information, establish the probable causes, and identify the necessary follow-up actions, for example, arranging out-of-turn investigations and any necessary upgrading works at the landslide site and any adjoining areas with instability problems.

There are dedicated resources in the GEO (i.e. Landslip Preventive Measures Division 2) to coordinate the work on landslide investigations. The Landslip Preventive Measures Division 2 carries out an overall diagnosis of the landslide data and findings from landslide studies yearly to consolidate experience and make recommendations to enhance slope engineering practice in Hong Kong.

The GEO continues to undertake in-house investigations of selected landslides. For example, investigation of significant landslides may be carried out by the Landslip Preventive Measures Division 2 or the Planning and Development Division. Input to landslide investigations is also provided by the Hong Kong Geological Survey through provision of specialist geological advice and by the Materials and Testing Division through provision of ground investigation and laboratory testing services. However, in-house resources are insufficient to study all the slope failures and assistance from consultants is needed. The use of consultants also provides a mechanism for external independent review.

Two consultants have been engaged to assist in landslide investigations, with one covering Hong Kong Island and outlying islands and another covering Kowloon and the New Territories. Both consultants can mobilise large teams of experienced and dedicated geotechnical engineers who are on standby round the clock. The investigation teams can also be backed up by overseas landslide experts where necessary. For cases involving conflict of interest by the LI consultants concerned, provisions have been made in the consultancy agreements for the other term LI consultants to carry out the investigation.

Output of Landslide Studies

Over the years, the GEO has undertaken detailed landslide studies and forensic investigations using in-house teams. Completed forensic investigations include the fatal landslides at Baguio Villa and Kennedy Road on 8 May 1992, the fatal landslide at Cheung Shan Estate on 16 June 1993, the fatal landslide at Kwun Lung Lau on 23 July 1994, the fatal landslide at Castle Peak Road on 7 August 1994, and the fatal landslides at Fei Tsui Road and Shum Wan Road on 13 August 1995. Detailed landslide studies with public interest include the Shatin Heights landslide on 20 August 2005, the Ting Kok Road landslide in June 2008, and the Tai Shek Kwu landslide in May 2022.

Notable examples of work completed under the LI consultancies to date include about 1 650 landslide inspections (out of more than 6 900 records examined), about 260 detailed landslide studies, and 11 forensic investigations, including the fatal landslides at Kau Wa Keng and Ten Thousand Buddhas' Monastery on 4 June 1997 and 2 July 1997 respectively, the Ching Cheung Road landslide on 3 August 1997, the fatal debris flow at Sham Tseng San Tsuen on 23 August 1999, the Shek Kip Mei landslide on 25 August 1999, the fatal landslides at Fu Yung Shan Tsuen and Cafeteria Old Beach on 20 August 2005 and 7 June 2008 respectively, and the two Sau Mau Ping landslides on 22 May 2013. Other detailed landslide studies with public interest include the Sai Kung Sai Wan Road landslide on 21 May 2016, the Yiu Hing

Road landslides on 8 September 2023 and the Shek O Road landslides on 8 and 14 September 2023.

The GEO, with the assistance of the LI consultants, has carried out several major reviews of batches of old slopes of potential concern, detailed mapping of natural terrain landslides with long runout, assessment of residual risk for significant natural terrain landslides to facilitate review of the adequacy of the urgent mitigation measures, annual diagnostic reviews of landslides since 1997, compilation of landslide statistics, and updating of the landslide database within the GEO's Slope Information System and the Enhanced Natural Terrain Landslide Inventory.

Examples of technical and system improvements arising from landslide studies in recent years include input to the drafting of the GEO Publication No. 1/2007 – Engineering Geological Practice in Hong Kong, improved guidelines for the GEO Emergency Manual on landslide inspections, and promulgation of lessons learnt to enhance the slope engineering practice through GEO Technical Guidance Notes. Areas of improved technical knowledge on landslide prevention and mitigation include slope deformation prior to landsliding, mobility of landslide debris, debris-barrier interaction, mechanisms of natural terrain landslides, the potential impact of climate change and extreme rainfall on landsliding, and effective landslide mitigation measures.

Most reports on forensic investigations have been published and made available to the geotechnical profession. The detailed landslide investigations are documented in a series of Landslide Study Reports (LSR) and Special Project Reports (SPR). Up to the end of December 2024, 193 LSR and 38 SPR on landslide investigations have been issued. Most of these are lodged in the Civil Engineering Library and are accessible to the general public. To further promulgate the study findings, selected study reports have been made available in a series of publications termed the GEO Reports series, which can be downloaded from the CEDD website (https://www.cedd.gov.hk).

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